

Review Article

Diagnosis and treatment of temporomandibular disorders: an ethical analysis of current practices

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SUMMARY The defining characteristic of a profession – and especially a health-care profession – is that the behaviour of its members is proscribed by a formal code of ethics. The main purpose of such codes is to guide practitioners' interactions with patients, assuring that patient interests are protected. In other words, the ethical code requires practitioners to place their patients' needs for proper diagnosis and appropriate treatment ahead of their own needs for income and advancement. The dental profession has a code of ethics that was developed by the American Dental Association many years ago; in most clinical situations, determination of proper behaviour is self-evident. However, the field of temporomandibular disorders (TMDs) has been the subject of considerable controversy for over half a century, and many people have argued that this makes it impossible to evaluate various approaches to treatment of TMDs within an ethical framework. In this article, the authors argue that the large volume of scientific evidence in the contemporary TMD literature provides an ethical framework for the diagnosis and treatment of patients with TMDs within a biopsychosocial medical model. They present a summary of the research with

contemporary scientific integrity, which has produced that information over a period of many years. Based on that research, they conclude that dentists may provide conservative and reversible treatments that will be successful for most TMDs and in doing so will comply with the profession's code of ethics. Conversely, the authors claim that those dentists who continue to follow the older mechanistic models of TMD aetiology and treatment are not only out of step scientifically, but are placing their patients' welfare at risk by providing unnecessary irreversible bite-changing and jaw-repositioning interventions. Therefore, debate of these issues should not be solely focused on scientific merit, but also upon the compelling ethical obligations that dentists have as a result of the contemporary scientific literature regarding TMDs.

KEYWORDS: temporomandibular disorders, dental ethics, respect for patient autonomy, non-maleficence, conservative treatment, evidence-based practice

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Introduction

Dentists around the world are aware that temporomandibular disorders (TMDs) are the subject of considerable controversy, and the voluminous literature on that topic reflects this reality. Especially in recent years, diametrically opposed concepts of aetiology and resul-

tant treatment recommendations have been the rule, not the exception. Some researchers and clinicians have stressed the importance of utilising an evidenced-based and scientifically derived approach to TMD diagnosis and treatment. However, others have criticised this approach as being 'ivory tower' thinking, and they argue for more subjective, experience-based paradigms

of treatment. As a result, the clinical management of TMDs varies according to the educational background and/or theoretical disposition of treating dentists. With no formally endorsed specialty group to manage these disorders, and without a sanctioned standard of care supported by the American Dental Association, the current scope of TMD diagnosis and treatment in the United States is unregulated, widely diverse and characterised by unconstrained professional autonomy. In other words, any dentist may employ nearly any diagnostic modality or treatment with impunity, regardless of its degree of scientific credibility. Unsuspecting TMD patients may be exposed to simple, conservative and relatively inexpensive treatments or to invasive, irreversible and costly treatments by another – both for the same set of symptoms. These controversies are universal and readily apparent in the international literature. Here, we underscore the ethical issues primarily as they relate to the United States, reflecting our perspective that a business ethic, as opposed to a health-care ethic, has come to dominate the field of TMDs in the United States. The salient USA-centric perspective of this article is key to emphasising our concerns about the widespread abdication of scientific and ethical principles in deference to profit motives. It is from this vantage point that we underscore the ubiquitous scientific and ethical shortcomings in the field of TMD diagnosis and management in the United States. However, we emphasise that abdication of scientific principles for any reason, in any country, not just for profit motives, warrants ethical review and analysis, and thus, our thesis has international applicability.

Given this state of affairs, Stohler and Zarb (1) have strongly recommended a conservative approach to the treatment of temporomandibular disorders in their article entitled, '*On the Management of Temporomandibular Disorders: A Plea for a Low-Tech, High-Prudence Approach*'. These authors argue that this is the ethical choice when the aetiology of the condition is uncertain, and risks of aggressive treatment are considerable. Greene and Laskin (2) have described the evolution of the TMD field from a dental mechanical model to a more complex medical model, and they concluded that this change requires initial use of a conservative medical approach to management of those disorders. In addition, a large number of articles about long-term outcomes of conservative TMD treatment approaches have reported that patients respond at least as well to

these as to various irreversible therapies (3, 4). As those conservative treatment approaches are, by definition, reversible and non-invasive, this implies that the ethical choices for clinicians treating TMDs should be discussed in terms of those findings. Furthermore, it suggests that dentists have a moral obligation to justify the use of invasive treatments by demonstrating that they are better for TMD patients than non-invasive treatments.

Conspicuously absent from the voluminous TMD literature is attention to the potential ethical morass created when professional autonomy is so notably unregulated as it is in the case of TMDs. Our aim in this article is to show that TMD research generated by contemporary scientific standards supports the position that in most cases, the only ethically justifiable approach to primary management of TMD pain is to employ conservative and non-invasive treatments. We argue that dentists have a professional and moral responsibility to treat TMDs without *routinely* resorting to irreversible modalities such as occlusal equilibration, orthodontic treatment, bite opening, mandibular repositioning with subsequent prosthodontic treatment and surgical intervention, because those treatment approaches are based on the scientifically indefensible position that static and/or dynamic occlusal and skeletal relationships are primary aetiological factors in TMDs. The scientific evidence supporting our central argument is presented in a series of four Tables; two of them deal with diagnostic issues (Tables 1 and 3), while the other two deal with treatment issues (Tables 2 and 4). Critical examination of our bibliography will reveal that we cite some reviews and opinion articles. We include these articles (reviews and opinions) solely to buttress the scientifically generated manuscripts we cite and that constitute the crux of our message: objective evidence compels reversible, simple diagnostic and treatment methods and that to practise otherwise may be reasonably construed as an abdication of professional ethical obligations. The credibility of our thesis lay firmly in the foundation created by studies based on contemporary scientific methodology; thus, we employ the terms 'contemporary scientific integrity' and 'contemporary scientific standards' neither of which include review articles nor opinions, even if authored by the most reputable of 'experts'.

