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Expanding the taxonomy of the diagnostic criteria for temporomandibular disorders

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SUMMARY **There is a need to expand the current temporomandibular disorders' (TMDs) classification to include less common but clinically important disorders. The immediate aim was to develop a consensus-based classification system and associated diagnostic criteria that have clinical and research utility for less common TMDs. The long-term aim was to establish a foundation, *vis-à-vis* this classification system, that will stimulate data collection, validity testing and further criteria refinement. A working group [members of the International RDC/TMD Consortium Network of the International Association for Dental Research (IADR), members of the Orofacial Pain Special Interest Group (SIG) of the International Association for the Study of Pain (IASP), and members from other professional societies] reviewed disorders for inclusion based on clinical significance, the availability of plausible diagnostic criteria and the ability to operationalise and study the criteria. The disorders were derived from the literature when possible and based on expert opinion as necessary. The expanded TMDs taxonomy was presented for feedback at international meetings. Of 56 disorders considered, 37 were included in the expanded taxonomy and were placed into the following four categories: temporomandibular joint disorders, masticatory muscle disorders, headache disorders and disorders affecting associated structures. Those excluded were extremely uncommon, lacking operationalised diagnostic criteria, not clearly related to TMDs, or not sufficiently distinct from disorders already included within the taxonomy. The expanded TMDs taxonomy offers an integrated approach to clinical diagnosis and provides a framework for further research to operationalise and test the proposed taxonomy and diagnostic criteria.**

KEYWORDS: **diagnosis, musculoskeletal pain, taxonomy, temporomandibular disorders, temporomandibular joint disorders**

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Background

Temporomandibular disorders (TMDs) are significant problems, not only for the individual who suffers from the condition but also for society that must bear the high economic cost of treatment and loss in productivity (1). Diagnosis of any of the TMDs is derived from assessment of signs and symptoms, and the most fre-

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quently cited diagnostic classification systems are the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) and the classification of the American Academy of Orofacial Pain (AAOP) (2,3). The former provides a standardised assessment for a limited set of TMDs which generates reliable data for researchers, whilst the latter does not have the same standardised approach but consists of a wider group of disorders and has more widespread clinical acceptance. Reconciling these two different approaches to classifying TMDs provides the basis for the development of the classification system herein.

The RDC/TMD has proven to be one of the most successful approaches to pain-related TMDs diagnoses in terms of clearly operationalised data collection procedures, specific diagnostic criteria, diagnostic reliability and dual assessment of physical, and behavioural and psychosocial aspects to obtain information about the TMDs as well as about the individual (3). The RDC/TMD protocol has been translated into over 20 languages and has an overwhelming number of literature citations. It has been used in a wide range of experimental, clinical and population-based studies among adults and adolescents around the world over the past 20 years (4–10). When the RDC/TMD was published, the authors stated that the validity of the RDC/TMD diagnostic criteria for the physical diagnoses needed to be further tested, because they were derived from consensus, expert opinion and review of the literature (i.e. content validity). Since publication in 1992, the RDC/TMD has been successful in promoting critical discussion about TMDs diagnoses; critical questions have included concerns about the criterion validity of the axis I diagnostic algorithms, the feasibility of some of the selected palpation sites and its application in clinical settings (11–13).

This introduction will trace the development of this TMDs classification system over the previous decade. The modification of the classification system commenced in 2001 when the National Institute for Dental and Craniofacial Research (NIDCR) funded a multisite Validation Project to specifically examine the reliability and validity of the RDC/TMD axis I and axis II components, and to recommend revisions. The investigators presented the findings of the Validation Project at a one-day symposium during the 2008 International Association for Dental Research (IADR) General Session in Toronto (14–18). They reported that all RDC/TMD axis I diagnostic algorithms had inadequate criterion validity and proposed revised RDC/TMD axis I diagnostic algorithms for the most common TMDs (19). At that symposium, researchers not associated with the study were invited to provide critical commentary regarding potential changes to the revised RDC/TMD (16,17,20–23). This was the first public opportunity for the field to contribute to a process that is still ongoing (see www.rdc-tmdinternational.org), and the articles reporting the data from this validation study were subsequently published (19,24–29).

Following that symposium, a closed workshop was held at the 2009 IADR General Session in Miami to synthesise the findings of the major studies over the years into a consensus set of criteria for use in the clinical and research settings; the specific recommendations are available (15), and the final product is the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) (30). Thirty-four professionals from 12 countries and representing 11 organisations participated. To derive diagnoses for the most common TMDs, the data set from the Validation Project (25) was used to assess criterion-related validity for the changes in the diagnostic algorithms as recommended by the workshop participants.

The outcome of these efforts is the evidence-based DC/TMD axis I and axis II diagnostic protocol, which provides a comprehensive assessment of the TMD patient based on the biopsychosocial health model (30) and is appropriate for immediate implementation in clinical and research settings. The DC/TMD axis I protocol includes reliable and valid diagnostic criteria that had sensitivity and specificity above the target values of at least 0.70 and 0.95 respectively, for the common pain-related TMDs and one intra-articular disorder affecting the masticatory system. The axis II protocol, psychosocial assessment, is simplified from the RDC/TMD and has two options: a set of shorter initial screening instruments and a set of instruments for expanded assessment (30). The AAOP has included the 12 DC/TMD diagnoses in a new revision of their Guidelines manual such that the DC/TMD and the AAOP taxonomic system for TMDs are now consistent (32).

Whilst this research has improved the diagnostic criteria for the common TMDs, there is a need to expand the classification to include less common, but clinically relevant, TMDs and review psychosocial and additional measures that have advanced with recent research and which may help further refine the classification of TMDs. Additional workshops designed to further the results of the 2009 workshop were organ-

ised by the Consortium Network and the Orofacial Pain Special Interest Group (SIG) at the 2011 IADR General Session in San Diego. The purposes were to (i) finalise an extended group of disorders outlined from the DC/TMD and identify a set of less common TMDs, (ii) expand assessment methods and measures for axis I and axis II to facilitate the diagnosis and prognosis of TMDs and (iii) create a third axis for additional measures (e.g. new technologies in genetics and neuroscience). It was anticipated that the workshop's recommendations would provide a mixture of evidence- and consensus-based diagnostic criteria, allowing future revision of criteria and addition of instruments and tests to the DC/TMD as new science becomes available. This article focuses only on the findings related to one purpose of the workshops, that is, to develop axis I diagnostic algorithms for the less common TMDs diagnoses, and the recommendations made here are considered an extension of the DC/TMD for clinical and research applications (30). Therefore, the aim of the present study is to describe a consensus-based classification system and diagnostic criteria for the less common TMDs.

Methods

Participants

Table 1 lists individuals who participated substantially in the 2011 workshop, the plenary session and/or subsequent meetings. The participants represented various areas of research and clinical expertise including TMDs, headache, orofacial pain, neurology, neuroscience and psychology and represented multiple and geographically diverse universities as well as organisations such as the AAOP, the European Academy of Craniomandibular Disorders, the Australian and New Zealand Academy of Orofacial Pain, the International Headache Society, the Orofacial Pain SIG of the International Association for the Study of Pain (IASP), the International RDC/TMD Consortium Network of IADR, and the National Institute of Dental and Craniofacial Research.

Consensus meeting procedure

Workgroup members worked together via multiple communication modes including email, videoconferencing, consensus workshop and subsequent meetings. The consensus workshops were held in conjunction with the annual general session of the IADR at San Diego, USA (14–16 March 2011), and the annual general sessions in Iguaçu Falls, Brazil (18–19 June 2012) and Seattle, USA (18–19 March 2013).

The workshop and meetings provided an opportunity for face-to-face discussion where consensus could be reached, and the sessions were closed to provide consistency and continuity to the discussion. An attempt was made to enlist the necessary expertise and also keep the workgroup to a manageable size that would facilitate discussion. Participation was by invitation; a Planning Committee from the Consortium Network and Orofacial Pain SIG invited participants based on proven clinical and research expertise in the diagnosis of TMDs and related conditions. The meetings' formats alternated between general sessions and workgroup sessions. The workgroup complemented other workshop activities including the consideration of new bio-behavioural assessments (axis II) and biomedical markers for TMDs (axis III).

Table 1. RDC/TMD Consortium Network Workshop participants. *Workgroup 1 participants of consensus workshop, San Diego 2011; ^ Workgroup 1 participants of meeting, Iguacu Falls 2012; $^{+}$Workgroup 1 participants of meeting, Seattle 2013. Other workshop participants listed below were not participants of the Workgroup but were participants of the Network Workshop.

