

Oral surgery: part 3.

Temporomandibular disorders

J. Durham¹

IN BRIEF

- Suggests that the diagnosis of temporomandibular disorders (TMDs) can be simplified by following published clinical diagnostic criteria.
- Outlines the principles of management of TMDs and provides references to more detailed explanations.
- Highlights that there are three areas of equal consideration in the management of TMDs – biomedical, psychological, and social.

Temporomandibular disorders (TMDs) are a collection of conditions affecting the temporomandibular joint (TMJ), the muscles of mastication and/or associated structures. They are probably one of the most commonly presenting chronic orofacial pain complaints to the dental profession. TMDs are recognised as a chronic illness and exert biopsychosocial effects on the patient and should therefore be managed in a biopsychosocial manner. This chapter will firstly cover the basic anatomy of the TMJ and its associated structures and then go on to discuss the signs and symptoms, aetiology, diagnosis, and broad management options for TMDs.

BASIC ANATOMY OF THE TEMPOROMANDIBULAR JOINT AND ASSOCIATED STRUCTURE

The following section is not intended as an exhaustive anatomical text but as a brief overview of pertinent structures. Its aim is to help the reader unfamiliar with the area to understand the anatomy behind some of the signs, symptoms and descriptors used later in the chapter.

The temporomandibular joint (TMJ) is located just in front of the ear. It is a synovial joint with a joint capsule surrounding it (Fig. 1) and has a ginglymoarthroidal articulation (gingly – hinge, arthroidal – sliding). It is situated in the glenoid (or mandibular) fossa, formed from

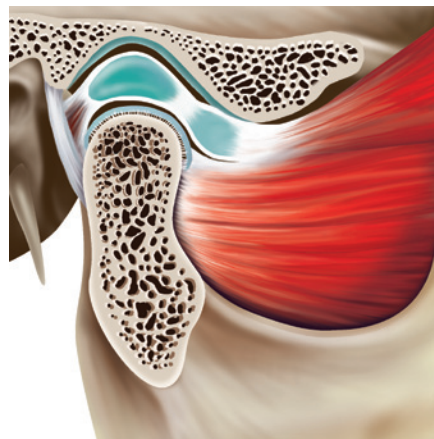


Fig. 1 Articular disc of the temporomandibular joint

the temporal bone above it. This fossa has an eminence at its anterior margin, the articular eminence. The eminence helps prevent dislocation of the TMJ. In between the condyle (the joint head) and the floor of the glenoid fossa there is a biconcave fibro-cartilaginous connective tissue disc.

The role of the articular disc is controversial; purported functions include creating two joint spaces, upper and lower; adapting to the changing shape of the condyle as it articulates with the bones above; providing decreased friction on the condyle by producing fluid on compression thereby aiding lubrication; and stabilising the condyle's position.¹ The disc, in 'health', should move relatively synchronously with the condyle as it moves within the fossa.

The disc is specialised for these functions having a number of distinct zones, the description of which is outwith the remit of this book. The most important distinction is that its posterior retrodiscal lamina is heavily innervated with sensory fibres as opposed to the rest of the disc that has minimal innervation.² If, therefore, the disc is displaced out of position and the condyle functions on the posterior retrodiscal lamina it causes a great deal of pain for the patient.

The movement of the TMJ is a complex process but most of the muscles involved are for jaw closing, as the opening of the jaw to a large extent occurs under the influence of gravity, lateral pterygoid and the suprahyoid musculature. The main muscles involved in the movement of the TMJ are a group known collectively as the muscles of mastication. These include the masseter, temporalis, lateral and medial pterygoid.

HISTORICAL PERSPECTIVE, PREVIOUS SYNONYMS AND CURRENT DEFINITION OF TMDS

Signs and symptoms of TMDs were first recognised by Costen in 1934.³ Costen attributed these signs and symptoms to occlusal disharmony and included symptoms such as impaired hearing and oropharyngeal burning sensations alongside the more classical symptoms of pain in the joint and surrounding musculature.

ORAL SURGERY*

- Part 1. Introduction
- Part 2. Endodontic surgery
- Part 3. Temporomandibular disorders
- Part 4. Minimising and managing nerve injuries and other complications

*This series represents chapters 1, 5, 7 and 8 from the *BDJ* book *A clinical guide to oral diagnosis – book 1*, edited by Tara Renton and C. Michael Hill. All other chapters are published in the complete clinical guide available from the *BDJ* Books online shop. Some illustrations have been cropped due to limitations on size and their full labelling/detail is available in the book.

