ILL Document Delivery

REG-14449903

CLXHKH

NLM -- W1 JO602VR (Gen)

Universidad de Chile
Biblioteca Central Facultad de Medicina
Independencia 1027
Santiago 8380453
CHILE

ATTN:		SUBMITTED:	2008-07-04 13:37:52
PHONE:	011-56-2-978-6125	PRINTED:	2008-07-07 11:30:56
FAX:	011-56-2-978-6100	REQUEST NO.:	REG-14449903
E-MAIL:	papers@med.uchile.cl	SENT VIA:	DOCLINE
		DOCLINE NO.:	25174689

REG | Copy | Journal | NEED BEFORE: 2008-07-10

TITLE:	JOURNAL OF CRANIOMANDIBULAR DISORDERS : FACIAL & ORAL PAIN
PUBLISHER/PLACE:	Quintessence Publishing Lombard Il
VOLUME/ISSUE/PAGES:	1992 Fall;6(4):301-55 301-55
DATE:	1992
AUTHOR OF ARTICLE:	Dworkin SF;LeResche L
TITLE OF ARTICLE:	RESEARCH DIAGNOSTIC CRITERIA FOR TEMPOROMANDIBULAR
ISSN:	0890-2739
OTHER NUMBERS/LETTERS:	Unique ID.: 8709733 25174689 1298767
SOURCE:	PubMed
COPYRIGHT COMP.:	Guidelines
CALL NUMBER:	W1 JO602VR (Gen)
NOTES:	veru urgent
DELIVERY:	E-mail: papers@med.uchile.cl
REPLY:	Mail:

KEEP THIS RECEIPT TO RECONCILE WITH BILLING STATEMENT
For problems or questions, contact NLM at http://wwwcf.nlm.nih.gov/ill/ill_web_form.cfm or phone 301-496-5511.
Include LIBID and request number.

RESEARCH DIAGNOSTIC CRITERIA FOR TEMPOROMANDIBULAR DISORDERS:

Review, Criteria, Examinations and Specifications, Critique

Edited by: Samuel F. Dworkin, DDS, PhD
Linda LeResche, ScD

Contributors

Samuel F. Dworkin, DDS, PhD
James R. Fricton, DDS, MS
Lars Hollender, DDS, Odont Dr
Kimberly H. Huggins, RDH, BS
Linda LeResche, ScD
James Lund, BDS, PhD
Norman D. Mohl, DDS, PhD
Richard Ohrbach, DDS, MS
Sandro F. Palla, Dr Med Dent
Earl E. Sommers, DDS, MSD
Christian Stohler, LDS, Dr Med Dent
Edmond L. Truelove, DDS, MSD
Michael Von Korff, ScD
Charles G. Widmer, DDS, MS

Approach to the Problem

Editor:
Samuel F. Dworkin, DDS, PhD
Professor
Department of Oral Medicine
University of Washington
Seattle, Washington

A critical obstacle to our further understanding of temporomandibular disorders (TMD) is the lack of standardized diagnostic criteria for defining clinical subtypes of TMD. A project to create research diagnostic criteria was undertaken to redress this lack. The project efforts yielded a set of research diagnostic criteria for TMD, labeled "RDC/TMD," which are offered to allow standardization and replication of research into the most common forms of muscle- and joint-related TMD.

Research into the causes and treatments for TMD requires that reliable and valid diagnostic criteria be available to: (a) generate case definitions that are reproducible among clinicians and researchers; (b) identify and evaluate etiologic, preventive, and risk factors, as well as associated characteristics that initiate, prevent, maintain or exacerbate the disorder; (c) allow prognostic studies of natural history and clinical course; and (d) establish treatment efficacy.

While it is agreed that diagnostic schemes of known reliability and validity currently do not exist for TMD, there does exist an abundant clinical literature describing constellations of signs and symptoms relevant to TMD.[1-5] However, these signs and symptoms have not yet been organized into reliable diagnostic classification systems and are not useful for research because they are not described using measurable (ie, quantitative) criteria.

The most important, almost universal, feature of TMD is chronic pain. Persistent orofacial pain is the overwhelming reason people seek TMD treatment. Tenderness of the muscles of mastication and the temporomandibular joint (TMJ) in response to palpation is also frequently reported. Restricted range of mandibular motion and several types of joint sounds elicited by mandibular excursions are clinical findings presumed central to certain types of TMD.

There is agreement in the clinical literature that these clinical signs and symptoms of TMD can be clustered into muscle disorders, intracapsular derangements of the components of the TMJ, and degenerative (eg, arthritic) changes to the bony components of the joint itself. However, there is no clear evidence (a) that when patients are examined by different clinicians, consistent groupings of patients can be identified; (b) whether more than one subtype of TMD can occur in a particular patient, or whether certain diagnostic combinations are mutually exclusive; and (c) whether all or any of the subtypes of TMD reflect valid pathophysiologic syndromes with long-term consequences for illness and dysfunction, or simply reflect self-limiting symptom states that cycle on and off in nonsystematic fashion.

Chronic pain conditions (eg, headache and back pain) are known to involve psychologic, behavioral, and social factors in addition to physical pathology. The management of chronic pain in most pain centers includes an emphasis on these biobehavioral components of the chronic pain problem. There seems to be widespread agreement that stress, depression, disability, and dysfunctional illness behaviors are critical aspects of the TMD patient's profile. Nevertheless, only minimal attention has been paid to classification of these behavioral factors as an aid to more detailed

understanding of the condition or to guide clinical management and evaluation of physical and psychosocial long-term outcomes.

Empirical data used to develop the RDC/TMD came from longitudinal epidemiologic research, supported by the National Institute for Dental Research (NIDR) and conducted at the University of Washington and Group Health Cooperative of Puget Sound, Seattle, Washington (Grant Nos. R01DE07197 and P05DE08773, Samuel F. Dworkin, principal investigator, and M. Von Korff and L. LeResche, co-principal investigators).

Perspectives on Approaching the Problem

The resulting TMD diagnostic system is offered for research purposes and is, of necessity, based more on a description of observable findings that appear to cluster together than on underlying etiologic mechanisms. We wish to emphasize the research nature of these RDC/TMD and view them as a useful first step toward putting the diagnosis of TMD on a more rational, scientific basis.

Scope of the Research Project. The RDC/TMD offered in this report deal only with the most common forms of TMD as they manifest themselves in adults. The scope of the project thus encompasses those TMD conditions for which there was information of sufficient reliability and validity to develop working case definitions using the physical examination and interview procedures described below. The project focused on the most common muscle- and TMJ-related forms of TMD, deliberately excluding related disorders that occur infrequently and for which there is even less agreement on reliable and valid methods for identifying and defining cases. Even for the more common forms of TMD, analyses have revealed that modest disagreements in diagnostic criteria could change the TMD diagnostic category assigned to a significant number of individuals.[6] Some of the less common conditions excluded from present consideration include ankylosis, aplasia or hyperplasia, contracture or hypertrophy, neoplasms, etc. Similarly, due to limited resources, it was not possible to evaluate examination methods and procedures and standardized questionnaires originally developed for adults for their possible generalizability to children and adolescents. The methods used to derive these RDC/TMD, taken together, allow them to represent an advance over what is currently available:

1. *An interdisciplinary effort:* The RDC/TMD represent the working agreement of a team of recognized researchers in the field whose areas of interest and expertise range from basic biologic sciences to clinical dental and biobehavioral sciences.
2. *Operational definition of terms:* The RDC/TMD are stated in operational, or measurable, terms to maximize reproducibility among investigators, hence facilitating their adoption for research and allowing comparison of results among researchers through the use of a common set of measurement criteria.
3. *Use of epidemiologic data:* Epidemiologic data were used to guide the selection and operationalization of these RDC/TMD.
4. *Specification of examination methods:* Detailed examination specifications are provided to allow clinical data associated with each RDC/TMD criterion to be gathered through standardized TMD clinical examination and interview methods.
5. *Reliability of measurement:* The reliability of clinical methods and measures was established and served as the basis for selecting specific clinical measurement methods.
6. *Dual axis system:* The two-axis approach taken allows physical diagnosis, placed on one axis, to be coordinated with operationalized assessment of psychological distress and psychosocial dysfunction associated with chronic TMD pain and orofacial disability, placed on a second axis.

The problem of establishing reliable and valid diagnostic and classification systems is, of course, not limited to TMD. The diagnosis and classification of spinal disorders, rheumatic diseases, and headache all involve grappling with chronic pain as a central characteristic and all share many other clinical, pathophysiologic, and behavioral features with TMD. Each of these major illness conditions has long been associated with a continuing struggle to evolve generally agreed upon approaches for diagnosing the multiple manifestations, or subtypes, of those disease conditions. Of particular relevance to TMD have been systematic efforts to evaluate the current status of research into diagnosing and managing rheumatic disease,[7] the creation of a Quebec Task Force on Spinal Disorders to define criteria or standards for methods of investigation and diagnosis of disorders of the spine,[8] and efforts to develop an internationally acceptable system for diagnosing and classifying headache disorders, cranial neuralgias, and facial pain.[9] Each of these ongoing efforts is concerned with a major public health problem, and the approaches taken are characterized by reliance on multidisciplinary teams and task forces comprising public health agencies; the private sector; and scientists from the biologic, clinical, behavioral, and health services research arenas. Moreover, these endeavors use epidemiologic data wherever possible and strive to formulate criteria and definitions that are stated in terms that lend themselves to scientific measurement.

Accordingly, the methods used to develop the RDC/TMD included, wherever possible, reliance on published analyses and data of known reliability to support decisions concerning specific criteria.[2,10–12]

With regard to the use of a multiaxial system, the RDC/TMD project was again influenced by important similar efforts in related fields. The major impetus for the approach taken in RDC/TMD, which uses two

axes, comes from perspectives on the complex and multidimensional nature of chronic pain as it is currently understood. Consistent with this understanding, the RDC/TMD project approached TMD as a chronic pain condition and not as a problem that requires assessment of only physical pathology. This view of pain, especially chronic pain, as essentially multidimensional in character is reflected in the diagnostic classification system designed by the International Association for the Study of Pain (IASP). The IASP classification system[13] employs five axes to capture the anatomic region or site of pain (Axis I); the organ system in which pathology might be located, including psychological and social components grouped under the nervous system (Axis II); the temporal characteristics and patterns of pain occurrence (Axis III); the patient's self-report of pain intensity and chronicity (Axis IV); and etiology, including psychophysiologic dysfunction and psychological origins as well as physical etiologies such as trauma, inflammation, and genetic influences (Axis V).

Two of the most relevant aspects of the IASP approach to classifying pain are (1) that conditions yielding persistent pain are too complex to be adequately diagnosed using a single axis and (2) the usefulness of incorporating psychological and behavioral factors into the classification system. In a similar vein, the Diagnostic and Statistical Manual III-R (DSM-III-R), the formal classification system of the American Psychiatric Association for diagnosing mental disorders,[14] also employs five axes, using two axes for classifying primary mental and personality disorders (Axes I and II) while reserving separate axes to reflect physical status (Axis III) and levels of psychosocial function (Axes IV and V).

Many workers, especially Fordyce[15] and Turk, Rudy, and colleagues[16,17] have demonstrated that the psychological and behavioral dysfunctional consequences of chronic pain cut across specific disease conditions or pain associated with specific anatomic sites. Turk and colleagues,[16,18] using a multiaxial assessment approach, have demonstrated that chronic pain patients may be usefully classified into subtypes including adaptive copers, those who are interpersonally distressed and, finally, those who are psychosocially dysfunctional. Such subtypes of patients emerge independent of the nature of the chronic pain condition and have been demonstrated for pain conditions as diverse as low back pain and TMD.

The RDC/TMD project, reflecting the complex interaction between physical and psychological dimensions of persistent pain, has evolved its dual-axis approach as an initial attempt to allow reliable measurement of physical findings (RDC/TMD Axis I) and reliable assessment of psychosocial status, yielding a profile of chronic pain dysfunction, depression, anxiety, and preoccupation with other physical symptoms (RDC/TMD Axis II). In addition, because of widespread interest in outcomes of TMD, RDC/TMD Axis II also includes an assessment of limitations in normal ability to use the jaw. It is important to reemphasize that the present multiaxial approach is consistent with current thinking while it simultaneously introduces some measures and measurement methods new to TMD. Part IIB provides a fuller description of the rationale, derivation, and use of Axis II measures and methods.

The RDC/TMD effort was divided into four components. Each component was assigned an editor/coordinator who worked with a team of major contributors. These components form successive sections of this report and are outlined as follows:

I. Review of the Literature
   A. *Current Diagnostic Systems:* A review of the available (ie, published) diagnostic systems for classifying the major subtypes of TMD, selected for review on the basis of their importance to the field and their comprehensiveness.
   B. *Reliability and Validation of Examination Methods:* A review of available examination methods, using review criteria to evaluate the suitability of samples studied, measurement methods used, level of data analysis, reliability and validity assessment, and generalizability of findings.

II. Research Diagnostic Criteria
   A. *Axis I:* A set of operationalized research diagnostic criteria for use in investigations of masticatory muscle pain, disc displacements, and degenerative diseases of the TMJ.
   B. *Axis II:* A set of operational research diagnostic criteria to assess chronic pain dysfunction, depression, nonspecific physical symptoms, and orofacial disability.

III. Examination and History Data Collection
   A set of examination and history forms, together with specifications for conducting a standardized TMD examination for gathering measurements required for each of the research diagnostic criteria.

IV. Review and Commentary
   Independent evaluations of the RDC from biologic science and clinical sciences perspectives, discussing the need for reliable and valid diagnostic criteria for TMD, emphasizing strengths and weaknesses of the approach taken in the present RDC project and implications and recommendations for future research.

We anticipate, indeed welcome, the further refinement and revision of these research diagnostic criteria and examination methods, through research aimed at evaluating their reliability and validity. Provision of a reliable and valid RDC/TMD system is necessary to describe and evaluate the prevalence and incidence of TMD, and its natural history and clinical course, as well as to evaluate risk factors and associated

conditions that foster the onset and/or exacerbation of TMD. Only with agreed upon diagnostic criteria, derived from clinical data gathered with standardized clinical procedures, will we eventually be able to establish methods for the prevention of TMD pain and dysfunction, and where prevention is not possible, to establish a scientific basis for making rational choices among available TMD treatments.

Resolution of Controversial Issues: Implications for Future Research

Given the acknowledged complexities surrounding the diagnosis and management of TMD, it was inevitable, indeed fully expected, that differences would emerge among RDC/TMD project members in preferred approaches to the evaluation of patients and the establishment of a TMD diagnosis. Two perspectives regarding present purposes and future implications were consistently invoked to facilitate resolution of controversial issues. First, the prime objective was to develop a set of RDC/TMD for research purposes that reflected the best available scientific information and that, of necessity, would require continued scientific review and validation. Hence, these RDC/TMD were not perceived as constraints or requirements which might limit clinical practice or even dictate research protocols beyond the expectation that use of the RDC/TMD would profoundly enhance communication of findings among clinical researchers. Since these RDC/TMD were understood to be primarily research oriented and are offered as a present-day approximation to a diagnostic system for TMD requiring scientific validation, equally critical was the second perspective, that the consensus was developed among project members to identify unresolvable problems as issues requiring future research.

Thus, the process of developing these RDC/TMD also yielded an additional highly valuable by-product—a set of identifiable issues that have immediate implications for research because they are critical to the formulation of reliable and valid diagnoses for TMD. The research issues identified in this manner ranged from broad questions, reflecting controversy over etiology or classification, to narrower issues concerning TMD examination methods and procedures. In addition to the need for further research identified in the process of evolving these RDC/TMD, we asked the two external reviewers to also give special emphasis in their review and commentary to the research implications of these RDC/TMD. Some of the most important research issues uncovered are summarized as follows:

1. Scope of RDC/TMD: Can the RDC/TMD be generalized to allow use with children, adolescents, and the elderly, or do examination methods and diagnostic criteria specific to these groups need to be developed? Similarly, are the present RDC/TMD and associated examination methods generalizable cross-nationally and cross-culturally?

2. Multiple diagnoses: Can the proposed use of multiple diagnoses, presently necessary if TMD clinic populations are to be usefully classified, be more carefully validated as more is learned about the etiology and exacerbation of TMD? Does allowing multiple diagnoses lead to more rational decision making concerning long- and short-term management?

3. Multiple axes: Does the use of multiple axes to classify TMD patients yield a consistent and valid method for classifying TMD patients and predicting clinical outcomes?

4. Distinguishing related conditions: Can reliable and valid distinctions be identified that operationally distinguish conditions not currently included in the RDC/TMD, such as myositis, muscle spasm, contracture, hyperplasia, etc, so as to improve diagnostic accuracy?

5. Sensitivity and specificity: Statistical issues, including the validity of cutoff scores used, especially cutoffs suggested for sensitivity, specificity, and the use of positive predictive values, need to be researched. Consideration should be given to the need for distinguishing statistical cutoff criteria for studies that focus on detecting specific diagnoses in a clinical setting versus population-based screening studies.

6. Imaging: Which methods and formats for imaging the TMJ most effectively increase diagnostic reliability and validity? Are certain methods (eg, plane films, arthrography, MRI) better suited to distinguish among subtypes of TMD?

7. Muscle palpations: The determination of pain and tenderness in response to intraoral palpation does not generally meet acceptable levels of reliability. Would it be useful to eliminate intraoral palpations from data gathered to form a TMD diagnosis? Similarly, the reliability, validity, and hence the diagnostic utility of identifying taut muscle bands or specific trigger points in the masticatory and related musculature has not been established for TMD. Is it possible to establish reliable and valid methods for identifying taut bands and trigger points in these muscles, and would the ability to identify these clinical features reliably improve the diagnosis and treatment of TMD?

8. Disc displacements: Would consideration of temporal factors and range of motion variables increase the reliability and validity of diagnoses involving disc displacement, for example, helping to better distinguish "IIb—disc displacement without reduction, with limited opening," from "IIc—disc displacement without reduction, without limited opening"?

9. Determination of joint sounds: Are joint sounds more reliably determined when both subject and examiner must agree on the presence of a joint sound, or can assessment of joint sounds depend reliably on being detected by only one of these sources? Is the

presence of certain sounds on two of three trials, as presently required with the RDC/TMD, the most reliable method available for determining presence of joint sounds?

10. Examination methods: To what extent does variation in examination procedures and methods influence the type of TMD data gathered? Specifically, are clinical findings significantly different depending on whether the subject is sitting upright or fully reclined? Are muscle palpations most reliably conducted using one versus two fingers; the tips of the fingers versus the finger pads; 1, 2, or 3 pounds of pressure? Is pressure algometry a more reliable method for assessing muscle pain and tenderness?

Using the RDC/TMD

The RDC/TMD are intended primarily for research purposes, allowing standardized methods for gathering relevant data and making possible comparison of findings among diverse clinical investigators. The RDC/TMD may be used by themselves, using the examination and questionnaire as a complete data base upon which to formulate research diagnoses and characterize research subjects or patients. RDC/TMD materials may also be incorporated into broader research or clinical protocols so that the data gathered using RDC/TMD forms a subset of a more extensive data base gathered on research or clinic populations. In the latter case, of course, comparisons across investigators would only be possible for those portions of the clinical data that were gathered across research settings using the common methods of the RDC/TMD. Thus, there is no reason to view the RDC/TMD as limiting the scope or method of inquiry for a particular investigator or study.

To allow the most meaningful use of RDC/TMD and to enhance clarity of communications among clinical investigators, we strongly recommend that reports using the RDC/TMD include the following information (see "Summary of Findings," p 345).

1. *Demographics of the study population:* Age, gender, ethnicity, race, education level, marital status, income level.
2. *Patient characteristics:* Variables that describe clinically important characteristics of the population being reported, although they do not enter directly into the determination of an Axis I or Axis II classification. These patient characteristics include self-reported oral habits and other possible risk factors and temporal patterns of TMD signs and symptoms.
3. *Axis I diagnosis:* Multiple diagnoses are allowed, with the following limitations: a maximum of one muscle disorder related diagnosis; a maximum of one disc displacement–related diagnosis per joint; and a maximum of one diagnosis per joint from the arthralgia/arthritis/arthrosis category of joint disorders.
4. *Axis II profile:* Graded chronic pain status, depression scores, nonspecific physical symptoms score, and summary score for limitations in ability to use the jaw.

Finally, we reemphasize our awareness that much research, especially longitudinal and outcome research, is needed before we can fully understand the clinical and personal complexities associated with TMD and before we can better interpret the impact of treatment.

References

1. Truelove EL, Epstein J, Schubert MM, Grushka M: Pain and behavior: Review of the Literature, in Millard HD, Mason DK (eds): *World Workshop on Oral Medicine.* Chicago, Year Book Medical Publishers, 1988.
2. Dworkin SF, Huggins KH, LeResche L, Von Korff M, Howard J, Truelove EL, Sommers E: Epidemiology of signs and symptoms in temporomandibular disorders: Clinical signs in cases and controls. *J Am Dent Assoc* 1990;120:273–281.
3. Fricton J: Recent advances in temporomandibular disorders and orofacial pain. *J Am Dent Assoc* 1991;122:24–33.
4. Rugh JD, Solberg WK: Oral health status in the United States: Temporomandibular disorders. *J Dent Educ* 1985;49:398–405.
5. Greene CS, Marbach JJ: Epidemiologic studies of mandibular dysfunction. *J Prosthet Dent* 1982;49:184–190.
6. LeResche L, Dworkin SF, Sommers E, Truelove EL: An epidemiologic evaluation of two diagnostic classification schemes for temporomandibular disorders. *J Prosthet Dent* 1991;65:131–137.
7. Ditunno J (ed): Proceedings: Current research and future directions in rehabilitation. *J Rheumatol* 1987;14(suppl 15):1–81.
8. Spitzer WO, LeBlanc FE, Dupuis M: Scientific approach to the assessment and management of activity-related spinal disorders: A monograph for clinicians. Report of the Quebec Task Force on Spinal Disorders. *Spine* 1987;12(suppl 7):S1–S352.
9. Olesen J: Classification and diagnostic criteria for headache disorders, cranial neuralgias and facial pain. *Cephalgia* 1988;8(suppl 7):9–96.
10. Dworkin SF, LeResche L, Derouen T: Reliability of clinical measurement in temporomandibular disorders. *Clin J Pain* 1988;4:89–99.
11. Fricton JR, Kroening RF, Hathaway KW: *TMJ and Craniofacial Pain: Diagnosis and Management.* St Louis, Ishiyaku EuroAmerica, 1988.
12. Von Korff M, Dworkin SF, LeResche L, Kruger A: An epidemiologic comparison of pain complaints. *Pain* 1988;32:173–183.
13. Merskey H: Classification of chronic pain—Descriptions of chronic pain syndromes and definitions of pain terms. *Pain* 1986(suppl 3).
14. Spitzer RL, Williams JB (eds): *Diagnostic and Statistical Manual of Mental Disorders,* ed 3. American Psychiatric Association, Washington DC, DSM-III-R.
15. Fordyce WE: *Behavioral Methods in Chronic Pain and Illness.* St Louis, CV Mosby, 1976.
16. Turk DC, Rudy TE: Toward an empirically derived taxonomy of chronic pain patients: Integration of Psychological Assessment Data. *J Consult Clin Psychol* 1988;56:233–238.
17. Rudy TE, Turk DC, Zaki HS, Curtin HD: An empirical taxometric alternative to traditional classification of temporomandibular disorders. *Pain* 1989;36:311–320.
18. Turk D: Strategies for classifying chronic orofacial pain. *Anesth Prog* 1990;37:155–160.

PART I

Review of the Literature

A: Current Diagnostic Systems

Editors:
Richard Ohrbach, DDS, MS
Department of Behavioral Sciences
State University of New York at Buffalo
Buffalo, New York

Christian Stohler, LDS, Dr Med Dent
Professor
Occlusion and TMJ Clinic
University of Michigan School of Dentistry
Ann Arbor, Michigan

B: Reliability and Validation of Examination Methods

Editor:
Charles G. Widmer, DDS, MS
Associate Professor
Department of Oral and Maxillofacial Surgery
University of Florida
Gainesville, Florida

A. Current Diagnostic Systems

Nine diagnostic systems for classifying TMD have been selected and evaluated. These systems were selected on the basis of having as their purpose the classification of a cohesive group of TMD. Other broad classification systems, such as ICD-10 for diseases in general[1] and the IASP Classification of Chronic Pain for pain conditions,[2] were not considered for review in this paper, in that their purpose is either not oriented toward the type of information (eg, specific diagnostic criteria, operationalized measurement) that we regard as essential in this review, or not oriented toward fine discriminations among the possible TMD.

Disease taxonomies are developed because classifying disease is considered a useful way to enhance understanding of what would otherwise be a confusing array of information. However, a taxonomy is itself a construct or a set of constructs, and, as such, needs to be evaluated according to criteria addressing critical issues such as validity and reliability. That is, a taxonomic system should not be accepted uncritically just because it has been developed and published. For a diagnostic construct to be considered valid, decision making requires information of valid disease descriptors used to support the overall construct. A disease descriptor is regarded as valid if it is frequently found in patients with the disease and rarely observed in subjects without the disease. Valid and accurate constructs for the classification of TMD are needed to advance our understanding of both etiology and treatment. In fact, in the absence of any significant specificity in case definition, it is doubtful whether new knowledge can be gained. The purpose of the present work was (1) to develop criteria for assessing the scientific merit of a classification system, and (2) to determine the performance of the nine systems using these criteria.

Evaluation Criteria for Assessing Diagnostic Systems

The nine taxonomic systems were compared according to a variety of evaluation criteria. Some of these criteria can be applied in the evaluation of any construct or taxonomic system (eg, Fenton et al[3]), while others were developed by the authors. The evaluation criteria are divided into two broad categories involving (a) methodological and (b) clinical issues. See Table 1 for an overview of the criteria.

Table 1 Evaluation Criteria

Criterion	Description	Ratings
Methodological Considerations		
Sample method	Study design for testing diagnostic criteria	Case-series vs case control Cross-sectional vs longitudinal Prospective vs retrospective
Sample type	Source of subjects used in testing diagnostic criteria	Population Clinical Unknown
Research suitability	Whether criteria are stated in measurable terms	Yes No
IRR method	Interrater reliability (IRR) for evaluation methods, according to whether data are provided by the proponents of the system and whether all evaluation methods have IRR support	Internal-full Internal-partial External-full External-partial
Specificity	Whether diagnostic criteria of a system detect "disease" in a nonpatient population	Acceptable Unacceptable Unknown
IRR diagnosis	Interrater reliability (IRR) for whether different judges would make the same diagnostic assignment	Acceptable Unacceptable Unknown
Clinical Considerations		
Biological	Whether the system is compatible with current anatomical, behavioral, and physiological knowledge	Strong Moderate Minimal
Exhaustive	Whether the system can classify all known clinical presentations	All Major Minor
Multiple diagnoses	Whether multiple diagnoses are allowed	Yes No Unknown
Decision making	Whether system is organized to facilitate decision making	Good Poor

Methodological Considerations. This set of criteria are accepted standards for clinical research,[4,5] those selected for use in this review being relevant to the present stage of development of this field.

