Supriya Ghurye
Roddy McMillan

Pain-Related Temporomandibular Disorder – Current Perspectives and Evidence-Based Management

Abstract: Pain-related temporomandibular disorder (TMD) is one of the top three most common chronic pain conditions, along with headaches and back pain. TMD has complex pathophysiology and significant associations with a variety of other chronic pain conditions, eg fibromyalgia, irritable bowel syndrome and migraine. Chronic TMD is associated with a negative impact upon quality of life and high levels of healthcare utility. It is important that clinicians are able to diagnose TMD correctly, provide appropriate management in keeping with current evidence-based practice, and identify when to refer patients to specialist care. The presence of risk factors, eg anxiety, depression, pain-related disability and chronic pain conditions elsewhere in the body, may help to identify which TMD patients require referral for multidisciplinary management. TMD should be managed using a holistic approach, incorporating patient education and encouragement towards self-management. TMD care pathways should consider using the three 'pillars' of pain management: physical therapies, pharmacotherapy and clinical psychology.

CPD/Clinical Relevance: TMD is associated with considerable comorbidity and significant negative impact upon quality of life. It therefore follows that dental practitioners should keep up-to-date with the recent scientific evidence and recommendations relating to the diagnosis and management of TMD.

Dental Update 2015; 42: 533–546

Temporomandibular disorders are a group of musculoskeletal disorders which constitute the most common cause of non-dental orofacial pain in the head and neck region.[1] TMD sits alongside chronic back pain and headaches, as one of the three most common chronic pain conditions.[1] The reported prevalence of TMD is between 5–50% of the general population.[1] A survey by Durham *et al*[2] in 2007, reported that dentists in primary care reported uncertainty with regards to the diagnosis of TMD, and thus had a low threshold for referral to secondary care. Patients with TMD often first present to their general dental practitioner, and therefore it is important that clinicians in primary dental care are able to identify TMD correctly and instigate appropriate management. Moreover, clinicians should also be able to identify patients with chronic TMD, or risk factors for developing chronic pain, who may require referral to specialist services.

Supriya Ghurye, BDS, MJDF RCS(Eng), Oral Medicine CDT, Guy's and St Thomas' NHS Foundation Trust, Guy's Hospital, Oral Medicine Department, Floor 22 Tower Wing, Great Maze Pond, London, SE1 9RT, **Roddy McMillan**, BDS, MBChB, MFDS RCS(Eng), FDS(OM) RCPS(Glasg), FHEA, Consultant and Honorary Clinical Teaching Fellow in Oral Medicine and Facial Pain, Eastman Dental Hospital, 256 Gray's Inn Road, London, WC1X 8LD, UK.

Epidemiology

TMD may affect up to a third of the population, however, the majority of patients do not seek help for their symptoms.[1] The prevalence of pain-related TMD is seen to be higher in females,[3-4] however, women are also more likely to seek help for their symptoms.[5-6] The peak incidence of TMD occurs in the second and third decades, with a significantly lower incidence occurring in those aged between 45–64 years, and 65 years and over.[7] Additionally, there is a significant financial cost attached to chronic TMD – in the United States, there is an estimated $4 billion per annum cost associated with TMD.[8] This cost burden has implications for both patients and healthcare providers.[9]

	Level of Supporting Evidence			
Factor	**Strong**	**Moderate**	**Low**	**No association**
Nervous system	Endogenous pain modulation	Autonomic nervous system	Neurodegenerative	
	Peripheral/central sensitization			
Trauma		Dental Interventions	Cervical (?)	
		Facial macro trauma		
Demographics	Gender	Age	Ethnicity	
Psychological	Catastrophizing	Stress	Personality disorders	Socioeconomic (?)
		Depression		
		Childhood events		
Dento-skeletal		Occlusion	Orthodontics	
Functional		Parafunction (daytime)		Parafunction (sleeping)
Lifestyle		Nutrition		
		Smoking		
Sleep		Sleep disorders		
Genetics		Genotypic		Inheritable
Co-morbidities /Secondary	Fibromyalgia	Headache (particularly migraine)	Infection	Secondary gain (?)
		Lower back pain		
		Irritable bowel syndrome		
		Chronic widespread pain		

Table 1. Pathophysiological factors associated with the development of pain-related TMD (derived from Benoliel *et al* 2011).[30]
Key: (?) - debatable evidence.

Furthermore, it has been stated that 85% of the cost of treating TMD is attributable to the small percentage of patients who develop chronic pain-related TMD.[10] Currently, there are no published United Kingdom figures for the financial burden of TMD. However, when looking at chronic pain in general, it has been reported that management of patients with chronic pain in primary care carries an estimated total cost of £69 million.[11] It has also been reported that over 100,000 people are absent from school or work due to migraine (a condition closely associated with TMD and with similar prevalence) every working day, with the cost to the economy exceeding £1.5 billion per annum.[12-13]

This reinforces the importance of early identification of patients at risk of developing chronic TMD and timely referral to secondary care, where appropriate. However, despite this, the prognosis for pain-related TMD remains good – the majority of patients who develop TMD will have transient symptoms and will not progress to a chronic pain state. One study looking at the determinants of treatment response found that 16% of the TMD patients included had persistent pain, which did not respond to treatment at one year follow-up.[14]

Aetiology

The cause of TMD is multifactorial and complex owing to the interaction of the numerous anatomical, physiological and psychosocial factors identified in the development of TMD.[15-16] These factors may be considered as predisposing, precipitating or perpetuating.[17] It is important to note that TMD may also occur in the absence of these factors.[18]

Anatomical factors may be associated with TMD. Internal derangement of the joint may be classified as:

- Disc displacement with reduction;
- Disc displacement without reduction with limited opening; and
- Disc displacement without reduction without limited opening.[16]

It should also be noted that patients with disc displacement with

reduction may not have any clinical signs or symptoms of TMD.[19]

Table 1 summarizes the various pathophysiological factors associated with the development of pain-related TMD.