Per Alstergren*$^{+}$	Sweden
Gary Anderson*	USA
Raphael Benoliel	Israel
Brian Cairns (Chair, Workgroup 3)	Canada
Reny de Leeuw*	USA
Mark Drangsholt	USA
Justin Durham	UK
Malin Ernberg	Sweden
Dominic Ettlin	Switzerland
Jean-Paul Goulet*^$^{+}$	Canada
Rigmor Jensen*	Denmark
John Kusiak	USA
Thomas List*^$^{+}$	Sweden
Frank Lobbezoo*^$^{+}$	The Netherlands
Bill Maixner	USA
Ambra Michelotti (Chair, Workgroup 2)	Italy
Don Nixdorf	USA
Richard Ohrbach*^	USA
Sandro Palla	Switzerland
Chris Peck*^$^{+}$ (Chair, Workgroup 1)	Australia
Arne Petersson*	Sweden
Doreen Pfau	Germany
Karen Raphael	USA
Eric Schiffman*^	USA
Peter Svensson	Denmark
Yoshihiro Tsukiyama	Japan

Pre-workshop activities

Prior to the first workshop, the workgroup members reviewed TMDs and their diagnostic criteria that were initially derived from multiple sources: review of the scientific literature, findings from the Validation Project including the initial expanded taxonomy (28), recommendations from the AAOP (2) and expert advice from other health professions including rheumatology and neurology. Research librarians contributed to the literature search process. Valid and reliable diagnostic criteria, as indicated by acceptable sensitivity and specificity values, are only available for the common TMDs (14,30).

Each member initially reviewed conditions for inclusion by considering the prevalence of the condition, likelihood of developing operationalised criteria, reliability and validity of associated diagnostic tests and the likelihood of future productive research. This material was summarised by the workgroup chair for discussion at the Workshop.

Workshop description

The workshop comprised sessions for (i) a general overview, (ii) discussion and consensus and (iii) finalising recommendations based on workgroup goals.

(i) General overview. Formal presentations were followed by open discussion by all attendees. These presentations included 15-min summaries by each workgroup chair to summarise the current status of their work, identify the major workgroup challenges associated with the goals of the workshop and provide an initial description of the planned activities of the workgroup. Workshop documents were placed on the Consortium Network's website for easy access and download by participants. These documents included scientific articles from a literature search on TMDs diagnoses.

(ii) Discussion and consensus. The TMDs taxonomic structure and diagnostic criteria developed pre-workshop by workgroup members were refined following discussion to arrive at consensus within the workgroup. Further ranking of TMDs occurred by reviewing the collated list of conditions, which was prioritised according to availability of diagnostic criteria and clinical significance of the conditions. Clinically significant conditions with existing diagnostic criteria were included in the classification system. For those conditions without diagnostic criteria and/or questionable clinical significance, the workgroup obtained information through consultation with experts and reached consensus on whether to include the conditions or not.

(iii) Finalising recommendations based on workgroup goals. A standardised format for conditions in the expanded taxonomy was developed. This format included:

- Disorder name
- Brief description (with or without aetiological mechanisms)
- Diagnostic criteria: History
- Diagnostic criteria: Examination
- Diagnostic criteria: Other tests

Results

Fifty-six conditions were considered for possible inclusion in the TMDs taxonomy. Following workgroup review, this list was reduced to 37 conditions (Table 2). Nineteen conditions were omitted because the group considered them low priority as they exhibited one or more of the following characteristics: extremely uncommon, inability to develop operationalised diagnostic criteria, not clearly related to TMDs or not sufficiently distinct from other disorders already included within the expanded taxonomy. These 19 omitted conditions included bifid condyle, condylosis, fibrous dysplasia, infectious arthritis, metabolic arthritis, traumatic systemic arthritis, mechanical impingement arthralgia, infectious myositis, non-infectious myositis, centrally mediated myalgia, infrequent episodic TMD-related headache, frequent episodic TMD-related headache, chronic TMD-related headache, myofascial pain with/without familiar referral, mitochondrial muscle disorders, polydermatomyositis, tardive dyskinesia, drug-induced dyskinesia and TMD secondary to or associated with other conditions (e.g. hemifacial paralysis, whiplash).

This document is considered an extension of the publication entitled 'Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group' (30).

As a reminder diagnostic criteria with acceptable criterion-related validity are only available for the

Table 2. Expanded Taxonomy for Temporomandibular Disorders

I. TEMPOROMANDIBULAR JOINT DISORDERS

1 Joint pain
- A Arthralgia
- B Arthritis

2 Joint disorders
- A Disc disorders
  - 1 Disc displacement with reduction
  - 2 Disc displacement with reduction with intermittent locking
  - 3 Disc displacement without reduction with limited opening
  - 4 Disc displacement without reduction without limited opening
- B Hypomobility disorders other than disc disorders
  - 1 Adhesions/Adherence
  - 2 Ankylosis
    - a Fibrous
    - b Osseous
- C Hypermobility disorders
  - 1 Dislocations
    - a Subluxation
    - b Luxation

3 Joint diseases
- A Degenerative joint disease
  - 1 Osteoarthrosis
  - 2 Osteoarthritis
- B Systemic arthritides
- C Condylysis/Idiopathic condylar resorption
- D Osteochondritis dissecans
- E Osteonecrosis
- F Neoplasm
- G Synovial Chondromatosis

4 Fractures

5 Congenital/developmental disorders
- A Aplasia
- B Hypoplasia
- C Hyperplasia

II. MASTICATORY MUSCLE DISORDERS

1 Muscle pain
- A Myalgia
  - 1 Local myalgia
  - 2 Myofascial pain
  - 3 Myofascial pain with referral
- B Tendonitis
- C Myositis
- D Spasm

2 Contracture

3 Hypertrophy

4 Neoplasm

5 Movement Disorders
- A Orofacial dyskinesia
- B Oromandibular dystonia

6 Masticatory muscle pain attributed to systemic/central pain disorders
- A Fibromyalgia/widespread pain

III. HEADACHE

1 Headache attributed to TMD

IV. ASSOCIATED STRUCTURES

1 Coronoid hyperplasia

This table was developed in collaboration with Schiffman and colleagues (30).

conditions in the DC/TMD publication referenced above, whereas proposed diagnostic criteria, which have not been formally operationalised, are provided for the additional disorders. These additional disorders are also noted, consequently, to lack estimates of sensitivity and specificity at this time. It is our intent to provide a framework for future investigation of the diagnostic criteria for these conditions.

Classification of temporomandibular disorders

Notes

1 The default time frame for assessing pain in the expanded taxonomy is in 'the last 30 days'; the examiner must identify with the patient all anatomical locations that they have experienced pain in the last 30 days. However, the examiner may choose a different time frame as dictated by clinical circumstances.

2 For a given diagnosis, the location of pain induced by the specified provocation test(s) must be in an anatomical structure consistent with that diagnosis.

3 'Familiar pain' or 'familiar headache' is based on patient report that the pain induced by the specified provocation test(s) has replicated the patient's pain, as identified by respective location and within the specified time frame (see note 1).

4 The phrase 'pain modified' is used in the diagnostic criteria for pain-related TMDs to emphasise that the pain may be made better or worse by jaw function, movement or parafunction, by history. The phrase is more inclusive than either phrase 'pain made worse' or 'pain made better' and is used to differentiate a musculoskeletal pain from other pain conditions of the trigeminal system.

5 Whilst jaw muscle pain is diagnosed based on the examination of the masseter and temporalis muscles, other masticatory muscles may be examined as required.

6 Diagnostic imaging should only be considered after a history and physical examination, indicates that

information from imaging will influence patient care. Whilst guidelines have been provided for TMJ imaging (29,33), further research is needed.

7 Magnetic resonance imaging (MRI) and computerised tomography (CT) are often the preferred imaging modalities. CT includes either conventional CT or cone beam computerised tomography (CBCT).

8 Where intra-muscular electromyography monitoring is indicated, this would be performed with fine wire or needle electrodes.

9 For all pain-related diagnoses, the pain/headache is not better accounted for by another pain/headache diagnosis.

I. TEMPOROMANDIBULAR JOINT DISORDERS

1. JOINT PAIN (ICD-10 M26·62; ICD-9 524·62)

A. ARTHRALGIA

From DC/TMD (30) (Sensitivity 0·89; Specificity 0·98)
Pain of joint origin that is affected by jaw movement, function, or parafunction, and replication of this pain occurs with provocation testing of the TMJ.

History: Positive for both of the following:

1. Pain in the jaw, temple, in front of the ear, or in the ear
   AND
2. Pain modified with jaw movement, function or parafunction.

Examination: Positive for both of the following:

1. Confirmation of pain location in the area of the TMJ(s)
   AND
2. Report of familiar pain in the TMJ with at least 1 of the following provocation tests:
   a. Palpation of the lateral pole or around the lateral pole
      OR
   b. Maximum unassisted or assisted opening, right or left lateral movements, or protrusive movements

Note: The pain is not better accounted for by another pain diagnosis.

B. ARTHRITIS

(Sensitivity and specificity have not been established)
Pain of joint origin with clinical characteristics of inflammation or infection over the affected joint: edema, erythema, and/or increased temperature. Associated symptoms can include dental occlusal changes (e.g., ipsilateral posterior open bite if intraarticular swelling or effusion is present unilaterally). This disorder is also referred to as synovitis or capsulitis, although these terms limit the sites of nociception. This is a localized condition; there should be no history of systemic inflammatory disease.

History: Positive for both of the following:

1. Arthralgia as defined in I.1.A
   AND
2a. Swelling, redness and/or increased temperature in front of the ear
   OR
2b. Dental occlusal changes resulting from articular inflammatory exudate (e.g., posterior open bite)

Examination: Positive for both of the following:

1. Arthralgia as defined in I.1.A
   AND
2a. Presence of edema, erythema, and/or increased temperature over the joint
   OR
2b. Reduction in dental occlusal contacts noted between two consecutive measurements (unilateral/bilateral posterior open bite), and not attributable to other causes

Rheumatologic consultation when needed:

1. Negative for rheumatologic disease, including those in 3B- Systemic arthritides

Note: The pain is not better accounted for by another pain diagnosis.