The study sampling method is the first criterion; it provides a basis for issues surrounding validity of a system. The sampling methods for the various taxonomic systems are classified as "case-series vs case-control," "cross-sectional vs longitudinal," and "prospective vs retrospective." "None" is reported if a study method was not identified.

The second criterion deals with the study sample type, which is classified as either "population-based," "clinic-based" (consecutive or random), or "unknown"; "none" is used when no particular sample was used. Sample type provides a basis for generalizability of the data associated with a system.

The third evaluation criterion was defined as research suitability. It refers to whether the disease descriptors are stated in measurable terms such that an independent investigator could apply them as listed, or with only minimal modification. We have made this assessment for the diagnostic criteria used in the system as a whole, recognizing that there is (a) likely to be considerable variability in the quality of measures within any taxonomic system, and (b) thus, most likely, variability in how other evaluators might apply this criterion to each taxonomic system. We have endeavored to qualify our decision for each system.

The fourth criterion represents interrater reliability (IRR) of the methods for evaluation. Although there is a separate section (Part IIB) focusing on a critical evaluation of many of the methods currently used in patient assessment for TMD, we have evaluated this form of reliability as well, in that a system as a whole must be considered on the basis of the quality of the data likely to be used in making diagnostic decisions. That is, a taxonomic system cannot be considered or evaluated independently of the advocated methods

for data acquisition. The following ratings were employed:

Internal-full—acceptable IRR provided by the advocates of the taxonomic system for all measures used.

Internal-partial—acceptable IRR is provided by the advocates of the taxonomic system for some of the measures used.

External-full—all measures in a system supported by acceptable IRR through research of others.

External-partial—some of the measures in a system supported by acceptable IRR through research of others.

Unknown—the taxonomic system uses measures that have no IRR, or the measures are insufficiently operationalized. We have defined acceptable IRR as a kappa statistic of 0.6 or better.

The fifth criterion deals with specificity, or how well the taxonomic system performs in not assigning "disease" to a nonpatient for conditions assumed to be associated with low prevalence. The ratings are:

Acceptable—specificity ≥ 0.75.

Unacceptable—specificity < 0.75.

Unknown—no data available.

The sixth criterion refers to the interrater reliability of diagnosis. This type of test is performed by having examiners formulate a diagnostic impression based on data acquired either from independent interviews and patient evaluations or from the same interview and patient evaluation data. The two methods assess different aspects of examiner reliability in making a diagnostic assignment and thus are considered complementary. The following ratings were used:

Acceptable—IRR ≥ 0.6 kappa value.

Unacceptable—IRR < 0.6 kappa value.

Unknown—no data are available.

Clinical Considerations. These criteria represent qualitative measures for other essential aspects of a taxonomic system.

The first criterion is biological plausibility, where the taxonomic system is rated on whether it is compatible with current anatomical, physiological, and behavioral knowledge. Ratings include:

Strong—the taxonomic system (as a whole) is compatible with current knowledge.

Moderate—the taxonomic system (as a whole) is generally compatible with current knowledge; however, the taxonomy includes diagnostic entities that are inconsistent with current research findings.

Minimal—the system (as a whole) displays little agreement with current knowledge.

The second criterion describes whether the taxonomic system is exhaustive in classifying all known clinical presentations. Ratings are defined as:

All—the taxonomic system performs as such.

Major—the taxonomic system includes the major clinical types but omits some presentations considered important.

Minor—the system omits major presentations.

The third criterion is whether multiple diagnoses are permitted, in that we consider it important that multiple diagnoses be possible so that the individual patient can be appropriately classified and treated. The ratings are: "yes"; "no"; and "unknown," where the issue is not addressed in the description of the taxonomic system. When multiple diagnoses are allowed, the system was also evaluated according to whether the system specifies how a user, in a given case, would decide on how the diagnoses would be selected and ranked.

The fourth criterion deals with whether the taxonomic system facilitates decision making according to three considerations: (1) a useful taxonomic system should be organized according to the decision-tree concept, that is, whether a clinical finding is abnormal or not, according to the specified diagnostic criterion, should be unambiguous; (2) clarity is expected regarding the essential clinical characteristics required for assigning a diagnosis in contrast to the clinical features that may occasionally be found; and (3) it is essential that the listed criteria for each diagnostic category lead to discriminant decisions.

We recognize that this evaluation is based very much on how we interpret the present literature on what constitutes a TMD patient. Disagreement by readers is not unexpected. We have thus included explanations for what we perceive to be the areas of divergence.

Other evaluation criteria that we deem useful, such as the comprehensiveness of patient assessment utilized by a system, predictive value of making a diagnostic assignment, and implications for differential treatment, were not formally assessed for each system; these considerations will be discussed further in the Discussion section.

Diagnostic Systems

The order of presentation of each taxonomic system is strictly chronological, based on the date of publication of the specific work used in this review. In some cases, this resulted in a particular taxonomic system appearing later in the discussion than it probably should in terms of the period of its development and earlier publications.

Farrar (1972).[6] "TMJ Dysfunction Syndrome" was the most prevalent diagnostic term at the time of Farrar's initial work. Although as early as 1890 there were reports of problems afflicting the joint proper, the focus of the field had moved to nonarticular concerns. The "dysfunction" part of the syndrome implicated primarily gross functional impairment of the masticatory apparatus. In this regard, Farrar reoriented the field toward the TMJ by placing considerable emphasis on internal joint derangements as the cause of dysfunction. This emphasis initiated numerous studies of the anatomy and function of the intact and deranged TMJ, which have contributed greatly to our current knowledge.

Although this system can be criticized because it places most emphasis on internal derangements of the TMJ, the taxonomy does include eight clinical problem areas, termed "dysfunctions": masticatory muscle hyperactivity, capsulitis and synovitis, loose or strained capsular ligaments, anterior dislocation of the disc, muscle incoordination, and decreased range of mandibular motion secondary to degenerative joint disease. Farrar attempted to reconcile clinical impressions of abnormal findings with rationally derived concepts of disease states. According to our classification criteria, the proposed diagnostic categories are thus based on uncontrolled clinical observation (which in fact is true for most of the other systems as well). There are no clinical epidemiologic data provided to support the proposed diagnostic entities within TMD. On the other hand, the specific clinical features of patients with anterior disc displacement are provided and could be operationalized for testing. Other conditions that may mimic the clinical picture of anterior disc displacement are listed; however, there is insufficient explanation provided regarding how to exclude them.

Concerning the entity of anterior dislocation of the disc, Farrar relies heavily upon transcranial radiographs for establishing condylar position based on the assumption that a posterior condylar position indicates anterior disc displacement. Transcranial radiographs, however, were subsequently shown to be of questionable value both in terms of reliability and validity for determining condylar position,[7,8] and condylar position on closure was subsequently shown to be invalid as an indicator for disc position.[9] Another criterion of presumed significance in the decision-making process deals with using the contralateral, unaffected joint as an estimate of "normal," upon which limitation in the affected joint is based. However, no validation of this criterion has been attempted.

Summary. Part of this system, at least the anterior disc displacement category, is based on patient material. However, the sample type is unknown. Criteria provided are not suitable for research applications, in that there are insufficient criteria for differentiating one entity from another, and most of the presumably diagnostic criteria are not easily operationalized. Reliability was not established by the author for any of the described evaluation methods, although some of the clinical evaluation methods have later been shown by others to be reliable. Specificity is unknown. It is uncertain whether multiple examiners would arrive at the same diagnostic conclusion given the same data as a basis for their diagnostic reasoning.

The biological plausibility was rated as moderate, despite the strength of the biological base for the internal derangement, because of problems with some of the "dysfunctions." Not all of the major clinical entities of TMD are included in Farrar's system. Most importantly, muscle pain disorders are completely omitted. There is no discussion of whether multiple diagnoses are permitted. Although simple, the system is of low clinical usefulness, in that clear inclusionary and exclusionary criteria are, in general, absent (ie, poor decision making); some diagnostic entities have poor general acceptance, such as "loose capsular ligaments" and "muscle incoordination"; and the methodological parameters are largely undocumented.

Block (1980).[10] This classification system is based on both neurologic and orthopedic models of pain and dysfunction, and it thus includes a wide spectrum of disorders affecting the masticatory system. Based on this medical model, disorders are classified in a way similar to the methods used in current texts of neurology and rheumatology. The organization of the pain syndromes is anatomical by body region. Although this approach produces overlap, the author states that it enables the clinician to be better organized conceptually and to consider all possibilities in each anatomic region. The dysfunctional syndromes are structured according to etiologic considerations.

The pain disorders are grouped under the section heading of "craniofacial-cervical pain." They encompass pain states related to craniofacial, oropharyngeal, cervical, psychogenic, and systemic disease. The craniofacial pain disorders are further divided into subcategories of superficial and deep pain, and the deep pain is subdivided into myogenic, secondary myogenic, skeletal, vascular, neurogenic, and associated tissues. The emphasis is notably not restricted to TMD; rather, pain of the head, neck, and shoulders is classified. The category of "cervical MPD" is inconsistent with the original description of the myofascial pain dysfunction (MPD) syndrome, but it is conceptually in agreement with the literature on myofascial pain. The listed criteria are based on symptom characteristics. This diagnostic system highlights the need for a taxonomy of TMD to be placed conceptually within the larger context of all craniofacial pain disorders and chronic pain problems elsewhere in the body. The dysfunctional disorders are divided into congenital and developmental muscle disorders, neoplasms, trauma, neuromuscular diseases, and inflammatory and infectious diseases. Notable is the fact that within these two major headings, internal derangements of the TMJ, as a distinct group of disorders, are absent. However, all of the major types of arthritis, subluxations, dislocations, fractures, and ankylosis of the TMJ are considered.

The inclusion of the MPD syndrome concept called attention to the fact that significant similarities between the clinical features of this condition in the jaw and other body parts exist. This encouraged alternative etiologic points of view that were different from the prevailing occlusal theories of pain and dysfunction. Subsequent studies[11–13] provided important construct validation for the MPD concept, which is, from the perspective of this review, the major scientific strength of this system. The process of construct validation represents a critical component in

the acceptance process of any taxonomic system. Besides adding data in support of the construct, these findings have significantly influenced the field in terms of etiologic issues. These studies represent a model for further efforts in construct validation.

Summary. Although this taxonomic system is rich in the selection of possible distinct disorders, it does not translate well into research diagnostic criteria according to our taxonomic evaluation criteria. The system, as a whole, is descriptive and not based on any identified sample population. Many of the clinical assessment measures have been shown to be reliable by others. Specificity is unknown, as is the reliability of diagnostic assignment. The greatest strengths of this taxonomic system are the strong biologic plausibility and the nearly exhaustive classification, except for the absence of the subentity of internal derangements. Multiple diagnoses are permitted, although there are no stated rules for how multiple diagnoses are to be established or ranked. Although the overlapping regional organization of the pain disorders most likely minimizes false-negative diagnoses, clear inclusion and exclusion criteria that would promote reliable diagnoses are absent.

Eversole and Machado (1985).[14] The authors based the development of their taxonomic system on a broad review of the literature. The system is simple and favors good clinical reasoning. The authors were concerned that classification systems that did not include the subcategory of TMJ internal derangements would likely include such cases within the entity of MPD. They contended that the phenomenon of internal derangements warranted a separate diagnostic category. The authors pointed out that arthrogenous and myogenous conditions often overlap in signs and symptoms, increasing the difficulty of making a reliable assignment of a patient to one or the other category. This taxonomic system provided an important improvement over the previous systems, in so far that it offered a simplification of the taxonomy to make the group of commonly encountered subentities accessible to a broad user base. However, there remain some concerns with this taxonomic system:

1. The authors made an attempt to improve the differentiation of arthrogenous from myogenous diagnoses by using exclusionary criteria for "myogenic facial pain." These include the absence of joint sounds and discontinuous osseous contours of the articulation on the tomographic image. However, these two exclusionary criteria would, in essence, prevent an individual from having both an internal derangement and myogenic pain simultaneously. Further, the high prevalence of joint sounds in asymptomatic subjects confounds joint sounds as an exclusionary criterion for a myogenous diagnosis, in that joint sounds should be expected in a large percentage of patients with "myogenous" diagnoses. In addition, an individual who previously developed osteoarthrosis of the TMJ cannot subsequently develop myogenic pain. Although these exclusionary criteria are aimed to achieve better case definition, they may on occasion lead to uncertainty or inaccuracies. Problems can also occur in classifying a patient who develops myogenic pain with a long-standing history of clicking due to "structural incompatibility of fossa and disc-condyle complex." The diagnosis of "myogenic facial pain" can be obtained in the sole presence of palpatory tenderness of cervical muscles which appears to be a problem with nomenclature. The authors should have used instead their parenthetical term "uncomplicated myalgia." Other naming problems include using "type 1," "type 2," and "type 3" for the different types of internal derangements; when their termed entities differ from the phenomena named more commonly with, for example, "displacement with reduction" and "displacement without reduction" is not clear.

2. There are good descriptions for the various disorders, but the system is compromised by a lack of clarity regarding the essential characteristics that distinguish one disorder from another.

3. Some statements require supporting evidence, but such evidence is unavailable. For example, it is stated that "myospasm may lead to decreased range of motion" and while spastic activity of a muscle would certainly be expected to reduce the range of motion, there is no scientific support in terms of what myospasm (as a term used in this system) is, and thus its role as a causal agent toward pain in TMD also needs support. Internal derangements are subdivided into clicks with and without pain; however, no rationale for this separation is given.

Summary. This taxonomic system is descriptive. The prevalence of the various clinical entities is consistent with present-day estimates. The study sample appears to be retrospectively analyzed and there are no controls upon which to evaluate specificity. Because of ambiguity (eg, qualifying criteria stating that a feature "may or may not" be present) in the essential inclusionary criteria, the proposed diagnostic system is not as well suited for research applications as it could be. Although many of the clinical evaluation measures are not well operationalized, the methods underlying them (eg, measurement of opening) have been shown by others to be reliable. Interrater reliability of the diagnostic assignment is unknown. Biologic plausibility of the proposed diagnostic entities is strong. The major clinical entities are listed, although in a named form that is hard to remember. Multiple diagnoses are permitted, but the criteria for doing so in a reliable fashion are not stated. The usefulness of the system is diminished due to ambiguity between (1) deemed essential, and (2) permitted but not essential features.

Bell (1986).[15] Bell's orientation largely follows the medical-orthopedic model. He recognizes that subtle differences exist between the various entities that comprise TMD. These differences are expressed—to a varying degree—both at the symptom level and by

clinical findings. The key clinical feature that dominates each category is stressed.

Besides the chief complaint, Bell's taxonomic system uses four criteria to differentiate among five major categories of TMD: masticatory pain, restriction of mandibular movement, articular interference during mandibular movement, and acute malocclusion. With the introduction of the concept of acute malocclusion representing the patient's perception of the bite not "feeling right" rather than only a structural discrepancy observed during an occlusal analysis, Bell makes an effort to explain the occlusal phenomenology in TMD. Convincing arguments are presented for an acute malocclusion to be considered the effect of a disease process rather than the causative event. In this regard, Bell challenged the prevailing thought that occlusal interferences were causally linked to the development of masticatory pain and dysfunction.

The diagnostic entities are defined by descriptive criteria. It should be noted, however, that the definitions of a number of entities are not necessarily consistent with views held by other authorities in this field. For example, protective muscle splinting is defined as CNS-induced hypertonicity in response to injury or threat of injury (ie, a change in the sensory pattern, which, according to Bell, does not necessarily have to include actual nociception) in a body part and is characterized by reduced range of motion and rigidity. We would consider a "definition" such as this to be better regarded as a hypothesis needing empirical support. It is stated that increased bruxism associated with emotional tension or illness has the potential to cause splinting, but in our opinion this does not adequately differentiate from, or rule out, the alternative hypothesis that decreased range of motion or "rigidity" could be bruxism-induced myofascial pain.

There are a number of statements that lack supporting evidence. Examples include: "a steep horizontal condylar inclination (eminence) predisposes to a 'Class IV interference' (hypermobility)"; "a 'Class I interference' is due to chronic occlusal disharmony, displacing the disc-condyle complex"; or, "a 'Class II interference' may develop from poor posterior occlusal support." While these statements, as hypotheses, can be subjected to testing, there are no data cited in their support. Indeed, there is a considerable amount of literature that refutes all three of these propositions.[16,17]

Bell's system omits entirely the MPD category in which, by the author's definition, none of the problems listed as muscle splinting, muscle spasm, or myositis would fit. The text states that inflammatory internal derangements should be reclassified as inflammatory joint disorders. This raises the need for a test that discriminates a noninflammatory from an inflammatory internal derangement, particularly in light of the fact that a mild inflammatory tissue response most likely escapes recognition using standard examination procedures.

Summary. This work appears to be based on the impressions gained from clinical experience, although the nature of the clinical sample is unknown. The proposed taxonomic system is not suitable for research purposes, in that the criteria are not stated in measurable terms. There is significant overlap among entities and there are no data in support of the examination measures. The interrater reliability of the examination measures is suspected to be low given the poor operationalization. However, some of the clinical measures have an acceptable interrater reliability as shown by others. Specificity is unknown and the interrater reliability of diagnostic assignment is likely low, given the overlap of signs and symptoms among entities. The biological plausibility is only moderately good because of unsupported categories such as "muscle splinting" and "muscle spasm." The system is almost exhaustive. A number of important categories are subsumed within other less important, more difficult to characterize, categories. Clear inclusionary and exclusionary criteria are notably absent. Multiple diagnoses are sometimes permitted and other times not, depending on the structure of the particular category. Ambiguity of signs and symptoms among entities makes decision making difficult.

Fricton et al (1988).[18] This system is influenced by the biopsychosocial model as applied to chronic pain. Similar to Block's system, its strength lies in the placement of TMD within the larger context of extracranial, intracranial, neurological, vascular, causalgic, and psychiatric disorders, all of which can produce symptoms that overlap with those of TMD. Notably, this system includes fibromyalgia as a differential diagnostic term. In patient assessment, behavioral and psychosocial aspects are considered in addition to the physical and structural aspects. Thus, the system appears to be well suited for the management of chronic facial pain patients. The system offers discriminant criteria that, taken together, most likely result in a pattern match between the findings of the clinical assessment and the appropriate diagnostic entity. Based on our knowledge of the pain literature, this system includes most of the applicable diagnostic categories involving muscle pain. The primary omission is chronic muscle pain without trigger points or radiating pain; whether such a disorder, as a separate entity, provides useful discrimination is a research question. It also uses "myofascial pain" as the term for that (highly prevalent) muscle disorder found in pain patient populations, rather than the term "myofascial pain dysfunction (syndrome)."

Some entities are at variance with other formulations; whether this is an improvement, or whether this makes the system more difficult to use, is not easy to determine in the absence of other data. For example, in "contracture," does it need local trigger points to make the diagnosis (as stated), or is the essential criterion a decreased range of motion by history and on assisted mouth opening, possibly in combination with a hard "end feel," so that a contracture diagnosis

could be made in the absence of trigger points? Sensitivity and predictive validity of disease predictors are important concerns and will help determine which diagnostic formulation is the more useful.

Summary. The proposed taxonomy is descriptive in origin. The criteria are amenable for research purposes, but in their present form, high levels of experience and skills in diagnostic reasoning are required. There are published data from this research group demonstrating that many of the evaluation measures are reliable; their findings on interrater reliability are consistent with those of others in the field. There are other examination items that have no supporting reliability data, but they are also not included as critical criterion items for any of the listed disorders. We assume that these additional, nonessential features are listed to rule out disorders not included in the taxonomy (for example, tooth hypermobility in combination with localized occlusal trauma such as might occur from a specific parafunctional behavior). However, the absence of a specific set of instructions is likely to favor ambiguity. Specificity is unknown, as is reliability of diagnostic assignment.

Biological plausibility is strong. Inclusionary and exclusionary criteria are reasonably clear among the disorders. As more knowledge is gained of the essential features for the various disorders, we would expect the system to evolve, improving the clarity of the inclusionary and exclusionary criteria. The system does not exhaustively classify all of the various entities of TMD, although the major ones are listed. Multiple diagnoses are not only permitted, they are explicitly encouraged through the mechanism of the patient problem list. However, there is no discussion of how to arrive at multiple diagnoses. We assume that the clinician uses best-fit pattern matches, not being concerned with any overlap of signs and/or symptoms onto more than one entity of a TMD.

American Academy of Craniomandibular Disorders (AACD) (1990).[19] This taxonomic system represents the consensual product of an extensive project performed by a committee of this Academy. It is important to note that the consensual process, whether by formal committee or by the refinement of knowledge through less formal means, constitutes the method by which the state of science is established, maintained, and revised. The conceptual theme was influenced by the classification project undertaken by the International Headache Society (*Cephalgia* 1988;8, suppl 7), with the AACD taxonomy comprising Category 11 of the International Headache Society's classification. The integration of TMD, not only conceptually but pragmatically, within the larger framework of face, head, and neck pains as viewed by medicine is commendable and may very well stimulate productive developments between dentistry and medicine. A positive impact in the level of care and in scientific understanding is likely to occur when both disciplines share a linked taxonomy. In addition, the proposed diagnostic classification system of the AACD addresses vital issues of third-party coverage, which determines whether a diagnostic system, no matter how sound it may be in every other respect, is actually utilized by the practicing clinician in the United States.

Two major categories of disorders emerged through this process, one for joint disorders and the other for muscle disorders. Each of the different entities within the categories is described by a number of criteria composed of signs and symptoms. However, it is not clear whether all criteria are required or whether only some of the criteria are necessary for a diagnosis. Criteria are not well operationalized; for example, "excessive range of motion" as a criterion for anterior joint dislocation allows the user to define what constitutes "excessive." The conceptualization of how some disorders are related pathophysiologically to others may be misleading; this is particularly evident in the degenerative joint arthritides.

As with the other taxonomies, this system also does not provide a diagnosis for the patient who has muscle pain without firm bands or trigger points. Difficulties arise with the subentities of spasm, reflex splinting, and hyperactivity states, again for the same reasons of ambiguity regarding what clinical condition the term is really referring to and what the essential characteristics are. It needs to be emphasized that stated disease entities are only valid when they represent a true phenomenon with unique pathogenesis. It is unfortunate that our current knowledge of these conditions is rather limited; these terms should be used cautiously.

Separate terms for similar disorders that are hard to distinguish clinically are listed. For example, the terms synovitis and capsulitis refer to anatomically distinct loci of possible inflammatory process; however, whether such distinctions can be practically made in the case of the TMJ is questionable. In addition, whether such distinctions are useful from a management point of view remains to be determined. For the disorders of synovitis and capsulitis, three out of the four listed criteria overlap completely. Using the available criteria, we consider it difficult to reliably distinguish between the two entities. Finally, there are important omissions in this system within the broad category of arthritides, such as traumatic and septic arthritis.

Summary. This system is based on expert opinion and evaluation of the research literature as a whole. The criteria, in their present form, are marginally suitable for research in that the essential inclusionary criteria could be more clearly described as well as being better operationalized. The interrater reliability of many evaluation measures has proven to be acceptable according to research performed by others. Specificity is unknown, as is the reliability of diagnostic assignment. Most of the listed disorders have biological plausibility; one example without plausibility is "temporomandibular joint hypermobility." With minor exceptions, the system exhaustively classifies the major problems encountered in the clinical

practice of TMD. Multiple diagnoses are possible, though without defined criteria for doing so. The system does not facilitate decision making because of ambiguity between essential characteristics and nonessential features of various TMD entities.

American Academy of Head, Neck, Facial Pain and TMJ Orthopedics (AAHNFP & TMJO); Talley et al (1990).[20] This taxonomic system represents a fairly complete list of the available diagnostic terms used within both the peer-reviewed as well as in the non–peer-reviewed medical and dental literature. There are disorders contained within this system that are not found within any of the other systems. The taxonomic system is based upon the traditional, and well-accepted view of intracapsular and extracapsular conditions forming the core of its organization. In addition, a rather unconventional listing of neurologic and vascular disorders has been included, a listing that contains as diagnostic labels both traditional diagnostic terms as well as generic symptom descriptions. Notable are the number of differences in classifying disease states between the present and other taxonomies. For example, this system contains "bruxism" as a diagnostic term, while the other taxonomic systems include it as a perpetuating factor (where a dysfunctional joint or pain condition is considered the primary clinical problem) and not as a diagnostic entity.

Though this system contains a wide range of disorders, there are some concerns about organization and scientific quality of the supporting literature. Disorders grouped within the broad category of "myofascial disorders" include myalgia, appropriately, but also trismus, dyskinesia, bruxism, tendonitis, stylomandibular ligament syndrome, hyoid bone syndrome, and others. These latter disorders would not be considered to fall within the category of "myofascial" by most authorities within the field on the basis of the involved anatomic structure (eg, hyoid bone syndrome), or difference in kind (eg, bruxism, which is a behavioral, not an anatomical, term). Finally, references in support of the entities of bruxism, "insertion tendonosis," and Ernest syndrome, among others, are from non–peer-reviewed sources. Publications relevant to these entities from peer-reviewed journals are unfortunately omitted.

Summary. This taxonomic system is based on clinical impressions with some literature cited as support. The criteria are not suitable for research applications due to the omission of presumably essential features recognized by the literature and difficulty in operationalizing those criteria that are present. The interrater reliability of the proposed evaluation measures is unknown for this taxonomic system, as is the interrater reliability of diagnostic assignment. Specificity is unknown and the biological plausibility is moderate. Major entities that are commonly considered to fall within TMD are acknowledged. Multiple diagnoses are permitted, though decision criteria for doing so are not provided. Ambiguity between essential and nonessential features makes decision making difficult.

International College of Cranio-Mandibular Orthopedics (ICCMO); Bergamini and Prayer-Galetti (1990).[21] This group has introduced a very different classification system for the "musculoskeletal disorders" of the stomatognathic system. Conceptually, the authors regard such disorders as being associated with an "accommodative state of the dental occlusion leading to functional overloading and neuromuscular imbalance." Unlike the other reviewed diagnostic systems, the authors introduce the idea of "occlusal flags," which they consider to be the early indicators of neuromuscular disturbance. Notable is the fact that these occlusal flags do not have to be associated with overt signs and/or symptoms.

According to this taxonomic system, three diagnostic headers are all inclusive for the disorders of the stomatognathic system: "Group I—Presence of occlusal flags"; "Group II—Musculoskeletal disorders associated with myofascial TP (trigger points) of the head and neck"; and "Group III—Organic osteoarticular damage of musculoskeleton of the head and neck." There are significant concerns about the face validity of this taxonomic system; for example, tic douloureux is referred to as a "symptom" of Group II disorder, while "pathologic craniocervical posture" is also considered a "symptom" of Group II disorder. As far as Group I disorders are concerned, there are no data in support of a causative role for the listed "occlusal flags" in the pathogenesis of TMD in general or any subset specifically. Midline discrepancy, as well as most other characteristics of any occlusion, is stated to be a sign of Group I disorder; there are no rules that distinguish the normal from the abnormal, which would result in low diagnostic specificity.