Genetic risk factors for the development of TMD have also been identified in relation to neurotransmission and mood regulation.[20-22] Similarly, psychological characteristics have been linked to the development of TMD. The results from a study published by Slade *et al*,[23] looking at healthy females aged 18–34, found that depression, perceived stress and low mood were significant predictors for the development of TMD. This is supported by results from the OPPERA study (Orofacial Pain: Prospective Evaluation and Risk Assessment)[1] – a recently published large, high quality series of four observational studies, designed to identify risk factors for the onset and persistence of TMD. The findings from the OPPERA study included higher levels of somatic awareness, affective distress, pain catastrophizing and psychosocial symptoms in patients with TMD.[24]

It has also been suggested that increased sensitivity in these patients may be due to central sensitization, which is also seen in other chronic pain conditions such as tension-type headache and fibromyalgia.[25] Moreover, other chronic pain co-morbidities have also been found to be associated with chronic TMD, such as:

- Headache (particularly migraine);
- Depression;
- Chronic fatigue syndrome;
- Fibromyalgia;
- Irritable bowel syndrome;
- Sleep disturbance.

The prevalence of these conditions are also influenced by psychosocial risk factors.[1,7,26-28]

Trauma may contribute to the development of TMD in some patients, for example, an acute phase of myofascial pain following a dental procedure, such as third molar extraction.[29-30] Chronic TMD pain may develop following head and neck trauma, if inflammatory and degenerative sequelae occur and other predisposing biopsychosocial and genetic factors are present.[4, 15, 20-22, 31-32]

Occlusion, orthodontics and parafunction (bruxism/clenching) have previously been reported as being aetiological factors for the development of TMD. Le Bell *et al*[33] found that patients with a history of TMD and provided with artificial occlusal interferences, reported greater occlusal discomfort and chewing difficulties compared to healthy controls. It has been suggested that TMD patients may have a greater susceptibility to occlusal interference, though there is little evidence to support the role of occlusal interferences and malocclusion in the development of TMD.[30,33-35] Similarly, parafunction appears to have a limited role in TMD, as previous studies have not demonstrated that masticatory muscle hyperactivity is a primary aetiological factor in the development of TMD.[29] Furthermore, orthodontic treatment has not been found to increase the risk of developing TMD.[36-37]

Clinical features

The clinical features associated with TMD consist of pain affecting the pre-auricular region, which may also include the cheeks and/or temporal area and limitations in mandibular excursions, which may also be accompanied by joint sounds.[18] Additionally, patients may also exhibit discomfort on palpation of the temporomandibular joint (TMJ) and muscles of mastication, headaches and otalgia.[1]

Temporomandibular disorders can be loosely categorized into three sub-groups:[38]

- Arthritis (inflammatory pathology of the TMJ);
- Arthrosis (non-inflammatory, mechanical derangement or degenerative disease of the TMJ);
- The most commonly occurring, musculoskeletal pain-related TMD (painful symptoms affecting an otherwise healthy TMJ complex).

TMD may also be classified into acute and chronic TMD.[18] Acute TMD pain is often of a short duration, self-limiting and frequently associated with an identifiable trigger, such as a stressful life event or mechanical trauma, such as prolonged dental treatment.[18,22] The condition normally resolves following rest, soft diet and analgesics. However, with chronic TMD, the pain normally exceeds three months' duration. This longer period of pain may result in depression, and the development of chronic pain behaviour and its associated disability.[24]

Diagnosis of TMD

The diagnosis of TMD is gleaned following an in-depth history and examination and exclusion of other potential causes for the pain. The history should include questions relating to pain character, development of the pain over time and any precipitating or exacerbating factors.[18] The history should also include an up-to-date medical history and systems review, in order to take note of conditions which may demonstrate TMD pain as a symptom, such as rheumatoid arthritis, osteoarthritis or Ehler's Danlos syndrome.

Clinical examination should include both extra-oral and intra-oral examination. The recently published *Diagnostic Criteria for Temporomandibular Disorders* (*DC/TMD*)[38] includes: assessment of history (presence of masticatory pain or headache) and examination (pain upon palpation of the associated muscles or upon jaw movement). Intra-oral examination should include a dental assessment to exclude any dental pathology, and assessment looking for any signs of parafunctional activity, such as tooth surface loss, tongue scalloping or frictional keratosis.[18] Screening questionnaires may aid the clinician in identifying patients with TMD. Gonzalez *et al*[39] have reported a sensitivity of 99% and a specificity of 97% for the correct identification of TMD, with the use of both short and long versions of a TMD screening questionnaire. The *DC/TMD*[38] also recommends psychosocial assessment, which is sensible given the well documented link between psychosocial risk factors and the experience of pain.[15] The chronic pain grade scale (CPGS)[40] has also been validated for use as a grading tool for pain-related disability in TMD patients. Patients scoring 1 or 2 on the CPGS are considered 'low pain-related disability', and those scoring 3 or 4 are considered 'high pain-related disability'. The hospital anxiety and depression scale (HAD)[41] is a screening tool for anxiety and depression widely used in outpatient settings. However, primary care clinicians may find the HAD too cumbersome, and thus the National Institute for Health and Care Excellence (NICE)[42] depression screening questions

may provide a simpler way of screening for depression in these patients. The questions promulgated by NICE for this purpose are: '*During the last month, have you often felt bothered by feeling down, depressed or hopeless?*' and '*During the last month, have you been bothered by having little interest or pleasure in doing things?*'[42] These questions may be asked verbally or included in a written questionnaire. A positive response to either of these two questions should prompt a referral to a medical practitioner in order that a formal mental state assessment can be performed. TMD patients identified to have chronic pain risk factors such as depression, anxiety or pain-related disability should be considered high risk, and therefore should be referred early for specialist management.