2. JOINT DISORDERS

A. DISC DISORDERS

(ICD-10 M26·62; ICD-9 524·63)

1. DISC DISPLACEMENT WITH REDUCTION

From DC/TMD (30) (Without imaging: Sensitivity 0·34; Specificity 0·92)
An intracapsular biomechanical disorder involving the condyle-disc complex. In the closed mouth position the disc is in an anterior position relative to the condylar head and the disc reduces upon opening of the mouth. Medial and lateral displacement of the disc may also be present. Clicking, popping or snapping noises may occur with disc reduction. A history of prior locking in the closed position coupled with interference in mastication precludes this diagnosis.

History: Positive for at least one of the following:

1. In the last 30 days any TMJ noise(s) present with jaw movement or function
   OR
2. Patient report of any noise present during the exam

Examination: Positive for at least one of the following:

1. Clicking, popping and/or snapping noise detected during both opening and closing, with palpation during at least 1 of 3 repetitions of jaw opening and closing
   OR
2a. Clicking, popping and/or snapping noise detected with palpation during at least 1 of 3 repetitions of opening or closing
   AND

2b. Clicking, popping and/or snapping noise detected with palpation during at least 1 of 3 repetitions of right or left lateral movements, or protrusive movements

Imaging: When this diagnosis needs to be confirmed, then TMJ MRI criteria are positive for both of the following:

1. In the maximum intercuspal position, the posterior band of the disc is located anterior to the 11:30 position and the intermediate zone of the disc is anterior to the condylar head
   AND
2. On full opening, the intermediate zone of the disc is located between the condylar head and the articular eminence

2. DISC DISPLACEMENT WITH REDUCTION WITH INTERMITTENT LOCKING

From DC/TMD (30) (ICD-9 524·63) (Without imaging: Sensitivity 0·38; Specificity 0·98)

An intracapsular biomechanical disorder involving the condyle-disc complex. In the closed mouth position the disc is in an anterior position relative to the condylar head, and the disc intermittently reduces with opening of the mouth. When the disc does not reduce with opening of the mouth, intermittent limited mandibular opening occurs. When limited opening occurs, a maneuver may be needed to unlock the TMJ. Medial and lateral displacement of the disc may also be present. Clicking, popping or snapping noises may occur with disc reduction.

History: Positive for both of the following:

1a. In the last 30 days, any TMJ noise(s) present with jaw movement or function
   OR
1b. Patient report of any noise present during the exam
   AND
2. In the last 30 days, jaw locks with limited mouth opening, even for a moment, and then unlocks.

Examination: Positive for the following:

1. Disc displacement with reduction as defined in I.2.A.1. Although not required, when this disorder is present clinically, examination is positive for inability to open to a normal amount, even momentarily, without the clinician or patient performing a specific manipulative maneuver.

Imaging: When this diagnosis needs to be confirmed:

1. The imaging criteria are the same as for disc displacement with reduction if intermittent locking is not present at the time of imaging. If locking occurs during imaging, then an imaging-based diagnosis of disc displacement without reduction will be rendered and clinical confirmation of reversion to intermittent locking is needed.

3. DISC DISPLACEMENT WITHOUT REDUCTION WITH LIMITED OPENING

From DC/TMD (30) (Without imaging: Sensitivity 0·80; Specificity 0·97)

An intracapsular biomechanical disorder involving the condyle-disc complex. In the closed mouth position the disc is in an anterior position relative to the condylar head, and the disc does not reduce with opening of the mouth. Medial and lateral displacement of the disc may also be present. This disorder is associated with persistent limited mandibular opening that does not resolve with the clinician or patient performing a specific manipulative maneuver. This is also referred to as 'closed lock'. Presence of TMJ noise (eg, click with full opening) does not exclude this diagnosis.

History: Positive for both of the following:

1. Jaw locked or caught so that the mouth would not open all the way
   AND
2. Limitation in jaw opening severe enough to limit jaw opening and interfere with ability to eat.

Examination: Positive for the following:

1. Maximum assisted opening (passive stretch) including vertical incisal overlap < 40 mm. (Maximum assisted opening of < 40 mm is determined clinically.)

Imaging: When this diagnosis needs to be confirmed, TMJ MRI critieria are positive for both of the following:

1. In the maximum intercuspal position, the posterior band of the disc is located anterior to the 11:30 position and the intermediate zone of the disc is anterior to the condylar head,
   AND
2. On full opening, the intermediate zone of the disc is located anterior to the condylar head.

4. DISC DISPLACEMENT WITHOUT REDUCTION WITHOUT LIMITED OPENING

From DC/TMD (30) (Without imaging: Sensitivity 0·54; specificity 0·79)

An intracapsular biomechanical disorder involving the condyle-disc complex. In the closed mouth position, the disc is in an anterior position relative the condylar head and the disc does not reduce with opening of the mouth. Medial and lateral displacement of the disc may also be present. This disorder is NOT associated with limited mandibular opening.

History: Positive for both of the following:

1. Jaw locked or caught so that the mouth would not open all the way
   AND
2. Limitation in jaw opening severe enough to limit jaw opening and interfere with ability to eat.

Examination: Positive for the following:

1. Maximum assisted opening (passive stretch) including vertical incisal overlap ≥ 40 mm.

(Maximum assisted opening of ≥ 40 mm is determined clinically.)

Imaging: When this diagnosis needs to be confirmed, then imaging analysis criteria are the same as for disc displacement without reduction with limited opening, as defined in I.2.A.3

B. HYPOMOBILITY DISORDERS OTHER THAN DISC DISORDERS

(ICD-10 M26·61; ICD-9 524·61)

Intra-articular fibrous adhesions/adherence and ankylosis are characterized by a restricted mandibular movement with deflection to the affected side on opening that may result as a long-term sequela of trauma including mandibular fracture. Note: in the case of bilateral involvement, asymmetries in mandibular movements during clinical examination will be less pronounced or absent. The diagnostic criteria of mandibular movement asymmetries are for unilateral causes of hypomobility. Hypomobility is firm and unyielding due to either intra-articular fibrous adhesions, more widespread fibrotic changes in the capsular ligaments (fibrous ankylosis) and/or, less frequently, the formation of a bony mass which results in fusion of the joint components (bony ankylosis). The condition is not usually associated with pain. The most frequent cause of TMJ ankylosis is macrotrauma (34); less frequent causes are infection of the mastoid or middle ear, systemic disease and inadequate surgical treatment of the condylar area.

1. ADHESIONS/ADHERENCE

(Sensitivity and specificity have not been established)

Fibrous adhesions within the TMJ are thought to occur mainly in the superior compartment of the TMJ (35,36). They produce a decreased movement of the disc-condyle complex. Adhesions may occur secondary to joint inflammation that results from direct trauma, excessive loading or systemic conditions such as a polyarthritic disease (37), and are typically associated with disc disorders (38,39).

History: Positive for both of the following:

1. No history of TMJ clicking
   AND
2. History of loss of jaw mobility.

Examination: Positive for all of the following:

1. Limited range of motion,
   AND
2. Uncorrected jaw deviation to the affected side on opening when present unilaterally
   AND
3. Marked limited laterotrusion to the contralateral side when present unilaterally.

Imaging: When this diagnosis needs to be confirmed,

1. Arthrography or MRI or arthroscopy may demonstrate the presence of adhesions (40,41)

2. ANKYLOSIS

(Sensitivity and specificity have not been established)

Bony ankylosis results from the union of the bones of the TMJ by proliferation of bone cells; this may cause complete immobility of that joint. In fibrous ankylosis, there are no gross bony changes, and the predominant radiographic finding is absence of ipsilateral condylar translation on opening. Note that fibrous ankylosis may be considered a more severe form of TMJ adhesions/adherence. Bony ankylosis is characterized by radiographic evidence of bone proliferation with marked deflection to the affected side and marked limited laterotrusion to the contralateral side.

a. FIBROUS ANKYLOSIS

History: Positive for the following:

1. History of progressive loss of jaw mobility.

Examination: Positive for all of the following:

1. Severely limited range of motion on opening
   AND
2. Uncorrected jaw deviation to the affected side on opening
   AND
3. Marked limited laterotrusion to the contralateral side.

Imaging: CT/CBCT is positive for both of the following:

1. Imaging findings of decreased ipsilateral condylar translation on opening
   AND
2. Imaging findings of a disc space between ipsilateral condyle and eminence.

b. OSSEOUS ANKYLOSIS

History: Positive for the following:

1. History of progressive loss of jaw mobility.

Examination: Positive for the following:

1. Absence of or severely limited jaw mobility with all movements.

Imaging: CT/CBCT is positive for the following:

1. Imaging-based evidence of bone proliferation with obliteration of part or all of the joint space.

C. HYPERMOBILITY DISORDERS

(ICD-10 S03·0XXA, ICD-9 830·0 closed dislocation; ICD-10 M26·69, ICD-9 524·69 recurrent dislocation; ICD-10 M24·20, ICD-9 728·4 ligamentous laxity)

Hypermobility disorders include two types of TMJ dislocations, in which the condyle is positioned anterior to the articular eminence and is unable to return to a closed position, without a specific maneuver by the patient (i.e., subluxation or partial dislocation) or by the clinician (i.e., luxation or complete dislocation). The latter disorder is also referred to as open lock. Note that the condyle is frequently anterior to the eminence at full mouth opening and thus by itself is not a predictor of

hypermobility disorders (42). The duration of dislocation may be momentary or prolonged. Pain may occur at the time of dislocation with residual pain following the episode.