Summary. This taxonomic system is opinion-based and conceptually different from all the other systems reviewed. It is not suitable for research. Interrater reliability for both clinical methods and diagnostic assignment is unknown, and specificity is unknown as well, and likely to be low. Biological plausibility is minimal. The system omits major disorders recognized by most of the other taxonomic systems reviewed here. It is unknown whether multiple diagnoses are allowed. The clinical usefulness of this system is low in that it meets none of our proposed clinical considerations.

Truelove et al (1992).[22] Unlike the other taxonomic systems, this system is driven by data that have been used for the validation of the diagnostic criteria used to assign a case to one class or another. Data have been obtained from three samples and, according to the sampling criteria applied, strongly suggest generalizability of findings. Due to the nature of the supporting research, the employed criteria are applicable to large-scale epidemiologic studies. Diagnostic criteria are limited by design to include only

the most powerful criteria needed for clinical decision making. Because of the established and proven validity of the included criteria, as well as the omission of the questionable criteria, greater reliability among clinical examiners can be expected. By design, the system encourages multiple concurrent diagnoses, a common practice in many areas of health care.

There are three basic muscle pain disorders, referred to as "Myalgia I and II" and MPD, which appear to be fairly similar. To verify that these three disorders truly represent distinct natural entities, data supporting decisive differences in the areas of pathogenesis, treatment, and/or prognosis are essential. The entity entitled "myofibrositis with trigger points" represents the combination of two legitimate, distinct disorders, myofibralgia and myofascial pain.[23] However, evidence from the pain literature suggests that the term "myofibrositis" is not consistent with the histologic findings, an absence of tissue reaction associated with an inflammatory response. In this regard, "myofibralgia" appears to be a better choice of term for this as yet poorly understood condition. Myofibralgia is regarded as a generalized systemic disorder, while "myofascial pain" is considered to be a more localized phenomenon, and thus combining them into one composite entity can be questioned. Further, the inclusion of trigger points into this composite category makes this taxonomic system somewhat discordant with the ideas proposed by Block, Fricton et al, and the AACD. The absence of categories for contracture, myositis, and myospasm is noted. However, it is not stated whether their absence is due to difficulties in operationalizing the criteria or to the fact that the authors might believe that they do not exist.

Another problem with their muscle-based disorders is how to classify the individual who has all the listed essential criteria, except that only a single muscle is involved. Under the present system, the subject would not be classified as having TMD. However, we consider the involvement of a single muscle a distinct possibility. Certainly, we realize the dilemma that using more than one muscle as a criterion reduces false-positive diagnoses, an important consideration in epidemiologic studies often dealing with lanthanic individuals.

Because this is a system oriented toward epidemiologic applications, the criteria were established to not require imaging, a procedure difficult to perform during field examinations. However, there are a few entities that either require imaging or are true radiographic diagnoses. True radiographic diagnoses are "fracture of the TMJ" and "developmental defects," but neither is stated to require imaging to obtain positive inclusionary criteria. Research diagnostic criteria will need to be supplemented by evidence from imaging if the taxonomy is to be applied in a clinical/laboratory setting. Finally, the subentity of "disc perforation" is considered problematic to the extent that this diagnosis can only be established from tissue specimens, or from arthrographic or arthroscopic evidence.

Summary. Because of the nature of the development of this diagnostic system, it rates well according to our proposed evaluation criteria. A population-based sample was used for validation, and appropriate controls were included to test the criteria for whether they discriminated among appropriate subpopulations. The criteria are quite suitable for research applications, although, as described above, they are formulated primarily for epidemiologic studies. Acceptable interrater reliability has been provided by this group for all of the methods used in their evaluation. Specificity for the system as a whole exceeds 85% when the criteria are applied to a community sample. Whether different examiners arrive at the same diagnosis is not documented as of yet. Because of the extensive use of correct analytical techniques coupled with matched controls, this diagnostic system critically distinguishes itself from the other systems reviewed in terms of providing a baseline for construct validation of the group of TMD overall. The biological plausibility is strong, and the system covers the major disorders found most often in the clinic, though we restate that there are some problems with how the muscle disorders are conceptualized in that false-negative diagnoses could arise. Multiple diagnoses are permitted, but the methods for doing so are not specified. The inclusionary criteria are clear and nonoverlapping.

Discussion

Using explicit criteria, we made an effort to evaluate the scientific merits and utility of nine classification systems. The results of our assessment are given in Table 2. In addition, the following points should be stressed. With the exception of Truelove and colleagues,[21] all classification systems include statements that are not essential for the final diagnosis. This makes the use of a taxonomy unnecessarily difficult. The elimination of nonessential features from the criteria list is strongly encouraged to improve the diagnostic reliability of a system, although we are not suggesting that those clinical characteristics currently considered to be not essential for a diagnosis, as defined by a system, should be ignored. We anticipate considerable modification in any system that is subjected to stringent data analysis according to the kinds of criteria described in this review under Methodological Considerations. Clinical characteristics currently viewed as nonessential could very well change to essential in a reformulation of the constructs following appropriate data analyses.

Variance has been observed in how different diagnostic systems are grouping one disease entity within their larger context. Further, there are differences among systems in terms of which diagnostic entities the area of TMD entails, indicating disagreement on

Table 2 Summary of Diagnostic Systems According to Evaluation Criteria*

Criterion	System								
	Farrar[6]	Block[10]	Eversole & Machado[14]	Bell[15]	Fricton et al[18]	AACD[19]	AAHNFP & TMJO[20]	ICCMO[21]	Truelove et al[22]
Methodological Considerations									
Sample method	Case-series Cross-section Retrospective	None	Case-series Cross-section Retrospective	None	None	None	None	None	Case-control Longitudinal Prospective
Sample type	Unknown	None	Consecutive	None	None	None	None	None	Population
Research suitability	No	No	Yes	No	Yes	Yes	No	No	Yes
IRR—methods†	Ext-partial	Ext-partial	Ext-partial	Ext-partial	Int-partial Ext-partial	Ext-partial	Unknown	Unknown	Int-full
Specificity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Acceptable
IRR—diagnosis‡	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Clinical Considerations									
Biological plausibility	Moderate	Strong	Strong	Moderate	Strong	Strong	Moderate	Minimal	Strong
Exhaustive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Multiple diagnoses	Unknown	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Decision making	Poor	Poor	Poor	Poor	Good	Poor	Poor	Poor	Good

*See Table 1 and text for explanations of ratings.
†Interrater reliability for methods; ext-partial: external-partial; int-partial: internal-partial.
‡Interrater reliability for diagnostic assignment.

the scope of the field. One problem concerns how to classify behavioral phenomena, such as parafunction. Should parafunction itself warrant a TMD diagnostic label? It appears that the authors of most of the systems do not think so. We recognize the criterion problems in classifying parafunctions. Clearly, parafunctions can be problematic and warrant treatment; where should they be classified if not within the broad category of TMD? The lack of data on the interrater reliability of diagnostic assignment needs to be noted; this is remarkable in that methods are readily available to provide data for the performance of a taxonomic system.

Terminology of disease entities is problematic in many of the systems in at least four ways. There are a number of entities, such as "contracture" and "myospasm," that, while widely held to be valid constructs in the clinical lore of this field, are notably lacking in supporting data that link them into the anatomical and physiological knowledge. We would regard, in the absence of appropriate data, such entities to be considered hypothetical; causal statements should thus be made cautiously. The loose use of terms for these hypothetical entities does not facilitate scientific advances for the field. Further, some entities, such as "muscle splinting," are defined using statements that have causal implications; we contend that such definitions should be explicated as hypotheses instead. Third, there is often internal inconsistency between how a disorder is defined and what the stated essential criteria are; we contend that in the absence of empirical data to the contrary, face validity should be important at this particular stage of development of the field. Finally, some systems have used somewhat nondescriptive terms for either spectra of disorders (eg, arthritis A, B, and C) or for a single disorder. While departing from traditional nomenclature is often necessary to revise problems in prior conceptualization, we contend that departures in terminology should be accompanied by clear statements regarding how the new term is critically different from the existing term. Ultimately, developments in this field will need to be incorporated into the International Classification of Disease.

All nine taxonomic systems emphasize the classification of the patient according to physical findings. Several systems have implied or proposed psychosocial variables for inclusion in the overall evaluation. We would anticipate that, given the enormous import of psychosocial variables in chronic pain, a second dimension for patient classification will emerge to augment the physical diagnosis. It is unclear which critical variables should comprise the evaluation for this second dimension, or what a tax-

onomy for that second dimension will include. There are obvious variables, such as depression, that need to be included. Others that have potential for inclusion are, for example, related to coping style. This is an area that is likely to change considerably as more knowledge is gained. Whether psychometric scales or structured interviews are the best way to obtain the data in the clinic is an open question.

Etiology, prognostic statements, and implications for treatment are considered to be the hallmark indicators for the utility of a taxonomic system.[4] We lack knowledge in this field regarding etiology of most of the disorders, and thus we felt that it was premature to evaluate the systems as a whole on this aspect. None of the proposed systems have data for prognosis, which is also not surprising given the stage of development of sound diagnostic criteria. When etiology and the natural course of the disorders is better understood, we would expect that a taxonomic system would be able to provide information regarding treatment issues. The evaluation of a system as a whole, with regard to its clinical usefulness, will ultimately rest on these three factors. It is premature at this point, however, to use them here in evaluating these systems.

The final point relates to determining the validity of a diagnostic system as such. With the state of present knowledge, we are not in a position to evaluate the construct validation of the proposed diagnostic entities within each system. However, studies oriented toward construct validation for the entity of MPD have been performed; such studies are necessary for all proposed entities of TMD.

References

1. *International Classification of Diseases.* Revision 10: Clinical Modification. World Health Organization, Geneva, Switzerland, 1991.
2. International Association for the Study of Pain and Subcommittee on Taxonomy: Classification of chronic pain: Description of chronic pain syndromes and definitions of pain terms. *Pain* 1986(suppl 3):S1–S225.
3. Fenton WS, Mosher LR, Matthews SM: Diagnosis of schizophrenia: A critical review of current diagnostic systems. *Scizo Bull* 1981;7:452–476.
4. Feinstein AR: *Clinical Judgment.* Baltimore, Williams and Wilkins, 1967.
5. Feinstein AR: *Clinical Epidemiology: The Architecture of Clinical Research.* Philadelphia, WB Saunders, 1985.
6. Farrar WB: Differentiation of temporomandibular joint dysfunction to simplify treatment [other articles included]. *J Prosthet Dent* 1972;28:555–629.
7. Bean LR, Thomas CA: Significance of condylar positions in patients with temporomandibular disorders. *J Am Dent Assoc* 1987;114:76–77.
8. Eckerdal O, Lundberg M: Temporomandibular joint relations as revealed by conventional radiographic techniques. *Dentomaxillofac Radiol* 1979;8:65–70.
9. Katzberg RW, Keith DA, Ten Eick WR, Guralnick WC: Internal derangements of the temporomandibular joint: An assessment of condylar position in centric occlusion. *J Prosthet Dent* 1983;49:250–254.
10. Block SL: Differential diagnosis of craniofacial-cervical pain, in Sarnat BG, Laskin DM (eds): *The Temporomandibular Joint,* ed 3. Springfield, Ill, Charles C. Thomas, 1980, pp 348–421.
11. Goodman P, Greene CS, Laskin DM: Response of patients with myofascial pain-dysfunction syndrome to mock equilibration. *J Am Dent Assoc* 1976;92:755–758.
12. Greene CS, Laskin DM: Splint therapy for the myofascial pain dysfunction (MPD) syndrome: A comparative study. *J Am Dent Assoc* 1972;84:624–628.
13. Laskin DM, Greene CS: Influence of the doctor-patient relationship on placebo therapy for patients with myofascial pain-dysfunction (MPD) syndrome. *J Am Dent Assoc* 1972;85:892–894.
14. Eversole LR, Machado L: Temporomandibular joint internal derangements and associated neuromuscular disorders. *J Am Dent Assoc* 1985;110:69–79.
15. Bell WE: *Temporomandibular Disorders: Classification, Diagnosis, Management,* (ed 2). Chicago, Year Book Medical Publishers, 1986.
16. Bush FM: Malocclusion, masticatory muscle, and temporomandibular joint tenderness. *J Dent Res* 1985;64:129–133.
17. De Boever JA, Adrianes PA: Occlusal relationship in patients with pain-dysfunction symptoms in the temporomandibular joints. *J Oral Rehabil* 1983;10:1–7.
18. Fricton JR, Kroening RJ, Hathaway KM: *TMJ and Craniofacial Pain: Diagnosis and Management.* St Louis, Ishiyaku EuroAmerica, 1988.
19. American Academy of Craniomandibular Disorders: *Craniomandibular Disorders: Guidelines for Evaluation, Diagnosis, and Management.* Chicago, Quintessence Publ Co, 1990.
20. Talley RL, Murphy GJ, Smith SD, Baylin MA, Haden JL: Standards for the history, examination, diagnosis, and treatment of temporomandibular disorders (TMD): A position paper. *J Craniomand Pract* 1990;8:60–77.
21. Bergamini M, Prayer-Galetti S: A classification of musculoskeletal disorders of the stomatognathic apparatus. *Front Oral Physiol* 1990;7:185–190.
22. Truelove EL, Sommers EE, LeResche L, Dworkin SF, Von Korff M: Clinical diagnostic criteria for RMD: New classification permits multiple diagnoses. *J Am Dent Assoc* 1992;123(4):47–54.
23. Boissevain MD, McCain GA: Toward an integrated understanding of fibromyalgia syndrome. I. Medical and pathophysiological aspects. *Pain* 1991;45:227–238.

B. Reliability and Validation of Examination Methods

Understanding the usefulness of examination methods for diagnosis requires a working knowledge of reliability (or reproducibility) and validity (or trueness) of clinical measurements. The purpose of this paper is, first, to provide a general overview of *clinical measurement* reliability and validity as well as the criteria needed to assess these factors. Next, general principles regarding *diagnostic* reliability and validity will be discussed, including sensitivity, specificity, and positive predictive values. These statistical indices have been commonly used to evaluate diagnostic tests that are applied in medical practice.[1-4] Finally, a review of the literature will be presented to assess the reliability and validity of six specific clinical measures and diagnostic techniques for TMD.

Measurement Reliability and Validity

Reliability of clinical measures means that any investigator or clinician should be able to apply a measurement technique to asymptomatic or symptomatic individuals and obtain approximately the same value repeatedly. Sometimes repeatability is conceptualized in terms of consistency among alternative measurements of the same attribute. At other times, repeatability is approached in terms of the consistency of a single examiner/observer over several measurement occasions, or as the consistency among multiple examiners/observers at any one point in time or at two or more points in time. Most of the reliability studies of TMD have focused primarily on intraexaminer and interexaminer repeatability over fairly short time intervals.

Studies that are designed to investigate reliability should follow the guidelines recently proposed by Dworkin et al[5]:

a. Reporting of specifications of examination procedures.
b. Careful definition of criteria for measuring each clinical variable.
c. Training of examiners in the use of examination procedures and criteria for measurement.
d. Appropriate selection of study samples to ensure that the clinical signs or symptoms are indeed present in the study population with enough regularity to determine if examiners can detect them dependably.
e. Randomized assignment within the study to ensure, wherever possible, that each examiner rates each subject in a random sequence, to control for possible effects of the passage of time and for repeated examination.
f. Appropriate statistical methods for the analysis of intraexaminer and interexaminer agreement, such as Cohen's kappa for discontinuous data or the use of the intraclass correlation (ICC) for continuous data.

These criteria are applied with the assumption that the clinical variable under investigation is stable and does not change over time or with repeated measures. However, some clinical variables associated with TMD, such as the patient's responses to muscle palpation, are not as stable as has been generally assumed, since such responses may show considerable variability not only in the long term, but also over relatively short-term periods.[5] This confounds the evaluation of test-retest reliability. Although the problems involved in separating unreliable measurements from true change in an indicator over relatively long periods have been generally recognized for some time, the problem of separating random measurement error from true change over relatively short time periods has been less well recognized and even less studied. Notable exceptions in the TMD literature are highlighted in some detail in the literature review to follow.

Validity of a clinical measure is an indicator of the truthfulness of the test. Clinical measures may be extremely reliable or repeatable, but if the measure does not accurately portray the entity examined, then it provides no useful information for diagnosis. The psychometric literature[6] identifies a broad spectrum of evidence that can be used to evaluate the validity of a measure under the headings of content validity, concurrent validity, predictive validity, and construct validity. Common to these last three types of evidence is the assumption, however, that there is another method that is commonly accepted as "true" or "already validated" with which to compare the validity of the measurement approach under analysis.

Diagnostic Reliability and Validity

Case definitions in the form of research diagnostic criteria specify the boundary conditions under which a specific disorder may be considered to be present or absent in an individual. Case ascertainment procedures are the methods used to obtain and summarize information related to the classification of individuals in terms of a given set of case definitions or diagnostic criteria. The phrase "diagnostic reliability" is used here to refer to the extent to which a set of case ascertainment procedures consistently classifies individuals as having or not having a specific disorder as defined by a given set of diagnostic criteria. Criteria for conducting a study of diagnostic reliability are similar to those previously delineated for measurement reliability. Intraexaminer and interexaminer reliability scores for the repeatability of the classifications produced by a given set of case ascertainment procedures provide quantitative estimates of diagnostic reliability.

The phrase "diagnostic validity" is used here to

refer to the extent to which a set of case ascertainment procedures classifies individuals in a way that is consistent with a "gold standard" classification of the same individuals with respect to the presence/absence of a specific disorder as defined by a given set of criteria. The evaluation of diagnostic validity is complex because of the requirement of a gold standard for comparison to determine the accuracy of the classification. Many argue that only an objective biological measurement will suffice as the gold standard, such as a biological assay for specific antibodies or calipers for measurement of a biological structure. Presently, however, we do not have specific "objective" biological measures to use for assessing the validity of musculoskeletal conditions. Instead, the presence of palpable tenderness of musculoskeletal structures serves as the closest gold standard to date for musculoskeletal conditions associated with TMD. A similar method has been established by rheumatologists for the diagnosis of fibromyalgia. A patient must have 12 positive palpation sites out of a total of 14 before a positive diagnosis of fibromyalgia can be made.[7]

In the absence of any gold standard, or in the presence of a standard that may be more adequately described as a less precious metal, Feighner-like criteria[8] may be used to examine the validity of the research diagnostic criteria that are based on a given set of case ascertainment procedures. The application of Feighner-like criteria to the validation of research diagnostic criteria for TMD would involve the examination of cross-sectional and longitudinal evidence to determine the homogeneity of the classified groups. Such evidence may include family background, genetic inheritance, risk factors, natural history, and response to treatment.

A fundamental aspect of the validation of any case definition is an evaluation of the clarity of the boundary conditions that specify when a disorder is present or absent. Ideally, case ascertainment procedures are based on well-defined inclusion and exclusion criteria, so that a specific disease category is identified as *present* in the diseased population (high sensitivity) and as *absent* in the nondiseased population (high specificity). The problem is that setting "acceptable" sensitivity and specificity levels is context-specific and depends on a variety of factors including the prevalence of the disease, as well as the cost of health care and level of mortality associated with the disease. In clinical research involving the delivery of treatment, for example, if the consequence of missing a diagnosis were death (disease with high mortality), then the sensitivity of the case ascertainment procedure would be maximized at the expense of the specificity so as to not miss diseased individuals. Alternatively, if the cost of treatment was high and the mortality and morbidity were low, then the specificity of the ascertainment procedure would be maximized so that nondiseased individuals were not treated unnecessarily. Striving for both high sensitivity and high specificity allows for accurate diagnosis in the diseased population and exclusion of nondiseased individuals.

Another measure, the positive predictive value (PPV), takes into account the prevalence of the disease and thereby gives a fuller indication of acceptability, because high sensitivity and high specificity levels do not guarantee a high positive predictive value. A low prevalence rate means that the number of nondiseased individuals is high, thus even a small percentage of the large number of nondiseased subjects identified as false positive may be nearly equal to the number of true-positive diseased cases found in the population. This emphasizes the need to examine prevalence rates when choosing acceptable sensitivity and specificity levels.

To understand the interrelationship of sensitivity and specificity with positive predictive values for TMD, a three-dimensional graph was generated using an estimated prevalence of 10% (Fig 1). This estimate is obtained from reports of the prevalence of TMD in the general population in the range of 5% to 10%.[9,10] If an acceptable value for PPV were 0.75 (ie, positive diagnostic tests are correct 3 out of 4 times), then the specificity would have to be set greater than 0.95 while the level of sensitivity could be anywhere between 0.70 to 1.00. This is due to the influence of the low prevalence rate of TMD and the need to be accurate in the nondiseased population to lower the number of false-positive cases. The impact on the PPV by different levels of prevalence, sensitivity, and specificity is shown in Figs 2 and 3. It is easy to see that small changes of specificity levels greatly affect the PPV while the same change in sensitivity levels only minimally alters the predictiveness of the test. In summary, valid positive prediction of disease with low prevalence in a population, such as TMD, requires a more accurate discrimination of nondiseased individuals in the asymptomatic population than diseased individuals in the symptomatic population. This information, coupled with the facts that TMD does not have a high mortality rate and can potentially have a high cost of treatment if carried into reconstructive, orthognathic, or orthodontic interventions, underscores the need for setting specificity levels greater than 0.95 while sensitivity levels may be acceptable at 0.70 or greater.

Evaluation of TMD Examination Methods

This review evaluated six general examination methods for TMD: muscle and joint palpation, auscultation of the TMJ, mandibular kinesiology, electromyography, TMJ imaging techniques, and indices for rating TMD conditions. Emphasis was first placed on assessing the reliability and validity of the measurement techniques in accordance with the previously delineated criteria, and then, whenever possible, on the subsequent use of these techniques for diagnosis including evaluation of sensitivity, specificity, and positive predictive values.

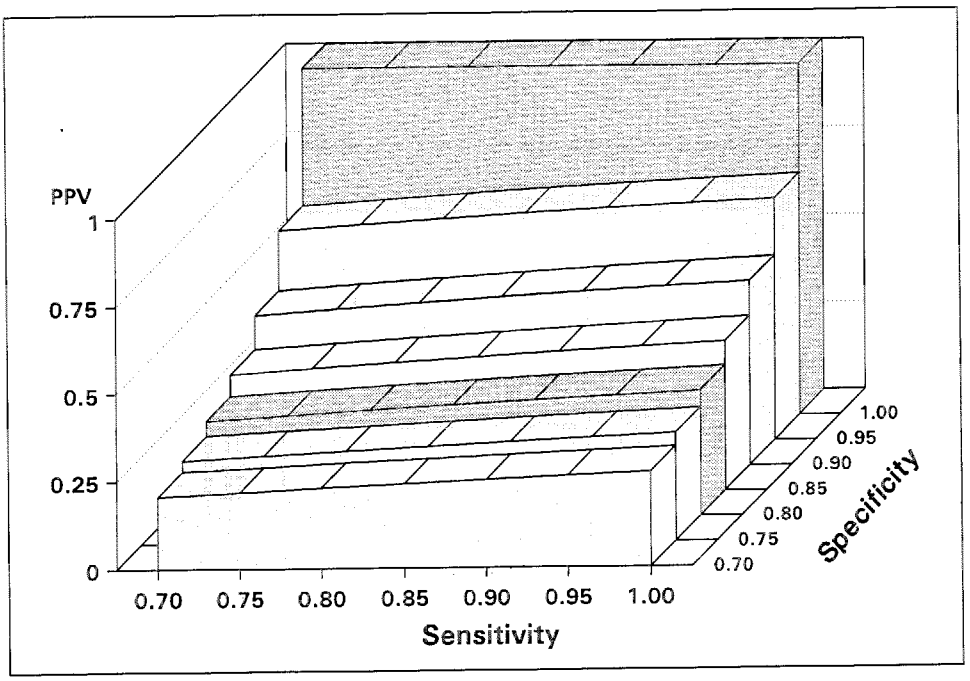

Fig 1 Positive predictive values (PPV) graphed at different sensitivity and specificity levels at a constant prevalence of 10% for TMD. Note the relatively flat change of PPV for different sensitivities but a rather steep increase of PPV at higher levels of specificities. If a PPV of at least 0.75 is required, then specificity would have to be greater than 0.95 and sensitivity could be any value between 0.75 and 1.0.

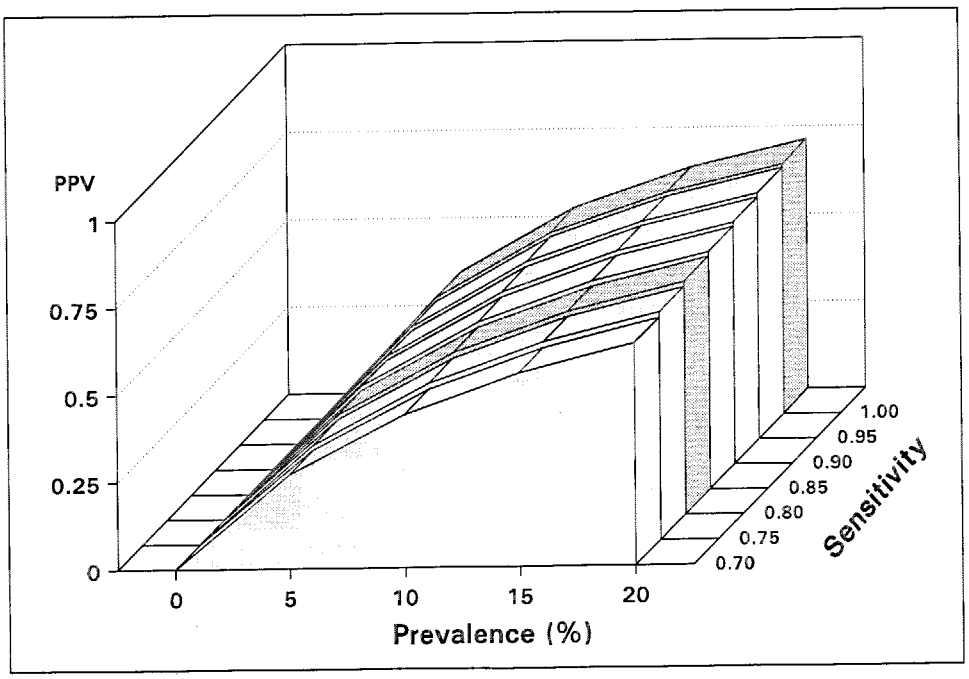

Fig 2 Positive predicitive values (PPV) at different sensitivity levels and different prevalences keeping the specificity constant at 0.90. Notice that PPV never reaches 0.75 at any of the sensitivities evaluated.