¹Senior Lecturer in Oral Surgery and Orofacial pain, Honorary Consultant Oral Surgeon, NIHR Clinician Scientist, School of Dental Sciences, Newcastle University
Correspondence to: Dr Justin Durham
Email: j.a.durham@ncl.ac.uk

Table 1 The clinical examination protocol (CEP-TMD) diagnostic criteria for TMDs ¹⁹	
Group	Criteria
Muscle disorders	
Myofascial pain Key: painful muscles	1. Reported pain in masticatory muscles ¹
	2. Pain on palpation in at least three sites, ² one of them at least in the same side of the reported pain
Myofascial pain with limited opening Key: painful muscles + limited movement	1. Myofascial pain
	2. Pain-free unassisted ³ opening <40 mm
	3. Passive ⁴ stretch ≥5 mm (from pain-free unassisted opening to 'painful' assisted opening)
Disc displacements	
Disc displacement with reduction Key: reproducible clicking	1. No pain in the joint neither reported nor on palpation
	2. Reproducible ⁵ click on any excursion ⁶ with either opening or closing click
	3. With click on opening and closing (unless excursive click confirmed): - Click on opening occurs at ≥5 mm interincisal distance than on closing - Clicks eliminated by protrusive opening
Disc displacement without reduction with limited opening Key: limited opening with no clicking	1. History of locking or catching that interfered with eating
	2. Absence of TMJ clicking meeting disc displacement reduction (DDR) criteria
	3. Unassisted 'painful' opening ≤35 mm
	4. Passive stretch <5 mm (from 'painful' unassisted opening to 'painful' assisted opening)
	5. Contralateral excursion <7 mm or uncorrected ipsilateral deviation on opening
Disc displacement without reduction without limited opening Key: history of previously limited opening-imaging needed to confirm disc displacement	1. History of locking or catching that interfered with eating
	2. The presence of TMJ sounds excluding DDR clicking
	3. Unassisted 'painful' opening >35 mm
	4. Passive stretch ≥5 mm (from 'painful' unassisted opening to 'painful' assisted opening)
	5. Contralateral excursion ≥7 mm
	6. Optional imaging (arthrography or MRI) to confirm disc displacement
Other common joint problems	
Arthralgia Key: painful TMJ/no crepitus	1. Pain on TMJ palpation either laterally or intra auricular
	2. Self reported joint pain with or without jaw movement
	3. Absence of crepitus, and possibility of clicking
Osteoarthritis Key: painful TMJ + crepitus	1. Pain as for arthralgia (reported and on palpation)
	2. Crepitus on any movement or tomographic evidence of joint changes ⁷
Osteoarthrosis Key: non-painful TMJ + crepitus	1. Crepitus on any movement or tomographic evidence of joint changes ⁷
	2. No reported joint pain, neither on palpation nor on any movement

¹In the jaw, temples, face, preauricular area, or inside the ear, at rest or function. ²There are 20 sites (10 on each side): posterior, middle and anterior temporalis; origin, body and insertion of masseter; posterior mandibular region; submandibular region; lateral pterygoid; tendon of temporalis. ³Interincisal opening plus overbite or interincisal opening minus anterior open bite. ⁴Passive stretch: the examiner's index and thumb are used to moderately force the mouth to open wider than unassisted opening. Patients are instructed to raise a hand to signal when the stretch becomes too uncomfortable. ⁵All clicks must be reproduced two out of three consecutive trials. ⁶Contra- or ipsilateral or protrusive. ⁷Erosion of cortical delineation, sclerosis of parts or all the condyle and articular eminence, flattening of joint surfaces, osteophyte formation

Costen's syndrome, as TMD was then known, was subject to a number of criticisms and probably represented an amalgam of different orofacial pain conditions.

Shore⁴ in the 1950s coined the term 'Temporomandibular joint dysfunction syndrome' and, similar to Costen, described the condition in relation to

occlusal disturbance. It was not until the 1980s that recognition of the multifaceted biopsychosocial nature of TMDs caused Bell⁵ to use the phrase by which the condition is now known.

The American Academy of Orofacial Pain defines TMDs as:

'A collective term embracing a number

of clinical problems that involve the masticatory musculature, the temporomandibular joint and associated structures, or both. They [TMD] are considered to be a sub classification of musculoskeletal disorders.'

