BMJ 2015;350:h1154 doi: 10.1136/bmj.h1154 (Published 12 March 2015)

CLINICAL REVIEW

Temporomandibular disorders

Justin Durham *NIHR clinician scientist, senior lecturer*[1], Toby R O Newton-John *senior lecturer, clinical psychology*[2], Joanna M Zakrzewska *professor*[3]

[1]Centre for Oral Health Research & Institute of Health and Society, Newcastle University, Newcastle, UK; [2]Graduate School of Health, University of Technology, Sydney, NSW, Australia; [3]Facial Pain Unit, Eastman Dental Hospital, UCLH NHS Foundation Trust, London, UK

After odontogenic pain, temporomandibular disorders (TMDs) are one of the most common causes of pain in the mouth and face and also have the potential to produce persisting (chronic) pain.[1 2] Chronic or persistent (myogenous) TMDs can be associated with other chronic pain conditions,[3] including migraine, fibromyalgia, and widespread pain.[4-8] They are also known to be comorbid with bruxism, depression, irritable bowel syndrome, and chronic fatigue.[6 9 10] With or without these comorbidities, TMDs are recognised to have a considerable impact on quality of life.[11-17]

Early diagnosis and explanation followed by management is likely to be key to improving prognosis and reducing the impact of this group of conditions on quality of life.[11 18] The purpose of this review is to give non-specialists an overview of the diagnosis and management of TMDs.

What are TMDs?

Some of the signs and symptoms suggestive of TMDs were identified back in the 1930s by Costen, who incorrectly attributed them to changes in occlusion (bite of the teeth).[19] Over the next 80 years the terminology has changed and been revised several times[20-22] until the collective term temporomandibular disorders has been accepted.[23-26] The most widely accepted definition is "a group of musculoskeletal . . . conditions that involve the temporomandibular joints (TMJs), the masticatory muscles and all associated tissues."[27] A new expanded taxonomy is now available defining the various subtypes of disorder or disease incorporated in this group.[28]

How common are TMDs and who gets them?

Data from a US large and ongoing prospective cohort study (OPPERA)[29] suggest that the incidence of first onset painful TMDs is 3-4% per annum. Among the population studied (adults aged 18-44) for first onset of painful TMDs there seemed to be only a slight preponderance for women to be affected more than men (imputed hazard ratio 1.3, P>0.05) and an increasing incidence with age: 18-24 age band 2.5%, 25-34 age band 3.7%, and 35-44 age band 4.5%.[30] The probability of first onset TMDs is also strongly associated with concurrent headaches and body pain.[31 32] The prevalence of painful TMDs in adolescents is still a matter of debate,[33] with some estimates reaching 25%, but in developed countries it is estimated to be between 2% and 6%.[34-36] In adults aged more than 45 the prevalence of painful TMDs is likely to lie in the range of 2-7%,[37] although estimates vary and those aged over 45 are more likely to display objective signs of TMDs but be asymptomatic.[38]

Among all incident cases in the OPPERA study, pain occurred as a singular episode in 12%, recurrent episode in 65%, and persistent episode in 19%. Pain was most commonly reported in both the joint and the muscles of mastication (arthralgia with myalgia: 73% of the incident cases); the next most common presentation was myalgia alone (23% of incident cases).[30] OPPERA and other US data suggest there is a disproportionate increase in healthcare utilisation with TMDs.[32 39] The reasons behind this are not fully explained, but ongoing research[40] in the United Kingdom seeking to determine the effectiveness and efficacy of care pathways for orofacial pain (http://research.ncl.ac.uk/deepstudy) may help to explain this from a UK context in due course.

What causes TMDs?

The causes and underlying pathophysiology of TMDs have been the subject of much debate and some controversy over the years.[26 41] It is suggested that the cause is likely to be both multifactorial and biopsychosocial, consisting of initiating, predisposing, and perpetuating factors, for example, macro-trauma or micro-trauma, linked to a failure to heal appropriately because of the underlying psychosocial profile of the patient, failed treatment, or genotype.[41-43] Evidence is now emerging for factors involved in the complex multifactorial pathophysiology of TMDs relating to both genotype and phenotype.[44 45]

Correspondence to: J Durham, Level 5—School of Dental Sciences, Newcastle University, Newcastle NE2 4BW, UK justin.durham@ncl.ac.uk

Extra material supplied by the author (see http://www.bmj.com/content/350/bmj.h1154?tab=related#datasupp)

Summary of systematic reviews on management of TMDs

The bottom line

- TMDs represent a range of conditions with multifactorial complex pathophysiology, which are common up to the age of 40 years
- TMDs can present as a continuous or episodic pain of varying intensity around and in the ears radiating up to the temple or down the mandible to the neck
- Persistent (chronic) TMDs can be associated with other chronic pain conditions
- Early management with education and counselling is highly effective
- More complex patients or those with persistent TMDs require a biopsychosocial approach delivered by a multidisciplinary pain team

Sources and selection criteria

We conducted a systematic search of Medline (1966 to 5 August 2014), PROSPERO, and Cochrane libraries for systematic reviews relating to interventions for TMDs. For systematic reviews in Medline we used the search strategy suggested by BMJ Clinical Evidence search strategy. We searched PROSPERO and Cochrane libraries using their own search engines with the terms "temporomandibular", "temporomandibular disorder", "temporomandibular joint", and "pain dysfunction syndrome". The supplementary table summarises the most recent and relevant systematic reviews. It excludes older systematic reviews that duplicate more recent ones unless they are within a five year period and offer contradictory evidence. All Cochrane reviews identified are contained within the summary table.

In recent years major advances have occurred in the knowledge of the underlying pathophysiology of TMDs. It is suggested that women with an oestrogen receptor polymorphism have twice and three times the odds of developing a non-painful or painful TMD, respectively, compared with women without the polymorphism.[46] Several studies suggest the pain of TMDs to be potentially mediated by several different mechanisms: central sensitisation, through neuroplasticity and calcitonin gene related peptide,[47-51] and differing haplotypes of the gene encoding catecholamine-O-methyltransferase, which produce less activity of this enzyme.[52 53] Some of the neural abnormalities detected in chronic TMDs are in the trigeminal and limbic systems,[54] and cortical activity may be changed such that cognitive and emotional tasks are harder to perform.[55]

Further to this genetic polymorphisms in the folate and oxidative metabolic pathways may be associated with oxidative stress and be implicated in degenerative joint disease.[56-58] Such disease has also been associated with a metalloproteinase gene polymorphism.[59]

Clearly there may be further advances in the coming years, but what is truly exciting are the potential advances in identifying targets for treatment, such as calcitonin gene related peptide and β adrenergic receptors. β Adrenergic receptors have already been shown in a proof of concept trial to be of benefit if targeted by treatment.[60]

What are the clinical features?