Our perspective in this article is derived primarily from the ethical obligations health-care professionals

have to respect patient autonomy (5). That is, dentists have a well-established fiduciary obligation to facilitate a patient's ability to make an informed decision about what is best for him or her. Given their inherent lack of knowledge about TMDs, patients are vulnerable to the proposals offered to them by medical

and dental professionals. Further, they are likely to be unaware that there is evidence, which reveals that invasive, irreversible occlusal intervention is highly controversial (see Tables 1–4). Similarly, they probably would be unaware of the fact that simple, non-invasive methods of treatment have been demon-

Table 1. Summary of findings from systematic reviews on TMD diagnosis (PubMed search, 9 November 2009)

Author and year	Diagnostic modality reviewed	No. of studies reviewed	Type of review	Main conclusions
Manfredini, 2009 (51)	Ultrasonography	20	Systematic	US accuracy: 54–100% for disc displacement, 72–95% for joint effusion, 56–93% for osteoarthritis US is operator dependent Parameters for normality should be set
Perinetti, 2009 (52)	Posturography	21	Qualitative systematic	Little usefulness of posturography (large variability of recordings) The different posturographic methods showed low diagnostic accuracy
Koh, 2009 (53)	Magnetic resonance (degenerative and inflammatory disorders)	23	Qualitative systematic	OR: pain-ID 1.54–2.04; pain-DDwoR 4.82; crepitus-DDwoR 3.71 No clear evidence for a relationship between clinical and MR findings
Hussain, 2008 (54)	Imaging techniques (erosions and osteophytes)	9	Systematic	Axially corrected sagittal tomography is the imaging modality of choice for TMJ erosions and osteophytes CT seems to add nothing to axially corrected sagittal tomography
Suvinen, 2007 (35)	EMG	142	Systematic	Many shortcomings of EMG literature Biological variation, capacity for adaptation and fluctuations in TMD symptoms are limits to the clinical application of EMG The clinical use of EMG as a diagnostic method for TMD is not recommended
Limchachaina, 2006 (55)	Magnetic resonance (degenerative and inflammatory disorders)	22	Qualitative systematic	Insufficient evidence for diagnostic efficacy expressed as sensitivity, specificity and predictive values
Turp, 2005 (56)	Clinical (palpation of digastric muscle)	2	Systematic	The posterior belly of the digastric muscle is not palpable (anatomical reasons) Risk for false positives with clinical palpation and consequently unnecessary diagnostic and therapeutic measures
Turp, 2001 (57)	Clinical (palpation of lateral pterygoid area)	5	Systematic	Unacceptable degree of intra- and interexaminer variability with regard to the palpation of the lateral pterygoid area
Baba, 2001 (58)	Electronic devices	62	Systematic	None of the proposed electronic devices (EMG and jaw motion recordings, joint vibration analysis, jaw muscle tenderness) has stand alone diagnostic value for TMD Unacceptable sensitivity and specificity values

US, ultrasonography; AADR, anterior disc displacement with reduction; MO, mouth opening; OR, odds ratio; ID, internal derangements; DDwoR, disc displacement without reduction.

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Table 2. Summary of findings from systematic reviews on TMD treatment (PubMed search, 9 November 2009)

Author and year	Treatment modality reviewed	No. of studies reviewed	Type of review	Main conclusions
Al-Riyami, 2009 (59)	Orthognathic treatment	53	Meta-analysis (when possible)	Orthognathic surgery in patients with dentofacial deformities and concurrent TMD associated with higher probability of symptoms improvement than deterioration
Guo, 2009 (60)	Arthrocentesis	2 (RCT)	Qualitative systematic	Insufficient evidence to support or refute the use of arthrocentesis and joint lavage for TMJ disorders treatment
Stapelmann, 2008 (61)	NTI-tss device	9	Qualitative systematic	NTI-tss device may be successfully used for the management of bruxism and TMDs Caution to avoid potential unwanted effects
Guarda-Nardini, 2008 (62)	TMJ total prosthesis	30	Systematic	Encouraging outcomes for all the three total prosthetic systems currently available on market Too few research groups involved
Abrahamsson, 2007 (63)	Orthognathic surgery	3	Systematic	Low methodological quality of included studies No conclusions on how and if orthognathic surgery affects TMD
Al-Belasy, 2007 (64)	Arthrocentesis (Closed lock)	19	Systematic	Flawed methodology of most studies Impression of positive findings, but no good prospective randomised clinical trials confirming the efficacy
Turp, 2007 (3)	Simple vs. multimodal therapies	11	Qualitative systematic	Multimodal therapies superior to either single therapy in patients with major psychological disorders In patients with painful DD, multimodal therapy not superior to explanation and advice
Turp, 2007 (65)	Any particular intervention's effect on quality of life	7	Qualitative systematic	All therapeutic interventions reported in the identified publications led to some improvement in patients' quality of life (only exception: patients with multiple TMJ surgeries)
Medlicott, 2006 (66)	Exercise, manual therapy, electrotherapy, relaxation training and biofeedback	30	Systematic	Active exercise and manual mobilisation may be effective. Multitreatment programmes involving relaxation techniques, biofeedback and proprioceptive re-education may be more effective than placebo or occlusal splints alone Poor quality of examined literature
McNeely, 2006 (67)	Physical therapy	12	Systematic	Most studies with very poor methodological quality Some positive indications on manual therapy and active exercises
Al-Ani, 2005 (68)	Stabilisation splints (myofascial pain)	12	Qualitative systematic	Insufficient evidence either for or against the use of stabilisation split therapy for myofascial pain

(continued)

Table 2. (continued)

Author and year	Treatment modality reviewed	No. of studies reviewed	Type of review	Main conclusions
Koh, 2004 (69)	Occlusal adjustment	17	Qualitative systematic	No evidence that occlusal adjustment treats or prevents TMD. Occlusal adjustment cannot be recommended for the management or prevention of TMD
Turp, 2004 (46)	Stabilisation splints (myofascial pain)	13	Qualitative systematic	Best available evidence: patients with myofascial pain benefit from the incorporation of a stabilisation splint Low quality of studies
Forssell, 2004 (70)	Occlusal adjustment and occlusal splints	16	Qualitative systematic	Equivocal results from studies on occlusal splints (not superior to pain treatment methods in general) None of the occlusal adjustment studies provided evidence supporting the use of this treatment method
List, 2003 (71)	Pharmacologic interventions	7	Qualitative systematic	Common use of analgesic in TMD patients not supported by scientific evidence
Forssell, 1999 (72)	Occlusal treatments (splints and adjustments)	18	Qualitative systematic	Occlusal splints may be of some benefit for TMD treatment Lack of evidence for the use of occlusal adjustment

RCT, randomised controlled trial; NTI-tss, nociceptive trigeminal inhibition splint; DD, disc displacement.
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Table 3. Controlled studies and review articles about diagnostic approaches to TMDs