Other previous synonyms for TMDs include: myofascial-pain dysfunction,

Table 2 Types of temporomandibular disorder

Temporomandibular disorders (TMDs) refers to three groups of conditions:¹⁸

1. Myofascial pain (*pain from the masticatory musculature*):

- With limited opening
- Without limited opening

2. Disc displacement (*abnormal movement of the articular disc*):

- With reduction of the disc (clicking)
- Without reduction of the disc displacement:
 - With limited opening
 - Without limited opening

3. Other joint disorders:

- Arthralgia (pain from the temporomandibular joint)
- Osteoarthritis (painful crepitus)
- Osteoarthrosis (an osteoarthritis that is now quiescent)

Other pathology that can affect the temporomandibular joint complex (*joint and associated structures*) can include:

- Tumours - either primary or secondary
- Rheumatoid arthritis
- Hyper- or hypomobility
- Growth disturbances

temporomandibular-pain dysfunction syndrome, facial arthromyalgia. The currently accepted, but still debated, terminology is temporomandibular disorders (plural).⁶

SIGNS AND SYMPTOMS OF TMDS

Prevalence of the signs and symptoms of TMDs varies widely in the literature. This is probably due to differing methodologies in examining prevalence and the fluctuating nature of TMDs' signs and symptoms.

The prevalence of signs and symptoms is higher (20–75%) than the number of individuals who present for treatment (2–4%). The age of presentation is usually between 20 and 40 years of age and the male to female ratio is 1:1 for symptoms, but females outnumber males in presenting for management.^{7–11} Suggestions that the difference in gender presentation for treatment is due to gender-linked behaviour are frequent in the literature but are not scientifically supported.⁸

Signs and symptoms of TMDs are clinically variable and often idiosyncratic but they include six broad groups:^{9,12–14}

- Muscular tenderness – in face (masseter, temporalis, medial or lateral

pterygoid), neck and

- Shoulders
- Pain – in head, neck and shoulders
- Joint noises – clicking, crepitus (grinding)
- Locking – open (dislocation), closed (inability to open fully)
- Ear complaints – otalgia
- Psychosocial effects.

AETIOLOGY OF TMDS

There has been no single aetiological factor identified for TMDs and it is likely that the aetiology is complex and multifactorial. A biopsychosocial model has recently been proposed and offers a potential way forward.¹³ There have also been some recent advances in understanding the possible physiological and genetic basis for TMDs.^{15–17}

DIAGNOSIS AND SUBTYPES OF TMDS

Clinical diagnosis and subtypes

Until 1992, clinical research found it difficult to investigate homogenous groups of specific TMD subtypes. This was because of

the lack of a reliable and valid diagnostic index to diagnose the different subtypes of TMDs. The Research Diagnostic Criteria for TMDs (RDC/TMD) helped solve this problem.¹⁸ It produced a set of valid and reliable diagnostic algorithms by which researchers could ensure they were examining homogenous groups. The three subtypes of TMDs defined by these criteria are detailed in Tables 1 and 2.

The consortium involved in the construction of the RDC/TMD is preparing a shortened version for every day clinical use: the DC/TMD (diagnostic criteria for TMDs). A recent publication, however, highlighted a clinical examination protocol for TMDs (CEP-TMD) for everyday clinical use that produces a parallel diagnosis to that of the RDC/TMD.¹⁹ The CEP-TMD is demonstrated and available online (<http://www.ncl.ac.uk/dental/AppliedOcclusion/>, see Table 1). This is probably the most applicable diagnostic system currently available for everyday clinical use.

Adjunctive use of radiography in diagnosis

The consensus on plain radiographs such as the dental panoramic tomograph for any of the subtypes of TMDs (myofascial pain, disc displacements, other joint disorders) is that they are not indicated or justified, as they are unlikely to change the clinician's treatment plan.^{20,21} That said, however, few things are absolute and there are some situations where one might choose to perform a plain radiograph for a patient suspected of suffering from a temporomandibular disorder (for instance, if one suspects there is an element of odontogenic pain contributing to the patient's complaint).

If one suspects a sinister or serious pathology mimicking TMDs, after urgent referral, advanced imaging rather than plain imaging would be indicated. For suspected bony pathology, computed tomography (CT), cone beam computed tomography (CBCT), or positron emission tomography (PET) alongside CT can be considered. For suspected soft tissue pathology MRI remains the gold standard imaging modality.²²

Advanced imaging for the subtypes of TMDs is not mandatory, as careful clinical examination with a robust diagnostic index has been proved to be reliable.

Advanced imaging would not be indicated or justifiable for myofascial pain that has been diagnosed clinically. The role and benefit of CT and MRI has also been questioned in treatment planning for non-myofascial TMDs although the basis for this was largely due to the lack of good quality evidence for their use.²³ The choice of advanced imaging would be between CT/CBCT for hard tissues and MRI for soft tissues. The clinician would have to have a specific justification in mind for ordering either investigation.