TMDs can present with any or all of the following signs and symptoms: pain in the temporomandibular joint or muscles of mastication (figures 1⇓ and 2⇓), which may radiate or refer to local or distant structures; clicking, popping, or crepitus of the temporomandibular joint on any of its movements with or without locking of the joint; headache limited to the temporal region[61]; and otalgia or tinnitus, or both in the absence of aural disease. The correlation between self reported severity of pain and pathological changes in the joints or muscles is poor.[26]

The table⇓ summarises the 12 most common TMDs and the most salient points of their history and examination findings. Some patients present principally with a self reported painless clicking (disc displacement with reduction) and are mistakenly concerned that this indicates damage. Others report episodic painful (closed) locking, an inability to open the mouth wide (disc displacement with reduction with intermittent limited opening), persistent closed lock (disc displacement without reduction with limited opening), or repeated dislocation of the temporomandibular joint, which are all clearly of functional importance.

How are TMDs diagnosed?

Over the past two decades progress in revising and validating the diagnostic criteria for TMDs has been considerable.[62-74] In their validated and revised form these criteria, originally known as the RDC/TMD (Research Diagnostic Criteria for TMD),[62] are now known as the DC/TMD (Diagnostic Criteria for TMD).[75] They provide a standard and operationalised manner in which to examine the temporomandibular joint and its associated structures (axis 1) physically and to screen for psychosocial comorbidity (axis 2).

A simple method to screen for painful TMDs (as a physical entity) is to use a six item self complete questionnaire developed in tandem with the Diagnostic Criteria for TMD.[76] When used in a facial pain clinic this method has 99% sensitivity and 98% specificity for painful TMDs and may be of utility in busy general medical practices. The questionnaire is freely available on the RDC/TMD consortium's website (www.rdc-tmdinternational.org/OtherInstruments/TMDPainScreener.aspx). A score of 3 or more is indicative of a positive screening for TMDs. Alternatively the questions posed could be incorporated into a standard clinical history for orofacial pain.

Axis 1

The physical axis of the DC/TMD, axis 1, defines 38 different types of TMDs of which 12 types present most commonly (table).[75] As this is a summary table the list is not exhaustive. We believe that the easiest way to recall these 12 separate TMDs is to subdivide them into four main categories or groups: myalgia, arthralgia, intra-articular disorders, and headache attributable to TMDs. Full details on DC/TMD diagnostic algorithms and their sensitivity and specificity (where determined) are available in an open access publication[75] and on the RDC/TMD consortium's website (table).

The concept of eliciting pain that is "familiar" by provocation underpins the new revised and validated diagnostic criteria for TMD.[75] Familiar pain is the process of recreating the patients' symptoms during an examination and confirming with them that this is what they experience. The following features on examination should raise suspicion of, but do not formally confirm or exclude, a diagnosis of painful TMD: provocation of familiar pain through palpation of masseter and or temporalis (fig 1), through palpation of the temporomandibular joint (fig

2), or by putting the joint through its normal range of movements.

Of note in the diagnostic algorithm of the DC/TMD is the rationalised, limited, use of either plain or computed imaging (employing ionising radiation), which is outlined on the consortium's website (table). Generally, imaging is only performed if clinical examination indicates a functional problem. Great care should be taken when explaining the results of any imaging to patients as the use of words such as "degenerative" may cause great concern and consequently affect patients' behaviour.

Axis 2

Axis 2 of the DC/TMD can be used in a shortened form (a brief screening axis for psychosocial comorbidity) or in its full form (a comprehensive axis for psychosocial comorbidity). The instruments comprising axis 2 are available in full on the consortium's website. Axis 2's focus on psychosocial comorbidity is because this is known to impact on prognosis and treatment outcome.[5 45 77]

What are the red flags?

Box 1 outlines some of the red flags that may mimic a TMD,[78-81] although this is not an exhaustive list. These red flags can act as signposts for conditions to consider in differential diagnoses.

Specialties that will help in the case of relevant oral and maxillofacial red flag symptoms include oral medicine, oral and maxillofacial surgery, and oral surgery. Referral to ear, nose, and throat surgeons should be considered for worrisome signs in these areas and referral to a headache neurologist should be considered for upper face pain.

What makes TMDs more likely to become a chronic musculoskeletal pain?

Box 2 describes the factors that are more likely to be associated with chronic pain.[83-87]

For patients with a noted affective problem in addition to the pain or where there is a preoccupation with somatic symptoms and experiences, referral to a clinical psychologist or psychiatrist is an important adjunctive pain management option.[89]

Convincing evidence shows that psychosocial factors are influential in the development of general chronic pain states[90] and of TMD specifically.[5 45 77]

Importantly, research has shown that a chronic pain trajectory can be modified. People with acute TMDs identified as being at high risk of chronic TMDs have been shown to benefit considerably from early psychological intervention.[91] This suggests that although mood disorder, pain catastrophising, somatic preoccupation, and poor coping skills may predispose people with acute TMDs to develop long term problems, intervening with appropriate psychological input before these problems become entrenched can be of great value.

What is the management?

The recurring theme in the systematic reviews examined for this review (see supplementary table) is that well designed pragmatic randomised controlled trials using standardised and patient based outcome measures in TMD are urgently needed.

An international consensus reached in 1995 and revised slightly in 2010[27 92] was that reversible, conservative treatments should generally form the first line intervention for TMDs. This is based on data that suggest between 75% and 90% of patients with TMDs will respond to these simpler, potentially less costly, and much less invasive techniques.[93] After an initial diagnosis of acute TMD the first approach to management should be a careful explanation of the (provisional) diagnosis alongside education about the condition and its largely benign course. This can be supplemented by advice on appropriate, time limited, simple analgesic use and altered dietary consistency for acute exacerbations plus information on self management techniques.

Reversible and conservative treatments

Education—education about the condition and reassurance of its benign and usually non-progressive nature can be helpful. Lack of, or uncertainty in, diagnosis for patients with TMD has a major impact on their quality of life and can lead to care pathways that are not efficacious and possibly compound or worsen symptoms.[11 12 94] Health professionals should seek to explain a clear (provisional) diagnosis to patients at the earliest opportunity and then signpost helpful information and supportive organisations. Providing diagrams to increase knowledge of the anatomy are useful. Education would be the starting point for management of any patient with a suspected TMD. Useful resources to help with this are signposted in the additional educational resources box.