Author and year	Diagnostic method	Type of article	Outcomes
Manfredini, 2008 (73)	Compare MRI vs. RDC/TMD to diagnose TMJ disc derangements	Clinical study	Good agreement – danger of over-DX with MRI
Lobbezoo-Scholte, 1994 (74)	Use of orthopaedic tests to separate TMD subgroups	Clinical study	Good reliability – adds a lot to regular examination
Clark, 2009 (75)	Predictors of TX outcome	Clinical study	Poor baseline jaw function is negative predictor
Schmitter, 2008 (76)	Examination variables that enhance TM joint-specific DX	Clinical study -RDC/TMD plus other tests	Found 16 variables that are helpful
Laskin, 1992 (77) Greene, 2006 (78)	Technological devices (EMG, jaw tracking, sonography)	Review Book chapter	Devices are mainly for clinical studies, not DX
Lund, 1995 (79)	Technological devices (EMG, jaw tracking, sonography)	Review	Devices lack sensitivity and specificity for DX
Gonzalez, 2008 (36)	Technological devices (EMG, jaw tracking, sonography)	Review – emphasis on sonography	Devices lack sensitivity and specificity for DX
Klasser, 2006 (34)	Electromyography	Review	Wide variation of normal baselines, poor correlation with muscle pain
Larheim, 2006 (80)	Imaging of the TMJ	Book chapter	Review of all methods – discusses when, where, and how to utilise imaging techniques for DX
Manfredini, 2012 (81)	Jaw kinesiography compared with MRI findings	Clinical study	Poor correlation regarding joint effusion or disc displacement

MRI, magnetic resonance imaging; RDC/TMD, research diagnostic criteria for TMD; EMG, electromyography; DX, diagnosis; TX, treatment.

Table 4. Articles that report outcomes of either clinical experiments or literature analysis of conservative treatment procedures for TMDs

Author, year and topics	Treatment method	Type of article	Outcomes
Studies of non-TX of DDR or DDNR: De Leeuw 1993 (39) Kurita 1998 (82) Sato 1999 (83) Minakuchi 2001 (84) Sato 2003 (85)	Three no TX provided One minimal TX One 30-year observation	Clinical studies	Improvement of symptoms, minimal # of negative progressions
Oral appliance studies: Greene & Laskin 1972 (86) Rubinoff 1987 (87) Dao 1994 (88) Ekberg 1998 (89), 2003 (90), 2004 (91) Jokstad 2005 (92) Wassell 2006 (93) Conti 2006 (94) Truelove 2006 (95)	Real oral appliances vs. placebo versions	Clinical studies	Usually a tie between active vs. placebo, but Ekberg group finds that OA > placebo
Biopsychosocial TX: Olson & Malow 1987 (96) Gatchel 2006 (97) Stovell 2007 (98)	Early intervention in acute phase vs. None	Clinical studies	(1) Reduces cost and reduces chronicity (2) Less psych outcomes, better symptom relief
Physical medicine: Michelotti 2005 (99) Feine & Lund 1997 (100) McNeely 2006 (66) Medlicott 2006 (67)	Exercise – home care programmes	Reviews	Evidence for good effectiveness
Oral appliances: Dao & Lavigne 1998 (101) Turp <i>et al.</i> 2004 (46) Al-Ani 2005 (68) Klasser & Greene 2009 (102)	Oral appliance therapy	Review and literature analysis	OA's are either = or > than placebo versions
Long-term follow-up studies: Greene & Laskin 1974 (103), 1983 (104) Cohen 1978 (105) Mjersjo & Carlsson 1983 (106), 1984 (107) Okeson 1986 (108), 1988 (109) Greene & Laskin 1988 (110) Garefis <i>et al.</i> 1994 (111) de Leeuw <i>et al.</i> 1995 (112)	Outcomes of conservative TX protocols	Clinical studies (1970s – 1990s)	Success of conservative TX over many years – no irreversible procedures performed
Multi-modal treatments: Turp 2007a (3), 2007b (65) List 2010 (113)	Comparisons of various single and combination conservative TX modalities	Review and literature analysis	Many therapies are helpful; none are far superior to others

TX, treatment; DDR, disc displacement with reduction; DDNR, disc displacement without reduction; OA, oral appliance.

strated to be effective for the management of TMD pain (3, 4).

Informed consent, which is based on respect for patient autonomy, obligates us to reveal those facts.

Our profession has a covenant with society to honour patient vulnerability, which then compels us to facilitate their understanding of the rationale, risks, benefits, alternatives and goals of the intervention we

may propose. To refrain from revealing the broad range of treatments available to them, or to either actively or passively limit their understanding of options, is to act in a paternalistic manner, which ignores the dignity of that person. As health-care professionals, we have a sacrosanct covenant with society based on trustworthiness (6) as well as an obligation to formulate our actions based on the primacy of patient welfare. One very important aspect of that obligation is to facilitate patient autonomy, which inherently includes intellectual honesty in presentation of treatment options. We will argue that strong evidence exists which supports the position that routine invasive occlusal therapies for TMDs are not only scientifically unjustifiable (see Tables 1–4), but in addition, they represent a conspicuous and blatant abdication of our moral obligations as professionals.

In order to make this argument within an ethical framework, we will discuss these matters in terms of *principlism*, that is, a set of ethical constructs that are rooted in common morality, and that are common to all learned professions (5). These principles include obligations to do good (beneficence), to avoid harming patients in a broad sense (non-maleficence) and to respect the autonomy of patients; they form the basis for the behaviour of professional practitioners as they interact with their patients and clients. Those professionals generally are licensed and, to some extent, regulated by the states in which they work, so there are legal as well as moral expectations that the public should have when they encounter such practitioners. Regarding the dental profession, there is a broad and rather non-specific code endorsed by the American Dental Association (7) that urges member dentists to behave ethically, and that incorporates the ethical constructs of principlism. However, this is the first article to focus specifically on the moral constructs of principlism contained in the ADA code of ethics and how they should be applied to TMD practice.

We will present compelling evidence for the concept that most TMDs are either self-limiting or simply managed and that non-invasive treatments often will result in positive outcomes (see Tables 1–4). Thus, dentists who claim otherwise have a moral obligation, based on the principle of non-maleficence (to avoid harm), to scientifically and ethically justify their proposed invasive treatments, and to demonstrate that they are unequivocally better for patients than less invasive methods. Dentists who immediately resort to

expensive irreversible therapies encourage the reaction from their fellow dentists and society that financial incentive has trumped the historical primacy of patient welfare. In other words, the professional ethical version of appropriate TMD management appears to be at risk of being supplanted by a commercial ethic, the priority of which is dentist profit.