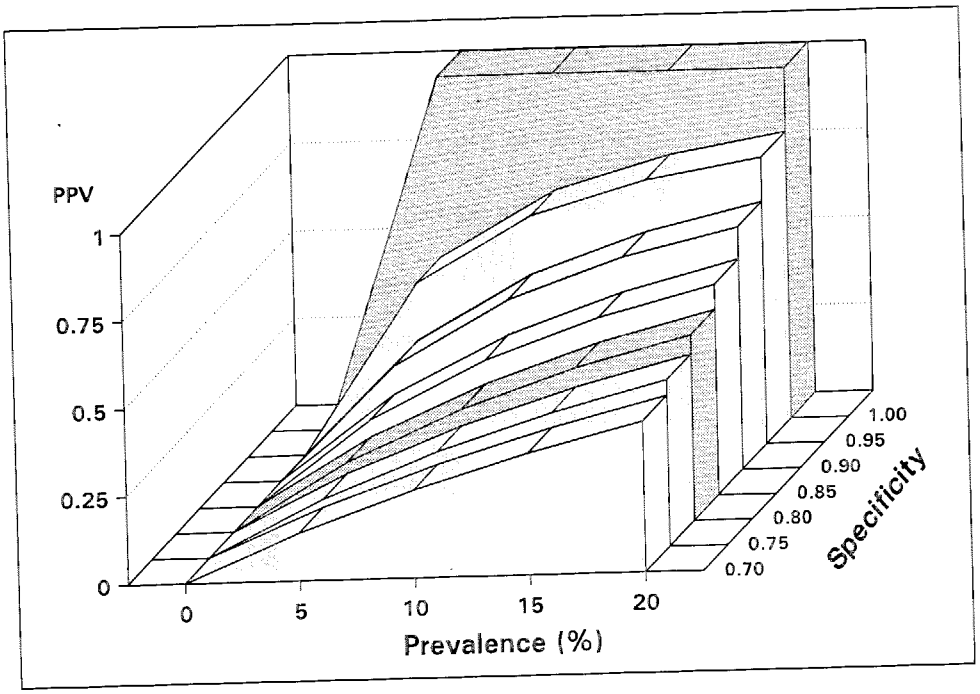

Fig 3 Positive predictive values (PPV) at different specificities for a range of prevalence. Sensitivity was set at 0.90. Note that PPV is greater than 0.75 only when the prevalence is at the high end of the range and with specificity levels greater than 0.95.

Palpation of Muscles and TMJ. The first sign in the classic triad of signs for TMD, according to Laskin,[11] is muscle and/or TMJ pain reported by the patient. Theoretically, determination of pain in these regions can be accomplished by palpation of specific regions representing the masticatory muscles and the lateral or posterolateral aspect of the TMJ.

Measurement Reliability and Validity. An excellent review of the literature regarding muscle palpation reliability study parameters and results for TMD was presented by Dworkin et al.[5] They found that many studies only evaluated general populations, which minimized the spectrum of clinical presentations (mainly asymptomatic) and, therefore, yielded satisfactory reliability scores. However, in their own study of reliability when assessing both symptomatic and asymptomatic populations using trained examiners, extraoral muscle reliability was acceptable but low (kappa = 0.47[5]; 0.4 to 0.6 indicates acceptable agreement and 0.6 to 1.0 is good to perfect agreement[12]) (Landis and Koch, 1977). Similar findings were reported by Goulet and Clark[13] (kappa = 0.31 to 0.55). Intraoral muscle reliability estimates (kappa = 0.27) were found to be lower than extraoral muscle reliability (kappa = 0.47) and TMJ palpation scores were also low (kappa = 0.47), again, similar to Goulet and Clark (kappa = 0.46 to 0.54). Dworkin et al[5] reported that retraining examiners improved the reliability from acceptable to good levels for extraoral (kappa = 0.65) and intraoral (kappa = 0.61) muscles while TMJ palpation scores improved to acceptable levels (kappa = 0.52). In general, trained examiners always had higher reliability scores than untrained examiners. Goulet and Clark[13] also reported that examiners using a pressure algometer to investigate pressure pain thresholds of muscles could achieve ICC reliability values between 0.61 and 0.71, which was higher than the manual palpation scores (ICC = 0.75 to 1.00 indicates acceptable to perfect levels of agreement[14]).

One of the difficulties with estimating reliability of muscle and TMJ palpation is that the reliability score is a reflection of intraexaminer and interexaminer reliability, stability of the phenomenon being measured over time, and reliability of patient report to pain. Since muscle and TMJ palpation responses can vary from one exam to another during the same day or from one day to the next, the difficulty with obtaining high reliability scores is apparent.[5] To overcome these problems, some investigators[5,15,16] have created a single composite score for muscle palpation that produced higher reliability scores (ICC = 0.87 to 0.91). Unfortunately, this approach evaluates muscles as a group rather than individually and may contribute little to a diagnosis involving a single painful muscle or a subset of muscles (see section on Indices for TMD).

Many studies require the examiner to rate the patient's pain response to palpation rather than having the patient rate the pain. Only one study has exam-

ined this issue and found a high reliability of patient ratings with trained examiners (ICC = 0.94) compared to untrained examiners (ICC = 0.80).[5]

Diagnostic Reliability and Validity. There has been no published study that has evaluated the diagnostic reliability and validity of muscle and TMJ palpation for both diseased and nondiseased populations. Several epidemiologic studies that might provide some insight into the diagnostic validity have been conducted; however, they lacked examination of both diseased and nondiseased populations[17] or failed to examine the population using standardized examiners. Only one recent epidemiologic study[10] has used standardized examiners to examine TMD clinic cases, community cases (identified as having facial pain within the last 6 months), and community controls, but specific diagnostic categories were not compiled since radiographic evaluations were lacking.

Auscultation of the TMJ. The second sign of the classic triad for TMD is TMJ sounds. These sounds may occur as a single click or pop, or may consist of multiple sounds or crepitus. The timing of these sounds in the opening and closing movements has often been used to categorize subtypes of intracapsular conditions such as disc displacement with reduction or an irregularity in the condylar path.

Measurement Reliability and Validity. Reliability studies evaluating the presence (or absence) and type of TMJ sounds have found that scores were good using trained examiners directly evaluating the TMJ (kappa = 0.62, palpation method; kappa = 0.61, stethoscope method).[5,15] Indirect evaluation of the TMJ has consisted of examiners listening to tape recordings of no sounds, click/pop, or crepitus sounds and two studies[18,19] have reported low interexaminer agreements of 49.8% and 14%, respectively. One factor regarding the lower reliability scores when listening to tape recordings may be the presence of background noise on the tape, which may be interpreted as crepitus.[19] The intraexaminer rating consistency was found to be fairly high (79%), so the interpretations of the noise were in good agreement by the same examiner.[19]

Another technique, electronic sonography, has been introduced to "objectively" record TMJ sounds and subsequently to characterize the sound based on duration, amplitude, or spectral characteristics. Previous reviews have discussed the advantages and limitations of this technique[20-22] and have questioned the validity of the method since skin and hair sounds, blood flow, respiration, and room sounds contaminate the recording. A recent report[23] has demonstrated that sounds recorded from the skin overlying the TMJ while not moving the mandible contribute to the spectral frequency.

Interestingly, no study has examined the reliability or validity of assessing the timing of TMJ sounds even though this has been used to describe the reciprocal click associated with displaced discs with reduction.

Diagnostic Reliability and Validity. Diagnostic reliability depends heavily upon a true measure of TMJ sounds as well as a stable phenomenon. It is becoming evident that current techniques used to evaluate joint sounds, such as palpation or auscultation, can provide a marginally acceptable assessment. Temporomandibular joint sounds are highly variable from one assessment to the next in the same individual[5,24] and the descriptions can vary from no joint sounds to crepitus to clicking.[5] This variability minimizes the diagnostic reliability, since different examiners may detect different sounds from the same patient.

Although diagnostic validity has not been assessed using standardized examiners, there is evidence in the literature that any TMJ sound is a questionable indicator of disease. The prevalence of any joint sound type in the asymptomatic population has been reported to be 34%[10] and 34.7%.[17] These prevalence estimates would mean that the specificity of the diagnostic criteria (joint sounds) would be approximately 0.65 which is well under the >0.95 specificity scores needed to successfully identify a non-TMD individual.

It may be necessary, therefore, to classify TMJ sounds into subcategories such as clicking or crepitus to further refine diagnostic classifications for TMD. Using these two subclassification as examples, clicking would have a sensitivity of 0.43 and a specificity of 0.76 using the data from Dworkin et al.[10] Using crepitus as a diagnostic criterion, sensitivity would be 0.08 in pain patients and specificity would be 0.92 in asymptomatic individuals. These low sensitivity values may be the result of the lack of stability of the measured joint sounds as discussed above.

The timing of the joint sound in the opening and closing jaw movements may also serve to subclassify joint sounds. One such type of joint sound, termed reciprocal clicking (claimed to be diagnostic for displaced disc with reduction), has been investigated by studies using arthrography, magnetic resonance imaging (MRI), open surgical procedures, and in dissected cadavers to serve as the gold standard (see review by Widmer[21]). The most convincing evidence that this technique may be useful has come from sequential cartooning of MR images of the TMJ and disc made at 5-mm intervals during vertical movements of the jaw.[25] Using this technique, there is no distortion of the joint by introduction of dye (arthrography), surgical procedures, or postmortem preparation (cadavers), and a much closer approximation of the true dynamics of the disc and condyle can be observed. Since this is a relatively new technique, there are no reported measures of diagnostic sensitivity and specificity.

Since the prevalence of joint sounds is similar in the symptomatic and asymptomatic populations, using sounds as a criterion for diagnosis may only serve to decrease the diagnostic validity. Therefore, it is probably necessary for diagnostic criteria to focus on other parameters such as presence or absence of TMJ pain (rather than a nonspecific pain report) to increase the sensitivity and specificity of a diagnostic test for intracapsular conditions.

Mandibular Kinesiology. Mandibular range of

motion studies and movement patterns have been commonly used by clinicians to investigate dysfunction of the masticatory system. Restricted maximal opening and deviations or deflections in the opening path have been reported as the third sign of the classic triad of signs representing TMD. Measurement techniques have included simple measurement devices, such as a millimeter ruler, to sophisticated electronic devices to record the movement of the mandible using magnets or photodiode sensors.

Measurement Reliability and Validity. Vertical mandibular movements measured by a millimeter ruler as maximum unassisted opening without pain, maximum unassisted opening, and maximum assisted opening all were found to be highly reliable using trained examiners with intraclass correlations of 0.90, 0.96, and 0.98, respectively.[5,15] The reliability of measurements made by untrained examiners was acceptable but lower (ICC = 0.72, 0.90, 0.92). Similar correlation coefficients were reported by Goulet and Clark,[13] who used Pearson product correlation coefficients rather than intraclass correlations (maximum unassisted opening without pain, $r = 0.89$; maximum assisted opening, $r = 0.95$).

Vertical jaw opening patterns, defined as straight, corrected deviation or uncorrected deviation, were measured with only marginally acceptable reliability (kappa = 0.70).[15] The low reliability of the vertical pattern may be partially attributed to the observation that jaw movement improves with practice and that the initial examiner may measure a different pattern than subsequent examiners.[26]

Horizontal jaw movements such as lateral excursions and protrusion were observed to be marginally acceptable, with intraclass correlations of 0.70 and 0.68.[15] Also, protrusive jaw movement patterns were much less reliable than the vertical patterns (kappa = 0.38).

The validity of the measurement technique using a millimeter ruler has not been addressed, but unless the ruler is uncalibrated (which is found more commonly than is expected), it is accepted that the measure is an accurate representation of the vertical or horizontal range of motion. It is important to note that the measurement points, such as the upper and lower incisal edges of the right central incisors, must be stated. These may differ among studies making comparisons difficult if not impossible.

Measurement reliability and validity for electronic instrumentation have been discussed in another review.[22,27] It is important to emphasize the necessity of calibrating the instrumentation and verifying that the output is linear within the field of measure. This is currently not a part of the protocol supplied with the instruments by the manufacturers.

Diagnostic Reliability and Validity. Diagnostic reliability of jaw movement parameters has been investigated in one study[28] using the parameters specified by an electronic instrumentation manufacturer to rate good, fair, or poor chewing patterns. Kappa indices were computed and ranged from 0.004 to 0.47, and represented poor to acceptable interexaminer agreement.

There is evidence that the diagnostic validity is low if a standard cutoff value is established for discriminating diseased and nondiseased individuals and if sex and age are not taken into account. Mean measures of maximum unassisted mandibular opening of asymptomatic individuals have been found to differ between sexes by 3.5 mm (males = 52.9; females = 49.4)[10] and 2.5 mm (males = 47.9; females = 45.4).[17] Gross and Gale[17] also reported a significant number of 80- to 89-year-old individuals who have maximal openings less than 37 mm (26.4%), suggesting that range of motion may vary with age.

Diagnostic validity measures of sensitivity, specificity, and positive predictive value can be calculated from a study assessing symptomatic and asymptomatic females.[13] In this study, which used less than 45 mm of maximum vertical opening as the diagnostic measure for diseased, sensitivity (0.79), specificity (0.71), and PPV (0.23 at a prevalence of 10%) were lower than ideal. In another study that used less than 35 mm as the diagnostic measure,[10] sensitivity (0.22) and PPV (0.45 at a prevalence of 10%) were again low, while specificity (0.97) was high.

Jaw movement patterns that deviated more than 4 mm from the midline (measured visually) during vertical opening had a sensitivity of 0.25, specificity of 0.85, and PPV of 0.16 (prevalence = 10%).[10] Movement patterns recorded by electronic instrumentation and defined as diseased according to the manufacturer's criteria have even lower sensitivity (0.57) and specificity (0.40) than visual measures.[22,28] Other parameters, such as speed of movement, vertical freeway space, anterior/vertical ratio, closure trajectory, and chewing movements, have been reviewed elsewhere[22] and have unacceptable sensitivity and specificity values.

Electromyography. Recording the electrical activity of the masticatory muscles has been advocated by many as an "objective" measure to be used on a routine basis to discover the resting and maximal activities of the muscle. Reliability and validity have been covered in detail elsewhere.[20,22,29] As a summary, EMG measurement reliability and validity were found to be technique dependent (surface vs needle vs fine wire). Sensitivity and specificity scores were determined based on the manufacturer's criteria and did not support the use of electromyography as a diagnostic tool for TMD. Also, EMG differences among different facial types, age and sex, thickness of subcutaneous fat, and history of bruxism were suggested as factors that would affect diagnostic validity.

Imaging of the TMJ. Temporomandibular joint images can be obtained by various techniques, such as transcranial radiography, tomography, arthrography, computerized tomography (CT), MRI, single photon emission computed tomography (SPECT), and planar bone scintigraphy. Bone can be visualized using all these techniques; however, soft tissue structures such as the TMJ disc requires CT or MRI. The

technique of MRI has attracted much attention in recent years because of its capabilities for producing an accurate portrayal of soft and hard tissue within and around the joint without using radiation.

Measurement Reliability and Validity. The MRI and CT reliability studies for TMJ imaging would need multiple acquisitions of the same structure using the same orientations. Although no reliability tests have been performed and reported, it appears that few questions have been raised regarding the reproducibility of the techniques for acquisition of the image. Evaluation of reliability for determining disc orientation relative to the condyle using the junction of the posterior band and the bilaminar zone has found a measurement error of ±5 degrees.[30]

More emphasis has been placed on determining the validity of measurement using MRI. A few studies have used anatomic cryosections of autopsy specimens to serve as the "true" structure and evaluated MR images for disc position, disc configuration, and bony abnormalities.[31,32] Disc orientation was determined accurately for 73% to 85% of the images; disc configuration 60% to 77% of the time; and bony abnormalities in 60% to 100% of the readings.[33]

Diagnostic Reliability and Validity. There are apparently no published reports evaluating the diagnostic reliability of various imaging techniques for the TMJ. This could easily be accomplished by having a number of examiners blindly evaluate a set of images and assign diagnoses and then compare their results.

Diagnostic validity of various types of imaging has been the subject of several studies. One such study reported that the junction of the posterior band and the bilaminar zone should be within ±10 degrees of a line vertical and through the center of the condylar head to be in the 95th percentile of normal after evaluating 50 asymptomatic TMJs.[30] Unfortunately, this criterion has not been applied to both an asymptomatic and symptomatic population for determination of true positives and true negatives.

Recently, Westesson et al[34] reported the sensitivity, specificity, and positive predictive value of both CT and MRI. When comparing MRI and CT for disc position, they found that MRI had an equal sensitivity (0.86 vs 0.86), higher specificity (0.63 vs 0.50), and higher positive predictive value (0.67 vs 0.60) using the prevalence rate of 47% (their actual sample of patients and nonpatients). However, the prevalence of clicking in the general population is approximately 25%, thus changing the PPV of MRI to 0.44, which is less than predicting by chance. For bony evaluation, computerized tomography was far superior to MRI, with higher sensitivity (0.75 vs 0.50), higher specificity (1.00 vs 0.67), and a higher PPV (1.00 vs 0.67), but again, this PPV was calculated using the prevalence in their sample rather than prevalence in the population. Since the prevalence of bony abnormalities in the general population is currently unknown, an accurate PPV cannot be calculated at this time.

Equally positive findings of high sensitivity and specificity for MRI were reported in a study comparing MRI, SPECT bone scintigraphy, and planar scintigraphy. Magnetic resonance imaging was more sensitive (0.88) compared to SPECT (0.76) or planar (0.56) scintigraphy for detecting internal derangements.[35] Diagnostic specificity of these techniques was reported as 0.50 for MRI, 0.17 for SPECT, and 0.33 for planar. It is interesting to note that the lower specificities for MRI may be due to the use of arthrography as the "gold" standard. The arthrographic procedure may distort the joint and incorrectly assign an internal derangement as "normal" while MRI identified the joint as a positive diagnosis. This would increase the number of false positives and thereby reduce the specificity of the diagnostic technique. Since arthrographic validation can only be achieved by some other independent measure of the joint anatomy, it is difficult to accept procedures such as arthrography or direct visualization of the joint anatomy during surgery as the gold standard, since it is obvious that these procedures can distort the true anatomy.

Indices for TMD. Reliability of diagnostic testing for TMD has been presented on a measure by measure basis, but another approach has been to create an index that consists of a summary score representing a group of measurements. Dworkin et al[5] have commented on some of the limitations of composite scores, including the inability to evaluate subgroups. Reliability measures using these indices are higher than the individual reliabilities for each component, but the meaning of the measure becomes more difficult to interpret.

Measurement Reliability and Validity. The reliability of the craniomandibular index, as one example, is based on a 62-item composite score and has been reported to have an intraclass correlation of 0.95.[16] Subindices of the craniomandibular index, such as the palpation index (ICC = 0.87), had lower reliabilities for each of its sets of measures including extraoral jaw muscle palpation (ICC = 0.81), neck muscle palpation (ICC = 0.84), and intraoral muscle palpation (ICC = 0.58). Similarly, the dysfunctional index (ICC = 0.84) was composed of mandibular movement (ICC = 0.88), TMJ noise (ICC = 0.85), and TMJ palpation (ICC = 0.77). The inclusion of specific physical signs, such as restricted maximal opening, and pain reports that are not specific to the examined structure obscure a focused assessment of what the index represents.

Diagnostic Reliability and Validity. There are no reported studies of diagnostic reliability and validity of the overall craniomandibular index. However, being composed of diagnostic measures, which were covered earlier in this paper, the diagnostic validity of the indices are limited to, at best, the diagnostic validity of their individual components.

Individual components of the craniomandibular index were tested as diagnostic criteria for internal derangements using arthrotomography as a gold stan-

dard. Sensitivity and specificity levels were reported for the global diagnosis of ID for a sample of consecutive clinic cases presenting for arthrograms.[36] Assessing the diagnostic validity of the TMJ Scale was reported in one study.[37] This study reported Pearson product correlation coefficients that ranged from 0.34 to 0.69 and were assessed as "satisfactory" as valid diagnostic measures. Unfortunately, no measures of sensitivity, specificity, or positive predictive values were included in their study, and since there are no reported numbers of successful or unsuccessful diagnoses by their indices it is not possible to calculate sensitivity or specificity.

Summary and Conclusions

This review has examined the background and developed the rationale for assessing the reliability and validity of clinical measurement and diagnosis for TMD. Formulation of the rationale involved the determination of acceptable levels of sensitivity, specificity, and positive predictive values of diagnostic tests specifically for TMD. This information then formed the basis for the second part of the review to assess current techniques used for evaluation of TMD. Knowledge of the advantages and limitations of current assessment techniques can aid in the development of research diagnostic criteria for TMD with the understanding that certain methodologies may be more reliable and valid than others. For example, traditional clinical measurements of muscle palpation and mandibular range of motion can be achieved with acceptable reliabilities. More important, it appears that reliabilities may be improved by retraining experienced examiners. In cases of existing TMJ arthropathy, imaging may help to substantiate clinical impressions of bony or soft tissue abnormalities but by itself lacks the ability to discriminate asymptomatic from symptomatic patients with a high predictive rate. The same conclusion was reached for TMJ sounds. There is also no apparent added advantage to using electronic instrumentation to enhance our clinical measurements and diagnostic abilities, since these instruments lack the necessary sensitivity and specificity levels required for acceptable positive prediction of TMD. Finally, composite indices that provide a general overview of musculoskeletal signs and symptoms may not isolate specific subpopulations of patients that are currently classified under the broad heading of TMD. Recognizing diagnostic subpopulations based on specific signs and symptoms may provide a starting point for establishing diagnostic criteria that can be further refined as epidemiologic data, treatment outcome studies, and other factors establish the boundaries for these conditions.

References

1. McNeil BJ, Keeler E, Adelstein SJ: Primer on certain elements of medical decision making. *N Engl J Med* 1975;293:211–215.
2. Feinstein AR: *Clinical Biostatistics*. St Louis, CV Mosby, 1977, pp 214–226.
3. Begg CB: Statistical methods in medical diagnosis. *Crit Rev Med Inform* 1986;1:1–22.
4. Swets JA: Measuring the accuracy of diagnostic systems. *Science* 1988;240:1285–1293.
5. Dworkin SF, LeResche L, Derouen T: Reliability of clinical measurement in temporomandibular disorders. *Clin J Pain* 1988;4:88–99.
6. Nunnally JC: *Psychometric Theory*, ed 2. New York, McGraw Hill, 1978.
7. Yunus MB: Diagnosis, etiology and management of fibromyalgia syndrome: An update. *Comp Ther* 1988;14:8–20.
8. Feighner JP, Herbstein J: Diagnostic validity, in Last CG, Hersen M (eds): *Issues in Diagnostic Research*. New York, Plenum Press, 1987, pp 121–140.
9. Rugh JD, Solberg WK: Oral health status in the United States: Temporomandibular Disorders. *J Dent Educ* 1985;49:398–405.
10. Dworkin SF, Huggins KH, LeResche L, Von Korff M, Howard J, Truelove E, Sommers E: Epidemiology of signs and symptoms in temporomandibular disorders: Clinical signs in cases and controls. *J Am Dent Assoc* 1990;120:273–281.
11. Laskin DM: Etiology of the pain-dysfunction syndrome. *J Am Dent Assoc* 1969;79:147–153.
12. Landis JR, Koch GG: The measurement of observer agreement for categorical data. *Biometr* 1977;33:159–174.
13. Goulet J-P, Clark GT: Clinical TMJ examination methods. *J Calif Dent Assoc* 1990;18:25–33.
14. Shrout PE, Fleiss JL: Intraclass correlations: Uses in assessing rater reliability. *Psychol Bull* 1979;86:420–428.
15. Dworkin SF, LeResche L, Derouen T, Von Korff M: Assessing clinical signs of temporomandibular disorders: Reliability of clinical examiners. *J Prosthet Dent* 1990;63:574–579.
16. Fricton JR, Schiffman EL: Reliability of the craniomandibular index. *J Dent Res* 1986;65:1359–1364.
17. Gross A, Gale EN: A prevalence study of the clinical signs associated with mandibular dysfunction. *J Am Dent Assoc* 1983;107:932–936.
18. Milner D, LeResche L, Dworkin SF, Hammen V: TMJ sounds: Characteristics and examiner reliability. *J Dent Res* 1991;70:371 (abstr).
19. Eriksson L, Westesson P-L, Sjoberg H: Observer performance in describing temporomandibular joint sounds. *J Craniomand Pract* 1987;5:32–35.
20. Mohl ND, Lund JP, Widmer CG, McCall WD Jr: Devices for the diagnosis and treatment of temporomandibular disorders. Part II: Electromyography and sonography. *J Prosthet Dent* 1990;63:332–336.
21. Widmer CG: Temporomandibular joint sounds: A critique of techniques for recording and analysis. *J Craniomandib Disord Facial Oral Pain* 1989;3:213–217.
22. Widmer CG, Lund JP, Feine JS: Evaluation of diagnostic tests for TMD. *J Calif Dent Assoc* 1990;18:53–60.
23. Gallo LM, Airoldi R, Ernst B, Palla S: TMJ sounds: Qualitative spectral analysis of asymptomatic subjects. *J Dent Res* 1991;70:371 (abstr).
24. Truelove E, LeResche L, Sommers E, Dworkin SF, Huggins KH, Reay B: Reliability of TMJ sounds in patients and controls. *J Dent Res* 1987;66:336 (abstr).
25. Conway WF, Hayes CW, Campbell RL, Laskin DM: Temporomandibular joint motion: Efficacy of fast low-angle shot MR imaging. *Radiology* 1989;172:821–826.
26. Clark GT, Lynn P: Horizontal plane jaw movements in controls and clinic patients with temporomandibular dysfunction. *J Prosthet Dent* 1986;55:730–735.
27. Mohl ND, McCall WD, Lund JP, Plesh O: Devices for the diagnosis and treatment of temporomandibular disorders. Part I: Introduction, scientific evidence, and jaw tracking. *J Prosthet Dent* 1990;63:198–201.