Self management (or self care) techniques—specific suggestions for self management and for physiotherapy are given in the recently published primary care guidance for TMDs (www.rcseng.ac.uk/fds/publications-clinical-guidelines/clinical_guidelines/documents/temporomandibular-disorders-guideline-2013). Simple generic advice around sleep hygiene, caffeine consumption, and avoidance of parafunctional activities such as daytime clenching, nail biting, or excessive chewing of gum can be helpful. This advice along with suggestions on relaxation techniques such as diaphragmatic breathing, and local measures for pain relief such as the use of covered ice or warm flannels to painful areas can be of benefit for some patients.

Physiotherapy and acupuncture—there is limited evidence to suggest that physiotherapeutic modalities such as massage or targeted exercises may help provide short term relief for acute TMDs, although the results of a Cochrane systematic review (see supplementary table) are awaited. A systematic review on acupuncture suggests that it may reduce pain intensity and specifically help with masseteric tenderness (see supplementary table).

Cognitive behavioural therapy—such treatment is considered the ideal psychological treatment for chronic pain.[95] Cognitive behavioural treatment for pain is an active, structured, collaborative therapy, which aims to teach patients the most adaptive ways of coping with their pain. Techniques might include dealing with pain related anxieties, behavioural activation plans, management of pain flare-ups, sleep hygiene, and optimal communication strategies with family members. The evidence for cognitive behavioural treatment in relation to TMDs indicates important long term improvements in pain intensity and mood, and reductions in activity limitation due to pain.[96 97] Cognitive behavioural treatment does not seem to reduce pain on muscle palpation.

Splints—"mouth guards" in either a soft polyethylene or a hard acrylic that provide full coverage of all the upper or lower teeth worn, can be worn at night in those who grind or clench their teeth. Mouth guards help to protect tooth substance and may also provide an element of biofeedback.

Box 1 Red flags that may mimic TMDs

- History of malignancy—potential for a new primary, recurrence, or metastases
- Presence of lymphadenopathy or neck masses—consider a neoplastic, infective, or autoimmune cause
- Sensory or motor function changes (specifically focusing on cranial nerves V, VII, and VIII)—consider intracranial causes, or malignancy affecting the nerve's peripheral branches
- Recurrent epistaxis, purulent nasal drainage, or anosmia—consider nasopharyngeal carcinoma or chronic sinusitis
- Trismus especially if history of using paan or betel nut—consider oral malignancy as part of differential diagnoses and think about employing the "Trismus checklist"[82]
- Unexplained pyrexia or weight loss—consider malignant tumours, immunosuppression, and infective causes as part of differential diagnoses
- First episode in over 50s, unilateral headache accompanied by jaw claudication, and general malaise—consider temporal arteritis
- Facial asymmetry or masses (uncommon in TMD unless there is masseteric hypertrophy)—consider neoplastic, infective, or inflammatory causes
- Occlusal changes (bite of teeth changes) as determined by dentist that do not predate the start of the TMD—consider growth disturbance of condyle, neoplasia, rheumatoid arthritis, and traumatic causes as part of differential diagnoses
- Ipsilateral objective change in hearing—consider acoustic neuroma, or other ear disease as part of differential diagnoses
- Persisting or worsening symptoms despite treatment—consider a misdiagnosis or more complex case
- History of recent head and neck trauma
- Paroxysmal unilateral lancinating pain with or without autonomic features—more likely to be associated with trigeminal neuralgia or one of the trigeminal autonomic cephalagias

Box 2 Factors associated with pain from TMDs becoming chronic

- Females with myogenous TMD
- Increasing age at presentation
- Graded chronic pain scale[88] score of 3 or 4
  Higher pain intensity

  Higher pain interference
- More widespread non-specific symptoms (or higher number of pain locations)
- Concurrent psychiatric diagnosis or mood disturbance (depression, anxiety, anger)

Simple analgesia—non-steroidal anti-inflammatory drugs can be used, being mindful of gastrointestinal side effects from continual use and drug overuse headache.

Other drug interventions—more "advanced" approaches include the use of neuromodulatory agents for persistent pain, which would all come under off-label prescribing. A small number of published trials support the use of gabapentin, benzodiazepines, amitriptyline, and propranolol for the management of pain of a myogenous origin.[60 98-100] Botulinum toxin applied to the muscles of mastication has been the subject of a small number of randomised controlled trials of varying quality and with the potential for type II errors.[101-104] Considering the results of these various studies as a whole the evidence at present is at best equivocal for the use of botulinum toxin in myogenous TMDs, but there is still a need for a definitive and appropriately powered randomised controlled trial.[105] Some concerns are emerging from a small scale study about the potential osteopenic effects on the temporomandibular joint of repeatedly administered botulinum toxin to the muscles of mastication over a long period.[106]

Irreversible approaches

The American Association for Dental Research has also issued a statement to recommend strongly that unless there are "specific and justifiable indications," irreversible approaches should not be used as primary management for TMDs.[27]

Orthodontics and occlusal equilibration—systematic reviews of irreversible approaches such as orthodontics and occlusal equilibration (careful grinding of the natural teeth to achieve a more "harmonious" bite) show these approaches lack evidence to support their use in the management of TMDs.[107 108]

Surgical interventions—these are only indicated in a small number of cases and only if there is an intra-articular disorder, degenerative joint disease, or other evident disease affecting the temporomandibular joint.[96]

Why is psychological management of TMDs important?

TMDs, as with other causes of pain, are best conceptualised in biopsychosocial terms.[109] The patient's beliefs, expectations, emotional state, family environment, and cultural background can all play a role in the onset, development, and maintenance of persistent pain. The axis 2 classification of the DC/TMD explicitly recognises the importance of psychological and social aspects of pain by assessing not just pain intensity but also depressed mood, anxiety, pain related disability, parafunctional behaviours, and a variety of associated comorbidities. The DC/TMD also helps to perform a basic ("screening") or a "comprehensive" assessment of the patient's psychosocial status and can be used to inform referrals for specialised psychological input.

In addition to cognitive behavioural therapy, there is limited evidence for a range of other psychologically based interventions for TMDs, including electromyographic biofeedback, stress management, and hypnosis.[96 97] In the past, referral for psychological therapy has tended to be the last resort, once all biological treatments have been exhausted and present treatment "failed." As a result of this type of approach patients may interpret the referral to a psychologist as an indication that their medical or dental practitioner has given up on them, or that their pain is considered to be "psychological" and somehow not genuine.[110] Making time for adequate explanation of the

multidisciplinary nature of complex pain treatment as early as possible in the diagnosis and management process is generally time well spent.