Investigations

Special investigations, such as imaging, may also be considered in the management of TMD. Dental pantomogram radiographs are commonly performed in the investigation of TMD. However, condylar changes, erosion and degenerative changes have been noted, independent of TMD status.[43]

Epstein *et al* advise imaging patients based on clinical findings, rather than performing routine panoramic radiography for all patients with suspected TMD or facial pain.[44] However, dental radiography may be considered at initial consultation, if a dental problem or other pathology is suspected.[18] Magnetic resonance imaging (MRI) may also be used to assess disc position, arthrosis or synovial proliferation. The use of MRI in patients with rheumatoid arthritis and TMD has also been documented, although in some patients anterior disc displacement is the only finding. Therefore, MRI may not be required in all patients with rheumatoid arthritis and TMD symptoms.[45-46] Osseous changes can also be detected using computed tomography (CT) and cone beam CT, although more evidence is required in order to support their routine use in the management of TMD.[47] Overall, current evidence has shown that imaging in most cases is unlikely to lead to changes in the diagnosis or management of TMD.[44-49]

'Red flag' differential diagnoses

The differential diagnoses of TMD include a range of serious conditions which clinicians should bear in mind when assessing a patient with suspected TMD.

Clinicians should be aware of certain 'red flag' signs and symptoms, which may mimic TMD and should prompt urgent referral.[4,18]

Patients over the age of 50, presenting with new onset TMD-type symptoms, headache and visual disturbance, should be referred for screening for giant-cell arteritis (temporal arteritis)[50] – a condition with potentially serious morbidity, including permanent blindness. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) can be conducted for such patients as, when both tests are within normal ranges, the patient can be considered not to have giant-cell arteritis (sensitivity 97%).[51] Furthermore, systemic symptoms, such as progressive weight loss, neurological signs or symptoms and headache should prompt referral to a neurologist.[52] It is also important that the clinician also screens for signs and symptoms suggestive of malignancy and actions prompt referral to a Department of Oral and Maxillofacial Surgery. Such referral would be indicated for patients presenting with TMD and a previous history of head and neck carcinoma, presence of suspicious oral mucosal lesions, such as persistent ulceration, erythroplakia, lymphadenopathy, profound trismus or cranial nerve abnormalities.[18, 53-54] Additionally, persistent, usually painless swellings of the TMJ complex should be considered for neoplasia of the TMJ, such as chondrosarcoma (two cases reported) or osteochondroma (39 cases reported).[55] Similarly, referral to Ear, Nose and Throat should be considered for patients demonstrating repeated nose bleeds, altered smell, difficulty swallowing and loss of hearing.[56]

Management of TMD

Most patients with TMD should be diagnosed and managed successfully in primary care. However, it may be appropriate to instigate early referral for patients with multiple unsuccessful treatments, chronic TMD, chronic pain co-morbidities, occlusal hypervigilance, significant psychosocial factors and disc displacement without reduction (unable to open or close mouth).[18] Additionally, patients with conditions such as rheumatoid arthritis may benefit from referral to secondary care, as they are likely to require multidisciplinary management for their TMD. With regards to the management of patients with chronic TMD, one could consider following the British Pain Society's guidelines on the management of chronic pain in adults.[57] This approach could be simplified into three 'pillars' of pain management:

- Physical therapies;
- Pharmacotherapy; and
- Psychology.

Education and self-management

The management of TMD should be guided by reversible and non-invasive therapy.[18,58-59] The overall aim of TMD management should be to facilitate patients' engagement in the self-management of their condition. This can be achieved by helping patients to develop skills – problem solving, goal setting, accepting change, finding coping strategies, managing relationships through communication, and finding quality of life in difficult circumstances.[60] The first line management in all cases of TMD should be to encourage self-management through patient education.[18] Patients should be educated regarding the proposed causes and associations of TMD, and be given conservative strategies on how to manage acute exacerbations of their symptoms and limit functional disability. These educational discussions with patients should be supplemented with suitable patient information leaflets.[61]

Dworkin *et al*[62] found that patients with minimal levels of psychosocial dysfunction demonstrated decreased pain, reduced pain-related interference on activity, improved muscular pain and reduced number of clinical visits, through the implementation of a tailored self-care programme for TMD. Similarly, Michelotti *et al*[63] found that patients who received education about self-management demonstrated better outcomes compared to those who received treatment with occlusal splint therapy alone. It is important that patients understand that TMD is

a fluctuating, often relapsing and remitting condition, and that they have a central role in the management of their condition.[18, 58-59,62]

Physical exercise

Studies have shown physical exercises, eg aerobic exercise, Tai-Chi and stretching to reduce pain, improve function and wellbeing in other chronic musculoskeletal conditions with similarities to TMD, such as fibromyalgia.[64]

Coupled with this, recent findings suggest that regular and long-term yoga practice improves pain tolerance, by teaching different ways to deal with sensory inputs and the potential emotional reactions attached to those inputs, leading to positive changes in connectivity within the pain centres of the brain.[65] Therefore, it follows that gradual introduction or reintroduction of graded physical exercise into a patient's routine should be the first step in the management of his/her TMD.

Physiotherapy

Physiotherapy for TMD is seen to be a desirable management strategy, owing to its low level of invasiveness, and the opportunity to enable patients to self-manage their condition. The rationale behind physiotherapy is to improve muscular pain and joint function, through the use of jaw stretch, posture training and muscular relaxation.[66-67] These techniques are normally used in conjunction with self-management techniques, such as relaxation and thermal packs.[67] Patients may benefit from physiotherapy for the management of acute exacerbations of TMD, however, long term benefits for chronic TMD have not yet been documented.[68]

Acupuncture

Acupuncture has been widely used for the management of chronic pain. A study by Witt *et al*[69] conducted on patients with chronic headache, low back pain and pain due to osteoarthritis, demonstrated positive benefits with acupuncture over conventional treatment. However, similar benefits were seen with both acupuncture and sham acupuncture, and thus the exact mechanism of action is unclear. Evidence has shown that acupuncture may be of benefit in the management of TMD, though further randomized controlled trials (RCTs) with larger sample sizes are required.[69-71]

Electro-physiotherapy

Electro-physiotherapy modalities, such as pulsed short-wave therapy, ultrasound and low level laser therapy, have been previously described in the management of TMD.[72,73] In one old study,[72] there were no statistically significant differences noted between modalities; however, improvement in comparison to a placebo was suggested.[72] A recent review of the literature relating to low level laser therapies suggested a lack of methodological quality in the clinical trials published in this area.[73] Therefore, larger and more robust studies are required in order to draw more definitive conclusions on these therapies in the management of TMD.