28. Feine JS, Hutchins MO, Lund JP: An evaluation of the criteria used to diagnose mandibular dysfunction with the mandibular kinesiograph. *J Prosthet Dent* 1988;60:374–380.
29. Lund JP, Widmer CG: An evaluation of the use of surface electromyography in the diagnosis, documentation and treatment of dental implants. *J Craniomandib Disord Facial Oral Pain* 1989;3:125–137.
30. Drace JE, Enzmann DR: Defining the normal temporomandibular joint; Closed-, partially open-, and open-mouth MR imaging of asymptomatic subjects. *Radiology* 1990;177:67–71.
31. Hansson L-G, Westesson P-L, Katzberg RW, Tallents RH, Kurita K, Holtas S, Svensson SA, Eriksson L, Johansen CC: MR imaging of the temporomandibular joint: Comparisons of images of autopsy specimens made at 0.3 T and 1.5 T with anatomic cryosections. *AJR* 1989;152:1241–1244.
32. Westesson P-L, Katzberg RW, Tallents RH, Sanchez-Woodworth RE, Svensson SA: Temporomandibular joint: Comparison of MR images with cryosectional anatomy. *Radiology* 1987;164:59–64.
33. Drace JE, Young SW, Enzmann DR: TMJ meniscus and bilaminar zone: MR imaging of the substructure-diagnostic landmarks and pitfalls of interpretation. *Radiology* 1990;177:73–76.
34. Westesson P-L, Katzberg RW, Tallents RH, Sanchez-Woodworth RE, Svensson SA: CT and MR of the temporomandibular joint: Comparison with autopsy specimens. *AJR* 1987;148:1164–1171.
35. Krasnow AZ, Collier BD, Kneeland JB, Carrera GF, Ryan DE, Gingrass D, Sewall S, Hellman RS, Isitman AT, Froncisz W, Jesmanowicz A, Hyde JS: Comparisons of high-resolution MRI and SPECT bone scintigraphy for noninvasive imaging of the temporomandibular joint. *J Nucl Med* 1987;28:1286–1274.
36. Schiffman E, Anderson G, Fricton J, Burton K, Schellhas K: Diagnostic criteria for intraarticular TM disorders. *Community Dent Oral Epidemiol* 1989;17:252–257.
37. Lundeen TF, Levitt SR, McKinney MW: Discriminative ability of the TMJ Scale: Age and gender differences. *J Prosthet Dent* 1986;56:84–92.

meniscus and
structure-diag-
tation. *Radiol-*

RH, Sanchez-
IR of the tem-
autopsy speci-

, Carrera GF,
n RS, Isitman
: Comparisons
e scintigraphy
romandibular

ton K, Schell-
ılar TM disor-
9;17:252–257.
Discriminative
differences. *J*

PART II

Research Diagnostic Criteria

A. Axis I: Clinical TMD Conditions

Editor:
Linda LeResche, ScD
Research Associate Professor
Department of Oral Medicine
University of Washington
Seattle, Washington

Major Contributors:
James Fricton, DDS, MS
Norman Mohl, DDS, PhD
Earl Sommers, DDS, MSD
Edmond Truelove, DDS, MSD

B. Axis II: Pain-Related Disability and Psychological Status

Editor:
Michael R. Von Korff, ScD
Associate Director for Research
Center for Health Studies
Group Health Cooperative
Seattle, Washington

Major Contributors:
Samuel Dworkin, DDS, PhD
James Fricton, DDS, MS
Richard Orbach, DDS, MS

A. Axis I: Clinical TMD Conditions

The strengths and weaknesses of the various existing classification schemes for TMD have been reviewed in Part I. The aim of the classification proposed in this section is to provide standardized criteria for research purposes, based on the current state of knowledge concerning TMD. It is important to emphasize that the classification criteria and assessment methods have been designed to maximize reliability across research settings and to minimize variability in examination methods and clinical judgment that might influence the classification process. Thus the classification criteria are proposed for clinical and epidemiologic research purposes. The strengths and limitations of these criteria for clinical practice were not considered.

The following aspects of the proposed classification scheme are designed to increase the standardization of the research diagnoses:

1. An attempt was made to word each criterion in unambiguous terms. Words such as "often" or "seldom" have been avoided. Phrases such as "limited opening" have been replaced with specific measurements, eg, "maximum unassisted opening $\leq$35 mm."
2. Each criterion is tied to a specific set of examination and/or interview items, which can be found in the proposed assessment materials (see Part III on history, examination, and specifications). For each examination item, detailed specifications are provided for performing the clinical procedures used in obtaining the measurement. Using the specifications provided, it is known that examiners (either dentists or dental hygienists) can be calibrated to acceptable levels of reliability for each measurement.
3. The criteria have been tested for their logic and internal consistency by applying them to existing examination and interview data bases with several hundred TMD cases and controls. (These analyses are currently being prepared for publication.) This exercise has assured us that the criteria can, in fact, be operationalized, and that they produce seemingly reasonable prevalence rates, logical patterns of multiple diagnoses, and nonoverlap of populations with diagnoses that are proposed as mutually exclusive. It is of course possible that ambiguities or inconsistencies remain despite these precautions. If any are found by investiga-

tors using these criteria, the authors would appreciate being informed so that changes can be made in future versions. It is essential to recognize that the validation of these diagnostic criteria (in terms of causal mechanisms, prognosis, response to treatment, internal consistency of objective findings, and other validating criteria) remains to be assessed through their application in research.

The diagnostic system as proposed is nonhierarchical and allows for the possibility of multiple diagnoses for a given subject. Diagnoses are divided into three groups:

I. Muscle diagnoses
   a. Myofascial pain
   b. Myofascial pain with limited opening
II. Disc displacements
   a. Disc displacement with reduction
   b. Disc displacement without reduction, with limited opening
   c. Disc displacement without reduction, without limited opening
III. Arthralgia, arthritis, arthrosis
   a. Arthralgia
   b. Osteoarthritis of the TMJ
   c. Osteoarthrosis of the TMJ

This diagnostic system is not comprehensive; it was felt that too little data currently exist on the reliability of criteria and assessment methods for the rarer disorders to develop a comprehensive classification system. Rather, the participants agreed that a standardized classification system for the most common temporomandibular disorders should be the priority at this time.

The rules for assigning diagnoses are as follows: A *subject* can be assigned at most one muscle (Group I) diagnosis (either myofascial pain or myofascial pain with limited range of motion, but not both). In addition, each *joint* may be assigned at most one diagnosis from Group II and one diagnosis from Group III. *That is, diagnoses within any given group are mutually exclusive.* This means that, in principle, a subject can be assigned from zero diagnoses (no diagnosable muscle or joint conditions) to five diagnoses (one muscle diagnosis plus one diagnosis from Group II and one from Group III for each joint). In practice, cases assigned more than three diagnoses are very rare.

The following sections list criteria for each disorder. The item numbers given after each criterion refer to the examination items (E) and/or history questionnaire items (Q) used to assess that criterion.

Group I: Muscle Disorders

Muscle disorders include both painful and nonpainful disorders. This classification deals only with the most common painful disorders associated with TMD. In using the classification, the following uncommon conditions should first be ruled out: muscle spasm, myositis, and contracture. Criteria for these disorders are included in an Appendix at the end of Axis I criteria.

I.a. Myofascial Pain: Pain of muscle origin, including a complaint of pain as well as pain associated with localized areas of tenderness to palpation in muscle.
1. Report of pain or ache in the jaw, temples, face, preauricular area, or inside the ear at rest or during function (Q 3); plus
2. Pain reported by the subject in response to palpation of three or more of the following 20 muscle sites (right side and left side count as separate sites for each muscle): posterior temporalis, middle temporalis, anterior temporalis, origin of masseter, body of masseter, insertion of masseter, posterior mandibular region, submandibular region, lateral pterygoid area, and tendon of the temporalis. At least one of the sites must be on the same side as the complaint of pain (E 1, 8, 10).

I.b. Myofascial Pain With Limited Opening: Limited movement and stiffness of the muscle during stretching in the presence of myofascial pain.
1. Myofascial pain as defined in I.a; plus
2. Pain-free unassisted mandibular opening of less than 40 mm (E 4a, 4d); plus
3. Maximum assisted opening (passive stretch) of 5 or more mm greater than pain-free unassisted opening (E 4a, 4c, 4d).

Group II: Disc Displacements

II.a. Disc Displacement With Reduction: The disc is displaced from its position between the condyle and the eminence to an anterior and medial or lateral position, but reduces on full opening, usually resulting in a noise. Note that when this diagnosis is accompanied by pain in the joint, a diagnosis of arthralgia (III.a) or osteoarthritis (III.b) must also be assigned.
1. Either:
   a. Reciprocal clicking in TMJ (click on both vertical opening and closing that occurs at a point at least 5 mm greater interincisal distance on opening than on closing and is eliminated on protrusive opening), reproducible on two of three consecutive trials (E 5); or
   b. Click in TMJ on both vertical range of motion (either opening or closing), reproducible on two of three consecutive trials, *and* click during lateral excursion or protrusion, reproducible on two of three consecutive trials (E 5a, 5b, 7).

II.b. **Disc Displacement Without Reduction, With Limited Opening:** A condition in which the disc is displaced from normal position between the condyle and the fossa to an anterior and medial or lateral position, associated with limited mandibular opening.
1. History of significant limitation in opening (Q 14, both parts); plus
2. Maximum unassisted opening ≤35 mm (E 4b, 4d); plus
3. Passive stretch increases opening by 4 mm or less over maximum unassisted opening (E 4b, 4c, 4d); plus
4. Contralateral excursion <7 mm and/or uncorrected deviation to the ipsilateral side on opening (E 3, 6a or 6b, 6d); plus
5. Either: (a) absence of joint sounds, or (b) presence of joint sounds not meeting criteria for disc displacement with reduction (see II.a) (E 5, 7).

II.c. **Disc Displacement Without Reduction, Without Limited Opening:** A condition in which the disc is displaced from its position between the condyle and the eminence to an anterior and medial or lateral position, not associated with limited opening.
1. History of significant limitation of mandibular opening (Q 14 both parts); plus
2. Maximum unassisted opening >35 mm (E 4b, 4d); plus
3. Passive stretch increases opening by 5 mm or more over maximum unassisted opening (E 4b, 4c, 4d); plus
4. Contralateral excursion ≥7 mm (E 6a or 6b, 6d); plus
5. Presence of joint sounds not meeting criteria for disc displacement with reduction (see II.a) (E 5, 7).
6. (In those studies that allow imaging, the following imaging criteria should also be met. The investigator should report whether the diagnosis was made with imaging or on the basis of clinical and history criteria only.) *Imaging* conducted by either arthrography or MRI reveals displacement of disc without reduction.
   a. *Arthrography:* (1) In intercuspal occlusal position, the anterior compartments appear larger and markedly more filled with contrast medium than in a normal joint; (2) on opening, significant contrast medium is retained anteriorly.
   b. *MRI:* (1) In intercuspal occlusal position, the posterior band of the disc is located clearly anterior to the 12:00 position, at least at the 11:30 position; (2) on full opening, the posterior band remains clearly anterior to the 12:00 position.

Group III: Arthralgia, Arthritis, Arthrosis

In making diagnoses of disorders in this group, polyarthridites, acute traumatic injuries, and infections in the joint should first be ruled out, as described on page 330.

III.a. **Arthralgia:** Pain and tenderness in the joint capsule and/or the synovial lining of the TMJ.
1. Pain in one or both joint sites (lateral pole and/or posterior attachment) during palpation (E 9); plus
2. One or more of the following self-reports of pain: pain in the region of the joint, pain in the joint during maximum unassisted opening, pain in the joint during assisted opening, pain in the joint during lateral excursion (E 2, 4b, 4c, 4d, 6a, 6b).
3. For a diagnosis of simple arthralgia, coarse crepitus must be absent (E 5, 7).

III.b. **Osteoarthritis of the TMJ:** Inflammatory condition within the joint that results from a degenerative condition of the joint structures.
1. Arthralgia (see III.a); plus
2. Either a or b (or both):
   a. Coarse crepitus in the joint (E 5, 7).
   b. *Imaging*—Tomograms show one or more of the following: erosion of normal cortical delineation, sclerosis of parts or all of the condyle and articular eminence, flattening of joint surfaces, osteophyte formation.

III.c. **Osteoarthrosis of the TMJ:** Degenerative disorder of the joint in which joint form and structure are abnormal.
1. Absence of all signs of arthralgia, ie, absence of pain in the region of the joint, and absence of pain in the joint on palpation, during maximum unassisted opening, during maximum unassisted opening, and on lateral excursions (see III.a); plus
2. Either a or b (or both):
   a. Coarse crepitus in the joint (E 5, 7).
   b. *Imaging*—Tomograms show one or more of the following: erosion of normal cortical delineation, sclerosis of parts or all of the condyle and articular eminence, flattening of joint surfaces, osteophyte formation.

APPENDIX TO AXIS I: Ruling Out Muscle and Joint Conditions Prior to Use of RDC Criteria

I. Muscle Spasm, Myositis, and Contracture. While diagnostic criteria for muscle spasm, myositis, and contracture are not precise, the following general guidelines are offered: *muscle spasm* is characterized by continuous muscle contraction; *myositis* is char-

acterized by generalized tenderness in a specific muscle associated with known trauma or infection; *contracture* is characterized by limited range of motion with unyielding firmness on passive stretch. These criteria are less specific than those offered for the major RDC categories because of the lack of research on these less common conditions.

II. Polyarthridites, Acute Traumatic Injury. Cases with TMJ arthralgia *and* symptomatic involvement of other joints in the body without evidence of traumatic causality should be classified by a rheumatologist with respect to the presence or absence of a specific *polyarthritic* condition, such as rheumatoid arthritis, juvenile rheumatoid arthritis, crystal-induced joint diseases, Lyme disease, or other relatively rare systemic conditions affecting joints. Because of the lack of a well-defined approach to diagnosis and the limited efficacy of the available diagnostic tests, different rheumatologists may use different criteria to define the presence or absence of such polyarthritides. The rheumatologist's diagnosis should be regarded as the "gold standard." Cases with a diagnostic label of systemic polyarthritic involvement should not be pooled with any of the subentities listed under "Other Joint Conditions." A screening item for polyarthritides is included as question 16 of the questionnaire. If either part a or part b of question 16 is answered "yes," or if both part c and part d of question 16 are answered "yes," the case should be classified by a rheumatologist with respect to the presence or absence of systemic arthritic diseases.

Acute cases of traumatic exposure to either the face or jaw should be examined for possible acute traumatic TMJ arthropathy. The clinical picture is characterized by pain and tenderness of the affected TMJ, limited range of motion due to pain, and lack of or reduced tooth contacts on the affected side due to increased intra-articular pressure. This diagnostic category is not to be included in any of the subentities listed under "Other Joint Conditions." A screening item for acute traumatic arthritis is included as question 17 of the questionnaire.

B. Axis II: Pain-Related Disability and Psychological Status

Clinical diagnoses of TMD, as defined by the Axis I diagnoses in the preceding section, apply criteria identifying abnormalities of structure and function of the muscles of mastication and/or the TMJs. Clinical experience and research for a variety of chronic pain conditions, including TMD, suggest that there is not a one to one correspondence between the global severity of a chronic pain condition and the nature or extent of pathophysiologic change described by a clinical diagnosis.[1-3] The assessment of global severity requires different information than that needed to make Axis I diagnoses.

From a clinical perspective, specific interventions *not targeting pathophysiology* may be used to control pain, disability, and depression. From a research perspective, these phenomena each have unique causes and consequences in addition to pathophysiologic bases of the pain condition. For these reasons, the proposed RDC/TMD employs Axis II to assess and classify the global severity of the pain condition in terms of: (1) pain intensity; (2) pain-related disability; (3) depression; and (4) nonspecific physical symptoms.

The measures incorporated into Axis II were specifically designed with ease of use in mind. While the development of some of these measures depends on more complex statistical analyses, the measures themselves are straightforward and brief. For example, it is possible to develop a reliable and valid measure for grading chronic pain dysfunction which requires only seven items and which can be answered by patients using scales very similar to the visual analog scales for grading pain that are in common use in research and clinical settings.

Criteria for Selecting Axis II Measures

The following criteria were considered in selecting assessment methods for Axis II:

1. The methods should have demonstrated reliability and validity.
2. The methods should provide a clinically meaningful classification of subjects, including the availability of population norms if possible;
3. The classification of subjects should be based on simple scoring algorithms not requiring complex computer scoring.
4. The methods should be brief and suitable for administration by paper and pencil test, in-person interview, or telephone interview to meet a broad range of research needs, including those of both epidemiologic and clinical research applications.

Dysfunctional Chronic Pain as a Summary Construct for Pain Intensity and Associated Disability

The subjective report of pain intensity is widely accepted as an important facet of the severity of a pain condition. However, pain intensity alone may

not discriminate the higher levels of pain severity. Clinical observation and behavioral theory[4,5] both suggest that activity limitation is at least as important in discriminating the higher levels of severity of a chronic pain condition as pain intensity.

In work relevant to assessment of the severity of chronic pain in terms of pain intensity and pain-related disability, Turk and Rudy[1,6] have advocated multiaxial classification of chronic pain. They developed a taxonomy of chronic pain based on Multidimensional Pain Inventory (MPI) data.[7] They identified three pain profiles: adaptive coping, interpersonally distressed, and dysfunctional chronic pain. Dysfunctional chronic pain is a profile of severe pain, functional disability, psychological impairment, and low perceived life control. They, and others, have shown that MPI data are reliable and have concurrent validity in classifying pain clinic patients as dysfunctional or not. The assessment method has been shown to have concurrent validity for several different anatomical pain sites including back pain, headache, and TMD pain.

Using a different set of items to assess pain dysfunction, but drawing on Turk and Rudy's concepts of dysfunctional chronic pain, Von Korff et al[8] evaluated the validity of grading chronic pain status in a general population sample. In this research, dysfunctional chronic pain was defined as severe and persistent pain accompanied by seven or more days in the prior 6 months when the subject was unable to carry out usual activities because of pain. They found that 2.7% of the population sample and 15.7% of a sample of persons from the same population seeking treatment for TMD pain met these criteria for dysfunctional chronic pain. In both samples, dysfunctional chronic pain was associated with psychological impairment, unfavorable self-assessment of global health status, and frequent use of health care visits and pain medications as assessed by computerized health care data. The predictive validity of the graded classification of dysfunctional chronic pain was also assessed among the TMD pain patients.[9] Among patients meeting criteria for dysfunctional chronic pain at baseline, 42.3% also met criteria again 1 year later. In contrast, 11.8% of patients with severe and persistent pain at baseline and 5.2% of patients with recurrent pain at baseline met study criteria for dysfunctional chronic pain 1 year later.

As part of the development of study measures for the Medical Outcomes Survey, Sherbourne[10] evaluated the concurrent validity of a global pain assessment scale whose items were consistent with Turk and Rudy's construct of dysfunctional chronic pain. She reported high internal consistency (alpha = 0.83). The scale was strongly associated ($r > 0.50$) with concurrent measures of physical functioning, physical role limitations, self-rated health status, and health distress. It was moderately associated ($r > 0.30$) with concurrent measures of emotional role limitations, sleep disturbance, cognitive functioning, psychological distress and well-being, and resistance to illness.

In primary care samples of back pain, headache, and TMD pain patients, Von Korff et al[11] used item response theoretic methods to develop a brief and simple approach to graded classification of dysfunctional chronic pain. These revised methods of graded classification of chronic pain employed items measuring pain intensity, interference with usual activities, family and social activities, work activities, and disability days due to pain. Reliability analyses for a hierarchical (Guttman-type) measurement scale suggested that measures of pain intensity tended to scale the lower range of global severity, while measures of pain-related disability scaled the upper range of global severity. Evaluation of concurrent validity found that this revised graded classification of chronic pain dysfunction showed a strong and monotonically increasing relationship with unemployment rate, a pain disability scale score, depression, unfavorable ratings of health status, frequent use of narcotic analgesics in the prior month, and frequent pain-related doctors visits. Applying the same criteria for grading chronic pain dysfunction to a population sample surveyed at baseline and followed up 3 years later, they found that chronic pain grade at baseline strongly predicted chronic pain status at the 3-year follow-up. It was also significantly associated with pain disability scale score, depression, and self-rated health status at the 3-year follow-up in the population sample.

These results provide strong support for the validity of Turk and Rudy's construct of dysfunctional chronic pain in general population, primary care, and pain clinic samples.[1] Available data suggest that the construct can be applied to different anatomically defined pain conditions, that it has concurrent and predictive validity across several different methods of assessment, and that measures of chronic pain dysfunction are associated with important psychological and behavioral correlates of chronic pain assessed by self-report and by medical records data.

Brief Methods of Assessing Dysfunctional Chronic Pain

Three alternative approaches to assessment of dysfunctional chronic pain were considered for inclusion in the RDC assessment methods: MPI items forming a brief screening assessment for dysfunctional chronic pain[12]; the Medical Outcomes Survey-Pain Index (MOS-PI) developed by Sherbourne[10]; and the methods of grading chronic pain severity identified by Von Korff et al.[13] A more detailed consideration of these methods and their relationship to the underlying concepts of dysfunctional chronic pain is presented elsewhere.[13]

Review of these three brief scales indicates many similarities and some differences. All three ask ques-

tions about characteristic pain intensity (pain right now, average pain, and/or worst pain). All three scales include items concerning pain-related interference with activities (pain-related activity limitation days and/or ratings of interference with activities). The MPI Short Scale and the MOS-PI also include items concerning psychological impairments associated with pain. The scale for grading chronic pain severity did not include items about psychological impairment, but it has been shown to strongly predict depression.[11]

What are the advantages and disadvantages of each? The MPI has been used extensively in pain clinic populations and provides multidimensional information about pain status. A researcher using MPI scales in epidemiologic work would be able to determine the extent to which cases were as severe as dysfunctional pain clinic cases. There are also normative data available for the MPI for TMD patients seen in pain clinics, but not for primary care and general population samples. It has not been extensively used in personal or telephone interview formats. Longer-term prognostic data for the MPI are not yet reported.

The MOS-PI is part of a larger assessment battery that assesses a number of aspects of functioning and well-being. Because it briefly covers a large number of areas using items that have generally been found to predict health outcomes and behaviors, the MOS is becoming widely adopted in health services research applications. Normative data are available for general medical patients, but not for general population or pain clinic samples. The MOS-PI has not been used specifically with TMD pain patients. The short- or long-term prognostic value of the MOS Pain Index has not yet been reported.

The scale for grading chronic pain severity has been evaluated in a large population survey with a 3-year follow-up and in large samples of primary care pain patients, including large numbers of TMD pain patients. It has not yet been evaluated in a pain clinic population. The prognostic value at 3-year follow-up has been reported for a general population sample. Site-specific normative data have been reported for primary care back pain, headache, and TMD pain patients. The questions and response scoring were designed to be suitable for administration as a paper and pencil questionnaire, by personal interview, or by telephone interview. The scale could be used as a continuous measure of global pain severity, but its intended use is grading the level of pain dysfunction into ordered categories. The hierarchical criteria for grading chronic pain status are simple to apply and easy to communicate.

Based on review of this work, the graded classification of chronic pain severity was selected as the basis for assessing pain intensity and associated disability for the RDC. The seven questions that comprise the scale for grading chronic pain severity in the RDC History Questionnaire (see Part III) are Q 7 through 13.

Methods of Assessing Depression and Nonspecific Physical Symptoms

A number of self-report approaches to measuring depression have been shown to be reliable and valid, including the Center for Epidemiologic Studies Depression scale (CES-D), the Beck Depression Scale, the Symptom Checklist 90 (SCL-90), and others. Research to date has not shown any of the available depression scales to consistently outperform the others. Population normative data are available for the CES-D and for the SCL-90.

The project team observed that a subset of TMD pain patients experience diffuse, nonspecific physical symptoms and that this pattern of symptomatology is an important but poorly understood phenomena. On the one hand, diffuse, nonspecific physical symptoms can sometimes be understood as a manifestation of a specific underlying TMD. On the other hand, mandibular pain can sometimes be understood as but one nonspecific physical symptom among many reported by a patient.[14] To permit further study of these issues, it was agreed that Axis II should include a measure of nonspecific physical symptoms. Because the SCL-90 provides both a depression scale and a scale measuring the severity of nonspecific physical symptoms (the somatization subscale), the project team agreed that relevant SCL-90 scales[15] should be used as part of the Axis II assessment.

The term somatization is not incorporated in the RDC. Somatization refers to preoccupation with physical symptoms disproportionate to actual physical disturbance.[16] The SCL-90 somatization scale measures the number and severity of nonspecific physical symptoms without identifying the underlying cause of the symptoms. Since diffuse nonspecific physical symptoms may be associated with an underlying disease, the effects of a pain condition per se, and/or psychological distress, it was felt that use of the term somatization was not accurate within the context of the RDC. The SCL-90 somatization scale is included to facilitate assessment of how persons with and without diffuse physical symptoms differ in terms of Axis I TMD status, psychological status, response to TMD pain, and disability.

SCL scale items appear in the RDC History Questionnaire Q 20 as follows: Depression and Vegetative Symptom Scale—b,e,h,i,k,l,m,n,v,y,cc,dd,ee; "Additional items" (these are added to the depression scale)—f,g,q,z,aa,bb,ff; Somatization Scale (nonspecific physical symptoms)—a*,c,d*,j*,o*,p*,f,a,w,x. (Items with an asterisk are dropped when scoring the "nonpain" nonspecific physical symptom scale.)

Jaw Disability Checklist

It was decided that a brief checklist was needed to assess the extent to which TMD interferes with activities specifically related to mandibular function (eg,

chewing). Because of the potential clinical relevance of this information, a checklist was constructed from items used by investigators on the project team. While this checklist is easy to administer and score, its reliability and validity have not yet been evaluated.

Jaw Disability Checklist

What activities does your present jaw problem prevent or limit you from doing?	No	Yes
Chewing	0	1
Drinking	0	1
Exercising	0	1
Eating hard foods	0	1
Eating soft foods	0	1
Smiling/laughing	0	1
Sexual activity	0	1
Cleaning teeth or face	0	1
Yawning	0	1
Swallowing	0	1
Talking	0	1
Having your usual facial appearance	0	1

Assessment Methods

For the reasons described, the following methods were adopted for use in assessing the status of TMD patients on Axis II:

1. A seven-item questionnaire for grading chronic pain severity [11]
2. The depression, vegetative symptom (additional items) and somatization subscales of the SCL-90-R developed by Derogatis[15] and others
3. A jaw disability checklist based on items commonly used in clinical TMD research

Classification Criteria

Using the assessment described above, the following classifications are proposed:

Pain Intensity and Disability (Graded Chronic Pain Severity):

Grade 0 No TMD pain in the prior 6 months
Grade I Low Disability—Low Intensity Pain
Grade II Low Disability—High Intensity Pain
Grade III High Disability—Moderately Limiting
Grade IV High Disability—Severely Limiting

Depression (SCL-90-R Depression and Vegetative Symptom Scales):

Normal
Moderate (Above 70th percentile on population norms)
Severe (Above 90th percentile on population norms)

Limitations Related to Mandibular Functioning:

No classification is proposed at this time.

Axis II Scoring Criteria

Scoring Criteria for Grading Chronic Pain Severity

Characteristic Pain Intensity is a 0 to 100 score derived from Questions 7 through 9:
Mean [Pain Right Now, Worst Pain, Average Pain] × 10

Disability Score is 0 to 100 score derived from Questions 11 through 13:
Mean [Daily Activities, Social Activities, Work Activities] × 10

Disability Points: Add the indicated points for Disability Days (Question 10) and for Disability Score.

Disability Points

Disability Days (0–180)		Disability Score (0–100)	
0–6 Days	0 Points	0–29	0 Points
7–14 Days	1 Point	30–49	1 Point
15–30 Days	2 Points	50–69	2 Points
31+ Days	3 Points	70+	3 Points

Classification

Grade 0	No TMD pain in prior 6 months
Low Disability Grade I *Low Intensity*	Characteristic Pain Intensity < 50, and less than 3 Disability Points
Grade II *High Intensity*	Characteristic Pain Intensity ≥ 50, and less than 3 Disability Points
High Disability Grade III *Moderately Limiting*	3 to 4 Disability Points, regardless of Characteristic Pain Intensity
Grade IV *Severely Limiting*	5 to 6 Disability Points regardless of Characteristic Pain Intensity

Scoring the SCL-90-R Scales (as modified)

Use the raw mean scale score, which is computed by adding up the item score for all items answered and dividing by the number of items answered. If less than two thirds of the items are answered, set the scale score to missing.

Classification

	Normal	Moderate	Severe
Depression (including vegetative symptoms)	<0.535	0.535 to <1.105	1.105+
Nonspecific Physical Symptoms (pain items included)	<0.500	0.500 to <1.000	1.000+
Nonspecific Physical Symptoms (pain items excluded)	<0.428	0.428 to <0.857	0.857+

Addendum: Standard Scores (Age-Sex Adjusted) for the Depression and Nonspecific Symptom Scales

For certain purposes, it is useful to report a standardized score adjusted for age and sex. A standard score describes how far a subject is from the population mean in standard deviation units. For example, a score of 0.00 is at the population mean while −1.0 is one SD below the mean. By standardizing within age-sex group, the scores are also adjusted for age and sex differences.