PATHOLOGY OF THE TEMPOROMANDIBULAR COMPLEX

Serious pathology of the temporomandibular complex (TMJ and associated structures) is rare. Primary tumours in the temporomandibular complex are thought to account for less than 1% of all head and neck tumours²⁴ and incidental findings on MRI for TMDs occur in less than 1% of TMDs.²⁵ Metastases to the temporomandibular joint can occur from multiple sites but the most likely are breast, lung, thyroid, kidney and prostate.

Primary malignant tumours in the head and neck can mimic the signs and symptoms of TMDs, but usually also present with some other signs and symptoms that should alert the attending clinician that there may be another cause for the patient's complaints. These 'red flag' signs and symptoms should mandate an urgent referral and they include:

- New signs and symptoms of TMDs presenting for the first time in the advanced age group (>60 years old)
- Ipsilateral lymphadenopathy
- Previous history of malignancy elsewhere in the body and new onset TMDs
- Cranial nerve dysfunction in relation to the complaint, especially in the fifth and seventh cranial nerves
- Profound and near absolute trismus precluding careful oral examination
- Recurrent ipsilateral epistaxis
- Anosmia
- Persistent nasal obstruction or purulent discharge
- Objective ipsilateral hearing loss.

More common benign pathologies are: hypomobility of the joint, hypermobility of the joint (recurrent dislocations), and

degenerative inflammatory states such as osteoarthritis (contained with the TMDs subgroup – other joint disorders) and rheumatoid arthritis.

MANAGEMENT OF TMDs

There is a vast literature around the management of TMDs stretching back several decades. The current literature suffers from a lack of a standardised, valid and reproducible patient-based outcome measure as well as a lack of consistency in diagnosis (especially pre-1992 and the introduction of RDC/TMD). This has led most attempts at meta-analyses of treatments to call for further research and a standardised outcome measure.^{26–29}

Given the paucity of good quality evidence to base practice on, and the fact that the majority of TMDs respond well to simple, reversible, conservative therapy it is suggested as the mainstay of initial management once mimicking pathology has been excluded.^{12,29–32} This suggestion has recently been supported by the release of an updated policy statement from the American Association of Dental Research on TMDs.³³ This states that unless there are 'specific and justifiable indications to the contrary' conservative reversible therapy should form the initial management of TMDs. Conservative reversible therapy was defined by the National Institutes of Health³⁴ as including: appropriate analgesia, intraoral appliances, supportive patient education and counselling, physiotherapy and gross occlusal therapy. Gross occlusal therapy pertains to the removal of newly created large interferences for example: a new fixed or removable prosthesis that has altered the occlusion and signs and symptoms of TMDs have occurred immediately after its insertion. It does *not* relate to full mouth occlusal equilibration.

Conservative reversible therapy

Given recent evidence on the importance of diagnosis to sufferers of TMDs, all therapy should be preceded by giving the patient a diagnosis, explaining it to them and reassuring them over TMDs' largely benign course.³⁵

Conservative therapy in the literature has shown to have between a 68 to 95% 'success' rate^{31,32,36–40} and TMDs have been shown to have a large response to placebo.^{31,41–45}

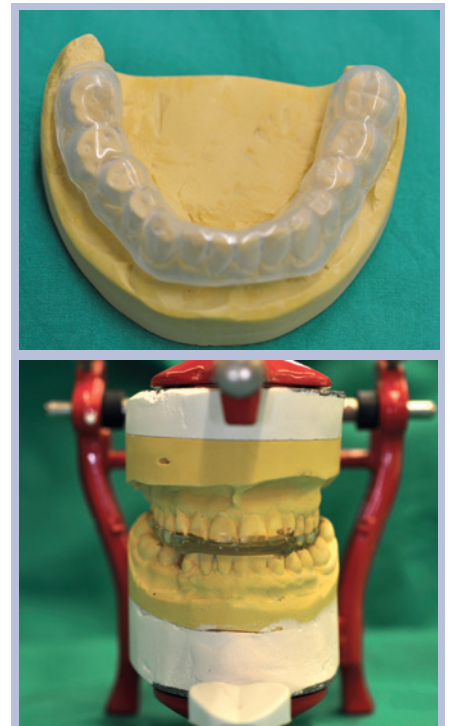


Fig. 2 (a) Lower soft splint; (b) Upper stabilisation splint on average value articulator with incisal guidance pin removed to allow photo. The thickness of beauty hard wax™ used for the registration determines the thickness of the splint manufactured

Conservative therapies possible for all three subtypes of TMDs (Table 1) are listed below. Citations in the bulleted list generally point the reader towards helpful articles in the literature on these techniques or appliances:

- Physiotherapy and home exercise programmes^{46,47}
- Patient physical self-regulatory training,⁴⁸ cognitive behavioural therapy⁴⁹
- Acupuncture⁵⁰ or moist heat applied locally to the masticatory musculature
- Intra-oral appliances, the simplest of these being a lower soft splint (orthotic).