Ethical obligations of a professional

Society trusts professions to monitor themselves; this includes the responsibility to train, license and ensure that members understand and comply with their fiduciary duty. Their implicit duty is to prioritise the welfare of patients, clients, parishioners and others above their own personal gain in their professional activities. This long-standing covenant between society and learned professions allows laypersons to trust that any given professional's behaviour is informed by contemporary standards of research in their respective professional domain. In the healing professions, prospective patients expect practitioners to be up to date with the relevant professional literature and to be honest about what is best for the patient's welfare, not for the practitioner's well-being (8).

Therefore, patients with symptoms of a temporomandibular disorder (TMD) should be confident that their dentists will meet their legal and moral obligation (9) to fully disclose information regarding diagnosis and treatment alternatives. Patients with TMD may reasonably expect that dentists have critically reviewed and analysed the TMD literature in accordance with current standards of scientific professional practice. Contemporary standards of research, on which treatments are ultimately based, stipulate that objective information should be derived from investigations expressly designed to avoid or minimise bias. Both clinicians and researchers may misinterpret information because of preconceived notions or preferences of what a body of information *should* look like or what it *should* indicate, even if it does not (10). This phenomenon is commonly referred to as *bias*. The scientific integrity that should characterise contemporary research and clinical practice is achieved in part when researchers and clinicians are mindful of this problem. Biased and uncritical analysis of research and educational literature in any format will ultimately degrade clinical practice. Dentists are morally obligated to take proactive steps to avoid allowing those biases to

influence how they conduct their research, interpret and report their results and treat their patients. Thus, contemporary clinical research should ideally attempt to include the following elements: randomisation of subjects into treatment and control groups, double-blind experimental protocols, evaluation by an independent examiner, and appropriate statistical methods. These all are steps employed to reduce bias and encourage impartial analysis of published or presented information. Purposefully taking steps to avoid bias reflects a conscientious effort to avoid manipulating data and/or disseminating information that supports more profitable, but less scientifically justifiable information (11).

Uncontrolled case series, case reports, other publications and continuing education courses also can be valuable in the dissemination of information, but care must be taken to recognise and identify bias in these formats, and to critically analyse them before incorporating their findings into clinical practice. Doctors should recognise that a scientifically and ethically justifiable practice cannot be based on opinions or experience-based publications. Also, it cannot rely on professional forums that support a favoured theory or a preferred method of practice without regard to evidence that disproves or convincingly challenges the veracity of those theories and practices. As there always are areas of incomplete knowledge or limited information, every health practitioner must continuously deal with this mixed state of their professional art.

A fiduciary obligation to patients requires professionals to behave in the manner described above. Failure to do so limits the scope of information to which the vulnerable and relatively uneducated patient is exposed, thus creating a doctor–patient relationship characterised by paternalism and lack of respect for the patient’s autonomy. People expect their doctors to diagnose conditions, and then to deliver care in a way that recognises their vulnerability as patients, thereby respecting the covenant between practitioners and society. Holding tenaciously to favoured views about aetiology, diagnosis, and treatment, while ignoring contemporary standards of research that question or invalidate those favoured theories, threatens the moral and ethical foundations of any professional health-care practice.

To fulfil obligations of beneficence (doing good) and non-maleficence (avoiding harm), and also to facilitate a patient’s autonomy, the practitioner must do what is best *for that patient*. This may very well include discus-

sion of a variety of treatments and their rationale, even if this discussion leads to treatments that are not as financially profitable as others. This approach has its origins in the ethics of health care and has been codified by many dental organisations (7, 12). Thus, placing a patient’s welfare above one’s own refers to the ethical commitment to conduct diagnosis and treatments primarily for the benefit of the patient and not for one’s own personal gain, financial or otherwise.

Adherence to outdated or scientifically unsubstantiated views about TMD may be a result of ignorance of best available evidence based on contemporary standards of research, lack of skills in critical analysis of literature, refusal to acknowledge competing methods of practice, or conducting a practice based primarily on profit. In a busy dental practice, it may be more expeditious to follow the recommendations of self-declared authoritative opinion than to critically analyse the literature and practice in an evidence-based or informed manner. However, dentists who publicly hold themselves out to be proficient in treating TMD are morally obligated to develop skills in critical literature reviews of that topic, to make themselves aware of recent developments in the current literature, and to update their personal approach to caring for patients accordingly. This is the essence of being a ‘professional’ expert (13), which requires the practitioner to assume the responsibility to be able to facilitate patient autonomy in a manner that reflects intellectual veracity. To passively or actively ignore contemporary literature, or to cherry-pick the results of publications to fit preconceived notions of aetiology and treatment, represents a failure to meet one’s fiduciary obligations to society and to individual patients.

Routine occlusal intervention cannot be ethically justified

The TMD literature is replete with strong and repeated evidence supporting the following summary statements:

- 1 TMDS are often self-limiting (14–18).
- 2 TMDS occur primarily in women between the ages of 15 and 45 (19–23).
- 3 TMDS are generally not caused by occlusal disharmonies, bad maxillomandibular relationships, wrong condylar positions or other structural factors (24–30).
- 4 Electronic diagnostic aids such as surface EMG and jaw tracking have not been demonstrated to pro-

vide clinically acceptable sensitivity or specificity for making clinical diagnoses of TMD (31–37).

- 5 TMDs generally are not progressive (19, 22, 38–42), although some symptoms may fluctuate over time while a few cases may develop more serious conditions.
- 6 TMDs initially should be treated with simple non-invasive therapies (3, 43–48).

These facts alone should direct a practitioner who is dedicated solely to the welfare of his/her TMD patients to avoid unnecessary diagnostic technology and routine invasive irreversible treatments. If pathological occlusal relationships were established on the basis of contemporary scientific methodology to be primarily responsible for TMD, it would be incumbent on dentists treating TMD to restore occlusion to a healthy configuration. Additionally, valid and reliable operational definitions of occlusal abnormality would be established in the dental literature, and patients with representative occlusal abnormalities could be readily identified with valid and reliable clinical diagnostic methods with high degrees of sensitivity and specificity. Dentists would therefore be ethically obligated to be aware that occlusal pathology causes TMD and, unless other less invasive, less costly, and at least equally efficacious treatments were discovered, they would have an ethical obligation to discuss this with patients and encourage therapeutic alteration of occlusal relationships.