Pharmacotherapy

A recent Cochrane review[74] has cited the need for a greater number of high quality RCTs to provide more robust evidence for pharmacological interventions in TMD.

There is some evidence to support the use of paracetamol coupled with non-steroidal anti-inflammatory drugs (NSAIDs) for the acute management of TMD.[18,75] Short-term use of analgesics may be of benefit, although long-term use is discouraged owing to potential adverse effects. The use of benzodiazepines has also been described, with some benefits being shown with short courses of clonazepam and diazepam.[76-77] The use of diazepam can be indicated in patients with acute exacerbations of pain-related TMD, accompanied with limited opening. However, careful consideration is required when using benzodiazepines for the management of TMD owing to their potential for dependency – courses should be issued for no longer than 7 days and dosages should be kept low.[18]

The use of antidepressant medications in the management of TMD is unlicensed in the United Kingdom and hence is probably best issued by medical practitioners or specialist centres. Tricyclic antidepressants (TCAs), such as amitriptyline and nortriptyline, have been used in the management of chronic pain,[78-79] normally at doses lower than those used to treat depression. TCAs have been seen to be effective in managing patients with chronic TMD who demonstrate co-morbid biopsychosocial factors, however, efficacy has been demonstrated for both depressed and non-depressed individuals.[76] The use of TCAs in the management of TMD probably has emerged from the widespread and successful use of these drugs in other chronic pain and headache conditions.[18]

Psychological supportive interventions

Psychological interventions in TMD, such as cognitive behavioural therapy (CBT), may help to improve quality of life in spite of the persistence of pain symptoms. CBT may act as an extension of self-management, enabling patients to identify factors which may precipitate, or exacerbate their TMD and implement techniques, such as relaxation, to manage their pain.[66,80] CBT has been shown to be of benefit in the management of chronic TMD,[81] and early implementation of CBT in association with other techniques may help to improve long-term management. These patients are likely to require referral to secondary care in order to receive this treatment.

Occlusal splints

Occlusal splints are still commonly used in the treatment of TMD, despite a paucity of evidence supporting the role of parafunction and occlusion in the development of TMD.[30] Occlusal stabilization splints still remain a favoured therapeutic option, even though they seem to have slid downhill from a potentially therapeutic device with mechanistic specificity, to one that is indistinguishable from a placebo.[82] Splints may be constructed of hard or soft material, and are normally worn at night.[63] A Michigan splint, also known as a stabilization splint, is a hard acrylic splint commonly designed for the maxillary arch, and covers all the teeth in the arch. The Michigan splint is adjusted to give centric relation occlusion, by eliminating posterior interferences, providing anterior incisal guidance and canine lateral guidance.[83,84] They may be

indicated for patients who demonstrate, or are at risk of, toothwear or periodontal trauma.[83] Conversely, soft splints are less expensive and require less chairside adjustment and may be considered for those patients who are at low risk of toothwear or periodontal trauma from parafunctional habits.[85]

The exact mechanisms for any benefits derived from occlusal splint therapy are unclear. However, a recent study by Lotze *et al*[86] demonstrated that hard Michigan splints may work centrally, by decreasing sensorimotor stimulation and by increasing the level of activity in the fronto-parietal-occipital and cerebellar networks. Further research into central processing, focusing upon the role of the insular cortex on pain processing, has demonstrated that Michigan splint therapy results in decreased TMD pain, which is associated with decreased insular representation, and increased condylar symmetry during occlusion.[87]

Anterior repositioning splints have also been indicated for the management of TMD disc displacement with reduction, associated with painful clicking/locking. This appliance consists of a full coverage maxillary splint, with occlusal indentations for the opposing posterior teeth. Intercuspation results in the condyles being positioned more anteriorly; it is believed that improved disc-condyle co-ordination results in a decrease in TMJ locking, noise and associated pain.[83] One study found that patients experience the most optimal benefit from anterior repositioning splint through 24-hour wear, however, this carries the risk of developing an open bite.[88]

Conversely, it has also been found that the benefits derived from splint therapy may only be due to the placebo effect; that they may increase occlusal hypervigilance and soft occlusal splints could also increase parafunctional activity.[18,30,63,83-84]

The Nociceptive Trigeminal Inhibition Tension Suppression System (NTI-TSS) is an anterior partial coverage splint, which normally just includes the central incisors on either the maxillary or mandibular arch. The NTI-TSS has shown a reduction in nocturnal electromyogram activity for jaw closing muscles. However, the benefits of NTI-TSS and full coverage occlusal splint appear to be comparable, and there is the risk of unwanted occlusal changes associated with NTI-TSS splints if they are worn too regularly. Therefore, the use of NTI-TSS splints are discouraged.[18,63,89] If splint therapy is employed, clinicians should also ensure that patients receive education about the condition, guidance on self-management, exercise and relaxation.

Occlusal adjustment, orthodontics and prosthodontic reconstruction

Occlusal adjustment is an irreversible treatment, and therefore should be looked upon with extreme caution. The adjustment of acute occlusal interference, such as a high restoration, may be of benefit in the management of acute TMD, however, occlusal adjustment for chronic TMD has not been shown to be beneficial.[33-34] Furthermore, patients with TMD have been found to be more susceptible to minor occlusal interferences,[33] and therefore occlusal adjustment may result in occlusal hypervigilance and preoccupation, whilst overlooking the contributing psychosocial factors in the development of symptoms. Furthermore, there is limited evidence for the role of orthodontics in the management and prevention of TMD.[36-37] Similarly, tooth loss and lack of posterior support seems to have little effect upon the development of TMD, and therefore prosthodontic reconstruction should only be considered once TMD has been addressed through the use of reversible treatments.[90]

Clinical hypnosis

The use of clinical hypnosis in the management of TMD has been suggested, with one study showing greater than 50% reduction in TMD pain intensity following treatment in 52% of the active arm, compared to 5% of controls.[91] The study findings have to be interpreted with caution, however, as the follow-up period was for 7 days only.