More advanced appliances include the stabilisation splint^{51,52} or an anterior repositioning splint⁵³ (Fig. 2). Patients using either stabilisation splints or anterior repositioning splints must be monitored very carefully as there is a potential for occlusal changes to occur with both these splints. Full coverage appliances reduce, but do not eliminate, the possibility of occlusal changes.

Simple pharmacological therapy can help relieve inflammation or pain associated



Fig. 3 Some of the surgical approaches to the TMJ



Fig. 4 Stance and positioning for reduction of a dislocated TMJ

with TMDs, for example the judicious use of non-steroidal anti-inflammatory drugs (NSAIDs) when not contraindicated.

These therapies can be used in isolation or, if appropriate, in combination. At present the paucity of evidence does not favour one therapy over another for the particular subtypes of TMDs. It should be noted that in the case of intra-oral

appliances a minority of patients' symptoms may worsen when using a lower soft splint, or they may report increased bruxism; in either case the soft splint should be discontinued and consideration should be given to constructing a stabilisation splint.

More advanced conservative therapy initiated by specialists may include the

use of centrally acting neuromodulatory pharmacological agents.⁵⁴⁻⁵⁶

Irreversible therapy

It is rare for irreversible therapy to be required due to the high success rate of conservative reversible therapy. Failure of conservative, reversible therapy is not an absolute indication to progress to irreversible therapy.

Two main types of irreversible therapy are reported within the literature. These are occlusal therapy, in the form of occlusal equilibration, and surgery. At present given their irreversible nature and lack of evidence to define the indications for their use these two forms of therapy should not be undertaken without very careful, detailed, consideration of the clinical case and the informed consent of the patient.

The most minimally invasive forms of surgery for TMDs are arthrocentesis and arthroscopy and are probably the more widely used, as opposed to open joint surgery. These two techniques both allow both lysis and lavage of the (upper) joint space(s) and arthroscopy has the additional advantage of allowing some instrumentation and surgery around the joint. Figure 3 shows the position of two of the more commonly used access points for arthroscopy and arthrocentesis along with the retromandibular, submandibular and preauricular approaches to the TMJ. A good description of open approaches to the temporomandibular joint can be found at the AO Foundation (www.aofoundation.org). Sidebottom provides a good review of other less frequently performed open surgical procedures for the temporomandibular complex.⁵⁷

MANAGEMENT OF OTHER PATHOLOGICAL STATES OF THE TEMPOROMANDIBULAR COMPLEX

It is outwith the remit of this chapter to give extensive details of the management of all pathology affecting the temporomandibular complex. Brief details on the management of the more common benign pathologies will, however, be presented for completeness.

Hypomobility (trismus)

Hypomobility can be due to a number of causes: mechanical derangement, infective processes, muscular pain, neoplasia,

inflammatory processes or diseases. Absolute hypomobility can be caused by ankylosis.

Ankylosis is either a fibrous or bony union between the condylar head and the glenoid fossa and can be precipitated by a number of factors including trauma and surgery to the joint. It generally requires surgical management and may necessitate a joint replacement. Suggested guidelines and indications for joint replacement are provided in the UK by the UK TMJ replacement surgeons⁵⁸ and NICE have also recently released guidance on the procedure.⁵⁹

One of the more commonly presenting causes of hypomobility to the general practitioner is that induced by a minor oral surgical procedure or infection near the masseter muscle, for example, pericoronitis of a lower third molar tooth. In the case of the infective origin the source should be removed, drainage instituted and antibiotics prescribed if appropriate. Persisting trismus following resolution of infection or the immediate post-surgical procedure can usually be helped by gentle stretching exercises performed by the patient through the use of increasing numbers of tongue spatulas placed between the incisor teeth. The rare possibility of a pharyngeal or tonsillar tumour should also be considered in cases that fail to resolve rapidly.

Hypermobility

The most common hypermobile state the general practitioner will encounter is that of a dislocation. This can occur outside of the dental chair (for example, following yawning or trauma), or while in the dental chair (for instance, following excessive unresisted downward force for extraction of lower teeth). The chief signs of a dislocation are a complete inability to occlude the teeth and palpable condylar head(s) outside of the glenoid fossa.