However, even a cursory review of current TMD literature with contemporary scientific integrity would show that studies supporting that position simply do not exist. Instead, several systematic reviews have dealt with concepts of occlusal aetiologies and treatments for TMDs that reveal the contrary (see Tables 1–4). None to date has published evidence supporting occlusal factors as being primary or even significant in the aetiology of TMDs; not surprisingly, none have revealed support for primary and routine occlusion-based treatments for TMDs. Therefore, treatments that routinely employ occlusal alteration, jaw repositioning, and other invasive interventions cannot be justified either scientifically or ethically.

How strong is the evidence supporting conservative treatment of TMDs?

Is there sufficient evidence to conclude that most temporomandibular disorders may be treated conservatively within a medical orthopaedic framework, and

without utilising invasive methods such as those described above? If TMDs are orthopaedic problems involving joints, muscles, ligaments, tendons, discs, etc., then they ought to be manageable by the same conservative modalities as other musculoskeletal disorders. We present a list of recently published significant articles in Tables 1–4 below, indicating that indeed, there is abundant evidence supporting that kind of approach to the management of TMDs. Tables 1 and 2 appeared originally in the excellent 2011 article by Manfredini *et al.* (49); they present nearly all of the recent major systematic reviews and meta-analyses dealing with the diagnosis (Table 1) and the treatment (Table 2) of temporomandibular disorders. Tables 3 and 4 were compiled by the authors, and they present a summary of landmark original research or position articles dealing with those same TMD management topics.

In support of our central argument in this article, we assert that this overwhelming body of peer-reviewed information compels all dental professionals to avoid irreversible treatments at risk of ethical and moral infractions that are inconsistent with the practice of dentistry. We emphasise that the studies cited meet the standards of contemporary scientific methodology (50) because they have incorporated design protocols to avoid biased results. Most readers will find that the articles and systematic reviews cited below are their best source for summary overview statements about the current approaches to diagnosis, aetiology and treatment of TMDs. Not only is this a more efficient way to obtain that information, but in addition, these types of publications will present a comprehensive list of supporting literature citations.

Evidence, experience and trustworthiness

This argument for the use of a robust literature to support treatment recommendations does not diminish the individual dentist's judicious reliance on experience and clinical judgment. It simply highlights the obligations we have as professionals dedicated to a health-care ethic, to make every attempt to practice on the basis of the best available evidence on behalf of our vulnerable patients. This health-care ethic includes our obligations to respect patient autonomy, to inform patients of alternatives and to practice in a manner that underscores primacy of patient welfare. A doctor–patient relationship where the dentist

merely provides a laundry list of available treatments from which patient choose which one(s) they 'like' is not what patients want (9).

Evidence-based practice does not exclude the wisdom and benefits of clinical judgment (114). The relative dearth of scientific evidence about many issues in medicine and dentistry demands frequent reliance on the practitioner's personal judgment, experience and observation. In fact, the measured balance of combining experience and evidence-based health care is the ideal to which evidence-based practice advocates aspire (115). This does not mean, however, that the privilege of professional autonomy conferred upon licensure justifies anecdotal-based practice, or the 'right to treat' in any way one wishes, regardless of currently available evidence. At the very least, clinicians should acknowledge the existence of information that is contrary to their preferred methods of treatment, and accordingly inform patients of those alternatives. Moreover, in addition to discussing potential strengths and benefits, patients should be educated about the weaknesses and limitations of any recommended treatment approaches.

Consideration and incorporation of evidence-based information into clinical practice are perceived by some to be a threat to professional autonomy. However, the professional role and its attendant freedoms are ultimately bestowed on health-care professionals by society and are thus linked inexorably with a sense of accountability. It is clear that patients expect health-care professionals to practise on the basis of contemporary information with high evidentiary standards (8), and thereby to fulfil the fiduciary role historically created on the moral pillars of trustworthiness and accountability. Categorical denial or consistent disregard of compelling information contrary to one's favoured theories and practice techniques is antithetical to fundamental notions of transparency, honesty, trustworthiness and respect for autonomy of persons. As Daniel Florien has noted (116):

If we start with a premise and only look for things that support it, we will find something, and we will be confirmed in our belief. But science — at least good science — looks not only for things that support it, but for things that disprove it. That is why studies and tests are done, instead of citing an ancient "authority" and/or appealing to emotions.

Business ethic versus health-care ethic – how do they differ?

A dental practice that is primarily profit-motivated may not be motivated to prioritise evidence-based treatments if they do not align with the profit-generating philosophy of the practice. As a result, treatment decisions may not necessarily be the best for the 'customer'. Rather, the profit-motivated practice will focus more on treatments that meet the primary goal of generating income. Divulging the strengths of treatments based on evidence that meets contemporary standards of research may produce less income, may not improve the bottom financial line, and in keeping with the practice goal, may be suppressed in a paternalistic manner. Thus, the unsuspecting patient may remain unaware of a less costly, less risky, and potentially efficacious approach to treatment. To withhold information in this manner is a paternalistic abdication of professional ethical obligations to inform patients of available alternatives out of respect for patient autonomy.

In such a practice, it would not be to the dentist's economic advantage to provide patients with information indicating that non-invasive, reversible and less expensive treatments for TMD have been demonstrated to be effective in long-term outcome studies (see Tables 1–4). However, there is a moral obligation based on respect for patient autonomy to inform TMD patients that these problems often are either self-limiting or very responsive to conservative treatment (see Tables 1–4). They also should be informed about the high statistical probability that painful symptoms will decline and even disappear over time (14, 22). However, when a much higher profit may be produced by the techniques employed to alter occlusion or to reposition the mandible, it may be very tempting to promote those kinds of treatments. Therefore, the dentist who is primarily engaged in a practice characterised by a business ethic would feel no moral urge to divulge less profitable treatments, assuming that he or she is even aware of them.

Clinical application of ethical principles

The ethical principles discussed in this article should guide dentists as they encounter oro-facial pain patients in their practices. After completing an initial triage to rule out odontogenic pain problems, dentists

should determine whether those patients have a TM disorder, or if they have some other type of pain condition that should be referred to oro-facial pain specialists or to medical specialists. As dentists have the primary responsibility in our society to provide treatment for TMD problems, they should be prepared to perform a detailed diagnostic workup and initial treatment for those patients, while working within the ethical framework of beneficence and non-maleficence. In an earlier paper, Greene (43) has pointed out that initial therapy for TMDs, which includes proper explanations of the problem, good pain management, home self-care, and possible splint therapy, is the key to success for a large number of patients.