Having laid the groundwork that chronic pain is best managed using a team approach (which includes the patient as an active member of the team), the literature relating to facilitating the engagement of patients in biopsychosocial intervention offers several useful suggestions.[111] As always, the quality of patient-provider communication is important, with empathy for the patient's pain experience particularly relevant.[112] The use of patient centered communication skills, promoting patient self efficacy, and providing positive feedback on patient's coping efforts can all enhance patient motivation to engage in self management approaches.[111] A further communication problem for clinicians relates to patients wanting to pursue treatment options that are risky, ill advised, or dangerous, such as an irreversible intervention where there is no objective clinical evidence to support its use. These requests are best understood as reflecting the patient's desperation in living with intractable pain. In response, clinicians should firstly empathise with the difficulty of the patient's situation, but provide a clear, evidence based explanation as to the inadvisability of the treatment. Encouraging patients to refrain from falling into the trap of seeking "quick fixes" for complex problems and assisting and supporting them to develop and expand their own coping resources, offers a better long term solution.

Contributors: JD and JMZ conceived and designed the article. JD drafted the manuscript. TNJ contributed the psychological aspects. All authors approved the final version of the manuscript and are the guarantors.

Competing interests: We have read and understood the BMJ policy on declaration of interests and declare the following: JMZ is part funded by UCL/UCLHT, which received a proportion of funding from the Department of Health's NIHR Biomedical Research Centre funding scheme; JD is funded by a NIHR clinician scientist award (NIHR-CS-011-003). The views expressed in this publication are those of the authors and not necessarily those of the National Health Service, the National Institute for Health Research, or the Department of Health in the United Kingdom.

Provenance and peer review: Commissioned; externally peer reviewed.