1. DISLOCATIONS

a. SUBLUXATION

From DC/TMD (30) (ICD-10 S03·0XXA; ICD-9 830·0) (Using history only: Sensitivity 0·98; Specificity 1·00)
A hypermobility disorder involving the disc-condyle complex and the articular eminence: In the open mouth position, the disc-condyle complex is positioned anterior to the articular eminence and is unable to return to a normal closed mouth position without a specific manipulative maneuver. The duration of dislocation may be momentary or prolonged. When the patient needs the assistance of the clinician to reduce the dislocation and normalize jaw movement; this is referred to as luxation. This disorder is also referred to as 'open lock'.

History: Positive for both of the following**:**

1. In last 30 days, jaw locking or catching in a wide open mouth position, even for a moment, so could not close from the wide-open position
   AND
2. Inability to close the mouth without a specific manipulative maneuver

Examination: Although no exam findings are required, when this disorder is present clinically, examination is positive for:

1. Inability to return to a normal closed mouth position without the patient performing a specific manipulative maneuver

b. LUXATION

(ICD-10 S03·0XXA; ICD-9 830·0) (Sensitivity and specificity have not been established)
A condition in which the disc-condyle complex is positioned anterior to the articular eminence and is unable to return to the fossa without a specific manipulative maneuver by a clinician. This is also referred as 'open lock'.

History: positive for both of the following**:**

1. Report of episode(s) of inability to close from wide opening
   AND
2. Report that mouth closing can be achieved only with a specific mandibular maneuver by the clinician.

Examination: Positive for one of the following persistent presentations**:**

1. Wide open mouth position
   OR
2. Protruded jaw position
   OR
3. Lateral position to the non-affected side (in the case of a unilateral luxation)

Imaging: When this diagnosis needs to be confirmed, CT/CBCT or MRI are positive for the following**:**

1. The condyle is anterior to the articular eminence with the patient attempting to close the mouth.

3. JOINT DISEASES

A. DEGENERATIVE JOINT DISEASE (DJD)

(ICD-10 M19·91; ICD-9 715·18 localized/primary)
From DC/TMD (30) (Without imaging: Sensitivity 0·55; Specificity 0·61)
A degenerative disorder involving the joint characterized by deterioration of articular tissue with concomitant osseous changes in the condyle and/or articular eminence. DJD can be sub-classified: DJD without arthralgia is osteoarthrosis and DJD with arthralgia is osteoarthritis. Flattening and/or cortical sclerosis are considered indeterminant findings for DJD and may represent normal variation, aging, remodeling or a precursor to frank DJD. DJD can result in malocclusions including an anterior open bite especially when present bilaterally or contra-lateral posterior open bite when present unilaterally (43).

1. OSTEOARTHROSIS

History: Positive for at least one of the following:

1. In the last 30 days any TMJ noise(s) present with jaw movement or function
   OR
2. Patient report of any noise present during the exam

Examination: Positive for the following:

1. Crepitus detected with palpation during maximum unassisted opening, maximum assisted opening, lateral, or protrusive movements

Imaging: When this diagnosis needs to be confirmed, TMJ CT/CBCT criteria (29) are positive for at least one of the following:

1. Subchondral cyst(s)
   OR
2. Erosion(s)
   OR
3. Generalized sclerosis
   OR
4. Osteophyte(s)

Rheumatologic consultation when needed:

1. Negative for rheumatologic disease, including those in 3B- Systemic arthritides

2. OSTEOARTHRITIS

History: Positive for both of the following:

1.a. In the last 30 days any TMJ noise(s) present with jaw movement or function
   OR
1.b. Patient report of any noise present during the exam
   AND
2. Arthralgia as defined in I.1.A

Examination: Positive for both of the following:

1. Crepitus detected with palpation during maximum unassisted opening, maximum assisted opening,

right or left lateral movements, or protrusive movements

AND

2. Arthralgia as defined in I.1.A

Imaging: TMJ CT/CBCT criteria (29) are positive for at least one of the following:

1. Subchondral cyst(s)
   OR
2. Erosion(s)
   OR
3. Generalized sclerosis
   OR
4. Osteophyte(s)

Rheumatologic consultation when needed:

1. Negative for rheumatologic disease, including those in 3B- Systemic arthritides

B. SYSTEMIC ARTHRITIDES

(ICD-10 M06·9, ICD-9 714·0 rheumatoid arthritis) (Sensitivity and specificity have not been established)

Joint inflammation resulting in pain or structural changes caused by a generalized systemic inflammatory disease, including rheumatoid arthritis, juvenile idiopathic arthritis, spondyloarthropathies (ankylosing spondylitis, psoriatic arthritis, infectious arthritis, Reiter's syndrome), and crystal-induced disease (gout, chondrocalcinosis). Other rheumatologically related diseases that may affect the TMJ include autoimmune disorders and other mixed connective tissue diseases (scleroderma, Sjögren's syndrome, lupus erythematosus). This group of arthritides therefore includes multiple diagnostic categories that are best diagnosed and managed by rheumatologists regarding the general/systemic therapy. Clinical signs and symptoms of ongoing chronic (TMJ) inflammation are variable among patients and often over time for a single patient. They can vary from no sign/symptom to only pain to only swelling/exudate to only tissue degradation to only growth disturbance. Resorption of condylar structures may be associated with malocclusion such as a progressive anterior open bite. A diagnostic instrument should aim to identify patients with chronic inflammation early and accurately, should not exclude patients with chronic arthritis of long duration and should not only diagnose rheumatoid arthritis but the whole range of chronic inflammatory states. Note that imaging in early stages of the disease may not demonstrate any osseous findings.

History: Positive for both of the following**:**

1. Rheumatologic diagnosis of a systemic inflammatory joint disease
   AND

2.a. In the past month, any temporomandibular joint pain present
   OR

2.b. Temporomandibular joint pain which worsens with episodes/exacerbations of the systemic inflammatory joint disease

Examination: Positive for both of the following:

1. Rheumatologic diagnosis of a systemic joint disease
   AND

2.a. Arthritis signs and symptoms as defined in I.1.B
   OR

2.b. Crepitus detected with palpation during maximum unassisted opening, maximum assisted opening, right or left lateral movements, or protrusive movements

Imaging: If osseous changes are present, TMJ CT/CBCT or MR imaging is positive for at least one of the following**:**

1. Subchondral cyst(s)
   OR
2. Erosion(s)
   OR
3. Generalized sclerosis
   OR
4. Osteophyte(s)

C. CONDYLYSIS/IDIOPATHIC CONDYLAR RESORPTION

(ICD-10 M26·69; ICD-9 524·69) (Sensitivity and specificity have not been established)

Resorption of the condyles, leading to the idiopathic loss of condylar height, and a progressive anterior open bite. The condition is almost always bilateral and predominantly occurs in adolescent and young adult females. The presence of pain or articular sounds is variable. In early stages, dental occlusal changes may not be evident but imaging findings would be positive. This disorder is also referred to as idiopathic condylar resorption (44–46). The cause is unknown, although it has been suggested that it may be a severe form of degenerative joint disease and that estrogen may be implicated (47).

History: Positive for the following**:**

1. Progressive dental occlusal changes

Examination: Positive for both of the following**:**

1. Anterior open bite
   AND
2. Evidence of progressive dental occlusal change with at least one of the following:
   a. Occlusal facets which cannot be approximated;
      OR
   b. Change in sequential dental occlusal measurement over time (horizontal overjet; vertical overbite; or intercuspal contacts).

Imaging: Positive for at least one of the following**:**

1. CT/CBCT evidence of resorption of part or all of the condyle(s)
   OR

2. Lateral cephalometric change with sequential imaging over time (clockwise mandibular rotation, i.e., increase in mandibular plane angle; increase in ANB)

Rheumatologic consultation when needed:

1. Negative for rheumatologic disease, including those in 3B- Systemic arthritides

D. OSTEOCHONDRITIS DISSECANS

(ICD-10 M93·20; ICD-9 732·7) (Sensitivity and specificity have not been established)

A joint condition in which a piece of cartilage, along with a small bone fragment, break loose from the end of the bone and result in loose osteochondral fragments within the joint. The pathophysiology is unclear. It occurs usually in the knee and elbow and is often related to sports. Case-reports describe the condition in the TMJ (48), but little is known about signs and symptoms. The clinical presentation may be a combination of pain, swelling, joint noises, and limitation of jaw movements (49).