Age-sex group	Scale	Mean	SD
Males 18–24	Depression*	0.4279	0.4089
	Physical symptoms including pain	0.4167	0.3313
	Physical symptoms excluding pain	0.2957	0.3170
Females 18–24	Depression*	0.6058	0.4974
	Physical symptoms including pain	0.5310	0.4037
	Physical symptoms excluding pain	0.3413	0.3879
Males 25–44	Depression*	0.4020	0.4391
	Physical symptoms including pain	0.3760	0.3953
	Physical symptoms excluding pain	0.2551	0.4099
Females 25–44	Depression*	0.5441	0.4789
	Physical symptoms including pain	0.4611	0.4225
	Physical symptoms excluding pain	0.3220	0.4305
Males 45–64	Depression*	0.2898	0.3689
	Physical symptoms including pain	0.3898	0.3913
	Physical symptoms excluding pain	0.2814	0.4129
Females 45–64	Depression*	0.4078	0.4429
	Physical symptoms including pain	0.4493	0.4709
	Physical symptoms excluding pain	0.3877	0.5013
Males 65–74	Depression*	0.1572	0.2035
	Physical symptoms including pain	0.4120	0.3986
	Physical symptoms excluding pain	0.3526	0.3980
Females 65–74	Depression*	0.2273	0.2454
	Physical symptoms including pain	0.3729	0.3645
	Physical symptoms excluding pain	0.3328	0.3730

*The depression scale includes 13 depression scale items and 7 additional items

References

1. Turk DC, Rudy TE: Toward a comprehensive assessment of chronic pain patients: A multiaxial approach. *Behav Res Ther* 1987;25:237–249.
2. Osterweis M, Kleinman A, Mechanic D: *Pain and Disability: Clinical, Behavioral and Public Policy Perspectives.* Washington DC, National Academy Press, 1987.
3. Dworkin SF, Von Korff M, LeResche L: Epidemiologic studies of chronic pain: A dynamic-ecologic perspective. *Ann Behav Med* 19??;14:3–11.
4. Fordyce WE: Learning process in pain, in Sternbach RA (ed): *The Psychology of Pain,* ed 2. New York Raven Press, 1986, pp 49–65.
5. Keefe FJ, Gil K: Behavioral concepts in the analysis of chronic pain syndromes. *J Consult Clin Psycho* 1986;54:776–783.
6. Turk DC, Rudy TE: Toward an empirically derived taxonomy of chronic pain patients: Integration of psychological assessment data. *J Consult Clin Psycho* 1988;56:233–238.
7. Kerns RD, Turk DC, Rudy TE: The West-Haven-Yale Multidimensional Pain Inventory (WHYMPI). *Pain* 1985;23:345–356.
8. Von Korff M, Dworkin SF, LeResche L: Graded chronic pain status: An epidemiologic evaluation. *Pain*1990;40:279–291.
9. Von Korff M, Dworkin SF: Problems in measuring pain by survey: The classification of chronic pain in field research, in Chapman CR, Loeser JD (eds): *Advances in Pain Research and Therapy; Vol 12: Issues in Pain Management.* New York Raven Press, 1989, pp 519–533.
10. Sherbourne CD: Pain measures, in Stewart AL, Ware JE (eds): *Measuring Functioning and Well-Being: The Medical Outcomes Study Approach.* Durham, NC, Duke University Press (in press).
11. Von Korff M, Ormell J, Keefe FJ, Dworkin SF: Graded chronic pain status: Concepts, uses and validity. *Pain* (submitted).
12. Rudy TE: Personal communication, 1992.
13. Von Korff M: Epidemologic and survey methods: Chronic pain assessment, in Turk DC, Melzack R (eds): *Handbook of Pain Assessment.* New York, Guilford Press, 1992, pp 389–406.
14. Dworkin, SF, Von Korff M, LeResche L: Multiple pains and psychiatric disturbance: An epidemiologic investigation. *Arch Gen Psychiatry* 1990;47:239–244.
15. Derogatis LR: *SCL-90-R: Administration, Scoring and Procedures Manual—II for the Revised Version.* Clinical Psychometric Research, Towson, Md.
16. American Psychiatric Association: *Diagnostic and Statistical Manual of Mental Disorders,* ed 3. American Psychiatric Association, Washington DC.

PART III

Examination and History Data Collection

History Questionnaire/Specifications for TMD Examinations/Examination Forms

Editor:
Charles G. Widmer, DDS, MS
Associate Professor
Department of Oral and Maxillofacial Surgery
University of Florida
Gainesville, Florida

Major Contributors:
Kimberly H. Huggins, RDH, BS
James Fricton, DDS, MS

For their use, the RDC/TMD depend on gathering history and physical examination data using the questionnaires, examination forms, and examination specifications provided in this section. Furthermore, it is critical that clinical examiners gathering data for RDC/TMD be calibrated to acceptable levels of interexaminer reliability. Dworkin et al have developed guidelines and procedures (see Part IB for specific references[10,15]) that allow examiners to achieve acceptable levels of interexaminer reliability through use of the examination specifications, questionnaire, and examination forms that follow. A data entry form has also been provided for concise summation of demographics, patient characteristics, RDC/TMD Axis I diagnosis, and Axis II profile. For ease of use, the questionnaire and examination forms as well as the examination specifications and the data entry form have been reproduced on separate pages.

ID# _____

Date: __ / __ / __

History Questionnaire

Please read each question and respond accordingly. For each of the questions below, circle only one response.

1. Would you say your health in general is excellent, very good, good, fair, or poor?
   Excellent 1
   Very good 2
   Good 3
   Fair 4
   Poor 5

2. Would you say your oral health in general is excellent, very good, good, fair, or poor?
   Excellent 1
   Very good 2
   Good 3
   Fair 4
   Poor 5

3. Have you had pain in the face, jaw, temple, in front of the ear, or in the ear in the past month?
   No 0
   Yes 1

   [If no pain in the past month SKIP to question 14]

   If Yes,

4.a. How many years ago did your facial pain begin for the first time? __ __ years
   [If one year ago or more SKIP to question 5]
   [If less than one year ago, code 00]

4.b. How many months ago did your facial pain begin for the first time? __ __ months

5. Is your facial pain persistent, recurrent, or was it only a one-time problem?
   Persistent 1
   Recurrent 2
   One-Time 3

6. Have you ever gone to a physician, dentist, chiropractor, or other health professional for facial ache or pain?
   No 1
   Yes, in the last 6 months 2
   Yes, more than 6 months ago 3

7. How would you rate your facial pain on a 0 to 10 scale at the present time, that is right now, where 0 is "no pain" and 10 is "pain as bad as could be"?

   No pain — Pain as bad as could be
   0 1 2 3 4 5 6 7 8 9 10

8. In the past six months, how intense was your worst pain, rated on a 0 to 10 scale where 0 is "no pain" and 10 is "pain as bad as could be"?

   No pain — Pain as bad as could be
   0 1 2 3 4 5 6 7 8 9 10

9. In the past six months, on the average, how intense was your pain rated on a 0 to 10 scale where 0 is "no pain" and 10 is "pain as bad as could be"? [That is, your usual pain at times you were experiencing pain].

   No pain — Pain as bad as could be
   0 1 2 3 4 5 6 7 8 9 10

10. About how many days in the last 6 months have you been kept from your usual activities (work, school, or housework) because of facial pain?
   _____ Days

11. In the past 6 months, how much has facial pain interfered with your daily activities rated on a 0 to 10 scale where 0 is "no interference" and 10 is "unable to carry on any activities"?

   No interference — Unable to carry on any activities
   0 1 2 3 4 5 6 7 8 9 10

12. In the past 6 months, how much has facial pain changed your ability to take part in recreational, social and family activities where 0 is "no change" and 10 is "extreme change"?

   No change — Extreme change
   0 1 2 3 4 5 6 7 8 9 10

13. In the past 6 months, how much has facial pain changed your ability to work (including housework) where 0 is "no change" and 10 is "extreme change"?

   No change — Extreme change
   0 1 2 3 4 5 6 7 8 9 10

14.a. Have you ever had your jaw lock or catch so that it won't open all the way?
   No 0
   Yes 1

   [If no problem opening all the way SKIP to question 15]

   If Yes,

14.b. Was this limitation in jaw opening severe enough to interfere with your ability to eat?
   No 0
   Yes 1

15.a. Does your jaw click or pop when you open or close your mouth or when chewing?
   No 0
   Yes 1

   b. Does your jaw make a grating or grinding noise when it opens and closes or when chewing?
   No 0
   Yes 1

   c. Have you been told, or do you notice, that you grind your teeth or clench your jaw while sleeping at night?
   No 0
   Yes 1

   d. During the day, do you grind your teeth or clench your jaw?
   No 0
   Yes 1

   e. Does your jaw ache or feel stiff when you wake up in the morning?
   No 0
   Yes 1

   f. Do you have noises or ringing in your ears?
   No 0
   Yes 1

   g. Does your bite feel uncomfortable or unusual?
   No 0
   Yes 1

16.a. Do you have rheumatoid arthritis, lupus, or any other systemic arthritic disease?
   No 0
   Yes 1

16.b. Do you know of anyone in your family who has had any of these diseases?
   No 0
   Yes 1

16.c. Have you had or do you have any swollen or painful joint(s) other than the joints close to your ears (TMJ)? No ..... 0 Yes 1

[If no swollen or painful joints, SKIP to question 17.a.]

If Yes,

16.d. Is this a persistent pain that you have had for at least one year? No ..... 0 Yes 1

17.a. Have you had a recent injury to your face or jaw? No ..... 0 Yes 1

[If no recent injuries SKIP to question 18]

If Yes,

17.b. Did you have jaw pain before the injury? No ..... 0 Yes 1

18. During the last 6 months have you had a problem with headaches or migraines? No ..... 0 Yes 1

19. What activities does your present jaw problem prevent or limit you from doing?

a. Chewing	No ..... 0 Yes 1
b. Drinking	No ..... 0 Yes 1
c. Exercising	No ..... 0 Yes 1
d. Eating hard foods	No ..... 0 Yes 1
e. Eating soft foods	No ..... 0 Yes 1
f. Smiling/laughing	No ..... 0 Yes 1
g. Sexual activity	No ..... 0 Yes 1
h. Cleaning teeth or face	No ..... 0 Yes 1
i. Yawning	No ..... 0 Yes 1
j. Swallowing	No ..... 0 Yes 1
k. Talking	No ..... 0 Yes 1
l. Having your usual facial appearance	No ..... 0 Yes 1

20. In the last month, how much have you been distressed by

	Not at all	A little bit	Moderately	Quite a bit	Extremely
a. Headaches	0	1	2	3	4
b. Loss of sexual interest or pleasure	0	1	2	3	4
c. Faintness or dizziness	0	1	2	3	4
d. Pains in the heart or chest	0	1	2	3	4
e. Feeling low in energy or slowed down	0	1	2	3	4
f. Thoughts of death or dying	0	1	2	3	4
g. Poor appetite	0	1	2	3	4
h. Crying easily	0	1	2	3	4
i. Blaming yourself for things	0	1	2	3	4
j. Pains in the lower back	0	1	2	3	4
k. Feeling lonely	0	1	2	3	4
l. Feeling blue	0	1	2	3	4
m. Worrying too much about things	0	1	2	3	4
n. Feeling no interest in things	0	1	2	3	4
o. Nausea or upset stomach	0	1	2	3	4
p. Soreness of your muscles	0	1	2	3	4
q. Trouble falling asleep	0	1	2	3	4
r. Trouble getting your breath	0	1	2	3	4
s. Hot or cold spells	0	1	2	3	4
t. Numbness or tingling in parts of your body	0	1	2	3	4
u. A lump in your throat	0	1	2	3	4
v. Feeling hopeless about the future	0	1	2	3	4
w. Feeling weak in parts of your body	0	1	2	3	4
x. Heavy feelings in your arms or legs	0	1	2	3	4
y. Thoughts of ending your life	0	1	2	3	4
z. Overeating	0	1	2	3	4
aa. Awakening in the early morning	0	1	2	3	4
bb. Sleep that is restless or disturbed	0	1	2	3	4
cc. Feeling everything is an effort	0	1	2	3	4
dd. Feelings of worthlessness	0	1	2	3	4
ee. Feeling of being caught or trapped	0	1	2	3	4
ff. Feelings of guilt	0	1	2	3	4

21. How good a job do you feel you are doing in taking care of your health overall? Excellent ..... 1 Very good ..... 2 Good ..... 3 Fair ..... 4 Poor 5

22. How good a job do you feel you are doing in taking care of your oral health?
Excellent 1
Very good 2
Good 3
Fair 4
Poor 5

23. When were you born? Month ___ Day ___ Year ___

24. Are you male or female?
Male 1
Female 2

25. Which of the following groups best represent your race?
Aleut, Eskimo or American Indian 1
Asian or Pacific Islander 2
Black 3
White 4
Other 5
_____ (please specify)

26. Are any of these groups your national origin or ancestry?
Puerto Rican 1
Cuban 2
Mexican/Mexicano 3
Mexican American 4
Chicano 5
Other Latin American 6
Other Spanish 7
None of the above 8

27. What is the highest grade or year of regular school that you have completed?
Never attended or Kindergarten: 00
Elementary School: 1 2 3 4 5 6 7 8
High School: 9 10 11 12
College: 13 14 15 16 17 18+

28a. During the past 2 weeks, did you work at a job or business not counting work around the house (include unpaid work in the family farm/business)?
Yes 1
No 2

[If Yes SKIP to question 29]

If No,

28b. Even though you did not work during the past 2 weeks, did you have a job or business?
Yes 1
No 2

[If Yes SKIP to question 29]

If No,

28c. Were you looking for work or on layoff from a job during those 2 weeks?
Yes, looking for work 1
Yes, layoff 2
Yes, both on layoff and looking for work. 3
No 4

29. What is your marital status?
Married—spouse in household 1
Married—spouse not in household 2
Widowed 3
Divorced 4
Separated 5
Never Married 6

30. Which of the following best represents your total combined household income during the past 12 months?
___ $0–$14,999
___ $15,000–$24,999
___ $25,000–$34,999
___ $35,000–$49,999
___ $50,000 or more

31. What is your 5-digit zip code? ___ ___ ___ ___ ___

History Questionnaire
Question by Question Distribution

Q	Axis I	Axis II	Demographics	Physical characteristics	Other factors of interest
1				X	
2				X	
3	X				
4			X		
5					X
6					
7–13		X (grading chronic pain)			
14	X				
15				e,f,g	a,b,c,d
16	X				
17	X				
18					X
19		X (jaw disability items)			
20		X			
21				X	
22				X	
23–31			X		

Specifications for TMD Examinations

A. General Directions for Examination

1. All questionnaire and examination items need to be completed unless the subject refuses or is unable to cooperate. In this case, write "SR" (subject refuses) in large block letters adjacent to the examination item and note why the subject refuses or cannot do item.
2. All measurements will be conducted with the jaw muscles in a passive state, unless the examination specifies otherwise. The joints and muscles should not receive additional weight or pressure at any time.
3. All millimeter recordings will be done as single or double digits. If a double-digit reading is only one digit, precede with a lead zero. If a measurement is between two millimeter markings, record the lesser value.
4. Subjects will sit in chairs at approximately a 90-degree angle to the examiner.
5. Examiners will wear gloves at all times.
6. Subjects with replacement prostheses will be examined with the prostheses in their mouth except if it is necessary to remove these for observing the mucosa and gingiva and performing intraoral palpations. Bite plates and other appliances that do not replace teeth are to be removed for the examination.
7. If the subject has a beard, a neck brace, or any other potential physical barrier that may interfere with muscle or TMJ palpation, indicate this.
8. Conduct the examination procedures in the order on the form and record all measurements in the appropriate places on the specified form.
9. Items 4.d, Vertical incisal overlap, and 6.d, Midline deviation, are included so corrections to measurements in items 4 and 6, respectively, can be done to determine actual values of openings and excursions. For items 4.a through 4.c, the amount of vertical incisor overlap (4.d) should be added to each of these measurements to determine the actual amount of opening. For items 6.a and 6.b, if midline deviation (6.d) is greater than 0, this measurement should be added to one side of the lateral excursion and subtracted from the other side.

   For example: If a subject has a 2-mm deviation to the right, then subtract 2 mm from the value given to the right lateral excursion and add 2 mm to the value given to the left lateral excursion.

Note: Because the research diagnostic criteria require self-report of pain location, (examination items 1 and 2) verified by the examiner, these items have been moved from the questionnaire to the examination. This will allow the examiner the opportunity to reliably confirm the type and location of pain.

B. Examination

1. Circle the appropriate answer. If the subject indicates midline pain score as "Both."
2. Circle the appropriate answer. If it is unclear to the examiner whether the subject is indicating a joint or muscle, press on the area as lightly as possible to correctly identify the anatomic site. For example, if the subject indicates pain in the joint, but the examiner identifies the location as muscle, the examiner's findings are those which are recorded.
3. *Opening Pattern.* General Instruction: Ask the subject to position the mandible in a comfortable position. ("Place your mouth in a comfortable position with your teeth lightly touching.") Place your thumb under the subject's lower lip so that the lip reveals the lower teeth. This will facilitate observing midline deviation. Ask the subject to open the mouth as wide as possible, even if he/she feels pain ("I'd like you to open your mouth as wide as you can, even if it's a little painful.") If the degree of deviation is unclear, then use a millimeter ruler held vertically between the maxillary and mandibular incisor embrasures (or mark mandibular incisor if midlines do not match) as a guide. Ask the subject to open three times. If the subject exhibits more than one opening pattern, then ask the subject to repeat the three openings and score according to the following criteria (*note:* only opening pattern is assessed):
   a. *Straight.* If there is no perceptible deviation upon opening.
   b. *Lateral Deviation to Right or Left.* For deviations that are visually perceptible to one side at maximum opening, determine which side of the subject's face the deviation goes toward and record accordingly.
   c. *Corrected Deviation ("S" Deviation).* The subject exhibits a perceptible deviation to the right or left but corrects to the midline before or upon reaching the maximum unassisted mandibular opening.
   d. *Other.* The subject exhibits jerky opening (not smooth or continuous) or has an opening other than those provided; indicate this and the type of deviation. If the subject has more than one opening pattern, use this category and write "more than one."
4. *Vertical Range of Motion of Mandible.* If the subject is wearing a denture or partial and it is loose, compress it against the ridge for all opening measurements.
   a. *Unassisted (Mandibular) Opening Without Pain*
      i. *Obtaining Measurement.* Ask the subject to place the mandible in a comfortable position. ("Place your mouth in a comfortable position.") Ask the subject to open the mouth as far as possible (unassisted), without feeling any pain. ("I would like you to open as wide as you can without feeling any pain.") Place the edge of the millimeter ruler at the incisal edge of the maxillary central incisor that is the most vertically oriented and measure vertically to the labioincisal edge of the opposing mandibular incisor; record this measurement. Indicate on the form which maxillary incisor was chosen. If the subject did not open at least 30 mm, to insure understanding, repeat the opening. If the second opening still does not produce more than a 30-mm opening, record the measurement.
   b. *Maximum Unassisted (Mandibular) Opening*
      i. *Obtaining Measurement.* Ask the subject to place the mandible in a comfortable posi-

tion. ("Place your mouth in a comfortable position.") Then ask the subject to open the mouth as wide as possible, even if he/she feels pain. ("I would like you to open your mouth as wide as you can, even if it's a little uncomfortable.") Place the edge of the millimeter ruler at the incisal edge of the maxillary central incisor that is the most vertically oriented and measure vertically to the labioincisal edge of the opposing mandibular incisor; record this measurement.

ii. *Pain.* Ask the subject if he/she felt pain on maximum unassisted opening. ("When you opened this time, did you have any pain?") Record whether or not they had pain, and the location. The location is scored in two ways: by left and/or right side and specifically whether or not the pain is in the joint. Two entries are required for items 4.b and 4.c to assess pain: record side of pain as "None" (0), "Right" (1), "Left" (2), or "Both" (3). Also record if pain in the joint is "Present" (1) or "Absent" (0). If the subject had no pain, circle "NA" (9) for location. If he/she indicates pressure or tightness, score as "None."

c. *Maximum Assisted (Mandibular) Opening*

i. *Obtaining Measurement.* Ask the subject to place the mandible in a comfortable position. ("Place your mouth in a comfortable position.") Ask the subject to open the mouth as wide as possible, even if he/she feels pain. ("I would like you to open your mouth as wide as you can, even if it's a little uncomfortable.") After the subject has opened this wide, place your thumb on the subject's maxillary central incisors, and cross your index finger over to the subject's mandibular central incisors. From this position you will gain the leverage necessary to force the subject's mouth open wider. Use moderate pressure, but do not forcefully open the mouth wider. ("I am checking to see if I can push your mouth open a little further and I will stop if you raise your hand.") Measure vertically from the labioincisal edge of the same maxillary central incisor as before to the labioincisal edge of the mandibular incisor with the millimeter ruler; record the measurement.

ii. *Pain.* Record whether or not the subject felt pain and the location. ("Did you feel any pain when I tried to open your mouth wider with my fingers?") Score pain locations as in maximum unassisted opening. If they indicated feeling pressure or tightness, score as "None."

d. *Vertical Incisal Overlap.* Ask the patient to close the teeth completely together. With a pen or fingernail, mark the line where the incisal edge of the same maxillary central incisor used before for measurements overlaps the mandibular incisor. Measure the distance from the mandibular incisal edge to the marked line and record the measurement.

5. *TMJ Sounds on Palpation for Vertical Range of Motion.*

General Instructions: Subjects will indicate the presence or absence of sounds; if present, the examiners will score the *type* of sound observed. Place the left index finger over the subject's right TMJ and the right index finger over the subject's left TMJ (preauricular area). The pad of the right finger is placed anterior to the tragus of the ear. Ask the subject to slowly open as wide as possible, even if it causes pain. Each closure should bring the teeth completely together in maximum intercuspation. Ask the subject: "While I have my fingers over your joint, I would like you to slowly open as wide as you can and then slowly close until your teeth are completely together." Ask the subject to open and close three times. Record the action/sound that the joint produces on opening or closing as detected by palpation and as defined below.

a. *Definition of Sounds*

0 = *None.*

1 = *Click.* A distinct sound, of brief and very limited duration, with a clear beginning and end, which usually sounds like a "click." Circle this item only if the click is reproducible on two of three openings/closings.

2 = *Coarse Crepitus.* A sound that is continuous, over a longer period of jaw movement. It is not brief like a click or pop; the sound may make overlapping continuous noises. This sound is not muffled; it is the noise of bone grinding against bone, or like a stone grinding against another stone.

3 = *Fine Crepitus.* A fine grating sound that is continuous over a longer period of jaw movement on opening or closing. It is not brief like a click; the sound may make overlapping continuous sounds. It may be described as a rubbing or crackling sound on a rough surface.

b. *Scoring of Clicking Sounds.* While many of the following types of sounds are not pertinent to specific diagnostic criteria, this exhaustive list of definitions is provided to better delineate how the sound types required to meet RDC may differ from other sounds.

i. *Reproducible Opening Click.* If upon opening and closing from maximum intercuspation, a click is noted on two of three opening movements, record as positive for opening click.

ii. *Reproducible Closing Click.* A click present on two of three closing mandibular movements.

iii. *Reproducible Reciprocal Click.* This sound is determined by the millimeter measurement of opening and closing clicks and the elimination of both clicks when the subject opens and closes from a protruded position. With the millimeter ruler, measure the interincisal distance at which the first opening and

6. M
a

closing clicks are heard. Measure from labioincisal embrasure of the maxillary central identified in 4 to the labioincisal embrasure of the opposing mandibular incisor. If the clicking ceases and therefore is not measurable, leave the — —'s unfilled. (Computer analyses will then indicate this is not a reciprocal click; even though a click *had* been present, it did not *continue* to be present.) Assess elimination of clicks on protrusive opening by asking the subject first to maximally protrude. Next ask the subject to open and close from this protruded jaw position. The opening and closing click will normally be eliminated. Circle "Yes" (1) if the click can be eliminated if the jaw is opened and closed in a protruded or more anterior jaw position. If the click is not eliminated, circle "No" (0). If the subject lacks either a reproducible opening click or a reproducible closing click, circle "NA" (9).

iv. *Non-reproducible Click* (Do Not Score). A nonreproducible click is present if the sound is only demonstrated periodically during opening or closing; it cannot be reproduced on at least two of three full mandibular movements. More than one sound can be circled overall for Opening (a) and Closing (b). If None (0), is circled, no other responses can be circled.

6. *Mandibular Excursive Movements*
   a. *Right Lateral Excursion*
      i. *Obtaining Measurement.* Ask subject to open slightly and move the mandible as far as possible to the right, even if it is uncomfortable. If necessary, repeat the movement. (*Example:* "Move your jaw as far as possible toward the right, even if it is uncomfortable, and move your jaw back to its normal position. Move your jaw back toward the right again.") With the teeth slightly separated, use a millimeter ruler to measure from the labioincisal embrasure between the maxillary central incisors to the labioincisal embrasure of the mandibular incisors; record this measurement.
      ii. *Pain.* Ask the subject if he/she had pain. Record whether or not the subject felt pain and the location. The location is scored in two ways: by left and/or right side and specifically whether or not the pain is in the joint. Two entries are required for items 6.a through 6.c to assess pain: record side of pain as "None" (0), "Right" (1), "Left" (2), or "Both" (3). Also record if pain in the joint is "Present" (1) or "Absent" (0). If the subject had no pain, circle "NA" (9). ("Did you feel any pain when you moved to the side?") If the subject indicated feeling pressure or tightness, score as "None."
   b. *Left Lateral Excursion*
      i. *Obtaining Measurement.* Ask the subject to move the mandible as far as possible to the other side (left). ("I would like you to now move your jaw as far as possible toward the other side and back to its normal position.") Record this measurement in the same manner as right excursion.
      ii. *Pain.* Ask the subject if he/she had pain. Record whether or not the subject felt pain and the location. ("Did you feel any pain when you moved to the side?") Score pain locations as in right lateral excursion. If the subject indicated feeling pressure or tightness, score as "None."
   c. *Protrusion*
      i. *Obtaining Measurement.* Ask the subject to open slightly and protrude the mandible. ("Slide your jaw straight out in front of you as far as you can, even if it is uncomfortable.") If the subject has a deep overbite, ask him/her to open wider so he/she can protrude without getting interference from the maxillary incisors.
      ii. *Pain.* Ask the subject if he/she had pain. Record whether or not the subject felt pain and the location. ("Did you feel any pain when you moved your jaw forward?") Score pain locations as in right lateral excursion. If the subject indicated feeling pressure or tightness, score as "None."
   d. *Midline Deviation.* If the incisal embrasures of the maxillary and mandibular incisors do not line up vertically, determine the horizontal difference between the two while the subject is biting together. Measure in millimeters how far the mandibular embrasure is from the maxillary embrasure and on which side of the subject the mandibular embrasure is located. If the midline deviation is less than 1 mm, or there is no deviation, enter "00."
7. *TMJ Sounds on Palpation for Lateral Excursions and Protrusion.*
   Ask the subject to move to the right, to the left, and protrude (see 6).
   a. *Definition of Sounds.* Refer to item 5.
   b. *Scoring of Clicking Sounds.*
      i. *Reproducible Laterotrusive or Protrusive Click.* Occurs when the TMJ displays a click with two of three lateral movements or protrusion of the mandible respectively.
      ii. *Nonreproducible Laterotrusive or Protrusive Click.* A nonreproducible click is present if the click is only demonstrated periodically during laterotrusion movements or protrusion but cannot be reproduced on at least two of three movements. Do not score.