1 Dworkin SF, Massoth DL. Temporomandibular disorders and chronic pain: disease or illness? *J Prosthet Dent* 1994;72:29-38.
2 Lipton JA, Ship JA, Larach-Robinson D. Estimated prevalence and distribution of reported orofacial pain in the United States. *J Am Dent Assoc* 1993;124:115-21.
3 Plesh O, Adams SH, Gansky SA. Temporomandibular joint and muscle disorder-type pain and comorbid pains in a national US sample. *J Orofac Pain* 2011;25:190-8.
4 Velly AM, Look JO, Schiffman E, Lenton PA, Kang W, Messner RP, et al. The effect of fibromyalgia and widespread pain on the clinically significant temporomandibular muscle and joint pain disorders—a prospective 18-month cohort study. *J Pain* 2010;11:1155-64.
5 Velly AM, Look JO, Carlson C, Lenton PA, Kang W, Holcroft CA, et al. The effect of catastrophizing and depression on chronic pain—a prospective cohort study of temporomandibular muscle and joint pain disorders. *Pain* 2011;152:2377-83.
6 Aggarwal VR, McBeth J, Zakrzewska JM, Lunt M, Macfarlane GJ. The epidemiology of chronic syndromes that are frequently unexplained: do they have common associated factors? *Int J Epidemiol* 2006;35:468-76.
7 Ballegaard V, Thede-Schmidt-Hansen P, Svensson P, Jensen R. Are headache and temporomandibular disorders related? A blinded study. *Cephalalgia* 2008;28:832-41.
8 Goncalves DA, Bigal ME, Jales LC, Camparis CM, Speciali JG. Headache and symptoms of temporomandibular disorder: an epidemiological study. *Headache* 2010;50:231-41.
9 Fernandes G, Franco AL, Goncalves DA, Speciali JG, Bigal ME, Camparis CM. Temporomandibular disorders, sleep bruxism, and primary headaches are mutually associated. *J Orofac Pain* 2013;27:14-20.
10 Hoffmann RG, Kotchen JM, Kotchen TA, Cowley T, Dasgupta M, Cowley AWJ. Temporomandibular disorders and associated clinical comorbidities. *Clin J Pain* 2011;27:268-74.
11 Durham J, Steele JG, Wassell RW, Exley C. Living with uncertainty: temporomandibular disorders. *J Dent Res* 2010;89:827-30.
12 Durham J, Steele J, Moufti MA, Wassell R, Robinson P, Exley C. Temporomandibular disorder patients' journey through care. *Community Dent Oral Epidemiol* 2011;39:532-41.
13 Durham J, Steele JG, Wassell RW, Exley C, Meechan JG, Allen PF, et al. Creating a patient-based condition-specific outcome measure for Temporomandibular Disorders (TMDs): Oral Health Impact Profile for TMDs (OHIP-TMDs). *J Oral Rehabil* 2011;38:871-83.
14 Moufti MA, Wassell RW, Meechan JG, Allen PF, John MT, Steele JG. The oral health impact profile: ranking of items for temporomandibular disorders. *Eur J Oral Sci* 2011;119:169-74.
15 Reissmann DR, John MT, Schierz O, Wassell RW. Functional and psychosocial impact related to specific temporomandibular disorder diagnoses. *J Dent* 2007;35:643-50.
16 Reissmann DR, John MT, Wassell RW, Hinz A. Psychosocial profiles of diagnostic subgroups of temporomandibular disorder patients. *Eur J Oral Sci* 2008;116:237-44.
17 Dahlstrom L, Carlsson GE. Temporomandibular disorders and oral health-related quality of life. A systematic review. *Acta Odontol Scand* 2010;68:80-5.
18 Durham J, Breckons M, Araujo-Soares V, Exley C, Steele J, Vale L. Developing Effective and Efficient care pathways in chronic Pain: DEEP study protocol. *BMC Oral Health* 2014;14:6.
19 Costen JB. A syndrome of ear and sinus symptoms based on disturbed function of the tempromandibular joint. *Ann Otol Rhinol Laryngol* 1934;43:1-15.
20 Gray RJ, Davies SJ, Quayle AA. A clinical approach to temporomandibular disorders. 1. Classification and functional anatomy. *Br Dent J* 1994;176:429-35.
21 Madland G, Feinmann C, Newman S. Factors associated with anxiety and depression in facial arthromyalgia. *Pain* 2000;84:225-32.
22 Shore NA. Occlusal equilibration and temporomandibular joint dysfunction. Lippincott, 1959.
23 Laskin DM. Temporomandibular disorders: a term past its time? *J Am Dent Assoc* 2008;139:124-8.
24 McNeill C. Temporomandibular disorders. Guidelines for classification, assessment and management. Quintessence, 1990.
25 Bell WE. Clinical management of temporomandibular disorders. Year Book Medical Publishers, 1982.
26 Cairns B, List T, Michelotti A, Ohrbach R, Svensson P. JOR-CORE recommendations on rehabilitation of temporomandibular disorders. *J Oral Rehabil* 2010;37:481-9.
27 Greene CS. Managing the care of patients with temporomandibular disorders: a new guideline for care. *J Am Dent Assoc* 2010;141:1086-8.
28 Peck CC, Goulet JP, Lobbezoo F, Schiffman EL, Alstergren P, Anderson GC, et al. Expanding the taxonomy of the diagnostic criteria for temporomandibular disorders. *J Oral Rehabil* 2014;41:2-23.
29 Dworkin SF. The OPPERA study: act one. *J Pain* 2011;12:T1-3.
30 Slade GD, Bair E, Greenspan JD, Dubner R, Fillingim RB, Diatchenko L, et al. Signs and symptoms of first-onset TMD and sociodemographic predictors of its development: the OPPERA prospective cohort study. *J Pain* 2013;14:T20-32.e1.
31 Sanders AE, Slade GD, Bair E, Fillingim RB, Knott C, Dubner R, et al. General health status and incidence of first-onset temporomandibular disorder: the OPPERA prospective cohort study. *J Pain* 2013;14:T51-62.
32 Slade GD, Sanders AE, Bair E, Brownstein N, Dampier D, Knott C, et al. Preclinical episodes of orofacial pain symptoms and their association with health care behaviors in the OPPERA prospective cohort study. *Pain* 2013;154:750-60.
33 Fernandes G, van Selms MK, Goncalves DA, Lobbezoo F, Camparis CM. Factors associated with temporomandibular disorders pain in adolescents. *J Oral Rehabil* 2015;42:113-9.
34 LeResche L, Mancl LA, Drangsholt MT, Huang G, Von Korff M. Predictors of onset of facial pain and temporomandibular disorders in early adolescence. *Pain* 2007;129:269-78.
35 List T, Wahlund K, Wenneberg B, Dworkin SF. TMD in children and adolescents: prevalence of pain, gender differences, and perceived treatment need. *J Orofac Pain* 1999;13:9-20.
36 Nilsson IM. Reliability, validity, incidence and impact of temporormandibular pain disorders in adolescents. *Swed Dent J Suppl* 2007;(183):7-86.
37 Isong U, Gansky SA, Plesh O. Temporomandibular joint and muscle disorder-type pain in U.S. adults: the National Health Interview Survey. *J Orofac Pain* 2008;22:317-22.
38 Schmitter M, Rammelsberg P, Hassel A. The prevalence of signs and symptoms of temporomandibular disorders in very old subjects. *J Oral Rehabil* 2005;32:467-73.
39 White BA, Williams LA, Leben JR. Health care utilization and cost among health maintenance organization members with temporomandibular disorders. *J Orofac Pain* 2001;15:158-69.
40 Durham J, Breckons M, Araujo-Soares V, Exley C, Steele J, Vale L. Developing Effective and Efficient care pathways in chronic Pain: DEEP study protocol. *BMC Oral Health* 2014;14:6.
41 McNeill C. Management of temporomandibular disorders: concepts and controversies. *J Prosthet Dent* 1997;77:510-22.
42 Suvinen TI, Reade PC, Kemppainen P, Kononen M, Dworkin SF. Review of aetiological concepts of temporomandibular pain disorders: towards a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. *Eur J Pain* 2005;9:613-33.
43 Svensson P. Temporomandibular disorders—a tough case to break! *Scand J Pain* 2014;2:70-1.
44 Meloto CB, Serrano PO, Ribeiro-DaSilva MC, Rizzatti-Barbosa CM. Genomics and the new perspectives for temporomandibular disorders. *Arch Oral Biol* 2011;56:1181-91.
45 Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Diatchenko L, Dubner R, et al. Psychological factors associated with development of TMD: the OPPERA prospective cohort study. *J Pain* 2013;14:T75-90.
46 Ribeiro-Dasilva MC, Peres Line SR, Leme Godoy dos Santos MC, Arthuri MT, Hou W, Fillingim RB, et al. Estrogen receptor-alpha polymorphisms and predisposition to TMJ disorder. *J Pain* 2009;10:527-33.
47 Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. *Pain* 2011;152:S2-15.
48 Cady RJ, Glenn JR, Smith KM, Durham PL. Calcitonin gene-related peptide promotes cellular changes in trigeminal neurons and glia implicated in peripheral and central sensitization. *Mol Pain* 2011;7:94.
49 Kopp S. Neuroendocrine, immune, and local responses related to temporomandibular disorders. *J Orofac Pain* 2001;15:9-28.
50 Sato J, Segami N, Kaneyama K, Yoshimura H, Fujimura K, Yoshitake Y. Relationship of calcitonin gene-related peptide in synovial tissues and temporomandibular joint pain in humans. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;98:533-40.
51 Appelgren A, Appelgren B, Kopp S, Lundeberg T, Theodorsson E. Neuropeptides in the arthritic TMJ and symptoms and signs from the stomatognathic system with special consideration to rheumatoid arthritis. *J Orofac Pain* 1995;9:215-25.
52 Diatchenko L, Slade GD, Nackley AG, Bhalang K, Sigurdsson A, Belfer I, et al. Genetic basis for individual variations in pain perception and the development of a chronic pain condition. *Hum Mol Genet* 2005;14:135-43.
53 Diatchenko L, Nackley AG, Slade GD, Fillingim RB, Maixner W. Idiopathic pain disorders—pathways of vulnerability. *Pain* 2006;123:226-30.

Tips for non-specialists

- Problems associated with TMDs are common and associated with pain and sometimes clicking and locking
- Consider either liaision with the patient's dental practitioner, or use of a simple screening questionnaire if confirmation of clinical diagnosis is required
- It is important to exclude temporal arteritis, especially if the patient is older than 50 years
- Reassurance, explanation, and non-steroidal anti-inflammatory drugs used early in the history of the disorder are highly effective
- Management of both comorbid migraine and TMDs may help improve outcome
- In patients with other chronic pains and depression, consider referral to specialist centres for biopsychosocial management