The traditional method for relocation of a dislocated TMJ is for the operator to place their thumbs over the lower molar teeth wrapping their fingers around the inferior body and parasymphysis of the mandible. Slow gentle increasing pressure is then directed down through the lower molars via the operator's thumbs to distract the mandible downwards while their fingers push upward in order to translate the condylar head(s) back over the

eminentia (Fig. 4). If there is a bilateral dislocation it is often that one side is easier to reduce than the other and unilateral relocation of the easier side often means the contralateral side then relocates. Once relocated it is possible to use a barrel bandage over the next 24 hours to help prevent a recurrence of the dislocation. A recent wrist-pivot method for relocation of a dislocated mandible has also been described.⁶⁰ This technique and pharmacological interventions (for example, benzodiazepines or general anaesthetic), might be considered should the traditional method of relocation fail.

Patients who have frequent dislocations are not uncommon and there are several surgical and non-surgical methods to attempt to manage this problem. Shorey and Campbell⁶¹ provide a good review of these treatment options along with their relative 'success' rates.

Rheumatoid arthritis

This is a chronic, systemic, autoimmune, inflammatory disease causing polyarthritides. It can affect the TMJ and cause problems ranging from pain and crepitus, to resorption of the condylar head and consequential anterior open bite. Most individuals suffering from this disease are under the care of a rheumatologist and management of complaints related to the temporomandibular complex is usually in liaison with a rheumatologist. Open joint surgery, joint replacement and orthognathic surgery can be indicated in more severe cases and therefore it is advisable to have oral and maxillofacial surgery involved at some point in the individual's care. It is important to note that severe resorptive changes as a result of rheumatoid arthritis are not common.

SUMMARY

Temporomandibular disorders are a collection of three benign conditions that largely respond to conservative reversible therapy. Conservative reversible therapy is the mainstay of initial management and its failure is not an absolute indication for irreversible therapy. Obtaining an accurate diagnosis and excluding other pathology that may mimic TMDs is paramount and once obtained the patient should be informed and reassured over the benign, usually self-limiting nature of TMDs and

their excellent response rate to conservative reversible therapy.

1. Standing S. *Grey's anatomy*. London: Elsevier, 2005.
2. Okeson J P. *Management of temporomandibular disorders and occlusion*. St. Louis: Mosby, 2003.
3. Costen J B. A syndrome of ear and sinus symptoms based on disturbed function of the temporomandibular joint. *Ann Otol Rhinol Laryngol* 1934; **43**: 115.
4. Shore N A. *Occlusal equilibration and temporomandibular joint dysfunction*. Philadelphia: J B Lipencott, 1959.
5. Bell W E. *Clinical management of temporomandibular disorders*. Chicago: Year Book Medical Publishers, 1982.
6. Laskin D M. Temporomandibular disorders: a term past its time? *J Am Dent Assoc* 2008; **139**: 124–128.
7. Von Korff M, Dworkin S F, Le Resche L, Kruger A. An epidemiologic comparison of pain complaints. *Pain* 1988; **32**: 173–183.
8. de Bont L G, Dijkgraaf L C, Stegenga B. Epidemiology and natural progression of articular temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1997; **83**: 72–76.
9. Grey R J, Davies S J, Quayle A A. A clinical approach to temporomandibular disorders. 1. Classification and functional anatomy. *Br Dent J* 1994; **176**: 429–435.
10. De Kanter R J, Käyser A F, Battistuzzi P G, Truin G J, Van't Hof M A. Demand and need for treatment of craniomandibular dysfunction in the Dutch adult population. *J Dent Res* 1992; **71**: 1607–1612.
11. De Kanter R J, Truin G J, Burgersdijk R C *et al*. Prevalence in the Dutch adult population and a meta-analysis of signs and symptoms of temporomandibular disorder. *J Dent Res* 1993; **72**: 1509–1518.
12. McNeill C. Management of temporomandibular disorders: concepts and controversies. *J Prosthet Dent* 1997; **77**: 510–522.
13. Suvinen T I, Reade P C, Kemppainen P, Könönen M, Dworkin S F. 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**: 613–633.
14. Turk D C. Psychosocial and behavioural assessment of patients with temporomandibular disorders: diagnostic and treatment implications. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1997; **83**: 65–71.
15. Diatchenko L, Slade G D, Nackley A G *et al*. Genetic basis for individual variations in pain perception and the development of a chronic pain condition. *Hum Mol Genet* 2005; **14**: 135–143.
16. Light K C, Bragdon E E, Grewen K M, Brownley K A, Girdler S S, Maixner W. Adrenergic dysregulation and pain with and without acute beta-blockade in women with fibromyalgia and temporomandibular disorder. *J Pain* 2009; **10**: 542–552.
17. Ribeiro-Dasilva M C, Peres Line S R, Leme Godoy dos Santos M C *et al*. Oestrogen receptor-alpha polymorphisms and predisposition to TMJ disorder. *J Pain* 2009; **10**: 527–533.
18. Dworkin S F, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord* 1992; **6**: 301–355.
19. Hasanain F, Durham J, Moufti A, Steen I N, Wassell R W. Adapting the diagnostic definitions of the RDC/TMD to routine clinical practice: a feasibility study. *J Dent* 2009; **37**: 955–962.
20. Crow H C, Parks E, Campbell J H, Stucki D S, Daggy J. The utility of panoramic radiography in temporomandibular joint assessment. *Dentomaxillofac Radiol* 2005; **34**: 91–95.
21. Epstein J B, Caldwell J, Black G. The utility of panoramic imaging of the temporomandibular joint in patients with temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001; **92**: 236–239.
22. Shintaku W H, Venturin J S, Langlais R P, Clark G T. Imaging modalities to access bony tumours and hyperplastic reactions of the temporomandibular