Conclusion

In the course of writing this article, we have reviewed a large number of publications in both the dental literature and the medical ethics literature. It would have been easy to cite hundreds more peer-reviewed articles in this manuscript to support the position we have taken, but space limits preclude that option. Based on our analysis of this material, we have concluded that sufficient evidence exists to set a moral and ethical standard for the clinical management of TMD patients. While many scientific issues about the pathophysiology of TM disorders remain unresolved, the efficacy and appropriateness of conservative TMD treatments are hard to deny, while the routine utilisation of aggressive and irreversible treatments is hard to defend. Nearly all of the contemporary guidelines for diagnosis and management of temporomandibular disorders published in the recent past are supportive of this conclusion. In addition to guideline articles published throughout the dental literature (45, 113, 117–123), a number of major dental organisations have proposed specific management guidelines for TMD patients in their official publications (48, 124–130). The amount of concordance between all of these guidelines is quite striking.

In closing, we present four questions previously published by Gross (131) that each clinician should answer before treating patients with various medical conditions. These questions should be a fundamental aspect of treatment philosophy in all clinical settings. If sufficient evidence is not available to answer one or more of these questions, patients should be informed accordingly in order to meet the professional obliga-

tions of respect for the patient's autonomy. Gross suggests that for each diagnostic and treatment decision, one should ask:

- 1 Will the problem get worse if the treatment is not performed?
- 2 Is the treatment valid with proven clinical value?
- 3 Would a lesser procedure solve the problem?
- 4 Does the risk/benefit ratio justify the invasiveness of procedure?

In regard to TMD management, questions 1, 2 and 4 cannot be answered affirmatively with scientific or moral integrity in support of routine invasive and irreversible treatments for TMD. This means that such treatments cannot be justified in a practice founded on a health-care ethic.

We welcome those who contend otherwise to provide an evidence-based rebuttal based on universally accepted methods of contemporary scientific research. The burden of proof is on them to demonstrate that irreversible and invasive occlusal intervention is routinely superior to non-invasive methods as we have outlined. To date, that type of rebuttal has not been clearly articulated and therefore a practice philosophy of invasive and irreversible alterations of jaw relationships and/or occlusion to treat TMDs cannot be morally or ethically justified.

Conflict of interest

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References

1. Stohler CS, Zarb GA. On the management of temporomandibular disorders: a plea for a low-tech, high-prudence therapeutic approach. *J Orofac Pain.* 1999;13:255–261.
2. Greene CS, Laskin DM. Temporomandibular disorders: moving from a dentally based to a medically based model. *J Dent Res.* 2000;79:1736–1739.
3. Turp J, Asbjorn J, 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. *Clin Oral Implant Res.* 2007;18:138–150.
4. Friction J. Current evidence providing clarity in management of temporomandibular disorders: summary of a systematic review of randomized clinical trials for intraoral

- appliances and occlusal therapies. *J Evid Base Dent Pract.* 2006;6:48–52.
5. Beauchamp TL, Childress JF. *Principles of biomedical ethics.* New York (NY): Oxford University Press; 2009.
 6. Pellegrino E. Professionalism, profession and the virtues of the good physician. *Mt Sinai J Med.* 2002;69:378–384.
 7. Available at: www.ada.org/sections/about/pdfs/code_of_ethics_2012.pdf, accessed 1 October 2012.
 8. Green M, Zick A, Makoul G. Defining professionalism from the perspective of patients, physicians, and nurses. *Acad Med.* 2009;84:566–573.
 9. Schouten BC, Eijkman MAJ, Hoogstraten J. Information and participation preferences of dental patients. *J Dent Res.* 2004;83:961–965.
 10. Manchikanti L. Evidence-based medicine, systematic reviews and guidelines in interventional pain management, Part 1: introduction and general considerations. *Pain Physician.* 2008;11:161–186.
 11. Lexchin J. Those who have the gold make the evidence: how the pharmaceutical industry biases the outcomes of clinical trials of medications. *Sci Eng Ethics.* 2012;18:247–261.
 12. Available at: <http://acd.org/acdethics4.htm>, accessed 31 October 2012.
 13. Pellegrino ED. Toward a reconstruction of medical morality: the primacy of the act of profession and the fact of illness. *J Med Philos.* 1979;4:32–56.
 14. LeResche L, Drangsholt M. Epidemiology of orofacial pain: prevalence, incidence, and risk factors. In: Sessle B, Lavigne GJ, Lund JP, Dubner R, eds. *Orofacial pain.* 2nd ed. Chicago (IL): Quintessence; 2008:13–18.
 15. Rugh JD, Solberg WK. Oral health status in the United States: temporomandibular disorders. *J Dent Educ.* 1985;49:398–405.
 16. Dworkin SF, LeResche L, Von Korff MR. Diagnostic studies of temporomandibular disorders: challenges from an epidemiologic perspective. *Anesth Prog.* 1990;37:147–154.
 17. Ohrbach R, Dworkin SF. Five-year outcomes in TMD: relationship of changes in pain to changes in physical and psychological variables. *Pain.* 1998;74:315–326.
 18. Dworkin SF, Huggins KH. 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;16:48–63.
 19. Magnusson T, Egermark I. A longitudinal epidemiologic study of signs and symptoms of temporomandibular disorders from 15 to 35 years of age. *J Orofac Pain.* 2000;14:310–319.
 20. Warren MP, Fried JL. Temporomandibular disorders and hormones in women. *Cells Tissues Organs.* 2001;169:187–192.
 21. Magnusson T, Egermark I, Carlsson GE. Treatment received, treatment demand, and treatment need for temporomandibular disorders in 35-year-old subjects. *J Craniomandib Pract.* 2002;20:11–17.
 22. Magnusson T, Egermark I, Carlsson G. A prospective investigation over two decades on signs and symptoms of temporomandibular and associated variables. A final summary. *Acta Odont Scand.* 2005;63:99–109.
 23. Wang J, Chao Y. The possible role of estrogen in the incidence of temporomandibular disorders. *Med Hypotheses.* 2008;71:564–567.
 24. Mohlin B, Axelsson S, Paulin G, Pietila T, Bondemark L, Brattstrom V *et al.* TMD in relation to malocclusion and orthodontic treatment. A systematic review. *Angle Orthod.* 2007;77:542–548.
 25. Yan-Fang R, Isberg A, Westesson P-L. Condyle position in the temporomandibular joint. Comparison between asymptomatic volunteers with normal disk position and patients with disk displacement. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1995;80:101–107.
 26. De Boever JA, Carlsson GE. Need for occlusal therapy and prosthodontic treatment in the management of temporomandibular disorders. Part I. Occlusal interferences and occlusal adjustment. *J Oral Rehab.* 2000;27:367–379.
 27. Pullinger AG, Seligman DA. Quantification and validation of predictive values of occlusal variables in temporomandibular disorders using a multifactorial analysis. *J Prosthet Dent.* 2000;83:66–75.
 28. Egermark I, Magnusson T, Carlsson G. A 20 year follow-up of signs and symptoms of temporomandibular disorders and malocclusion in subjects with and without orthodontic treatment in childhood. *Angle Orthod.* 2003;73:109–115.
 29. Gesch D, Bernhardt O, Kocher T, John U, Hensel E, Alte D. Association of malocclusion and functional occlusion with signs of temporomandibular disorders in adults: results of the population-based study of health in Pomerania. *Angle Orthod.* 2004;74:512–520.
 30. Gesch D, Bernhardt O, Mack F, John U, Kocher T, Alte D. Association of malocclusion and functional occlusion with subjective symptoms of TMD in adults: results of the Study of Health in Pomerania (SHIP). *Angle Orthod.* 2005;75:183–190.
 31. Mohl ND. Reliability and validity of diagnostic modalities for temporomandibular disorders. *Adv Dent Res.* 1993;7:113–119.
 32. Clark GT, Tsukiyama Y. The validity and utility of disease detection methods and of occlusal therapy for temporomandibular disorders. *Oral Surg Oral Med Oral Pathol.* 1997;83:101–106.
 33. Glaros AG, Glass EG, Brockman D. Electromyographic data from TMD patients with myofascial pain and from matched control subjects: evidence for statistical, not clinical, significance. *J Orofac Pain.* 1997;11:125–129.
 34. Klasser GD, Okeson JP. The clinical usefulness of surface electromyography in the diagnosis and treatment of temporomandibular disorders. *J Am Dent Assoc.* 2006;137:763–771.
 35. Suvinen T, Kempainen P. Review of clinical EMG studies related to muscle and occlusal factors in healthy and TMD subjects. *J Oral Rehabil.* 2007;34:631–644.