Additional educational resources

Resources for healthcare professionals

- Research Diagnostic Criteria for TMD consortium network (www.rdc-tmdinternational.org/OtherResources/TrainingReliability/RDCExaminerTraining.aspx)—contains all instruments and parts of the DC/TMD
- Davies S, Al-Ani Z. The three minute examination of the articulatory system. Video in the E-Den (on e-lfh) session on "Assessing the articulatory system." (http://portal.e-lfh.org.uk/)—e-learning for healthcare (requires registration and working within the National Health Service)
- Royal College of Surgeons of England guidance on Primary care management of TMD (www.rcseng.ac.uk/fds/publications-clinical-guidelines/clinical_guidelines)
- Open access diagnosis and treatment of non-dental facial pain on Cardiff pain community (www.paincommunitycentre.org/article/diagnosis-and-treatment-non-dental-facial-pain)—e-learning on facial pain

Resources for patients

- American Academy of Orofacial Pain (www.aaop.org/content.aspx?page_id=22&club_id=508439&module_id=108085)—patient leaflets
- European Federation of International Association for the Study of Pain chapters (www.efic.org/index.asp?sub=F8AMLHLAP9216P&topicsid=314#view)—patient leaflets
- International Association for the Study of Pain (www.iasp-pain.org/Advocacy/Content.aspx?ItemNumber=1078&navItemNumber=580)—healthcare providers leaflets
- National Institute for Health and Care Excellence. Clinical knowledge summary on TMDs (http://cks.nice.org.uk/tmj-disorders)—practical guidance for the diagnosis and management of TMD
- National Institute for Health (www.nidcr.nih.gov/oralhealth/topics/tmj/tmjdisorders.htm)—general information on TMD for patients
- Temporomandibular Joint Association (www.tmj.org)—patient advocacy agency in United States

54 Younger JW, Shen YF, Goddard G, Mackey SC. Chronic myofascial temporomandibular pain is associated with neural abnormalities in the trigeminal and limbic systems. *Pain* 2010;149:222-8.
55 Weissman-Fogel I, Moayedi M, Tenenbaum HC, Goldberg MB, Freeman BV, Davis KD. Abnormal cortical activity in patients with temporomandibular disorder evoked by cognitive and emotional tasks. *Pain* 2011;152:384-96.
56 Aneiros-Guerrero A, Lendinez AM, Palomares AR, Perez-Nevot B, Aguado L, Mayor-Olea A, et al. Genetic polymorphisms in folate pathway enzymes, DRD4 and GSTM1 are related to temporomandibular disorder. *BMC Med Genet* 2011;12:75.
57 Milam SB, Zardeneta G, Schmitz JP. Oxidative stress and degenerative temporomandibular joint disease: a proposed hypothesis. *J Oral Maxillofac Surg* 1998;56:214-23.
58 Milam SB. Pathogenesis of degenerative temporomandibular joint arthritides. *Odontology* 2005;93:7-15.
59 Planello AC, Campos MI, Meloto CB, Secolin R, Rizatti-Barbosa CM, Line SR, et al. Association of matrix metalloproteinase gene polymorphism with temporomandibular joint degeneration. *Eur J Oral Sci* 2011;119:1-6.
60 Light KC, Bragdon EE, Grewen KM, Brownley KA, Girdler SS, Maixner W. Adrenergic dysregulation and pain with and without acute beta-blockade in women with fibromyalgia and temporomandibular disorder. *J Pain* 2009;10:542-52.
61 Schiffman E, Ohrbach R, List T, Anderson G, Jensen R, John MT, et al. Diagnostic criteria for headache attributed to temporomandibular disorders. *Cephalalgia* 2012;32:683-92.
62 Dworkin SF, LeResche L. Research Diagnostic Criteria for Temporomandibular Disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord* 1992;6:301-55.
63 Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL, et al. Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;107:844-60.
64 Anderson GC, Gonzalez YM, Ohrbach R, Truelove EL, Sommers E, Look JO, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. VI: future directions. *J Orofac Pain* 2010;24:79-88.
65 Dworkin SF. Research Diagnostic Criteria for Temporomandibular Disorders: current status & future relevance. *J Oral Rehabil* 2010;37:734-43.
66 Lobbezoo F, Visscher CM, Naeije M. Some remarks on the RDC/TMD validation project: report of an IADR/Toronto-2008 workshop discussion. *J Oral Rehabil* 2010;37:779-83.
67 Look JO, John MT, Tai F, Huggins KH, Lenton PA, Truelove EL, et al. The Research Diagnostic Criteria For Temporomandibular Disorders. II: reliability of Axis I diagnoses and selected clinical measures. *J Orofac Pain* 2010;24:25-34.
68 Look JO, Schiffman EL, Truelove EL, Ahmad M. Reliability and validity of Axis I of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) with proposed revisions. *J Oral Rehabil* 2010;37:744-59.
69 Ohrbach R. Assessment and further development of RDC/TMD Axis II biobehavioural instruments: a research programme progress report. *J Oral Rehabil* 2010;37:784-98.
70 Ohrbach R, Turner JA, Sherman JJ, Mancl LA, Truelove EL, Schiffman EL, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. IV: evaluation of psychometric properties of the Axis II measures. *J Orofac Pain* 2010;24:48-62.
71 Schiffman EL, Ohrbach R, Truelove EL, Tai F, Anderson GC, Pan W, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. V: methods used to establish and validate revised Axis I diagnostic algorithms. *J Orofac Pain* 2010;24:63-78.
72 Schiffman EL, Truelove EL, Ohrbach R, Anderson GC, John MT, List T, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. I: overview and methodology for assessment of validity. *J Orofac Pain* 2010;24:7-24.
73 Truelove E, Pan W, Look JO, Mancl LA, Ohrbach RK, Velly AM, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. III: validity of Axis I diagnoses. *J Orofac Pain* 2010;24:35-47.
74 Visscher C, Lobbezoo F, Naeije M. The RDC/TMD validation project: an important or a final step towards a revised version of the RDc/TMD? *J Orofac Pain* 2010;24:234-5.
75 Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, et al. 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. *J Oral Facial Pain Headache* 2014;28:6-27.
76 Gonzalez YM, Schiffman E, Gordon SM, Seago B, Truelove EL, Slade G, et al. Development of a brief and effective temporomandibular disorder pain screening questionnaire: reliability and validity. *J Am Dent Assoc* 2011;142:1183-91.
77 Litt MD, Porto FB. Determinants of pain treatment response and nonresponse: identification of TMD patient subgroups. *J Pain* 2013;14:1502-13.
78 Durham J. Acute presentations of chronic orofacial pain conditions. In: Greenwood M, Corbett I, eds. Dental emergencies. Wiley-Blackwell, 2012.
79 Epstein JB, Jones CK. Presenting signs and symptoms of nasopharyngeal carcinoma. *Oral Surg Oral Med Oral Pathol* 1993;75:32-6.
80 Siccoli MM, Bassetti CL, Sandor PS. Facial pain: clinical differential diagnosis. *Lancet Neurol* 2006;5:257-67.
81 Durham J, Aggarwal VA, Davies SJ, Harrison SD, Jagger RG, Leeson R, et al. Temporomandibular Disorders (TMDs): an update and management guidance for primary care from the UK Specialist Interest Group in Orofacial Pain and TMDs (USOT). 2013. www.rcseng.ac.uk/fds/publications-clinical-guidelines/clinical_guidelines.
82 Beddis HP, Davies SJ, Budenberg A, Horner K, Pemberton MN. Temporomandibular disorders, trismus and malignancy: development of a checklist to improve patient safety. *Br Dent J* 2014;217:351-5.
83 Epker J, Gatchel RJ, Ellis E. A model for predicting chronic TMD: practical application in clinical settings. *J Am Dent Assoc* 1999;130:1470-5.
84 Garofalo JP, Gatchel RJ, Wesley AL, Ellis E 3rd. Predicting chronicity in acute temporomandibular joint disorders using the research diagnostic criteria. *J Am Dent Assoc* 1998;129:438-47.
85 Slade GD, Bair E, By K, Mulkey F, Baraian C, Rothwell R, et al. Study methods, recruitment, sociodemographic findings, and demographic representativeness in the OPPERA study. *J Pain* 2011;12:T12-26.
86 Von Korff M, Dunn KM. Chronic pain reconsidered. *Pain* 2008;138:267-76.
87 Wright AR, Gatchel RJ, Wildenstein L, Riggs R, Buschang P, Ellis E. Biopsychosocial differences between high-risk and low-risk patients with acute TMD-related pain. *J Am Dent Assoc* 2004;135:474-83.
88 Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain* 1992;50:133-49.