- joint. *J Oral Maxillofac Surg* 2010; **68**: 1911–1921.
23. Ribeiro-Rotta R F, Marques K D, Pacheco M J, Leles C R. Do computed tomography and magnetic resonance imaging add to temporomandibular joint disorder treatment? A systematic review of diagnostic efficacy. *J Oral Rehabil* 2010; **38**: 120–135.
 24. Nwoku A L, Koch H. The temporomandibular joint: a rare localisation for bone tumours. *J Maxillofac Surg* 1974; **2**: 113–119.
 25. Yanagi Y, Asaumi J, Maki Y *et al*. Incidentally found and unexpected tumours discovered by MRI examination for temporomandibular joint arthrosis. *Eur J Radiol* 2003; **47**: 6–9.
 26. Al-Ani M Z, Davies S J, Grey R J, Sloan P, Glenny A M. Stabilisation splint therapy for temporomandibular pain dysfunction syndrome. *Cochrane Database Syst Rev* 2004; CD002778.
 27. Koh H, Robinson P G. Occlusal adjustment for treating and preventing temporomandibular joint disorders. *Cochrane Database Syst Rev* 2003; CD003812.
 28. Shi Z, Guo C, Awad M. Hyaluronate for temporomandibular joint disorders. *Cochrane Database Syst Rev* 2003; CD002970.
 29. List T, Axelsson S. Management of TMD: evidence from systematic reviews and meta-analyses. *J Oral Rehabil* 2010; **37**: 430–451.
 30. Dimitroulis G. Temporomandibular disorders: a clinical update. *BMJ* 1998; **317**: 190–194.
 31. Greene C S, Laskin D M. Long-term evaluation of conservative treatment for myofascial pain-dysfunction syndrome. *J Am Dent Assoc* 1974; **89**: 1365–1368.
 32. Greene C S, Laskin D M. Long-term evaluation of treatment for myofascial pain-dysfunction syndrome: a comparative analysis. *J Am Dent Assoc* 1983; **107**: 235–238.
 33. Management of patients with TMDs: a new 'Standard of Care'. American Association for Dental Research, 2010.
 34. Albino J E N. Management of temporomandibular disorders. National Institutes of Health Technology Assessment Conference Statement. *J Am Dent Assoc* 1996; **127**: 1595–1606.
 35. Durham J, Steele J G, Wassell R W, Exley C. Living with uncertainty: temporomandibular disorders. *J Dent Res* 2010; **89**: 827–830.
 36. Sato S, Kawamura H, Nagasaka H, Motegi K. The natural course of anterior disc displacement without reduction in the temporomandibular joint: follow-up at 6, 12, and 18 months. *J Oral Maxillofac Surg* 1997; **55**: 234–238; discussion 238–239.
 37. Randolph C S, Greene C S, Moretti R, Forbes D, Perry H T. Conservative management of temporomandibular disorders: a post-treatment comparison between patients from a university clinic and from private practice. *Am J Orthod Dentofacial Orthop* 1990; **98**: 77–82.
 38. Magnusson T, Carlsson G E. A two and a half year follow-up of changes in headache and mandibular dysfunction after stomatognathic treatment. *J Prosthet Dent* 1983; **49**: 398–402.
 39. Nel H. Myofascial pain-dysfunction syndrome. *J Prosthet Dent* 1978; **40**: 438–441.
 40. Carraro J J, Caffesse R G. Effect of occlusal splints on TMJ symptomatology. *J Prosthet Dent* 1978; **40**: 563–536.
 41. Greene C S, Laskin D M. Meprobamate therapy for the myofascial pain-dysfunction (MPD) syndrome: a double-blind evaluation. *J Am Dent Assoc* 1971; **82**: 587–590.
 42. Greene C S, Laskin D M. Splint therapy for the myofascial pain-dysfunction (MPD) syndrome: a comparative study. *J Am Dent Assoc* 1972; **84**: 624–628.