36. Gonzalez YM, Greene CS, Mohl ND. Technological devices in the diagnosis of temporomandibular disorders. *Oral Maxillofac Surg Clin North Am.* 2008;20:211–220.
37. Al-Saleh MAQ, Armijo-Olivo S, Flores-Mir C, Thie NMR. Electromyography in diagnosing temporomandibular disorders. *J Am Dent Assoc.* 2012;143:351–362.
38. Carlsson GE, Egermark I, Magnusson T. Predictors of signs and symptoms of temporomandibular disorders: a 20-year follow-up study from childhood to adulthood. *Acta Odontol Scand.* 2002;60:180–185.
39. De Leeuw R, Boering G, Stegenga B, De Bont LGM. Temporomandibular joint osteoarthritis: clinical and radiographic characteristics 30 years after non-surgical treatment. A preliminary report. *Cranio.* 1993;11:15–24.
40. Osterberg T, Carlsson GE. A cross-sectional and longitudinal study of craniomandibular dysfunction in an elderly population. *J Craniomandib Disord.* 1992;6:237–245.
41. Greene CS. Temporomandibular disorders in the geriatric population. *J Pros Dent.* 1994;72:507–509.
42. Ow RK, Loh T. Symptoms of craniomandibular disorder among elderly people. *J Oral Rehab.* 1995;22:413–419.
43. Greene CS. Managing TMD patients: initial therapy is the key. *J Am Dent Assoc.* 1992;123:43–45.
44. Clark GT, Choi JK, Browne PA. The efficacy of physical medicine treatment, including occlusal appliances, for a temporomandibular disorder population. In: Sessle BJ, Bryant PS, Dionne RA, eds. *Temporomandibular disorders and related pain conditions.* Seattle (WA): IASP Press; 1995:375–397.
45. McNeill C. Management of temporomandibular disorders: concepts and controversies. *J Prosthet Dent.* 1997;77:510–522.
46. Turp JC, Komine F, Hugger A. Efficacy of stabilization splints for the management of patients with masticatory muscle pain: a qualitative systematic review. *Clin Oral Invest.* 2004;8:179–195.
47. Manfredini D, Landi N, Tognini F, Orlando B, Bosco M. Muscle relaxants in the treatment of myofascial face pain. A literature review. *Minerva Stomatol.* 2004;53:305–313.
48. Greene CS. Managing the care of patients with temporomandibular disorders: a new guideline for care. *J Am Dent Assoc.* 2010;141:1086–1088.
49. Manfredini D, Bucci MB, Montagna F, Guarda-Nardini L. Review article: temporomandibular disorders assessment: medicolegal considerations in the evidence-based era. *J Oral Rehabil.* 2011;38:101–119.
50. Katz MH. *Study design and statistical analysis.* New York (NY): Cambridge University Press; 2006.
51. Manfredini D, Guarda-Nardini L. Ultrasonography of the temporomandibular joint: a literature review. *Int J Oral Maxillofac Surg.* 2009;38:1229–1236.
52. Perinetti G, Contardo L. Posturography as a diagnostic aid in dentistry: a systematic review. *J Oral Rehabil.* 2009;36:922–936.
53. Koh KJ, List T, Petersson A, Rohlin M. Relationship between clinical and magnetic resonance imaging diagnoses and findings in degenerative and inflammatory temporomandibular joint diseases: a systematic literature review. *J Orofac Pain.* 2009;23:123–139.
54. Hussain AM, Packota G, Major PW, Flores Mir C. Role of different imaging modalities in assessment of temporomandibular joint erosions and osteophytes: a systematic review. *Dentomaxillofac Radiol.* 2008;37:63–71.
55. Limchachaina N, Petersson A, Rohlin M. The efficacy of magnetic resonance imaging in the diagnosis of degenerative and inflammatory temporomandibular joint disorders: a systematic review of literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006;102:521–536.
56. Turp JC, Arima T, Minagi S. Is the posterior belly of the digastrics muscle palpable? A qualitative systematic review of the literature. *Clin Anat.* 2005;18:315–322.
57. Türp JC, Minagi S. Palpation of the lateral pterygoid region in TMD—where is the evidence? *J Dent.* 2001;29:475–483.
58. Baba K, Tsukiyama Y, Yamazaki M, Clark GT. A review of temporomandibular disorder diagnostic techniques. *J Prosthet Dent.* 2001;86:184–194.
59. Al-Riyami S, Cunningham SJ, Moles DR. Orthognathic treatment and temporomandibular disorders: a systematic review. Part 2. Signs and symptoms and meta-analyses. *Am J Orthod Dentofacial Orthop.* 2009;136:626.e1–626.e16, discussion 626–7 Review.
60. Guo C, Shi Z, Revington P. Arthrocentesis and lavage for treating temporomandibular joint disorders. *Cochrane Database Syst Rev.* 2009;4:CD004973.
61. Stapelmann H, Turp 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.
62. Guarda-Nardini L, Manfredini D, Ferronato G. Temporomandibular joint total replacement prosthesis: current knowledge and considerations for the future. *Int J Oral Maxillofac Surg.* 2008;37:103–110.
63. Abrahamsson C, Ekberg E, Henrikson T, Bondemark L. Alterations of temporomandibular disorders before and after orthognathic surgery: a systematic review. *Angle Orthod.* 2007;77:729–734.
64. Al-Belasy FA, Dolwick MF. Arthrocentesis for the treatment of temporomandibular joint closet lock: a review article. *Int J Oral Maxillofac Surg.* 2007;36:773–782.
65. Turp JC, Motschall E, Schindler HJ, Heydecke G. In patients with temporomandibular disorders, do particular interventions influence oral health-related quality of life? A qualitative systematic review of the literature. *Clin Oral Implants Res.* 2007;18(Suppl. 3):127–137.
66. Medlicott MS, Harris SR. A systematic review of the effectiveness of exercise, manual therapy, electrotherapy, relaxation training, and biofeedback in the management of temporomandibular disorders. *Phys Ther.* 2006;86:955–973.
67. McNeely ML, Armijo-Olivo S, Magee DJ. A systematic review of the effectiveness of physical therapy interventions for temporomandibular disorders. *Phys Ther.* 2006;86:710–725.