89 Turp JC, Jokstad A, Motschall E, Schindler HJ, Windecker-Getaz I, Ettlin DA. Is there a superiority of multimodal as opposed to simple therapy in patients with temporomandibular disorders? A qualitative systematic review of the literature. [Erratum appears in *Clin Oral Implants Res* 2008;19:326-8.] *Clin Oral Implants Res* 2007;18(Suppl 3):138-50.
90 Phillips K, Clauw DJ. Central pain mechanisms in chronic pain states—maybe it is all in their head. *Best Pract Res Clin Rheumatol* 2011;25:141-54.
91 Gatchel RJ, Stowell AW, Wildenstein L, Riggs R, Ellis E. Efficacy of an early intervention for patients with acute temporomandibular disorder-related pain: a one-year outcome study. *J Am Dent Assoc* 2006;137:339-47.
92 Albino JEN. Management of temporomandibular disorders. National Institutes of Health Technology Assessment Conference Statement. *J Am Dent Assoc* 1996;127:1595-606.
93 Greene CS. The etiology of temporomandibular disorders: implications for treatment. *J Orofac Pain* 2001;15:93-105; discussion 106.
94 Beecroft EV, Durham J, Thomson P. Retrospective examination of the healthcare 'journey' of chronic orofacial pain patients referred to oral and maxillofacial surgery. *Br Dent J* 2013;214:E12.
95 Ehde DM, Dillworth TM, Turner JA. Cognitive-behavioral therapy for individuals with chronic pain: efficacy, innovations, and directions for research. *Am Psychol* 2014;69:153-66.
96 List T, Axelsson S. Management of TMD: evidence from systematic reviews and meta-analyses. *J Oral Rehabil* 2010;37:430-51.
97 Aggarwal VR, Lovell K, Peters S, Javidi H, Joughin A, Goldthorpe J. Psychosocial interventions for the management of chronic orofacial pain. *Cochrane Database Syst Rev* 2011;11:CD008456.
98 Kimos P, Biggs C, Mah J, Heo G, Rashiq S, Thie NM, et al. Analgesic action of gabapentin on chronic pain in the masticatory muscles: a randomized controlled trial. *Pain* 2007;127:151-60.
99 Rizzatti-Barbosa CM, Nogueira MT, de Andrade ED, Ambrosano GM, de Barbosa JR. Clinical evaluation of amitriptyline for the control of chronic pain caused by temporomandibular joint disorders. *Cranio* 2003;21:221-5.
100 Sharav Y, Singer E, Schmidt E, Dionne RA, Dubner R. The analgesic effect of amitriptyline on chronic facial pain. *Pain* 1987;31:199-209.
101 Kurtoglu C, Gur OH, Kurkcu M, Sertdemir Y, Guler-Uysal F, Uysal H. Effect of botulinum toxin-A in myofascial pain patients with or without functional disc displacement. *J Oral Maxillofac Surg* 2008;66:1644-51.
102 Ernberg M, Hedenberg-Magnusson B, List T, Svensson P. Efficacy of botulinum toxin type A for treatment of persistent myofascial TMD pain: a randomized, controlled, double-blind multicenter study. *Pain* 2011;152:1988-96.
103 Guarda-Nardini L, Manfredini D, Salamone M, Salmaso L, Tonello S, Ferronato G. Efficacy of botulinum toxin in treating myofascial pain in bruxers: a controlled placebo pilot study. *Cranio* 2008;26:126-35.
104 Nixdorf DR, Heo G, Major PW. Randomized controlled trial of botulinum toxin A for chronic myogenous orofacial pain. *Pain* 2002;99:465-73.
105 Laskin DM. Botulinum toxin A in the treatment of myofascial pain and dysfunction: the case against its use. *J Oral Maxillofac Surg* 2012;70:1240-2.
106 Raphael KG, Tadinada A, Bradshaw JM, Janal MN, Sirois DA, Chan KC, et al. Osteopenic consequences of botulinum toxin injections in the masticatory muscles: a pilot study. *J Oral Rehabil* 2014;41:555-63.
107 Koh H, Robinson PG. Occlusal adjustment for treating and preventing temporomandibular joint disorders. *Cochrane Database Syst Rev* 2003;1:CD003812.
108 Luther F, Layton S, McDonald F. Orthodontics for treating temporomandibular joint (TMJ) disorders. *Cochrane Database Syst Rev* 2010;7:CD006541.
109 Palla S. Biopsychosocial pain model crippled? *J Orofac Pain* 2011;25:289-90.
110 Cohen M, Quintner J, Buchanan D, Nielsen M, Guy L. Stigmatization of patients with chronic pain: the extinction of empathy. *Pain Med* 2011;12:1637-43.
111 Dorflinger L, Kerns RD, Auerbach SM. Providers' roles in enhancing patients' adherence to pain self management. *Transl Behav Med* 2013;3:39-46.
112 Vowles KE, Thompson M. The patient-provider relationship in chronic pain. *Curr Pain Headache Rep* 2012;16:133-8.
113 Standring S. Gray's anatomy: the anatomical basis of clinical practice, 40th edn. Fig 31.11. Churchill Livingstone, 2008;538.
114 Drake RL, Vogl W, Mitchell AWM. Gray's anatomy for students. Fig 8.128 A & B. Churchill Livingstone, 2005;874.