History: Positive for at least one of the following**:**

1. Arthralgia as defined in I.1.A
   OR
2. Any joint noises with mandibular movements
   OR
3. Limitation of jaw movements
   OR
4. Swelling

Examination: Positive for at least one of the following**:**

1. Arthralgia as defined in I.1.A
   OR
2. Crepitus detected with palpation, or reported by the patient, during maximum unassisted opening, maximum assisted opening, right or left lateral or protrusive movements
   OR
3. Maximum assisted opening (passive stretch) < 40 mm including vertical incisal overlap
   OR
4. Swelling about the affected joint

Imaging: TMJ CT/CBCT is positive for the following**:**

1. Evidence of loose osteochondral fragments within the joint

Rheumatologic consultation when needed:

1. Negative for rheumatologic disease, including those in 3B- Systemic arthritides

E. OSTEONECROSIS

(ICD-10 M87·08; ICD-9 733·45) (Sensitivity and specificity have not been established)

Osteonecrosis is a painful condition most commonly affecting the ends of long bones such as the femur. Other common sites include the humerus and the knees. The condition is found in the mandibular condyle on MRI as decreased signal in T1-weighted or proton density images and on T2-weighted images (sclerosis pattern) and can be combined with increased signal on T2 images (edema) (50). This condition has also been referred to in the literature as avascular necrosis (AVN).

History: Positive for the following**:**

1. Arthralgia as defined in I.1.A

Examination: Positive for the following**:**

1. Arthralgia as defined in I.1.A

Imaging: TMJ MRI is positive for the following**:**

1. Decreased signal in T1-weighted or proton density MRI and on T2-weighted MRI and can be combined with increased signal on T2 MRI

Rheumatologic consultation when needed:

1. Negative for rheumatologic disease, including those in 3B- Systemic arthritides

F. NEOPLASM

(ICD-10 C41·1, ICD-9 170·1 jaw malignant; ICD-10 D16·5, ICD-9 213·1 jaw benign) (Sensitivity and specificity have not been established)

Neoplasms of the joint result from tissue proliferation with histologic characteristics, and may be benign (e.g., chondroma or osteochondroma) or malignant (e.g., primary or metastatic). They are uncommon but well documented. They may present with swelling, pain during function, limited mouth opening, crepitus, occlusal changes, and/or sensory-motor changes. Facial asymmetry with a midline shift may occur as the lesion expands. Diagnostic imaging, typically using CT/CBCT and/or MRI, and biopsy are essential when a neoplasm is suspected.

G. SYNOVIAL CHONDROMATOSIS

(ICD-10 D48·0; ICD-9 238·0) (Sensitivity and specificity have not been established)

Cartilagenous metaplasia of the mesenchymal remnants of the synovial tissue of the joint. Its main characteristic is the formation of cartilagenous nodules that may be pedunculated and/or detached from the synovial membrane becoming loose bodies within the joint space (51). Calcification of the cartilage can occur (i.e., osteochondromatosis).The disease may be associated with malocclusion, such as a progressive ipsilateral posterior open bite. Imaging is needed to establish the diagnosis.

History: Positive for at least one of the following**:**

1. Report of preauricular swelling
   OR
2. Arthralgia as defined in I.1.A
   OR
3. Progressive limitation in mouth opening
   OR
4. In the past month, any joint noise(s) present

Examination: Positive for at least one of the following**:**

1. Preauricular swelling
   OR
2. Arthralgia as defined in I.1.A
   OR

3. Maximum assisted opening (passive stretch) < 40 mm including vertical incisal overlap
   OR
4. Crepitus as per I.3.A (DJD)

Imaging: TMJ MRI or CT/CBCT is positive for at least one of the following**:**

1. MRI: multiple chondroid nodules, joint effusion and amorphous iso-intensity signal tissues within the joint space and capsule (52)
   OR
2. CT/CBCT: loose calcified bodies in the soft tissues of the TMJ

Laboratory testing:

1. Histological examination confirms cartilagenous metaplasia

4. FRACTURES

(ICD-10 S02·61XA, ICD-9 802·21 closed fracture of condylar process; ICD-10 S02·62XA, ICD-9 802·22 closed fracture of subcondylar process; ICD-10 S02·61XB, ICD-9 802·31 open fracture of condylar process; ICD-10 S02·62XB, ICD-9 802·32 open fracture of subcondylar process) (Sensitivity and specificity have not been established)

A non-displaced or displaced break in bone involving the joint (i.e., temporal bone and/or mandible). The fracture may include the cartilage. The most common is the subcondylar fracture. The condition may result in a malocclusion (e.g. contralateral posterior open bite) and impaired function (e.g. uncorrected ipsilateral deviation with opening; restricted contralateral jaw movement), and typically results from a traumatic injury.

History: Positive for both of the following**:**

1. Trauma to the orofacial region
   AND
2.a. Preauricular swelling
   OR
2.b. Arthralgia as defined in I.1.A
   OR
2.c. Limited mouth opening

Examination: Positive for at least one of the following, consistent with the history findings**:**

1. Preauricular swelling
   OR
2. Arthralgia as defined in I.1.A
   OR
3. Maximum assisted opening (passive stretch) < 40 mm including vertical incisal overlap

Imaging: CT/CBCT is positive for the following**:**

1. Evidence of fracture

5. CONGENITAL/DEVELOPMENTAL DISORDERS

A. APLASIA

(ICD-10 Q67·4; ICD-9 754·0) (Sensitivity and specificity have not been established)

Typically a unilateral absence of condyle and incomplete development of the articular fossa and eminence, resulting in facial asymmetry. It is commonly associated with other congenital anomalies (e.g., oculo-auriculo-vertebral spectrum [Goldenhar syndrome, hemifacial microsomia] and mandibulofacial dysostosis [Treacher Collins syndrome]). It is occasionally bilateral and in such cases, asymmetry is not present but micrognathia is the dominant clinical manifestation. The condition may be associated with malocclusion, which may include open bite.

History: Positive for both of the following**:**

1. Progressive development of mandibular asymmetry or micrognathia from birth or early childhood
   AND
2. Development of malocclusion which may include anterior or posterior open bite

Examination: Positive for both of the following**:**

1. Confirmation of mandibular asymmetry, with deviation of the chin to the affected side, or micrognathia
   AND
2. Unable to detect condyle with palpation during open-close, protrusive or lateral jaw movements

Imaging: TMJ CT/CBCT is positive for the following**:**

1. Aplasia of the condyle
   AND
2. Severe hypoplasia of the fossa and eminence

B. HYPOPLASIA

(ICD-10 M27·8; ICD-9 526·89) (Sensitivity and specificity have not been established)

Incomplete development or underdevelopment of the cranial bones or the mandible. Growth is proportionately reduced and less severe than in aplasia. Condylar hypoplasia spans the continuum from aplasia to normal condylar size. It can be secondary to facial trauma, as well as the same congenital anomalies associated with aplasia. Facial asymmetry or micrognathia occur and the condition may be associated with malocclusion (e.g. non-horizontal occlusal plane and contralateral posterior open bite in unilateral cases or anterior open bite in bilateral cases).

History: Positive for both of the following**:**

1. Progressive development of mandibular asymmetry or micrognathia from birth or early childhood
   AND
2. Development of malocclusion, which may include posterior open bite

Examination: Positive for the following**:**

1. Confirmation of mandibular asymmetry, with deviation of the chin to the affected side, or micrognathia

Imaging: CT/CBCT is positive for at least one of the following**:**

1. Hypoplasia of the condyle
   OR
2. Hypoplasia of the fossa
   OR

3. Shortened mandibular ramus height

C. HYPERPLASIA

(ICD-10 M27·8; ICD-9 526·89) (Sensitivity and specificity have not been established)

Overdevelopment of the cranial bones or mandible. There is a non-neoplastic increase in the number of normal cells. Hyperplasia is typically unilateral (53) as a localized enlargement such as condylar hyperplasia (54), or as an overdevelopment of the entire mandible or side of the face (53,55).

History: Positive for the following:

1. Progressive development of mandibular or facial asymmetry.

Examination: Positive for the following:

1. Confirmation of a positive history.

Imaging: Panoramic radiography and/or CT/CBCT and single photon emission computed tomography are positive for both of the following:

1. Asymmetry in mandibular ramus height
   AND
2. History of increased uptake of Technetium-99 m-hydroxy diphosphonate on bone scintigraphy (56)

II. MASTICATORY MUSCLE DISORDERS

1. MUSCLE PAIN

A. MYALGIA

From DC/TMD (30) (ICD-10 M79·1; ICD-9 729·1) (Sensitivity 0·90; Specificity 0·99)

Pain of muscle origin affected by jaw movement, function, or parafunction, and replication of this pain with provocation testing of the masticatory muscles. Limitation of mandibular movement(s) secondary to pain may be present. Whilst a diagnosis is made based on examination of the masseter and temporalis muscles, a positive finding with the specified provocation tests when examining the other masticatory muscles can help to corroborate this diagnosis. There are three sub-classes of myalgia: local myalgia, myofascial pain, and myofascial pain with referral (see below). When myalgia is further subclassified as local myalgia, myofascial pain or myofascial pain with referral, the latter diagnoses are based on using only the examination findings from palpation with the palpation pressure being held over the site being palpated for 5 seconds compared to 2 seconds for myalgia.

History: Positive for both of the following:

1. Pain in the jaw, temple, in front of the ear, or in the ear
   AND
2. Pain modified with jaw movement, function or parafunction

Examination: Positive for both of the following, when examining the temporalis or masseter muscles:

1. Confirmation of pain location(s) in the temporalis or masseter muscle(s)
   AND
2. Report of familiar pain in the temporalis or masseter with at least 1 of the following provocation tests:

a. Palpation of the temporalis or masseter muscle(s)
   OR
b. Maximum unassisted or assisted opening

Note: The pain is not better accounted for by another pain diagnosis.