 43. Shipman W G, Greene C S, Laskin D M. Correlation of placebo responses and personality characteristics in myofascial pain-dysfunction (MPD) patients. *J Psychosom Res* 1974; **18**: 475–483.
 44. Laskin D M, Greene C S. Influence of the doctor-patient relationship on placebo therapy for patients with myofascial pain-dysfunction (MPD) syndrome. *J Am Dent Assoc* 1972; **85**: 892–894.
 45. Goodman P, Greene C S, Laskin D M. Response of patients with myofascial pain-dysfunction syndrome to mock equilibration. *J Am Dent Assoc* 1976; **92**: 755–758.
 46. Michelotti A, de Wijer A, Steenks M, Farella M. Home-exercise regimes for the management of nonspecific temporomandibular disorders. *J Oral Rehabil* 2005; **32**: 779–785.
 47. Wright E F, Domenech M A, Fischer J R J. Usefulness of posture training for patients with temporomandibular disorders. *J Am Dent Assoc* 2000; **131**: 202–210.
 48. Carlson C R, Bertrand P M, Ehrlich A D, Maxwell A W, Burton R G. Physical self-regulation training for the management of temporomandibular disorders. *J Orofac Pain* 2001; **15**: 47–55.
 49. Aggarwal V R, Tickle M, Javidi H, Peters S. Reviewing the evidence: can cognitive behavioural therapy improve outcomes for patients with chronic orofacial pain? *J Orofac Pain* 2010; **24**: 163–171.
 50. La Touche R, Goddard G, De-la-Hoz J L *et al*. Acupuncture in the treatment of pain in temporomandibular disorders: a systematic review and meta-analysis of randomized controlled trials. *Clin J Pain* 2010; **26**: 541–550.
 51. Moufti M A, Lilioco J T, Wassell R W. How to make a well-fitting stabilization splint. *Dent Update* 2007; **34**: 398–400, 402–404, 407–408.
 52. Davies S J, Grey R J. The pattern of splint usage in the management of two common temporomandibular disorders. Part II: The stabilisation splint in the treatment of pain dysfunction syndrome. *Br Dent J* 1997; **183**: 247–251.
 53. Davies S J, Grey R J. The pattern of splint usage in the management of two common temporomandibular disorders. Part I: The anterior repositioning splint in the treatment of disc displacement with reduction. *Br Dent J* 1997; **183**: 199–203.
 54. Hersh E V, Balasubramaniam R, Pinto A. Pharmacologic management of temporomandibular disorders. *Oral Maxillofac Surg Clin North Am* 2008; **20**: 197–210.
 55. Kimos P, Biggs C, Mah J *et al*. Analgesic action of gabapentin on chronic pain in the masticatory muscles: a randomized controlled trial. *Pain* 2007; **127**: 151–60.
 56. Plesh O, Curtis D, Levine J, McCall W D Jr. Amitriptyline treatment of chronic pain in patients with temporomandibular disorders. *J Oral Rehabil* 2000; **27**: 834–841.
 57. Sidebottom A J. Current thinking in temporomandibular joint management. *Br J Oral Maxillofac Surg* 2009; **47**: 91–94.
 58. Sidebottom A J. Guidelines for the replacement of temporomandibular joints in the United Kingdom. *Br J Oral Maxillofac Surg* 2008; **46**: 146–147.
 59. National Institute for Health and Clinical Excellence. *Total prosthetic replacement of the temporomandibular joint*. London: NICE, 2009. Online article available at <http://www.nice.org.uk/nicemedia/live/12136/46672/46672.pdf> [accessed July 2013].
 60. Lowery L E, Beeson M S, Lum K K. The wrist pivot method, a novel technique for temporomandibular joint reduction. *J Emerg Med* 2004; **27**: 167–170.
 61. Shorey C W, Campbell J H. Dislocation of the temporomandibular joint. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000; **89**: 662–668.