Cite this as: *BMJ* 2015;350:h1154

Table

Table 1| Summary of salient history and examination findings for 12 most common (numbers in parentheses) temporomandibular disorders[62]

Category	Subcategory	Summary history and examination findings
Myalgia (1): history positive for both of following: pain in jaw, temple, in ear, or in front of ear; pain modified with jaw movement, function, or parafunction. Examination: pain in masseter or temporalis produced by palpation or maximum assisted or unassisted opening	Local myalgia (2); myofascial pain (3); myofascial pain with referral (4)	Pain local to palpation; pain within body of muscle; pain spreads outside the body muscle
Arthralgia (5): history as for myalgia		Pain in temporomandibular joint region produced by one of: palpation or assisted or unassisted jaw movements
Intra-articular disorders	Disc displacements: with reduction (6); with reduction with intermittent locking (7); without reduction with limited opening (8); without reduction without limited opening (9)	Click, pop, snap: on open and close (1 out of 3 movements), or one of opening and closing plus a lateral movement; as above but history of lock does not matter how long; history: decreased mouth opening and inability to eat or interference with eating. Examination: maximum assisted opening <40 mm; history as above but maximum assisted opening >40 mm
	Degenerative joint disease (10)	Crepitus in any movement, with relatively little pain
	Subluxation (11)	History: lock open and self manipulation to achieve closure
Headache attributable to temporomandibular disorder (12)*		History: headache in temple and modified with jaw movement, function, or parafunction. Examination: familiar headache with palpation temporalis or with jaw movements

*As determined in the Diagnostic Criteria for TMD. The Diagnostic Criteria for TMD definition differs slightly from that described in international classification of headache disorders, version 3.

Figures

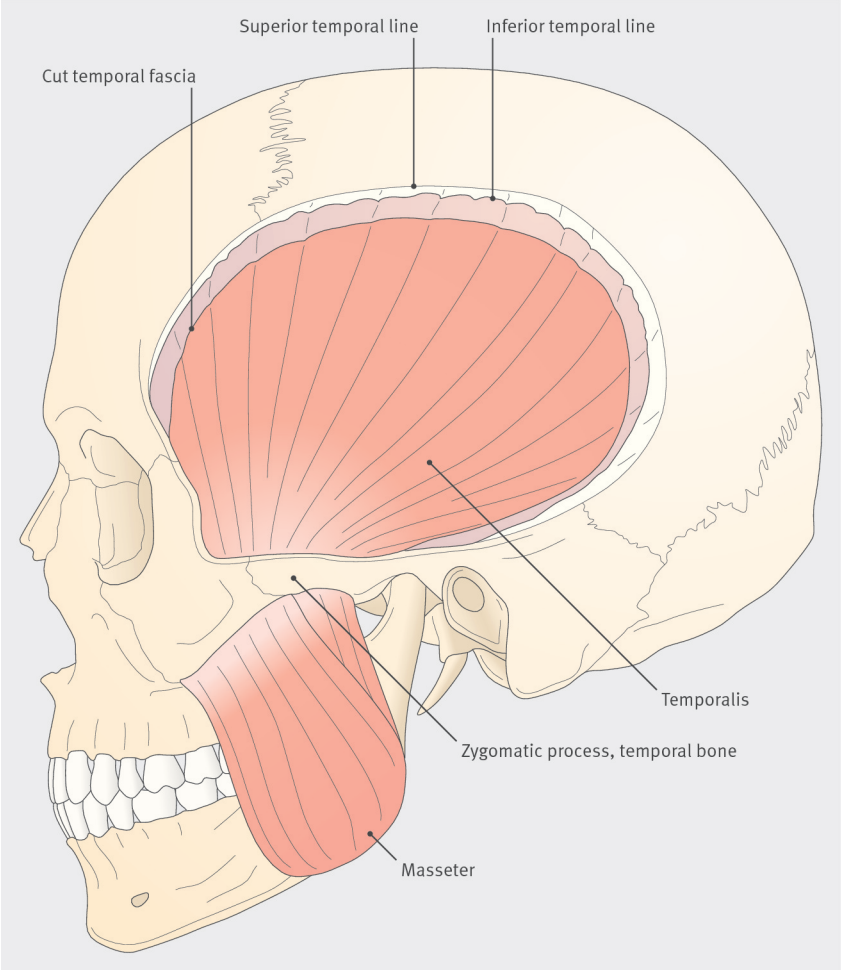

Fig 1 Surface anatomy of temporalis and masseter muscles. Adapted from Standring 2008[113]

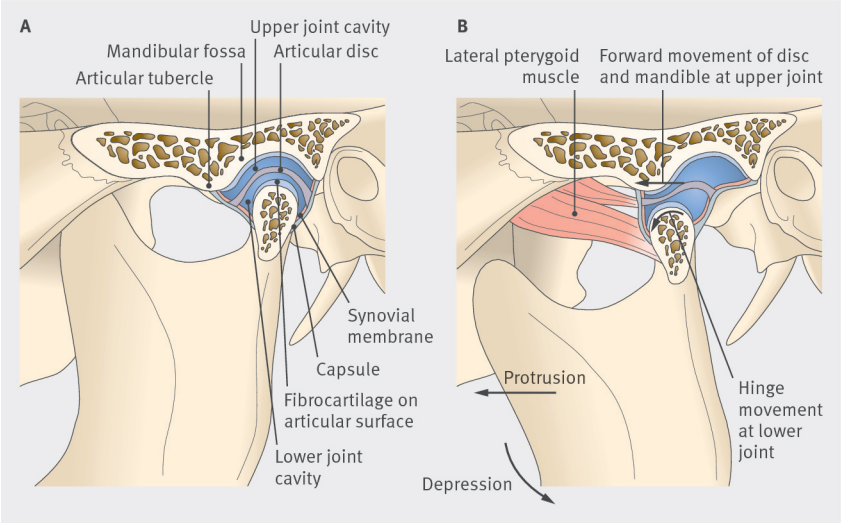

Fig 2 Surface anatomy of temporomandibular joint. Mouth closed (left) and mouth open (right). Adapted from Drake et al 2005[114]