Application of injections

The use of botulinum toxin type A has been described for the management of chronic TMD. In this regard, botulinum toxin type A toxin is normally injected into the masseter and temporalis, though injection into the medial and lateral pterygoid muscles has been documented. Schwartz and Freund describe guidelines for dosing based upon muscle size, pain and activity.[92] Injection into the lateral pterygoid often requires electromyography guidance owing to the location and size of the muscles.[92] Botulinum toxin type A injection into the lateral pterygoid has been documented in the management of clicking and locking associated with anterior disc displacement; although positive outcomes have been described, further studies are required to confirm effectiveness and fully elucidate the mechanism of action.[93] However, there is no high quality evidence to support the use of botulinum toxin type A injections for the treatment of pain-related TMD.[94] The only high quality RCT looking at botulinum toxin type A injections in TMD found no difference in pain outcomes compared to a placebo.[95] Therefore, the use of botulinum toxin type A injections for pain-related TMD is not indicated. Local injection of botulin toxin A may be of benefit for patients who suffer from recurrent TMJ dislocation.[96]

There has been no benefit found with the use of local anaesthetic injections in the treatment of TMD.[97]

Surgery

Patients with pain-related TMD are normally managed with conservative, non-surgical measures. However, those that present with disc-displacement or significant degenerative joint pathology, associated with pain and significant functional problems that have not benefited from conservative management, may be considered for surgical intervention. Arthrocentesis, consisting of lavage of the temporomandibular joint space, is the least invasive surgical option,[98] although arthroscopy, which utilizes a fibre-optic camera to explore the joint space and perform simultaneous lavage, has demonstrated some additional benefits.[99] However, it is important to note that these treatments should be approached with caution in those patients with chronic pain-related TMD, who may not derive benefit and may develop more severe symptoms following surgical intervention.

Degeneration of the TMJ associated with rheumatoid arthritis may result in TMJ ankylosis, with limited opening and a reduction in the range of

mandibular movements. Conservative, non-surgical treatment for these patients may not be sufficient to improve the range of mandibular movements. Arthrocentesis and arthroscopy are indicated for mild cases, although patients with more severe TMJ degeneration may require procedures such as arthroplasty and, in end stage degenerative disease, TMJ replacement may be considered.[100-101] For such patients who may require TMJ replacement, NICE have provided guidance for case selection and treatment.[102]

Conclusions

Pain-related TMD is a common orofacial pain condition with complex pathophysiology and significant associations with a variety of other chronic pain conditions. Chronic TMD is associated with a considerable negative impact upon psychosocial function and wellbeing; in addition to a high economic burden placed on healthcare providers. Therefore, it is imperative that clinicians are able to recognize TMD, and instigate timely and appropriate management in keeping with current evidence-based practice. Identifying the presence of risk factors for the development of chronic TMD, such as anxiety, depression, pain-related disability and chronic pain conditions elsewhere in the body, will enable clinicians to identify which TMD patients require onward referral for multidisciplinary care. Clinicians should seek to adopt a holistic approach to the management of TMD. In addition to patient education and encouragement towards self-management, TMD care pathways should also consider the three 'pillars' of pain management: physical therapies, pharmacotherapy and clinical psychology.

References

1. Dworkin SF. The OPPERA study: Act One. *J Pain* 2011; **12**(11 Suppl): T1–T3.
2. Durham J, Exley C, Wassell R, Steele JG. 'Management is a black art' – professional ideologies with respect to temporomandibular disorders. *Br Dent J* 2007; **202**(11): E29.
3. Drangsholt M, LeResche L. Temporomandibular disorder pain. In: *Epidemiology of Pain I*. Crombie IK, Croft PR, Linton SJ, LeResche L, Von Korff M, eds. Seattle: IASP Press, 1999: 203–233.
4. Durham J, Newton-John TR, Zakrzewska JM. Temporomandibular Disorders. *BMJ* 2015; 350: h1154. doi: 10.1136/bmj.h1154 (Published 12 March 2015).
5. Hunt K, Adamson J, Hewitt C, Nazareth I. Do women consult more than men? A review of gender and consultation for back pain and headache. *J Hlth Servs Res Policy* 2011; **16**(2): 108–117.
6. De Kanter RJ, Käyser AF, Battistuzzi PG, Truin GJ, Van't Hof MA. Demand and need for treatment of craniomandibular dysfunction in the Dutch adult population. *J Dent Res* 1992; **71**: 1607–1612.
7. Maixner W, Diatchenko L, Dubner R, Fillingim RB, Greenspan JD, Knott C *et al*. Orofacial pain prospective evaluation and risk assessment study – the OPPERA study. *J Pain* 2011; **12**(11 Suppl): T4–T11.e2.
8. 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**(3): 339–347.
9. Stowell AW, Gatchel RJ, Wildenstein L. Cost-effectiveness of treatments for temporomandibular disorders: biopsychosocial intervention versus treatment as usual. *J Am Dent Assoc* 2007; **138**(2): 202–208.
10. Fricton JR, Schiffman EL. Epidemiology of temporomandibular disorders. In: *Advances in Pain Research and Therapy; Orofacial Pain and Temporomandibular Disorders.* Fricton JR, Dubner R, eds. New York: Raven Press, 1995: pp1–14.
11. Phillips C. The cost and burden of chronic pain. *Br J Pain* 2009; **3**(1): 2–5.
12. *Guidelines for all Healthcare Professionals in the Diagnosis and Management of Migraine, Tension-Type Headache, Cluster Headache, Medication Overuse Headache* 3rd edn (1st revision) 2010. British Association for the Study of Headache. **http://www.bash.org.uk/wp-content/uploads/2012/07/10102-BASH-Guidelines-update-2_v5-1-indd.pdf** (accessed 11 May 2015).
13. Steiner TJ, Scher AI, Stewart WF, Kolodner K, Liberman J, Lipton RB. The prevalence and disability burden of adult migraine in England and their relationships to age, gender and ethnicity. *Cephalalgia* 2003; **23**: 519–527.
14. Litt MD, Porto FB. Determinants of pain treatment response and nonresponse: identification of TMD patient subgroups. *J Pain* 2013; **14**(11): 1502–1513. doi: 10.1016/j.jpain.2013.07.017. Epub 2013 Oct 2.
15. Suvinen TI, Reade PC, Kemppainen P, Könönen 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**(6): 613–633.
16. Dworkin SF, LeResche L, eds. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord Facial Oral Pain* 1992; 4. Vol 6: 301–355.
17. McNeill C. Management of temporomandibular disorders: concepts and controversies. *J Prosthet Dent* 1997; **77**(5): 510–522.
18. Durham J, Aggarwal V, 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). Royal College of Surgeons of England. **http://www.rcseng.ac.uk/fds/publications-clinical-guidelines/clinical_guidelines/documents/temporomandibular-disorders-guideline-2013** (accessed 11 May 2015).
19. Anderson GC, Gonzalez YM, Ohrbach R, Truelove EL, Sommers E, Look JO *et al*. Research diagnostic criteria for temporomandibular disorders: future directions. *J Orofac Pain* 2010; **24**(1): 79–88.
20. 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**(1): 135–143.
21. Mutlu N, Erdal ME, Herken H, Oz G, Bayazit YA. T102C polymorphism of the 5-HT2A receptor gene may be associated with temporomandibular dysfunction. *Oral Dis* 2004; **10**(6): 349–352.
22. Smith SB, Maixner DW, Greenspan JD, Dubner R, Fillingim RB, Ohrbach R *et al*. Potential genetic risk factors for chronic TMD: genetic associations from the OPPERA case control study. *J Pain* 2011; **12**(11 Suppl): T92–T101.