C. General Instruction for Muscle and Joint Palpation for Tenderness

1. Examining the muscles and joint capsules for tenderness requires that you press on a specific site using the fingertips of the index and third fingers or the spade-like pad of the distal phalanx of the index finger only with standardized pressure, as follows: palpations will be done with 2 lbs of pressure for

extraoral muscles, 1 lb of pressure on the joints and intraoral muscles. Palpate the muscles while using the opposite hand to brace the head to provide stability. The subject's mandible should be in a resting position, without the teeth touching. Palpate while muscles are in a passive state. As needed, have the subject lightly clench and relax to identify and to insure palpation of the correct muscle site. ("I'm going to press on some muscles. I would like you to clench your teeth together gently and then relax and have your teeth slightly apart from each other.") First locate the site of palpation using the landmarks described and then press. Because the site of maximum tenderness may vary from subject to subject and is localized, it is important to press in multiple areas in the region specified to determine if tenderness exists. Before beginning the palpations, say: "In the next part of the exam, we'd like you to record whether you feel pain or pressure when I palpate or press on certain parts of your head and face." Ask the subject to determine if the palpation hurts (painful) or if he/she just feels pressure. If it hurts, ask the subject to indicate if the pain is mild, moderate, or severe. Record any equivocal response or the report of pressure only as "No Pain."

2. *Description of Specific Extraoral Muscle Sites (2 lbs digital pressure)*
   a. *Temporalis (Posterior).* Palpate posterior fibers behind the ears to directly above the ears. Ask the subject to clench and then relax to help identify muscle. Walk fingers toward the subject's face (medially) to the anterior border of the ear.
   b. *Temporalis (Middle).* Palpate fibers in the depression about 2 cm lateral to the lateral border of the eyebrow.
   c. *Temporalis (Anterior).* Palpate fibers over the infratemporal fossa, immediately above the zygomatic process. Ask the subject to clench and relax to help identify muscle.
   d. *Origin of Masseter.* Ask the subject to first clench then relax and observe masseter for location. Palpate the origin of the muscle beginning in the area 1 cm immediately in front of the TMJ and immediately below the zygomatic arch, and palpate anteriorly to the border of the muscle.
   e. *Body of the Masseter.* Start just below the zygomatic process at the anterior border of the muscle. Palpate from here down and back to the angle of the mandible across a surface area about two fingers wide.
   f. *Insertion of the Masseter.* Palpate the area 1 cm superior and anterior to the angle of the mandible.
   g. *Posterior Mandibular Region (Stylohyoid/ Posterior Digastric).* Ask the subject to tip the head back a little. Locate the area between the insertion of the SCM and the posterior border of the mandible. Place finger so it is going medially and upward (and not on the mandible). Palpate the area immediately medial and posterior to the angle of the mandible.
   h. *Submandibular Region (Medial Pterygoid, Suprahyoid, Anterior Digastric).* Locate the site under the mandible at a point 2 cm anterior to the angle of the mandible. Palpate superiorly, pulling toward the mandible. If a subject has a lot of pain in this area, try to determine if the subject is reporting muscle or nodular pain. If it is nodes, indicate on the exam form.
3. *Description of Specific Joint Palpation Sites (1 lb digital pressure)*
   a. *Lateral Pole.* Place your index finger just anterior to the tragus of the ear and over the subject's TMJ. Ask the subject to open slightly until you feel the lateral pole of the condyle translated forward. Use 1 lb pressure on the side that is being palpated, supporting the head with the opposite hand.
   b. *Posterior Attachment.* This site can be palpated intrameatally. Place tips of the right little finger into the subject's left external meatus and the tip of the left little finger into the subject's right external meatus. Point the fingertips toward the examiner and ask subject to slightly open the mouth (or wide open if necessary) to make sure the joint movement is felt with the fingertips. Place firm pressure on the right side and then the left side while the subject's teeth are completely together. (Change examination gloves.)
4. *Description of Specific Intraoral Palpation Sites (1 lb digital pressure).* Explain to the subject that you will now be palpating the inside of the mouth. ("Now I am going to palpate around the inside of your mouth. While I do these palpations I would like you to keep your jaw in a relaxed position.")
   a. *Lateral Pterygoid Area.* Before palpating, make sure the fingernail of the index finger is trimmed to avoid false positives. Ask the subject to open the mouth and move the jaw to the side that is being examined. ("Move your jaw toward this hand.") Place the index finger on the lateral side of the alveolar ridge above the right maxillary molars. Move the finger distally, upward, and medial to palpate. If the index finger is too large, use the little finger (5th digit).
   b. *Tendon of Temporalis.* After completing the lateral pterygoid, rotate your index finger laterally near the coronoid process, ask the subject to open slightly, and move your index finger up the anterior ridge of the coronoid process. Palpate on the most superior aspect of the process. *Note:* If it is difficult to determine in some subjects if they are feeling pain in the lateral pterygoid or the tendon of the temporalis, rotate and palpate with the index finger medially and then laterally. If there is still difficulty, the lateral pterygoid is usually the more tender of the two.

Examination Form

1. Do you have pain on the right side of your face, the left side, or both sides?
   None 0
   Right 1
   Left 2
   Both 3

2. Could you point to the areas where you feel pain?

Right	*Left*
None 0	None 0
Jaw Joint 1	Jaw Joint 1
Muscles 2	Muscles 2
Both 3	Both 3

[Examiner feels area subject points to if it is unclear whether it is joint or muscle pain]

3. Opening Pattern
   Straight 0
   Right Lateral Deviation (uncorrected) 1
   Right Corrected ("S") Deviation ... 2
   Left Lateral Deviation (uncorrected) 3
   Left Corrected ("S") Deviation 4
   Other 5
   Type _____ (specify)

4. Vertical Range of Motion
   Maxillary incisor used 8 9
   a. Unassisted Opening Without Pain ___ ___ mm
   b. Maximum Unassisted Opening ___ ___ mm
   c. Maximum Assisted Opening ___ ___ mm
   d. Vertical Incisal Overlap ___ ___ mm

Pain				Joint		
None	Right	Left	Both	Yes	No	NA
0	1	2	3	1	0	9
0	1	2	3	1	0	9

5. Joint Sounds (palpation)

		Right	Left
a. Opening	None	0	0
	Click	1	1
	Coarse Crepitus	2	2
	Fine Crepitus	3	3

Measurement of Opening Click ___ mm ___ mm

		Right	Left
b. Closing	None	0	0
	Click	1	1
	Coarse Crepitus	2	2
	Fine Crepitus	3	3

Measurement of Closing Click ___ mm ___ mm

		Right	Left
c. Reciprocal click eliminated on protrusive opening	No	0	0
	Yes	1	1
	NA	9	9

6. Excursions
   a. Right Lateral Excursion ___ ___ mm
   b. Left Lateral Excursion ___ ___ mm

Pain				Joint		
None	Right	Left	Both	Yes	No	NA
0	1	2	3	1	0	9
0	1	2	3	1	0	9

   c. Protrusion ___ ___ mm

Right	Left
1	2

   d. Midline Deviation ___ ___ mm

7. Joint Sounds on Excursions

Right Sounds:	None	Click	Coarse crepitus	Fine crepitus
Excursion Right	0	1	2	3
Excursion Left	0	1	2	3
Protrusion	0	1	2	3

Left Sounds:	None	Click	Coarse crepitus	Fine crepitus
Excursion Right	0	1	2	3
Excursion Left	0	1	2	3
Protrusion	0	1	2	3

Directions, Items 8–10:

The examiner will be palpating (touching) different areas of your face, head and neck. We would like you to indicate if you do not feel pain or just feel pressure (0), or pain (1–3). Please rate how much pain you feel for each of the palpations according to the scale below. Circle the number that corresponds to the amount of pain you feel. We would like you to make a separate rating for both the right and left palpations.

0 = No Pain/Pressure Only
1 = Mild Pain
2 = Moderate Pain
3 = Severe Pain

8. Extraoral Muscle Pain With Palpation:

	Right				Left			
a. Temporalis (posterior) "Back of temple"	0	1	2	3	0	1	2	3
b. Temporalis (middle) "Middle of temple"	0	1	2	3	0	1	2	3
c. Temporalis (anterior) "Front of temple"	0	1	2	3	0	1	2	3
d. Masseter (origin) "Cheek/under cheekbone"	0	1	2	3	0	1	2	3
e. Masseter (body) "Cheek/side of face"	0	1	2	3	0	1	2	3
f. Masseter (insertion) "Cheek/jawline"	0	1	2	3	0	1	2	3

g. Posterior Mandibular Region (stylohyoid/posterior digastric region) "Jaw/throat region"	0	1	2	3	0	1	2	3
h. Submandibular Region (medial pterygoid/suprahyoid/anterior digastric region) "Under chin"	0	1	2	3	0	1	2	3

9. Joint Pain With Palpation:

	Right				Left			
a. Lateral Pole "Outside"	0	1	2	3	0	1	2	3
b. Posterior Attachment "Inside ear"	0	1	2	3	0	1	2	3

10. Intraoral Muscle Pain With Palpation:

	Right				Left			
a. Lateral Pterygoid Area "Behind upper molars"	0	1	2	3	0	1	2	3
b. Tendon of Temporalis "Tendon"	0	1	2	3	0	1	2	3

Subject Patient Summary of Findings

ID number [Name] _____

Demographics:
Age _____ Gender _____ Ethnicity _____ Race _____

Educational level _____ Annual Household Income _____

Self-Reported Patient Characteristics:

Click	Yes	No	AM Stiffness	Yes	No
Grating/Grinding	Yes	No	Ringing in Ears	Yes	No
Nocturnal Clenching/Grinding	Yes	No			
Diurnal Clenching/Grinding	Yes	No			
Uncomfortable/Unusual bite	Yes	No			

Axis I Diagnosis:
Group I. Muscle Disorders (Circle only one response for Group I):
A. Myofascial Pain (I.a)
B. Myofascial Pain With Limited Opening (I.b)
C. No Group I Diagnosis

Group II. Disk Displacements (Circle only one response for each joint for Group II):

Right Joint	Left Joint
A. Disc Displacement With Reduction (II.a)	A. Disc Displacement With Reduction (II.a)
B. Disc Displacement Without Reduction, With Limited Opening (II.b)	B. Disc Displacement Without Reduction, With Limited Opening (II.b)
C. Disc Displacement Without Reduction, Without Limited Opening (II.c)	C. Disc Displacement Without Reduction, Without Limited Opening (II.c)
D. No Right Joint Group II Diagnosis	D. No Left Joint Group II Diagnosis

Group III. Other Joint Conditions (Circle only one response for each joint for Group III):

Right Joint	Left Joint
A. Arthralgia (III.a)	A. Arthralgia (III.a)
B. Osteoarthritis of the TMJ (III.b)	B. Osteoarthritis of the TMJ (III.b)
C. Osteoarthrosis of the TMJ (III.c)	C. Osteoarthrosis of the TMJ (III.c)
D. No Right Joint Group III Diagnosis	D. No Left Joint Group III Diagnosis

Axis II Profile:

1. Graded Chronic Pain Status (0–4) _____
2. Depression score: Normal Moderate Severe
3. Nonspecific physical symptoms scale: Normal Moderate Severe
4. Limitations Related to Mandibular Functioning: _____ (No. of positive responses/No. of items answered)

PART IV

Review and Commentary

A. Basic Sciences
Editor:
James P. Lund, BDS, PhD
Professor
Department of Stomatology
Centre for Research in Neurological Sciences
University of Montreal
Montreal, Quebec, Canada

B. Clinical Sciences
Editor:
Sandro Palla, Dr Med Dent
Professor and Chairman
Department of Masticatory Disorders and Complete Dentures
School of Dentistry
University of Zürich
Zürich, Switzerland

A. Basic Sciences

In this paper, I have tried to comply with the request from the members of the project team to be a constructive critic and to suggest directions for future research. I was given copies of the preliminary reports and many of my suggested changes have already been made. The project team tackled a difficult job, but the final report justifies the effort.

Although there has been a lot of research carried out on TMD, there have been few excellent studies. The lack of acceptable RDC is probably one of the reasons for this, because it has been difficult to get funding for clinical research in this field. I have seen several good grant applications founder because one or more of the referees quarreled with the authors' case definitions. It has been safer to lump all of the TMD together, thereby avoiding the thorny problem of classification. The same tendency is evident in the clinic; many clinicians use a standard treatment for all TMD patients and make little or no distinction between even the most obvious groups.

Even though one may quarrel with some feature of the system of classification that is being proposed, it is nevertheless vital that it be accepted as a starting point. The RDC do not limit the scope of research, they only require that specific types of simple, basic data be gathered to allow comparisons across studies. The authors state clearly that they expect their operational definitions to be changed as new data emerges, and indeed they welcome comments and criticisms. I propose that the NIDR formalize this process by commissioning another report in about 5 years.

Approach to the Problem

In the introduction to this report, the need to develop research diagnostic criteria for the TMD is clearly justified. Several attempts have been made before by individuals or groups, but their taxonomies have never been widely accepted in the scientific community because they were not based on controlled population studies. The new RDC/TMD are based on these earlier systems but draw their strength from the data gathered during a longitudinal epidemiologic study of the signs and physical symptoms of TMD and of the psychosocial factors that are associated with them.

That the system has a second axis is a reflection of the fact that distress and psychosocial dysfunction are important personal and public health issues. As long as the etiology of TMD is a mystery and treatment nonspecific, coping with the conditions will be of great importance for patients and for society. The same situation exists for most other chronic pain conditions. Despite this, I do not agree with the approach

taken by the International Association for the Study of Pain (IASP),[1] "that conditions yielding persistent pain are too complex to be diagnosed using a single axis." Management of these conditions is complex, but the underlying pathology may have a simple cause, although we do not know what it is at this time. I suggest that we concentrate our research on the underlying pathology. Once the causes can be identified and treated, it is probable that the need for Axis II will diminish, just as better iron lungs and improved coping strategies for polio victims and their families were made unnecessary by the development of vaccines.

Operational definitions are used in the RDC/TMD whenever possible to remove the bias that is associated with many of the older taxonomies. Terms such as myofascial pain are retained because of their descriptive value, not because we are espousing the myofascial pain-dysfunction hypothesis.[2,3] The proposed RDC are not based on any etiologic theory. This is a strength, not a weakness, since there is no conclusive scientific support for any of the prevailing etiological hypotheses. In fact, the situation is even worse; there is good evidence that the most popular hypothetical causes of TM pain and dysfunction, muscle hyperactivity caused by dentoskeletal structural abnormalities[4] and/or stress,[3,5] are probably invalid.[6-8]

Review of Current Diagnostic Systems

The working group headed by Ohrbach and Stohler used clearly defined methods of analysis developed for other areas of clinical research to evaluate nine taxonomic systems. All the criteria are explained and are appropriate. The group paid particular attention to the methodology used in the clinical research that formed the basis of each diagnostic system. They conclude that the system recently developed by Truelove et al[9] came closest to meeting the criteria they had established. It is worth repeating that this is the only system based on the analysis of data from large well-defined populations. Although the system of classification finally chosen by the whole team is based on data used by Truelove et al, it also includes some of the features of other taxonomies.

Reliability and Validation of Examination Methods

Like Ohrbach and Stohler, Widmer used well-established guidelines to estimate the validity and reliability of examination methods used to quantify the physical signs (Axis I). The section on sensitivity and specificity is particularly important, because it emphasizes the point that the biggest problem with most of the tests used clinically is the inclusion of nondiseased individuals in TMD populations. Indeed, if any of the tests described were used alone, the "TMD" groups would probably contain a majority of nondiseased individuals. The requirement that pain must have been reported in the area in the past month probably reduces this risk, but it now becomes important to assess the reliability and validity of questions on pain.

Classification

Axis I: Clinical TMD Conditions. I favor the decision to maximize the usefulness for research, even if this does make the taxonomy difficult to use in the clinic. However, this did not turn out to be the case, because the system chosen seems to be clinically useful. Also, there is no reason the clinical reader should not modify his/her examination procedures to increase precision. For instance, the recommendation that ambiguous terms should be avoided in the RDC surely applies to the clinic.

It needs to be pointed out that many terms used to describe clinical cases are generally used loosely. Spasm, contracture, contraction, hyperactivity, tension are a few that come to mind. Diagnostic criteria for muscle spasm, myositis, and contracture can be found in the medical literature. For instance, myositis is characterized by weakness, EMG abnormalities recorded with needle electrodes, an elevated erythrocyte sedimentation rate, an elevated serum creatinine phosphokinase concentration, and evidence of inflammation in biopsy specimens.

In the system of classification that is proposed, patients are assigned to the three major groups (I, muscle conditions; II, disc displacements; III, arthralgia, arthritis, and arthrosis) on the basis of a simple physical examination and case history. With the exception of bruxism and dyskinesias (see later), I agree this is the most that should be attempted at this time. Whether one chooses to call the muscle conditions myofascial pain, fibromyalgia, myofibrositis, or myalgia is not important at the moment. Some people believe that myofascial pain and fibromyalgia can be distinguished by the presence of trigger points in the latter condition; others suggest that they may be indistinguishable. One person's trigger point may be another's tender point.[10]

Subgroups of I and II are defined on the basis of limitations of jaw opening. I realize that the "limitation" is an operational definition and that it is open for change. It is obvious that the first thing to do is to adjust for sex, age, and perhaps size. This may help to improve the low sensitivity associated with the 35-mm cutoff. Widmer quotes two studies that report differences of 2.5 and 3.5 mm between the sexes. The cutoffs for maximum unassisted opening is different for Groups I and II (40 vs 35 mm), as are the limits of pain-free passive stretch (>5mm vs ≤4 mm). Although the reason for choosing different limits was not explained, the decision is not surprising, because

it is likely that mechanical factors limit movement in Group II, while pain is the primary cause in Group I. There is evidence that pain causes the jaw closing muscles to co-contract during jaw opening,[8,11] and that the limitation to movement may well be proportional to the level of pain that the subject is experiencing. We should therefore not be surprised if a subject could fall in Group Ia on one day and in Group Ib the next.

The authors paid little attention to bruxism, oral habits, and orofacial dyskinesias. They were not assigned to specific categories, although it seems that most would be given a diagnosis of myofascial pain. When discussing Bell's taxonomy, Ohrbach and Stohler state that bruxism could induce myofascial pain. I think it is time that we recognize that bruxism and myofascial pain are probably unrelated. There are several major differences between the two conditions. Many patients who brux do not have pain,[12] and when pain does occur in people who brux sporadically during sleep, it begins after the start of the nocturnal episodes.[13] This evidence suggests that the pain caused by bruxism, oral habits, and dyskinesias is a form of postexercise muscle soreness.[8] On the other hand, there is now good evidence that neither trigeminal myofascial pain nor similar pains elsewhere in the body are caused by increases in muscle activity.[6-8,14]

There should be little difficulty in identifying subjects who have signs and symptoms of these disorders while awake, but the classification of sleep disorders is difficult. At the moment, it appears that a definitive diagnosis can only be made using data gathered in a sleep laboratory.[15,16] However, positive answers to questions 15c (Have you been told, or do you notice that you grind your teeth or clench your jaw while sleeping at night?) and 15e (Does your jaw ache or feel stiff when you wake up in the morning?) strongly suggest that the subject has some form of movement disorder during sleep.[16]

Axis II: Pain-Related Disability and Psychological Status. Subjects can be assigned to a diagnostic category independently of information gathered from the psychological and disability questionnaire, but the team is right to emphasize the need to gather data on the psychologic, behavioral, and social status of subjects. The authors point out that many types of therapy now used do not target the pathophysiology, but instead aim to manage the pain, disability, and depression. They also explain the choice of the methods of measurement of pain and dysfunction.

Although the history taken for Axis I includes a few basic questions about pain, the measurement of pain is part of Axis II. The team recommends that chronic pain can be quantified on category scales (CAT). They have some significant advantages, particularly for epidemiologic surveys: they are easy to understand and administer, even by telephone, and are easy to score. However, they may not be as appropriate for other types of studies and cannot normally be analyzed using parametric statistical tests.[17,18] Those who are planning studies in which pain is an important variable should consider using a continuous scale, such as the visual analog scale (VAS), or a ratio scale, such as verbal descriptor checklists (VDCL). Many studies have shown that VAS and VDCL are valid and reliable measures of clinical and experimental pain in several populations that use different languages.[19,20]

The TMD history questionnaire includes three questions for grading pain: one for the actual pain (Q 7), one for maximal pain in the last 6 months (Q 9), and one for average pain in the last 6 months (Q 10). The interpretation of the last two is difficult, because it is known that chronic pain patients have a poor memory of their pain.[21] In fact, TMD patients remember their pain as being significantly higher than it actually was.[22] With the questions chosen, it is not possible to distinguish the sensory (intensity) and affective (emotional) dimensions of pain. It is has been clearly shown that this can be done.[19,20] In some types of studies it may be important to measure the two dimensions, because treatment may modify one more than the other.

All of the four questions on disability (Q 11 through 14) also rely on the patient's memory; this may be more reliable than for pain, but I suspect that it is not. In some types of studies it may be necessary to gather other data on disability, perhaps by using diaries or company records of absence from work.

The authors recommend that depression, vegetative, and nonspecific physical symptoms be scored using the SCL-90-R scale. This scale has been extensively tested on several populations, including those with TMD. I was pleased to see that they decided not to employ the term "somatization." Again, this reflects the decision of the team to avoid assigning an etiology to symptoms.

In the jaw disability scale (Q 19a through 19l), chewing appears three times, once unqualified and then related to soft and hard foods; the first is redundant. The restriction on sexual activity will depend on which sexual activities the respondent engages in, if any. Finally, the two-category scale allows no gradation of response and is likely to provide very poor discrimination.

Suggestions for Future Research

The RDC must continue to be evaluated in long-term population studies. Chronic pain is an important dental and general health problem, and epidemiologic data on the course of the diseases are lacking.[23] There is a popular hypothesis that the various TMD form a continuum, along which the patient moves from occlusal abnormalities to muscle dysfunction, pain, abnormal joint loading, and finally to the arthritides (this concept of "cranio-mandibular harmony" was critically reviewed by Hannam.[24]) Although there are no good data that support this idea, it is important

from the clinical standpoint that the hypothesis be tested using the results of long-term studies of the progression of the diseases. The fact that the prevalence of facial pain decreases with age[25] suggests that some forms of TMD resolve. On the other hand, the prevalence of the arthritides increases.[26]

It is important that the co-occurence of TMD, and between TMD and other disease categories (eg, bruxism and sleep disorders, trigeminal myofascial pain and other similar chronic pain conditions elsewhere in the body) be investigated. McCain and Scudds[27] consider generalized fibromyalgia, generalized myofascial pain, and TMD to be related and overlapping conditions. There is some preliminary data that suggests an increased incidence of fibromyalgia in TMD populations.[5]

As far as I know, no one has yet looked to see if a susceptibility to any of the TMDs is inherited.

It is important that the validity, reliability, specificity, etc, of the individual diagnostic entities be better established. Muscle tenderness scores need to be adjusted for age and sex.[28] If no way can be found to improve the reliability of intraoral palpation, this should be dropped. More attention needs to be given to the intensity, quality, and pattern of pain, because this could lead to more precise diagnosis. For instance, most patients seem to report that the intensity of myofascial pain is in the bottom half of the scale, and it may turn out that a report of intense pain indicates some other form of pathology.

There is more and more evidence that most of our present treatments for chronic pain are no better than a good placebo. Malone and Strube[29] carried out a meta-analysis of various non-medical treatments for chronic pain of various types, including cancer, "dental or facial," and headache. In general, treatment effects were modest and of short duration. They suggested that the effectiveness of treatments is attributed to features that they have in common, rather than to differences. More recently, Chapman[30] concluded that is there is little evidence that the treatments commonly used by physical therapists have more than transient effects on chronic pain. However, there have been few well-controlled studies of the efficacy of treatment of TMD. The common methods now need to be tested on the different categories of disease as defined by the RDC/TMD. To evaluate the efficacy of a treatment, it will be necessary to describe the effects not only on the physical signs and symptoms, but also on the stress, depression, disability, and dysfunctional illness behaviors.

The etiologies of none of the TMD are known. It is unfortunate that a lot of effort has been wasted on testing hypotheses that were based on philosophy and not science. The teeth have been a major distraction! We need to study each of the three major disease categories as separate entities and, when possible, use information from animal models. Beginning with pain receptors, a great deal is now known about muscle, joint, and vascular nociceptors in other parts of body, and the effects that trauma, sensitizing factors, and anti-inflammatory agents have on their properties, but we have very little information on the equivalent trigeminal afferents.[6,31] This needs to be rectified.

There are animal models for arthritis of the ankle and knee,[32] and these have been used to show that chemicals released from the peripheral terminals of unmyelinated sensory axons act via mast cells on sympathetic axon terminals. All three elements are essential to the inflammatory process. We need data such as these for the TMJ. There is no animal model for myofascial pain, but we can study the link between muscle pain and dysfunction using both clinical and experimental pain.[33]

It is important that the studies of normal and diseased TMJs using CT and MRI summarized by Widmer in Part IB be continued, so as to establish reliable criteria for the detection of pathology.

It has been suggested that muscle microcirculation is reduced in trigeminal myofascial pain (eg, Moller[34]), and there have been several reports over the years of a decreased microcirculation in fibromyalgia, leading to decreased oxidative metabolism and damage to muscle fibers (for review see Henriksson and Bengtsson[35]). As in arthritis, the immune system, primary afferents, and the sympathetic axons have been implicated in this process. Unfortunately, the evidence in favor of this hypothesis is rather poor because it mainly comes from the interpretation of punch biopsy specimens. The development of MRI spectroscopy techniques for the study of muscle energy metabolism will eventually allow clinical trials to be carried out on groups of patients and matched controls.[36] Lam and Hannam[37] have done some of the essential groundwork by describing regional changes in metabolic activity and pH in the human masseter during exercise.