1. LOCAL MYALGIA

From DC/TMD (30) (Sensitivity and specificity have not been established)

Pain of muscle origin plus a report of pain localized to the immediate site of tissue stimulation (e.g., localized to the area under the palpating finger). Limitation of mandibular movement(s) secondary to pain may be present.

History: Positive for both of the following:

1. Pain in the jaw, temple, in front of the ear, or in the ear
   AND
2. Pain modified with jaw movement, function or parafunction

Examination: Positive for all of the following, when examining the temporalis or masseter muscles:

1. Confirmation of pain location(s) in the temporalis or masseter muscle(s)
   AND
2. Familiar muscle pain with palpation
   AND
3. Pain with muscle palpation with pain localized to the immediate site of the palpating finger(s)

Note: The pain is not better accounted for by another pain diagnosis.

2. MYOFASCIAL PAIN

From DC/TMD (30) (Sensitivity and specificity have not been established)

Pain of muscle origin plus a report of pain spreading beyond the immediate site of tissue stimulation (e.g., the palpating finger) but within the boundary of the masticatory muscle being examined. Limitation of mandibular movement(s) secondary to pain may be present.

History: Positive for the following:

1. Local myalgia as defined in II.1.A.1

Examination Positive for all of the following, when examining the temporalis or masseter muscles:

1. Confirmation of pain location(s) in the temporalis or masseter muscle(s)
   AND
2. Familiar muscle pain with palpation
   AND
3. Pain with muscle palpation with spreading of the pain beyond the location of the palpating finger(s) but within the boundary of the muscle

Note: The pain is not better accounted for by another pain diagnosis.

3. MYOFASCIAL PAIN WITH REFERRAL

From DC/TMD (30) (Sensitivity 0·86; Specificity 0·98)
Pain of muscle origin as defined for myalgia (II.1.A) plus a referral of pain beyond the boundary of the masticatory muscle(s) being palpated such as to the ear, teeth or eye. Limitation of mandibular movement(s) secondary to pain may be present. Although not required for this diagnosis, taut bands (i.e., contracture of muscle fibers) in the muscles may be present.

History: Positive for the following:

1. Local myalgia as defined in II.1.A.1

Examination: Positive for all of the following, when examining the temporalis or masseter muscles:

1. Confirmation of pain location(s) in the temporalis or masseter muscle(s)
   AND
2. Familiar muscle pain with palpation
   AND
3. Pain with muscle palpation beyond the boundary of the muscle

Note: The pain is not better accounted for by another pain diagnosis.

B. TENDONITIS

(ICD-10 M67·90; ICD-9 727·9) (Sensitivity and specificity have not been established)
Pain of tendon origin affected by jaw movement, function, or parafunction, and replication of this pain with provocation testing of the masticatory tendon. Limitation of mandibular movement(s) secondary to pain may be present. The temporalis tendon may be a common site of tendonitis and refer pain to the teeth and other nearby structures. Tendonitis could also apply to other masticatory muscle tendons.

History: Positive for the following:

1. Myalgia as defined in II.1.A

Examination: Positive for the following:

1. Myalgia as defined in II.1.A, in any tendon in the masticatory muscles including the temporalis tendon.

Note: The pain is not better accounted for by another pain diagnosis.

C. MYOSITIS

(ICD-10 M60·9, ICD-9 729·1 non-infective; ICD-10 M60·009, ICD-9 728·0 infective) (Sensitivity and specificity have not been established)
Pain of muscle origin with clinical characteristics of inflammation or infection: edema, erythema, and/or increased temperature. It generally arises acutely following direct trauma of the muscle or from infection, or chronically with autoimmune disease. Limitation of unassisted mandibular movements secondary to pain is often present (57). Calcification of the muscle can occur (i.e., myositis ossificans) (58,59).

History: Positive for the following:

1. Local myalgia as defined in II.1.A.1;

Examination: Positive for both of the following, when examining the temporalis or masseter muscles:

1. Local myalgia as defined in II.1.A.1
   AND
2. Presence of edema, erythema, and/or increased temperature over the muscle

Laboratory testing:

1. Serologic tests may reveal elevated enzyme levels (e.g., creatine kinase), markers of inflammation, and the presence of autoimmune diseases.

Note: The pain is not better accounted for by another pain diagnosis.

D. SPASM

(ICD-10 M62·838; ICD-9 728·85) (Sensitivity and specificity have not been established)
A sudden, involuntary, reversible tonic contraction of a muscle. Spasm may affect any of the masticatory muscles. Acute malocclusion may be present.

History: Positive for both of the following:

1. Immediate onset of myalgia as defined in II.1.A
   AND
2. Immediate report of limited range of jaw motion.

Examination: Positive for both of the following:

1. Myalgia as defined in II.1.A and may include any of the masticatory muscles
   AND
2. Limited range of jaw motion in direction that elongates affected muscle; (i.e for jaw closing muscles, opening will be limited to <40 mm; for lateral pterygoid muscle, ipsilateral movement will be limited to <7 mm)

Laboratory testing: When this diagnosis needs to be confirmed, laboratory testing is positive for the following**:**

1. Elevated intramuscular electromyography (EMG) activity when compared to contralateral unaffected muscle

Note: The pain is not better accounted for by another pain diagnosis.

2. CONTRACTURE

(ICD-10 M62·40, ICD-9 728·85 muscle; ICD-9 727·81 tendon) (Sensitivity and specificity have not been established)
The shortening of a muscle due to fibrosis of tendons, ligaments, or muscle fibers. It is usually not painful unless the muscle is over-extended. A history of radiation therapy, trauma, or infection is often present. It is more commonly seen in the masseter or medial pterygoid muscle.

History: Positive for the following**:**

1. Progressive loss of range of motion

Examination: Positive for the following**:**

1. Unassisted and assisted jaw movements are limited (i.e., for jaw closing muscles, opening will be limited to an assisted opening of <40 mm and assisted opening will demonstrate a hard end-feel [firm, unyielding resistance to assisted movements])

3. HYPERTROPHY

(ICD-10 M62·9; ICD-9 728·9) (Sensitivity and specificity have not been established)

Enlargement of one or more masticatory muscles. Usually not associated with pain. Can be secondary to overuse and/or chronic tensing of the muscle(s). Some cases are familial or genetic in origin. Diagnosis is based on clinician assessment of muscle size, and needs consideration of craniofacial morphology and ethnicity.

History: Positive for the following**:**

1. Enlargement of one or more masticatory muscles as evidenced from photographs or previous records

Examination: Positive for the following**:**

1. Enlargement of one or more masticatory muscles

4. NEOPLASM

(ICD-10 C49·0, ICD-9 171·0 soft tissues of head face and neck malignant; ICD-10 D21·0; ICD-9 215·0 soft tissues of head face and neck benign) (Sensitivity and specificity have not been established)

Neoplasms of the masticatory muscles result from tissue proliferation with histologic characteristics, and may be benign (e.g., myoma) or malignant (e.g., rhabdomyosarcoma, or metastatic). They are uncommon. They may present with swelling, spasm, pain during function, limited mouth opening, and/or sensory/motor changes (e.g., paresthesia, weakness). Diagnostic imaging, typically using CT/CBCT and/or MRI, and biopsy are essential when a neoplasm is suspected.

5. MOVEMENT DISORDERS

A. OROFACIAL DYSKINESIA

(ICD-10 R25·1 tremor unspecified; R25·2 cramp and spasm; R25·3 fasciculations; ICD-9 781·0 abnormal involuntary movements; ICD-10 R27·0, ICD-9 781·3 ataxia, unspecified; ICD-10 R27·9, ICD-9 781·3 muscular incoordination; ICD-10 G24·01, ICD-9 333·85 subacute, due to drugs; oral tardive dyskinesia) (Sensitivity and specificity have not been established)

Involuntary, mainly choreatic (dance-like) movements that may involve the face, lips, tongue, and/or jaw.

History: Positive for both of the following**:**

1. Neurological diagnosis of dyskinesia in the orofacial region
   AND
2.a. Arthralgia as defined in I.1.A, which worsens with episodes of dyskinesia
   OR
2.b. Myalgia as defined in II.1.A, which worsens with episodes of dyskinesia

Examination: Positive for all of the following (60)**:**

1. Sensory and/or motor nerve conduction deficit
   AND
2. Central and/or peripheral myopathic disease
   AND
3. Muscular hyperactivity confirmed by intramuscular EMG
   AND
4.a. Arthralgia as defined in I.1.A
   OR
4.b. Myalgia as defined in II.1.A

Note: The pain is not better accounted for by another pain diagnosis.

B. OROMANDIBULAR DYSTONIA

(ICD-10 G24·02, ICD-9 333·72 acute, due to drugs; ICD-10 G24·1, ICD-9 333·6 deformans, familial, idiopathic and torsion dystonia) (Sensitivity and specificity have not been established.)

Excessive, involuntary and sustained muscle contractions that may involve the face, lips, tongue, and/or jaw.