23. Slade GD, Diatchenko L, Bhalang K, Sigurdsson A, Fillingim RB, Belfer I *et al*. Influence of psychological factors on risk of temporomandibular disorders. *J Dent Res* 2007; **86**: 1120–1125.
24. Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Dubner R, Bair E *et al.* Potential psychosocial risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. *J Pain* 2011; **12**(11) Suppl: T46–T60.
25. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. *Pain* 2011; **152**(3 Suppl): S2–S15.
26. Buenaver LF, Quartana PJ, Grace EG, Sarlani E, Simango M, Edwards RR *et al.* Evidence for indirect effects of pain catastrophizing on clinical pain among myofascial temporomandibular disorder participants: the mediating role of sleep disturbance. *Pain* 2012; **153**: 1159–1166.
27. 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**(11): 1155–1164.
28. Chen H, Slade G, Lim PF, Miller V, Maixner W, Diatchenko L. Relationship between temporomandibular disorders, widespread palpation tenderness, and multiple pain conditions: a case-control study. *J Pain* 2012; **13**(10): 1016–1027.
29. Huang GJ, LeResche L, Critchlow CW, Martin MD, Drangsholt MT. Risk factors for diagnostic subgroups of painful temporomandibular disorders (TMD). *J Dent Res* 2002; **81**(4): 284–288.
30. Benoliel R, Svensson P, Heir GM, Sirois D, Zakrzewska J, Oke-Nwosu J *et al*. Persistent orofacial muscle pain. *Oral Dis* 2011; **17**(Suppl 1): 23–41.
31. Pullinger AG, Seligman DA. Trauma history in diagnostic groups of temporomandibular disorder. *Oral Surg Oral Med Oral Pathol* 1991; **71**: 529–534.
32. Yun PY, Kim YK. The role of facial trauma as a possible etiologic factor in temporomandibular joint disorder. *J Oral Maxillofac Surg* 2005; **63**(11): 1576–1583.
33. Le Bell Y, Niemi PM, Jämsä T, Kylmälä M, Alanen P. Subjective reactions to intervention with artificial interferences in subjects with and without a history of temporomandibular disorders. *Acta Odontol Scand* 2006; **64**(1): 59–63.
34. Gesch D, Bernhardt O, Kirbschus A. Association of malocclusion and functional occlusion with temporomandibular disorders (TMD) in adults: a systematic review of population-based studies. *Quintessence Int* 2004; **35**(3): 211–221.
35. Sessle B. Oral parafunction, pain and the dental occlusion. *J Orofac Pain* 2012; **26**(3): 161–162.
36. Luther F, Layton S, McDonald F. Orthodontics for treating temporomandibular joint (TMJ) disorders. *Cochrane Database Syst Rev* 2010 Jul 7; (7): CD006541.
37. McNamara JA Jr, Türp JC. Orthodontic treatment and temporomandibular disorders: is there a relationship? Part 1: Clinical studies. *J Orofac Orthop*1997; **58**(2): 74–89.
38. 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, International Association for Dental Research, International Association for the Study of Pain). *J Oral Facial Pain Headache* 2014; **28**(1): 6–27. doi: 10.11607/jop.1151.
39. 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. *J Am Dent Assoc* 2011; **142**(10): 1183–1191.
40. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain* 1992; **50**: 133–149.
41. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand* 1983; **67**(6): 361–370.
42. Depression: the treatment and management of depression in adults (update). NICE clinical guideline 90; October 2009. National Institute for Health and Clinical Excellence. **http://www.nice.org.uk/CG90** (accessed 11 May 2015)
43. Crow HC, Parks E, Campbell JH, Stucki DS, Daggy J. The utility of panoramic radiography in temporomandibular joint assessment. *Dentomaxillofac Radiol* 2005; **34**(2): 91–95.
44. Epstein JB, 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**(2): 236–239.
45. Narváez JA, Narváez J, Roca Y, Aguilera C. MR imaging assessment of clinical problems in rheumatoid arthritis. *Eur Radiol* 2002; **12**(7): 1819–1828.
46. Smith HJ, Larheim TA, Aspestrand F. Rheumatic and non rheumatic disease in the temporomandibular joint: gadolinium-enhanced MR imaging. *Radiology* 1992; **185**(1): 229–234.
47. Ribeiro-Rotta RF, Marques KD, Pacheco MJ, Leles CR. Do computed tomography and magnetic resonance imaging add to temporomandibular joint disorder treatment? A systematic review of diagnostic efficacy. *J Oral Rehabil* 2011; **38**(2): 120–135.
48. Limchaichana N, Petersson A, Rohlin M. The efficacy of magnetic resonance imaging in the diagnosis of degenerative and inflammatory temporomandibular joint disorders: a systematic literature review. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006; **102**(4): 521–536.
49. Petersson A. What you can and cannot see in TMJ imaging – an overview related to the RDC/TMD diagnostic system. *J Oral Rehab* 2010; **37**(10): 771–778.
50. Dasgupta B, Borg FA, Hassan N, Alexander L, Barraclough K, Bourke B *et al*. BSR and BHPR guidelines for the management of giant cell arteritis. *Rheumatology* (Oxford) 2010; **49**(8): 1594–1597.
51. Kermani TA, Schmidt J, Crowson CS, Ytterberg SR, Hunder GG, Matteson EL *et al*. Utility of erythrocyte sedimentation rate and C-reactive protein for the diagnosis of giant cell arteritis. *Semin Arthritis Rheum* 2012; **41**(6): 866–871. doi: 10.1016/j.semarthrit.2011.10.005. Epub 2011 Nov 25.
52. Dodick D. Diagnosing headache clinical clues and clinical rules. *Adv Stud Med* 2003; **3**(2): 87–92.
53. 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**(7): 351–355.