References

1. International Association for the Study of Pain, & Subcommittee on Taxonomy: Classification of chronic pain: Descriptions of chronic pain syndromes and definitions of pain terms. *Pain Suppl* 1986;3:S1–S225.
2. Travell J, Rinzler S, Herman M: Pain and disability of the shoulder and arm: Treatment with intramuscular infiltration with procaine hydrochloride. *JAMA* 1942;417–422.
3. Laskin DM: Etiology of the pain-dysfunction syndrome. *J Am Dent Assoc* 1969;79:147–153.
4. Bergamini M, Prayer-Galetti S: A classification of musculoskeletal disorders of the stomatognathic apparatus. *Front Oral Physiol* 1990;7:185–190.
5. Blasberg B, Chalmers A: Temporomandibular pain and dysfunction syndrome associated with generalized musculoskeletal pain: A retrospective study. *J Rheumatol* 1989;16(suppl 19):87–90.
6. Lund JP, Widmer CG: An evaluation of the use of surface electromyography in the diagnosis, documentation, and treatment of dental patients. *J Craniomandib Disord Facial Oral Pain* 1989;3:125–137.
7. Lund JP, Widmer CG, Schwartz G: What is the link

between myofascial pain and dysfunction?, in van Steenberghe D and De Laat A (eds): *Electromyography of Jaw Reflexes in Man*. Leuven, Belgium, Leuven University Press, 1989, pp 427–444.
8. Lund JP, Widmer CG, Donga R, Stohler CS: The pain adaptation model: An explanation of the relationship between chronic pain and muscular activity. *Can J Physiol Pharmacol* 1991;69:683–694.
9. Truelove E, Sommers EE, LeResche L, Dworkin SF, Von Korff M: Clinical diagnostic criteria for TMD: New classification permits multiple diagnoses. *J Am Dent Assoc* 1992;123:47–54.
10. Hadler NM: A critical reappraisal of the fibrositis concept. *Am J Med* 1986;81(suppl 3a):26–30.
11. Stohler CS, Ashton-Miller JA, Carlson DS: The effects of pain from the mandibular joint and muscles on masticatory motor behavior in man. *Arch Oral Biol* 1988;33:175–182.
12. Sherman RA: Relationships between jaw pain and jaw muscle contraction level: Underlying factors and treatment effectiveness. *J Prosthet Dent* 1985;54:114–118.
13. Rugh JD, Solberg WK: Electromyographic studies of bruxist behavior before and during treatment. *J Calif Dent Assoc* 1975;3:56–59.
14. Nouwen A, Bush C: The relationship between paraspinal EMG and chronic low back pain. *Pain* 1984;20:109–123.
15. American Sleep Disorder Association: Parasomnias, in: Thorpy MJ (ed): *International Classification of Sleep Disorders: Diagnostic and Coding Manual*. Rochester, Minn, American Sleep Disorder Association, 1990, pp 142–185.
16. Velly Miguel AM, Montplaisir J, Rompre PH, Lund JP, Lavigne G: Bruxism and other movements during sleep. *J Craniomandib Disord Facial Pain* 1992;6:71–81.
17. Joyce RB, Zutski DW, Hrubes Z, Mason RM: Comparison of fixed intervals and visual analogue scales for rating chronic pain. *Eur J Clin Pharmacol* 1975;8:415–420.
18. Heft MW, Parker SR: An experimental basis for revising the graphic rating scale for pain. *Pain* 1984;19:153–161.
19. Price DD, McGarth PA, Raffi A, Buckingham B: The validation of visual analog scales as ratio scale measures for chronic and experimental pain. *Pain* 1983;17:45–56.
20. Duncan GH, Buschnell MC, Lavigne G, Duquette P: Développement d'une echelle verbale français pour mésurer l'intensité sensorielle et l'aspect désagréable de la douleur. *Doul Analgés* 1988;1:121–126.
21. Linton SJ, Melin L: The accuracy or remembering chronic pain. *Pain* 1982;13:281–285.
22. Feine JS, Dao TTT, Lavigne GJ, Lund JP: Is treatment success due to faulty memory of chronic pain? *J Dent Res* 1989;68(special issue):1018.
23. Osterweis M, Kleinman A, Mechanic D: *Pain and Disability: Clinical and Public Policy Perspectives*. Washington, DC, National Academy Press, 1987.
24. Hannam AG: Optimum occlusal relationships are essential for craniomandibular harmony, in Klineberg I, Sessle B (eds): *Oro-facial Pain and Neuromuscular Dysfunction*. Advances in the Biosciences, vol 52. Oxford, Pergamon, 1985, pp 167–175.
25. Von Korff M, Dworkin SF, LeResche L, Kruger A: Epidemiology of temporomandibular disorders: TMD pain compared to other common pain sites, in Dubner R, Gebhart GF, Bond MR (eds): *Pain Research and Clinical Management*, vol 3. Amsterdam, Elsevier, 1988, pp 506–511.
26. Reider CE, Martinoff JT, Wilcox SA: The prevalence of mandibular dysfunction. Part I: Sex and age distributions of various signs and symptoms. *J Prosthet Dent* 1987;50:81–88.
27. McCain GA, Scudds RA: The concept of primary fibromyalgia (fibrositis): Clinical value, relation and significance to other chronic musculoskeletal pain syndromes. *Pain* 1988;33:273–287.
28. Schiffman E, Fricton J, Haley D, Tylka D: A pressure algometer for myofascial pain syndrome: Reliability and validity testing, in Dubner R, Gebhart G, Bond MR (eds): *Pain Research and Clinical Management*, vol 3. Amsterdam, Elsevier, 1988, pp 407–413.
29. Malone MD, Strube MJ: Meta analysis of nonmedical treatments for chronic pain. *Pain* 1988;34:231–244.
30. Chapman CE: Can the use of physical modalities for pain control be rationalized by the research evidence? *Can J Physiol Pharmacol* 1991;69:704–712.
31. Sessle BJ, Hu JW: Mechanisms of pain arising from articular tissues. *Can J Physiol Pharmacol* 1991;69:617–626.
32. Bausbaum AI, Levine JD: The contribution of the nervous system to inflammation and inflammatory disease. *Can J Physiol Pharmacol* 1991;69:647–651.
33. Stohler CS, Zhang X, Ashton-Miller JA: An experimental model of jaw muscle pain, in Davidovitch Z (ed): *The Biological Mechanisms of Tooth Movement and Craniofacial Adaptation*. Birmingham, Ala, Ebsco Media, 1991, pp 261–267.
34. Moller E: Muscle hyperactivity leads to pain and dysfunction: Position paper, in Klineberg I, Sessle B (eds): *Oro-facial Pain and Neuromuscular Dysfunction*. Advances in the Biosciences, vol 52. Oxford, Pergamon, 1985, pp 70–92.
35. Henriksson KG, Bengtsson A: Fibromyalgia–A clinical entity? *Can J Physiol Pharmacol* 1991;69:672–677.
36. Kushmeric MJ: Muscle energy metabolism, nuclear magnetic resonance spectroscopy and their potential in the study of fibromyalgia. *J Rheumatol* 1989;16(suppl 19):40–46.
37. Lam EWM, Hannam AG: Regional 31P magnetic resonance spectroscopy of exercising human masseter muscle. *Arch Oral Biol* 1992;37:49–56.

B. Clinical Sciences

The aim of the RDC/TMD project is to establish reliable and valid diagnostic criteria to diagnose and define subtypes of TMD. This is an important goal, as one of the major methodological problems of past research on TMD has been the lack of a precise definition of the populations investigated. Although it has long been known that TMD represents a group of different entities with different pathologies and, probably, with different etiologies, authors continue to classify patients solely as TMD, without specifying inclusion and exclusion criteria. Consequently, it is difficult, if not impossible, to draw valid conclusions from such studies. Another problem that makes comparison of research data almost impossible is the lack of a universally accepted and validated classification system. An excellent critical evaluation of the meth-

odological problems inherent to some taxonomic systems, especially "popular" in the United States, is presented by Orhbach and Stohler in Part IA of this report. The imprecise definitions of the patients investigated, the lack of a universally accepted classification system, and the use of different inclusion and exclusion criteria for the definition of similar subgroups in different taxonomic systems has resulted in confusion and inability to compare observations and results of research, thus hindering the improvement of our knowledge on TMD. Therefore, the time has come to start a project to develop a valid classification system. It is to be hoped that the efforts of worldwide, well-respected clinical and research scientists will provide an RDC/TMD system that will be generally recognized. Of course, this also implies that scientists and clinicians outside the United States will be involved in the process of validation of the proposed taxonomic system.

Almost all classification schemes defined in the literature classify subtypes of TMD according to physical signs and symptoms. There is, however, a great variability in pain perception within patients belonging to the same subgroup (ie, having the same pathology). Nevertheless, a common feature of TMD patients is that they suffer from chronic pain. As such, they share several characteristics in terms of psychosocial distress with chronic pain patients (ie, those with low back pain or headache),[1] where illness behavior is a dimension of the patient's suffering. Differences in pain behavior may explain why identical treatment approaches often have different outcomes among patients with similar physical impairments. Consequently, patients with different illness behaviors may need different therapies independent of the TMD pathology. These clinical experiences indicate that TMD patients should not only be classified on pathophysiological but also on psychosocial-behavioral characteristics. This multidiagnostic approach, allowing classification of individuals with complementary taxonomic systems, is needed in research to classify subjects in homogeneous groups, a prerequisite to investigate the etiology, natural course, or the treatment outcome of TMD. Such a system is proposed in this project, increasing significantly the importance of the RDC project.

The physical taxonomic system allows for multiple diagnoses. This is not only correct but a necessity, as several pathologies are often present in the same TMD patient, for instance, a tendomyopathy with ostheoarthrosis or with a disc disorder. This multidiagnostic approach has been used for more than 10 years at our institute and has proven to be valid for education. The different diagnoses do not have to be weighted as we do not know which pathology is more disabling for a patient, especially as the disability and degrees of suffering are often influenced more by illness behavior than by the disease itself.

It is to be hoped that the proposed RDC/TMD dual-axial classification system will allow the classification of patients in more homogeneous groups than previous uniaxial taxonomic systems. "Gold standards" should be used to validate the new taxonomic system. Both the development of gold standards and use to validate the taxonomic system should be the task of an international multicenter study. Otherwise, an argument against the proposed criteria could be that they are sensitive and specific only because the taxonomic system has not been validated in an objective manner. The validation of some subgroups will not be easy because of the lack of available definitive diagnostic procedures or of "biological gold standards" that define some pathologic changes. This is a problem common to other taxonomic systems for diseases where specific tissue changes are not readily demonstrated, for instance, in the case of headache or fibromyalgia. Therefore, despite all its limitations, the clinical diagnosis, which includes imaging and other diagnostic techniques, will probably remain the best gold standard to validate the system. Unless this validation phase is finished, the main goal of the present RDC/TMD project will be missed.

In this context, it is difficult, for example, to determine which gold standard should be used to validate the criteria for the diagnosis of "disc disorders with or without reduction." Both MRI and CT have inadequate specificity and sensitivity (see Widmer's contribution). Of these two techniques, CT presents serious radiation concerns and doubts exist in literature about the possibility of visualizing the disc using this method.[2-4] Widmer, in Part IB of this report, considers it difficult to accept arthrography as the diagnostic gold standard because the procedure could distort the "true" anatomy. However, a preliminary report on condylar movements indicated that joint anesthesia and injection of the contrast medium did not alter the joint biomechanics to an extent to invalidate the arthrographic diagnosis.[5] The main contraindication to using arthrography as the gold standard is certainly its invasiveness. Thus, because of its noninvasiveness, static and "dynamic" MRI could become the best gold standard, provided that its diagnostic reliability is evaluated in double-blind studies.

Because of the low reliability of researchers in collecting clinical data, a set of "specifications for field examinations" are provided. This is very important to maximize examination reliability across studies. However, it is doubtful whether these guidelines are sufficient to improve interrater reliability between examiners in different parts of the world, especially considering that even TMD specialists who were noncalibrated showed low reliability compared with examiners trained and calibrated for 40 hours.[6,7] Should this project end up in a multicenter project, there would be a need to calibrate examiners according to the suggested specifications.

The RDC/TMD offers a classification system for research purposes and not for the clinic. It is important to keep this in mind, because the decision analy-

sis is based on clinical criteria that have been validated extensively in epidemiologic studies.[6,8] Imaging and other laboratory diagnostic procedures, which must sometimes be used in the clinic to confirm a provisional diagnosis or to assess the degree of pathologic alteration, are not essential for making certain diagnoses according to this taxonomic system. Consequently, some pathologic conditions such as adhesions and disc perforations, which can only be diagnosed using invasive techniques, have not been included in this taxonomic system. This decision is correct from both a clinical and epidemiologic point of view, as the incidence of these pathologies is low according to our clinical experience. Furthermore, they belong by definition to the group of degenerative joint diseases (ie, of ostheoarthrosis or ostheoarthritis). Minimizing imaging and/or other diagnostic procedures from the RDC/TMD is acceptable, as a provisional diagnosis can be made in most of the cases just by means of the history and the clinical examinations. This has also been confirmed by research.[9,10]

Issues for Future Clinical Research

The following discussion considers the strengths and weaknesses of the proposed taxonomic system from a clinical-scientific point of view.

Diagnostic Scheme: Axis I. As a general comment, there is a certain discrepancy between the goal of the project, which is to reduce the ambiguity and uncertainty surrounding the diagnosis of TMD by using a set of operational or measurable parameters to evaluate the health of the masticatory system, and some terminology as well as some of the diagnostic criteria chosen. The proposed examination protocol contains several criteria that are not operationally defined, ie, that seem dictated more by clinical than research needs. It is therefore difficult to imagine how these could be used in the study of TMD prevalence, incidence, natural history, clinical course, and risk factor evaluation. The impression gathered from analyzing Axis I is that it was generated with too much consideration of clinical needs, which are far different from those targeted by this project.

The proposed diagnostic scheme divides TMD into three subgroups ("muscle disorders," "disc displacements," and "other joint conditions") and correctly excludes all joint and muscle diseases caused by known pathologies such as inflammatory rheumatism, infections, metabolic diseases, tumors, traumata, and so forth. Also excluded are diagnoses pertinent to TMD such as adhesions, capsule and muscle contracture, disc perforation, or joint hypermobility that cannot be diagnosed by clinical examination only. The diagnostic scheme proposed is probably the only one possible with the present knowledge and the proposed examination parameters. However, further research may reveal that the present terminology is not ideal. Except for "disc displacements" in the initial state, the pathology, natural course, therapy outcome, and probably the etiology of TMD resemble that of joint and/or nonarticular rheumatism. Refinement of criteria and accumulation of further clinical data may suggest that TMD subtypes be classified using the same terminology used in rheumatology: I, tendomyopathy (of masticatory muscles); II, disc disorders (a, with reduction, and b, without reduction); III, synovitis/capsulitis; IV, ostheoarthrosis; V, ostheoarthritis. Such use of medical terminology may improve communication with other providers.

The pathophysiology of muscle pain is poorly understood. Clinical experience as well as epidemiologic data indicate that the source of the TMD pain is both the muscles and the tendons. For instance, the tendon of the temporal muscle is often the most tender site to palpation.[8,11] Therefore, it may turn out that replacing the term "myofacial pain" with "tendomyopathy" more specifically defines the anatomic structures affiliated with the pain.

It is proposed to differentiate between mastication muscle pain "with" and "without limited range of motion." A correct diagnosis of the cause of jaw opening restriction is of utmost importance in the clinic, as it may influence the therapy. The question is whether this classification is important for research purposes. For instance, the range of motion may also be reduced in the case of an ostheoarthritis due to the joint pain. However, a subdivision of ostheoarthritis "with" and "without restricted jaw movements" was not suggested. Furthermore, the terminology "with limited range of motion" defines a sign and is therefore not a diagnosis. Future clinical and epidemiologic research may indicate that the subgroup "TMD with tendomyopathy" is adequately descriptive.

The common term "disc displacement" is used in the RDC/TMD. The term "disc disorder" may come to be preferred, as it refers to functional aspects of the problem. The classification "with reduction" and "without reduction, with limited opening" should be maintained, despite the fact that the terms are only descriptions. The differentiation between these two groups is important at present for clinical purposes. There is a need for better data on the incidence and prevalence of discs that lose the ability to reduce, so that patients can be counseled regarding conservative therapies and not harmed with aggressive, unproven invasive therapies. Thus for continued study of the natural history of disc displacement, the two subgroups should be maintained.

The diagnosis of a "disc disorder without reduction, without limitation" is difficult without an imaging technique and may have to be discarded. The diagnosis of "disc displacement with reduction/chronic," shows a low degree of agreement (61.5%) with the arthrographic "gold standard diagnosis," pointing to

the difficulty in separating normal joints from those with "disc displacement, without reduction/chronic."[10]

The diagnostic category "arthralgia" presents well-known problems, and at present it is probably impossible to arrive at a single nomenclature that would please all clinicians and researchers. Arthralgia is not a diagnosis. It just describes a condition or pain in the joint with objective findings of heat, redness, tenderness to touch, loss of motion or swelling.[12] As correctly mentioned in the Appendix to Axis I, rheumatological joint diseases and traumatic joint arthritis are not a subcategory of TMD. Consequently, according to our present knowledge on joint pathology, the only joint inflammation that can occur in TMD patients is either as "activated" osteoarthrosis, that is, an osteoarthrosis with secondary inflammation (RDC/TMD defined as osteoarthritis) or as a "disc disorder" with secondary synovitis or/and capsulitis. Thus, as for the term tendomyopathy, the diagnosis "synovitis/capsulitis" more specifically defines the anatomic structures affiliated with the pain and should therefore be preferred to the term "arthralgia." Further underscoring our present dilemma for the classification of painful joint conditions, it is difficult to decide whether to use the term synovitis in the case of arthralgia because it is impossible to differentiate between these two pathologies by clinical examination.

As the present RDC/TMD confirm, diagnostic criteria to diagnose "arthralgia" are certainly weak. First of all, the reliability of TMJ palpation was only marginally acceptable even for calibrated examiners.[6] The prevalence of tenderness to palpation of the lateral aspect of the TMJ and of the deep masseter muscle was similar both in control and non-TMD individuals (9% and 14%, respectively). On the contrary, the intrameatal joint palpation had a far lower prevalence (3%). Also, in TMD patients seeking treatment, the ratio between the prevalence of tenderness in these sites was similar, though the absolute values were far higher (values of 58% for deep masseter, 57% for TMJ lateral, and 10% for TMJ intrameatal).[8] The muscle fibers of the deep masseter are in close relationship with the joint capsule and may even originate from the lateral wall.[13,14] These epidemiologic and anatomic data give rise to the question as to whether lateral joint palpation really indicates an inflammation of the capsular apparatus or whether it is due to the phenomenon of sensitization and/or increase of the nociceptive field. The question is even more pertinent because joint play[15,16] is often negative, indicating absence of joint inflammation, even in cases in which the patients report tenderness to the lateral palpation. The examination of joint play is probably the most important clinical test to assess whether a joint is inflamed or not. However, this test cannot, at present, be required as a research diagnostic criterion because it cannot be performed all the time. Patients are often so tense that the joint cannot be freely moved, making the test impossible to perform and/or the results difficult to interpret.

The other criteria to diagnose joint "arthralgia," ie, "report of pain in the region of the joint, pain in the joint during maximum unassisted opening, pain in the joint during lateral excursion, pain in the joint during assisted opening" are also questionable as indicators of TMJ arthralgia. Better evidence that a patient can correctly localize pain as arising in the joint is required. On the contrary, studies on referred pain indicated that the deep masseter and lateral pterygoid muscles often project the pain in the TMJ area.[17]

Crepitus joint sounds should be included as RDC/TMD criterion for osteoarthrosis diagnosis despite its low reliability, since this sign has important clinical diagnostic utility at present. In addition, a history of crepitation or hard grating should be included in future clinical research and the question needs to be added to the present questionnaire.

Pain-Related Disability and Psychologcal Status: Axis II. Chronic pain patients, including many TMD patients, cannot be defined and classified only by the type and degree of pathophysiologic alterations. Chronic pain is a complex perceptual process where affective and cognitive behaviors play an important role. Unlike acute pain, it is not directly linked to the extent of tissue damage. The inability to recognize this phenomenon and the restricted use of single etiologic (eg, occlusal) concepts has led to irreversible therapies that might potentially harm patients. Introduction of a behavioral classification axis in addition to a pathophysiologic axis, is therefore important, not only for research but also for educational and clinical purposes.

The proposed Axis II protocol aims to evaluate the psychosocial status and extent of disability of TMD patients. There is some evidence in the literature that stress may precipitate or maintain pain.[18] From an etiologic point of view, the important issue is not which type of stress factors burden a patient or the frequency of their occurrence, but how well one copes with these stresses. Assessing the patient's strategy for coping with disease is important to prevent induction of truly long-standing chronic conditions. Furthermore, the emergence of illness behavior often depends upon social, economic, and family support, which may act as "buffers." Good support systems may help to prevent the development of illness behavior and vice versa. Indeed, one of the major disabling profiles recognized in chronic pain patients was characterized by inadequate social support.[19] Thus, for completeness, Axis II would benefit from items to evaluate these aspects.

The Axis II test items are easily understood and short. This would imply that they can be used worldwide without difficulty as they are adapted to different cultures, a well known problem with a more psychometrically complex test. This is important for comparing data worldwide.

The proposed taxonomic psychobehavioral system

and the evaluation criteria need to be evaluated for validity and utility. The results of the proposed assessments could be compared to those obtained with other psychosometric measures of psychosocial functions that have been already validated and applied to chronic pain patients, including TMD patients, such as the MPI.[20]

Comments Concerning Specifications for Field Examinations

Unassisted opening should not be measured after the first, but rather after several opening attempts (at least three). Subjects tend not to open as wide as possible the first time.

Midline deviations on opening are to be noted when "visually perceptible." The necessity of avoiding unambiguous wording has been pointed out and "visually perceptible" seems unnecessarily ambiguous. Data are needed concerning the practicality as well as the reliability of incorporating a cutoff measure. Also, it would seem practically impossible to check deviations in the midline without keeping a ruler in the midsagittal plane in front of the patient.

Measurements of mandibular movements by means of a millimeter ruler reach good reliability only for the vertical movement. Reliability of protrusion and laterotrusion measurements is only marginally acceptable. Furthermore, with this method one does not measure the actual length of the laterotrusive movement, but rather its length on the "frontal" plane. Clinical experience indicates also the impossibility of accurately measuring the difference between assisted and unassisted opening and of the position at which the click occurs. Thus, for the purpose of the RDC project, mandibular movements and the location of the click should be recorded by means of calibrated electronic devices.

The determination that a clicking sound can be eliminated if the jaw is opened and closed in a protruded or more anterior jaw position does not yet seem a reliable or valid diagnostic criterion to classify subgroups. Indeed, clicking sounds not caused by disc disorders also disappear when the patient opens and closes in a protruded position. This measurement may be important for the therapy, but better data are needed to determine if the criterion is important for the taxomony.

The criteria to diagnose "disc displacement without reduction, without limitation" do not consider range of motion, but do include a history of significant limitation of mandibular opening and the presence of joint noise, not meeting the criteria for "disc displacement with reduction." At present it is not clear if such a definition is adequately operationalized.

Even with trained examiners, the reliability of muscle palpation only reaches acceptable levels.[6] Several problems account for this phenomenon, one of these being the difficulty of palpating deep masticatory muscles. There is, for example, evidence that it is anatomically impossible to palpate the lateral pterygoid muscle.[21] As the aim of the project is to use only valid parameters, muscle palpation must be limited to those muscles that can really be palpated, thus palpation of the lateral pterygoid muscle and of the styloid posterior should be deleted from the protocol.

References

1. Turk DC, Rudy TE: The robustness of an empirically derived taxonomy of chronic pain patients. *Pain* 1990;43:27-35.
2. Christiansen EL, Thompson JR, Hasso AN, Hinshaw DB, Moore RJ, Roberts D, Kopp S: CT number characteristics of malpositioned TMJ menisci. Diagnosis with CT number highlighting (Blinkmode). *Invest Radiol* 1987;22:315-321.
3. Juliani G, Fava C, Preti G: L'esame radiologico dell articolazione temporo-mandibolare (ATM). *Radiologia Medica* 1987;74:145-165.
4. Tanimoto K, Hansson L-G, Petersson A, Rohlin M, Johansen CC: Computed tomography versus single-contrast arthrotomography in evaluation of the temporomandibular joint disc. A study of autopsy specimens. *Int J Oral Maxillofac Surg* 1989;18:354-358.
5. Rohrer FA, Palla S, Engelke W: Condylar movements in clicking joints before and after arthrography. *J Oral Rehabil* 1991;18:111-123.
6. Dworkin SF, LeResche L, Derouen T, Von Korff M: Assessing clinical signs of temporomandibular disorders: Reliability of clinical examiners. *J Prosthet Dent* 1990;63:574-579.
7. LeResche L, Dworkin SF, Sommers EE, Truelove EL: An epidemiologic evaluation of two diagnostic classification schemes for temporomandibular disorders. *J Prosthet Dent* 1991;65:131-137.
8. Dworkin SF, Huggins KH, LeResche L, Von Korff M, Howard J, Truelove EL, Sommers EE: Epidemiology of signs and symptoms in temporomandibular disorders: Clinical signs in cases and controls. *J Am Dent Assoc* 1990;120:273-281.
9. Lundeen TF, Levitt SR, McKinney MW: Clinical application of the TMJ scale. *J Craniomand Pract* 1988;6:339-345.
10. Anderson GC, Schiffman EL, Schellhas KP, Fricton JR: Clinical vs. arthrographic diagnosis of TMJ internal derangement. *J Dent Res* 1989;68:826-829.
11. Ruggia GM: *An Epidemiological Survey of Signs and Symptoms of Myoarthropathies of the Masticatory System in 11-16 year-old children in Ticino.* Thesis, University of Zürich, 1990.
12. Becker EL, Butterfield WJH, McGehee Harvey A, Heptinstoll RH, Thomas L: *International Dictionary of Medicine and Biology.* New York, John Wiley, 1986.
13. Maienberg K, Kubic S, Palla S: Relationships of the muscles of mastication to the articular disc of the temporomandibular joint. *Helv Odontol Acta* 1986;30:1-20.
14. Axelsson S, Fitins D, Hellsing G, Holmlund A: Arthrotic changes and deviation in form of the temporomandibular joint—An autopsy study. *Swed Dent J* 1987;11:195-200.
15. Palla S: Neue Erkentnisse und Methoden in der Diagnose der Funktionsstörungen des Kausystems. *Schweiz Mschr Zahnmed* 1986;96:1329-1351.
16. Hansson T, Honée W, Hesse J: *Funktionsstörungen im Kausystem.* Heidelberg, Hthig, 1987, pp 55-56.
17. Travell JG, Simons DG: *Myofascial Pain and Dysfunction: The Trigger Point Manual.* Baltimore, Williams and Wilkins, 1983, pp 219-261.

18. Rugh JD: Psychological factors in the etiology of masticatory pain and dysfunction, in Laskin D, Greenfield W, Gale E, Rugh J, Neff P, Alling C , Ayer WA (eds): *The President's Conference on the Examination, Diagnosis and Management of Temporomandibular Disorders*. Chicago, American Dental Association, 1983.
19. Turk DC, Rudy TE: Towards a comprehensive assessment of chronic pain patients. *Res Ther* 1987;4:237–249.
20. Kerns RD, Turk DC, Rudy TE: The West Haven-Yale Multidimensional pain Inventory (WHYMPI). *Pain* 1985;23:345–356.
21. Johnston DB, Templeton MCC: The feasibility of palpating the lateral pterygoid muscle. *J Prosthet Dent* 1980;40:318–323.