History: Positive for both of the following**:**

1. Neurological diagnosis of oromandibular dystonia
   AND
2.a. Arthralgia as defined in I.1.A which worsens with episodes of dystonia
   OR
2.b. Myalgia as defined in II.1.A which worsens with episodes of dystonia

Examination: Positive for all of the following (60)**:**

1. Sensory and/or motor nerve conduction deficit
   AND
2. Central and/or peripheral myopathic disease
   AND
3. Dystonia confirmed by intramuscular EMG
   AND
4.a. Arthralgia as defined in I.1.A
   OR
4.b. Myalgia as defined in II.1.A

Note: The pain is not better accounted for by another pain diagnosis.

6. MASTICATORY MUSCLE PAIN ATTRIBUTED TO SYSTEMIC/ CENTRAL PAIN DISORDERS

A. FIBROMYALGIA

(ICD-10 M79·7; ICD-9 729·1); Widespread Pain (Sensitivity and specificity have not been established)

Widespread pain with concurrent masticatory muscle pain.

History: Positive for both of the following:

1. A rheumatologic-based diagnosis of fibromyalgia (61,62)
   AND
2. Myalgia as defined in II.1.A.

Examination: Positive for both of the following**:**

1. A rheumatologic-based diagnosis of fibromyalgia
   AND
2. Myalgia as defined in II.1.A

Note: The pain is not better accounted for by another pain diagnosis.

III. HEADACHE

1. HEADACHE ATTRIBUTED TO TMD(30,63)

From DC/TMD (30) and Cephalalgia (63).(ICD-10 G44·89; ICD-9 339·89, or ICD-10 R51; ICD-9 784·0) (Sensitivity 0·89; Specificity 0·87)

Headaches that are related to, and aggravate TMDs (64). Headache in the temple area secondary to pain-related TMD (derived using valid diagnostic criteria) that is affected by jaw movement, function, or parafunction, and replication of this headache occurs with provocation testing of the masticatory system.

History: Positive for both of the following**:**

1. Headache of any type in the temple
   AND
2. Headache modified with jaw movement, function or parafunction

Examination: Positive for both of the following:

1. Confirmation of headache location in the area of the temporalis muscle(s)
   AND
2. Report of familiar headache in the temple area with at least one of the following provocation tests:
   a. Palpation of the temporalis muscle(s)
      OR
   b. Maximum unassisted or assisted opening, right or left lateral movements, or protrusive movements

Note: The headache is not better accounted for by another pain diagnosis.

IV. ASSOCIATED STRUCTURES

1. CORONOID HYPERPLASIA

(ICD-10 M27·8; ICD-9 526·89) (Sensitivity and specificity have not been established)

Progressive enlargement of the coronoid process that impedes mandibular opening when it is obstructed by the zygomatic process of the maxilla.

History: Positive for the following**:**

1. Complaint of limitation of jaw opening

Examination: Positive for the following**:**

1. Reduction of active and passive maximum jaw opening

Imaging: CT/CBCT is positive for the following**:**

1. An elongated coronoid process which approximates the posterior aspect of the zygomatic process of the maxilla on opening

Discussion

The expanded TMDs taxonomy is derived from reliable diagnostic criteria that have proven criterion-related validity and from consensus-based diagnostic criteria for the other less common TMDs. The DC/TMD is the source publication for the common TMDs: arthralgia, the four types of disc displacements, degenerative joint disease, subluxation, myalgia, local myalgia, myofascial pain, myofascial pain with referral and headache attributed to TMD (30). For the consensus-based diagnostic criteria for those TMDs not included in the DC/TMD, the current article becomes the source publication for them, and due to further revisions, replaces the earlier version in the newest edition of the AAOP guidelines (32). The consensus-based diagnoses were derived from expert opinion and review of the literature using the framework of the 2008 AAOP taxonomy and thus have construct and content validity. The outcome of a consensus process is determined, in part, by the character of the members as well as the meeting structure. A consensus-based diagnostic system represents therefore a set of opinions and its validity is limited. However, the level of validity should not be the determinant regarding the value of a consensus-based diagnostic system; rather, coherence, biological plausibility, appropriate foundation in accepted science and utility should be the determinants. If the goal of developing a consensus-based system is clearly recognised at the outset as only a first step in a self-sustaining process that includes next steps of operationalised criteria, data collection, analysis, review and revision, then the true value of a consensus-based system is measured by its ability to foster the next steps. Consequently, as little to no data supporting any given formulation of a disorder exists, the absence of data was not regarded as a limitation in the present process.

Consensus was reached for this expanded taxonomy by reviewing multiple sources: general scientific literature, findings from the Validation Project (25,28), recommendations from the AAOP (2) and expert advice from other health professions including rheumatology and neurology. The AAOP taxonomy was used as a structural framework for the workgroup because it is a comprehensive resource with good content validity that has evolved by consensus over many years by clinicians and researchers. The current expanded taxonomy advances the AAOP taxonomy using a consensus-based method, with international input and broad consultation, with a focus on clear separation across disorders and opportunity to operationalise a given criterion. This method has been successful with the development of the RDC/TMD and subsequent DC/TMD.

The development of this expanded taxonomy was undertaken without utilising an ontological framework (65,66); increasingly, evidence points to the need for strong incorporation of controlled terminologies and clear hierarchy of constituent variables for the organisation of disease concepts. For example, the orofacial pain disorder, atypical odontalgia, was recently completely revised based on strong input from biomedical ontology (67). Nevertheless, the present expanded TMDs taxonomy will have sufficient research and clinical utility to support the long-term goal of using the present structure for data collection which can serve the next step of taxonomy development, which is anticipated to include concepts from biomedical ontology. Another long-term goal, part of the Network's plan for natural progression of methods, is to develop an orofacial pain classification based on the experience gained with this evolving set of concepts.

The expanded taxonomy requires research and appropriate reference standard diagnoses to assess the criterion-related validity for the less common TMDs. As these disorders are less common, multisite research is essential and will require the support of, amongst others, the AAOP and international sister academies, IADR and IASP. A template exists for this process with the successful Validation Project examining the reliability and validity of the RDC/TMD undertaken for the common TMDs (28). There are also other scientifically sound study designs that can be used for this type of validation research, such as the one implemented by Visscher and colleagues (13).

The classification system is based on diagnoses characterised by signs and symptoms and not underlying mechanisms or aetiologies. It has been intentional to omit putative mechanisms and aetiologies for most of the listed disorders. Of course some of the disorders have clear mechanisms such as trauma-induced fractures. With the other working groups' findings into psychosocial and other biomarkers, it is hoped that this classification system will evolve with a focus on underlying mechanisms and aetiologies.

The consensus process

A number of proposed disorders were omitted from this expanded taxonomy. Whilst the workgroup made this decision for the present version of the expanded taxonomy, our expectation is that future workshops, presumably aided by more information that emerges in the process of collecting controlled data for what has been defined to date, will allow currently omitted disorders to be reconsidered. The process of inclusion and exclusion is a dynamic one which depends on research including epidemiology, advances in diagnostic tools and technology, and refinement of this expanded taxonomy. Those disorders included currently in the expanded taxonomy will cover the majority of clinical TMDs presentations. In a number of cases, the additions help provide a comprehensive group of diagnoses for the clinician (e.g. the continuum of local myalgia, myofascial pain and myofascial pain with referral; the group of arthritis, condylysis, osteonecrosis, osteochondritis dissecans and degenerative joint disease). It is important to note that these groups of disorders do not necessarily represent progressively worsening disorders, and research is needed to determine whether the groupings span a continuum, whether they are distinct entities, whether there is overlap between some of the disorders and whether the distinctions matter in terms of natural progression, selection of treatment or treatment outcomes.

Temporal pattern of disorders

The time frame for assessing the disorders described in this document is in 'the last 30 days', because the stated sensitivity and specificity of the criteria for the most common TMDs were established in the DC/TMD using this time frame (30). In clinical settings, experience to date with the field tests of the DC/TMD indicates that for individuals with chronic TMDs, the 'last 30 days' is generally applicable at any time point in the disorder's natural history with few exceptions, and for individuals seeking care because of a current disorder, the 'last 30 days' is seldom a problem. However, the specific time frame can be dependent on the context in which the disorder is being assessed, and we recommend that users adjust the time frame as needed by circumstances, recognising that the validity of a diagnosis based on different time frames has not been established. With the present wording focusing on the past 30 days, pain can range from a single mild episode of a few minutes' duration to a constant disabling pain. This is an important area which needs to be addressed in future research and the International Headache Society time frames could be considered as a working template. Whether core diagnostic (and definitional criteria) remains valid across a range of

time frames and whether additional time-based criteria need to be included are important areas for future research.

Disorders that had the most extensive deliberations

There was extensive discussion on some disorders including arthritis, muscle pain disorders, hypermobility disorders, degenerative joint disease and movement disorders.

Arthritis. The discussion of diagnostic criteria for TMJ arthritis resulted in the inclusion of the cardinal signs of inflammation: oedema, erythema, increased temperature over the joint and articular pain; the consensus was not to include loss of function. It was also acknowledged that signs and symptoms of arthritis could lie on a continuum from no sign or symptom to a combination of any of pain, swelling/exudate, tissue degradation or growth disturbance. The presentation at any time point may include none or one or more of these signs and symptoms. Nevertheless, the diagnostic criteria were simplified at this stage in an attempt to separate arthritis from arthralgia and degenerative joint disease.