54. Klasser GD, Epstein JB, Utsman R, Yao M, Nguyen PH. Parotid gland squamous cell carcinoma invading the temporomandibular joint. *J Am Dent Assoc* 2009; **140**(8): 992–999.
55. Coleman H, Chandraratnam E, Morgan G, Gomes L, Bonar F. Synovial chondrosarcoma arising in synovial chondromatosis of the temporomandibular joint. *Head Neck Pathol* 2013; **7**(3): 304–309. doi: 10.1007/s12105-013-0439-y. Epub 2013 Apr 11.
56. Epstein JB, Jones CK. Presenting signs and symptoms of nasopharyngeal carcinoma. *Oral Surg Oral Med Oral Pathol* 1993; **75**(1): 32–36.
57. *Guidelines for Pain Management Programmes for Adults*. London: The British Pain Society, 2013.
58. Greene CS. Managing patients with temporomandibular disorders: a new 'standard of care'. *Am J Orthod Dentofacial Orthop* 2010; **138**(1): 3–4.
59. Durham J, Wassell RW. Recent advancements in temporomandibular disorders (TMDs). Reviews in pain. *Br Pain Soc* 2011; **5**(1): 18–25.
60. De longh A. Patients need support to self manage their long term conditions. *BMJ* 2014; **348**: g2973 doi:10.1136/bmj.g2973.
61. Eastman Dental Hospital (University College London Hospitals NHS Foundation Trust): Facial Pain Service. **http://www.uclh.nhs.uk/OurServices/ServiceA-Z/EDH/MAXMED/FPAIN/Pages/Home.aspx** (accessed 11 May 2014)
62. Dworkin SF, Huggins KH, Wilson L, Mancl L, Turner J, Massoth D *et al*. A randomized clinical trial using research diagnostic criteria for temporomandibular disorders – axis II to target clinic cases for a tailored self-care TMD treatment program. *J Orofac Pain* 2002; **16**(1): 48–63.
63. Michelotti A, Iodice G, Vollaro S, Steeks MH, Farella M. Evaluation of the short-term effectiveness of education versus an occlusal splint for the treatment of myofascial pain of the jaw muscles. *J Am Dent Assoc* 2012; **143**(1): 47–53.
64. Oral A, Ilieva EM, Küçükdeveci AA, Varela E, Valero R, Berteanu M *et al*. Generalised and regional soft tissue pain syndromes. The role of physical and rehabilitation medicine physicians. The European perspective based on the best evidence. A paper by the UEMS-PRM Section Professional Practice Committee. *Eur J Phys Rehabil Med* 2013; **49**(4): 535–549.
65. Villemure C, Ceko M, Cotton VA, Bushnell MC. Insular cortex mediates increased pain tolerance in yoga practitioners. *Cereb Cortex* 2014; **24**(10): 2732–2740. doi: 10.1093/cercor/bht124. Epub 2013 May 21.
66. Carlson CR, Bertrand PM, Ehrlich AD, Maxwell AW, Burton RG. Physical self-regulation training for the management of temporomandibular disorders. *J Orofac Pain* 2001; **15**(1): 47–55.
67. Wright EF, Domenech MA, Fischer JR Jr. Usefulness of posture training for patients with temporomandibular disorders. *J Am Dent Assoc* 2000; **131**(2): 202–210.
68. Feine JS, Lund JP. An assessment of the efficacy of physical therapy and physical modalities for the control of chronic musculoskeletal pain. *Pain* **17**(1): 5–23.
69. Witt CM, Brinkhaus B, Willich SN. Acupuncture. Clinical studies on efficacy and effectiveness in patients with chronic pain. *Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz* 2006; **49**: 736–742.
70. Cho SH, Whang WW. Acupuncture for temporomandibular disorders: a systematic review. *J Orofac Pain* 2010; **24**: 152–162.
71. Jung A, Shin BC, Lee MS, Sim H, Ernst E. Acupuncture for treating temporomandibular joint disorders: a systematic review and meta-analysis of randomized, sham-controlled trials. *J Dent* 2011; **39**(5): 341–350.
72. Gray RJ, Quayle AA, Hall CA, Schofield MA. Physiotherapy in the treatment of temporomandibular joint disorders: a comparative study of four treatment methods. *Br Dent J* 1994; **176**: 257–261.
73. Herpich CM, Amaral AP, Leal-Junior ECP *et al*. Analysis of laser therapy and assessment methods in the rehabilitation of temporomandibular disorder: a systematic review of the literature. *J Phys Therap Sci* 2015; **27**(1): 295–301.
74. Mujakperuo HR, Watson M, Morrison R, Macfarlane TG. Pharmacological interventions for pain in patients with temporomandibular disorders. *Cochrane Database Syst Rev* 2010 Oct 6; (10): CD004715.
75. Ta LE, Dionne RA. Treatment of painful temporomandibular joints with a cyclooxygenase-2 inhibitor: a randomized placebo-controlled comparison of celecoxib to naproxen. *Pain* 2004; **111**(1–2): 13–21.
76. Hersh EV, Balasubramaniam R, Pinto A. Pharmacologic management of temporomandibular disorders. *Oral Maxillofac Surg Clin N Am* 2008; **20**: 197–210.