The use of cardinal signs of inflammation as the only basis for clinical diagnosis of TMJ arthritis may, however, lack clinically utility. The cardinal signs are indicative for inflammation, but swelling, oedema and increased temperature are only seldom seen, especially in chronic TMJ arthritis. Indeed, chronic TMJ inflammation may not show any of the cardinal signs although there is still an ongoing arthritis with disease progression occurring, causing tissue degradation and/or growth disturbance. On the other hand, TMJ arthritis may cause arthralgia, but arthralgia could also be due to other factors which trigger articular nociceptors (e.g. noxious mechanical stimuli), referred pain and general/central sensitisation. For example, glutamate causes arthralgia in a non-inflamed joint (68). As pain is likely the most common clinical finding in TMJ arthritis, it was decided to categorise arthritis in Joint Pain rather than in Joint Diseases section. Future research exploring the other aspects of inflammation may indeed suggest that TMJ arthritis fits better within Joint Diseases.

An important goal with diagnostic criteria for arthritis should be the possibility of early identification of patients with ongoing TMJ arthritis with high risk of chronicity and damage because there is evidence that early arthritis treatment allows less damage, suffering and treatment (69). The American College of Rheumatology recently updated their classification criteria for rheumatoid arthritis with a primary focus on establishing clinical findings important for early diagnosis of cases with high risk of chronicity and damage whilst not excluding more established cases (70). This approach seems reasonable to implement in the future development of the extended DC/TMD taxonomy. By then, clinical symptoms and signs, other than the cardinal signs, should be considered for inclusion in the diagnostic criteria to enable early and more specific diagnosis. Examples of such signs could be pain from the TMJ on jaw movement, pain from the TMJ on loading and recent progressive occlusal changes. Ideally, in the future, biomarker(s) may provide a more objective identification of these disorders.

According to the discussion above, TMJ condylar resorption may be considered to be part of the diagnosis TMJ arthritis. If so, radiographic imaging would be required to detect TMJ cartilage and bone tissue destruction.

For the arthritis diagnosis, there was consideration for a diagnostic criterion of TMJ MRI demonstrating intra-medullary oedema, joint exudate or synovitis. However, this proposed criterion was omitted because it may not differentiate from other systemic arthritides nor detect early stages of arthritis. Regarding osteonecrosis, the clinical as well as radiographic presentation shows a large overlap with the diagnosis arthritis, as discussed above, and is therefore very likely a part of the broad spectrum of the inflammatory process. Today it is not possible to radiologically distinguish osteonecrosis from other inflammatory TMJ conditions, and the diagnosis osteonecrosis does not lead to specific treatment compared with arthritis.

Systemic arthritides require a rheumatologic-based diagnosis. It is important that the clinician consider these systemic disorders as they may assign an early diagnosis particularly when orofacial signs and symptoms manifest early in the condition.

In systemic arthritides as well as monoarthritic conditions, TMJ pain on jaw movements has been found to be strongly related to an inflammatory intra-articular milieu (71–74). TMJ pain on jaw movement thus seems to be useful clinical symptom or sign when attempting to diagnose TMJ arthritis. In the future revisions of this taxonomy, TMJ pain on jaw movement could be considered as an additional clinical feature added into the taxonomy. The criterion of local

pain for a diagnosis of arthralgia, part of the common TMDs, is met from either palpation of the TMJ or from jaw movement; by extension, that criterion for TMJ arthralgia should undergo review in terms of it being more specific to another disorder.

Although synovial fluid analysis was not included in the criteria for arthritis, further research needs to be undertaken on the safety and clinical feasibility of synovial fluid extraction analysis and sensitivity and specificity of targeted biomarkers such as elevated levels of tumour necrosis factor, interleukin-1 beta, interleukin-1 receptor antagonist, interleukin-6, serotonin or glutamate or reduced levels of tumour necrosis factor receptor II or interleukin-1 receptor II (75–82).

Muscle pain. The expanded taxonomy has added further diagnoses for muscle pain disorders. This addition captures the observation from the Validation Project that subjects with myalgia exhibited three distinct clinical subtypes (30). One group reported pain limited to the palpation site (i.e. local myalgia), a second group reported pain at the palpation site that would spread beyond the palpated area but remain inside the boundary of the examined muscle (i.e. myofascial pain), and a third group reported pain at the palpation site and pain extending beyond the boundary of the examined muscle (i.e. myofascial pain with referral). As different mechanisms could be responsible for these different types of muscle pain on palpation, myalgia was subdivided into three subclasses: local myalgia, myofascial pain and myofascial pain with referral. Therefore, the three muscle pain disorders subclassified under the generic umbrella of myalgia in the expanded taxonomy provide diagnoses for assessing a possible temporal progression of muscle pain from a localised myalgia to more widespread pain. The biologically plausible argument that these three disorders could respond differently to treatment and have a different prognostic value will only hold true with time if research looks more closely at this set of muscle pain diagnoses.

Although centrally mediated myalgia has been a distinct clinical entity in the AAOP classification system, it was not included in the expanded taxonomy because it overlaps with the muscle pain disorders as listed and more specifically with myofascial pain with referral and fibromyalgia. In addition, the non-painful symptoms often described in centrally mediated myalgia, such as ear symptoms, muscle stiffness, weakness or fatigue, are non-specific and general symptoms that can still be reported by patients with varying distributions of muscle pain. Such reports of non-specific symptoms also occur with the somatoform disorders which represent a shift from a disorder with local mechanisms to a disorder that is associated with CNS dysregulation (83). Centrally mediated myalgia may represent less a disorder and perhaps more a mechanism, such as in the widespread pain disorder (84); its omission from the present expanded taxonomy should not be interpreted to reflect a lack of potential relevance. Rather, we encourage research into this intriguing concept.

The proposed taxonomy for the muscle pain disorders should evolve as mechanisms unfold, and more is known about the treatment responses based on the characteristics of these three distinct clinical entities.

Hypermobility disorders. The proposed criteria for subluxation and luxation were based on the relationship of the condyle to the articular eminence, rather than the relationship of the disc–condyle complex to the eminence, which is the case with disc displacements. Whilst the disc position might contribute to the mechanisms causing hypermobility disorders, without imaging it is not possible to determine either its location or its role. Moreover, these hypermobility disorders are acute and imaging the joint in these cases is largely impractical. Nevertheless, with advances in technology, imaging may become more accessible and demonstrate the position of the disc in these disorders, thereby allowing better definition of the hypermobility disorders.

Degenerative joint disease. The expanded taxonomy continues to use the terms ‘osteoarthritis’ and ‘osteoarthrosis’ but identifies them as two subclasses of DJD. This allows for providing a diagnosis of DJD as well as an additional diagnosis arthralgia, if concurrent joint pain is present. There was significant discussion regarding the nomenclature, and only a slight majority of participants voted for DJD versus using both osteoarthritis and osteoarthrosis. Therefore, the preferred name for this disorder is DJD, but osteoarthritis and osteoarthrosis can still also be used to and designate whether there is joint pain (i.e. arthritis) present or not.

Movement disorders. The two main types of movement disorders included in the expanded taxonomy are orofacial dyskinesia and oromandibular dystonia. Possible causes include a loss of physiological inhibitory

control of the basal ganglia, certain psychiatric diseases, excessive dopamine medications and the chronic use of neuroleptic (antipsychotic) medications. In the latter case, the condition is also known as tardive dyskinesia/dystonia. Edentulism, inadequate dental prostheses and dento-alveolar trauma have also been suggested as possible causes. It should be noted, however, that the level of evidence for any causal association for these movement disorders is poor and is mainly based on case studies (For reviews see 85,86).

Movement disorders have been included in the expanded DC/TMD taxonomy, because in some cases, they may present primarily as masticatory muscle disorders. However, one might question their presence in this taxonomy, because they are merely possible aetiological (i.e. overloading) factors causing certain types of TMDs rather than TMDs themselves. Likewise and rightfully so, bruxism defined as a repetitive jaw-muscle activity characterised by clenching or grinding of the teeth and/or by bracing of thrusting of the mandible whilst asleep and/or during wakefulness (87), has not been considered for inclusion in this taxonomy: bruxism has been suggested to be a possible causal factor for certain TMDs, and not a TMD as such (88). Moreover, sleep bruxism is appropriately defined as a sleep disorder (89).

Conclusions

The expanded taxonomy that classifies disorders as TMJ disorders, masticatory muscle disorders, headache disorders and disorders affecting associated structures was developed by consensus by multiple dental and medical experts. Importantly, it offers an integrated approach to clinical diagnosis and research opportunities to operationalise and test the proposed taxonomic system and diagnostic criteria. As with the evolution of the RDC/TMD to the DC/TMD, it is expected that this proposed expansion of the DC/TMD taxonomy classification system provides the framework to critically assess further the clinical entities and their diagnostic criteria. Importantly, as with the RDC/TMD, this classification only describes one axis (the physical diagnosis), whereas for comprehensive assessment and phenotype consideration of the psychosocial aspects of the disorder, axis II is necessary. In the future, having validated objective biomarkers available (axis III) will enhance rendering physical diagnosis beyond the current use of signs and symptoms.

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