77. Harkins S, Linford J, Cohen J, Kramer T, Cuever L. Administration of clonazepam in the treatment of TMD and associated myofascial pain: a double-blind pilot study. *Craniomandib Disord* 1991; **5**(3): 179–186.
78. Chan HN, Fam J, Ng BY. Use of antidepressants in the treatment of chronic pain. *Ann Acad Med Singapore* 2009; **38**(11): 974–979.
79. Pettengill CA, Reisner-Keller L. The use of tricyclic antidepressants for the control of chronic orofacial pain. *Cranio* 1997; **15**(1): 53–56.
80. Dworkin SF, Turner JA, Wilson L, Massoth D, Whitney C, Huggin KH *et al*. Brief group cognitive-behavioral intervention for temporomandibular disorders. *Pain* 1994; **59**(2): 175–187.
81. Aggarwal VR, 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**(2): 163–171.
82. Stohler C. Temporomandibular joint disorders – the view widens while therapies are constrained. *J Orofac Pain* 2007; **21**(4): 261.
83. Fricton J, Look JO, Wright E, Alencar FG Jr, Chen H, Lang M *et al.* Systematic review and meta-analysis of randomized controlled trials evaluating intraoral orthopedic appliances for temporomandibular disorders. *J Orofac Pain* 2010; **24**(3): 237–254.
84. Al-Ani MZ, Davies SJ, Gray RJ, Sloan P, Glenny AM. Stabilisation splint therapy for temporomandibular pain dysfunction syndrome. *Cochrane Database Syst Rev* 2004; (1): CD002778.
85. Klasser G, Greene C. Oral appliances in the management of temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009; **107**(2): 212–223.
86. Lotze M, Lucas C, Domin M, Kordass B. The cerebral representation of temporomandibular joint occlusion and its alternation by occlusal splints. *Hum Brain Mapp* 2012; **33**(12): 2984–2993.
87. Lickteig R, Lotze M, Kordass B. Successful therapy for temporomandibular pain alters anterior insula and cerebellar representations of occlusion. *Cephalalgia* 2013; **33**(15): 1248–1257.
88. Davies SJ, Gray RJ. 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**(6): 199–203.
89. Stapelmann H, Türp JC. The NTI-tss device for the therapy of bruxism, temporomandibular disorders, and headache – where do we stand? A qualitative systematic review of the literature. *BMC Oral Health* 2008; **8**: 22.
90. De Boever JA, Carlsson GE, Klineberg IJ. Need for occlusal therapy and prosthodontic treatment in the management of temporomandibular disorders. Part II: Tooth loss and prosthodontic treatment. *J Oral Rehabil* 2000; **27**(8): 647–659.
91. Abrahamsen R, Baad-Hansen L, Zachariae R, Svensson P. Effect of hypnosis on pain and blink reflexes in patients with painful temporomandibular disorders. *Clin J Pain* 2011; **27**(4): 344–351.
92. Schwartz M, Freund B. Treatment of temporomandibular disorders with botulinum toxin. *Clin J Pain* 2002 Nov-Dec; **18**(6 Suppl): S198–S203.
93. Bakke M, Møller E, Werdelin LM, Dalager T, Kitai N, Kreiborg S. Treatment of severe temporomandibular joint clicking with botulinum toxin in the lateral pterygoid muscle in two cases of anterior disc displacement. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005; **100**(6): 693–700.
94. Ihde SK, Konstantinovic VS. The therapeutic use of botulinum toxin in cervical and maxillofacial conditions: an evidence-based review. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2007; **104**(2): e1–e11.
95. 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**(9): 1988–1996.
96. Majid OW. Clinical use of botulinum toxins in oral and maxillofacial surgery. *Int J Oral Maxillofac Surg* 2010; **39**(3): 197–207.
97. McMillan AS, Nolan A, Kelly PJ. The efficacy of dry needling and procaine in the treatment of myofascial pain in the jaw muscles. *J Orofac Pain* 1997; **11**(4): 307–314.
98. Vos LM, Huddleston Slater JJ, Stegenga B. Lavage therapy versus nonsurgical therapy for the treatment of arthralgia of the temporomandibular joint: a systematic review of randomized controlled trials. *J Orofac Pain* 2013; **27**(2): 171–179.
99. Rigon M, Pereira LM, Bortoluzzi MC, Loguercio AD, Ramos AL, Cardoso JR. Arthroscopy for temporomandibular disorders. *Cochrane Database Syst Rev* 2011 May 11; (5): CD006385.
100. Saeed NR, McLeod NM, Hensher R. Temporomandibular joint replacement in rheumatoid-induced disease. *Br J Oral Maxillofac Surg* 2001; **39**(1): 71–75.
101. Speculand B. Current status of replacement of the temporomandibular joint in the United Kingdom. *Br J Oral Maxillofac Surg* 2009; **47**(1): 37–41.
102. Total prosthetic replacement of the temporomandibular joint. NICE interventional procedures guidance [IPG500]; August 2014. National Institute for Health and Clinical Excellence **https://www.nice.org.uk/guidance/ipg500** (accessed 11 May 2015).