68. Al-Ani Z, Gray RJ, Davies SJ, Sloan P, Glenny AM. Stabilization splint therapy for the treatment of temporomandibular myofascial pain: a systematic review. *J Dent Educ.* 2005;69:1242–1250.
69. Koh H, Robinson PG. Occlusal adjustment for treating and preventing temporomandibular joint disorders. *J Oral Rehabil.* 2004;31:287–292.
70. Forssell H, Kalso E. Application of principles of evidence based medicine to occlusal treatment for temporomandibular disorders: are there lessons to be learned? *J Orofac Pain.* 2004;18:9–22.
71. List T, Axelsson S, Leijon G. Pharmacologic interventions in the treatment of temporomandibular disorders, atypical facial pain, and burning mouth syndrome. A qualitative systematic review. *J Orofac Pain.* 2003;17:301–310.
72. Forssell H, Kalso E, Koskela P, Vehmanen R, Puukka P, Alanen P. Occlusal treatments in temporomandibular disorders: a qualitative systematic review of randomized controlled trials. *Pain.* 1999;83:549–560.
73. Manfredini D, Guarda-Nardini L. Agreement between Research Diagnostic Criteria for Temporomandibular Disorders and magnetic resonance diagnoses of temporomandibular disc displacement in a patient population. *Int J Oral Maxillofac Surg.* 2008;37:612–616 Epub 2008 May 16.
74. Lobbezoo-Scholte AM, De Wijer A, Steenks MH, Bosman F. Interexaminer reliability of six orthopaedic tests in diagnostic subgroups of craniomandibular disorders. *J Oral Rehabil.* 1994;21:273–285.
75. Clark GT, Baba K, McCreary CP. Predicting the outcome of a physical medicine treatment for temporomandibular disorder patients. *J Orofac Pain.* 2009;23:221–229.
76. Schmitter M, Kress B, Leckel M, Henschel V, Ohlmann B, Rammelsberg P. Validity of temporomandibular disorder examination procedures for assessment of temporomandibular joint status. *Am J Orthod Dentofacial Orthop.* 2008;133:796–803.
77. Laskin DM, Greene CS. Technological methods in the diagnosis and treatment of temporomandibular disorders. *Int J Technol Assess Health Care.* 1990;6:558–568 Reprinted in *Quintessence Internat.* 1992;23:95–102.
78. Greene CS. The role of technology in TMD diagnosis. In: Laskin DM, Greene CS, Hylander WL, eds. *Temporomandibular disorders: an evidence-based approach to diagnosis and treatment.* Chicago (IL): Quintessence Publishing Co; 2006:193–202.
79. Lund JP, Widmer CG, Feine JS. Validity of diagnostic and monitoring tests used for temporomandibular disorders. *J Dent Res.* 1995;74:1133–1143.
80. Larheim TA, Westesson P-L. Imaging of the temporomandibular joint. In: Laskin DM, Greene CS, Hylander WL, eds. *Temporomandibular disorders: an evidence based approach to diagnosis and treatment.* Chicago (IL): Quintessence; 2006:149–180.
81. Manfredini D, Favero L, Federzoni E, Cocilovo F, Guarda-Nardini L. Kinesiographic recordings of jaw movements are not accurate to detect magnetic resonance-diagnosed temporomandibular joint (TMJ) effusion and disk displacement. Findings from a validation study. *Oral Surg, Oral Med, Oral Pathol, Oral Radiol.* 2012;114:457–463.
82. Kurita K, Westesson P-L, Yuasa H, Toyama M, Machida J, Ogil N. Natural course of untreated symptomatic temporomandibular joint disc displacement without reduction. *J Dent Res.* 1998;77:361–365.
83. Sato S, Sakamoto M, Kawamura H, Motegi K. Long-term changes in clinical signs and symptoms and disc position and morphology in patients with nonreducing disc displacement in the temporomandibular joint. *J Oral Maxillofac Surg.* 1999;57:29–30.
84. Minakuchi H, Kuboki T, Matsuka Y, Maekawa K, Yatani H, Yamashita A. Randomized controlled evaluation of non-surgical treatments for temporomandibular joint anterior disk displacement without reduction. *J Dent Res.* 2001;80:924–928.
85. Sato S, Goto S, Nasu F, Motegi K. Natural course of disc displacement with reduction of the temporomandibular joint: changes in clinical signs and symptoms. *J Oral Maxillofac Surg.* 2003;61:32–34.
86. Greene CS, Laskin DM. Splint therapy for the myofascial pain-dysfunction (MPD) syndrome: a comparative study. *J Am Dent Assoc.* 1972;84:624–628.
87. Rubinoff MS, Gross A, McCall WD. Conventional and nonoccluding splint therapy compared for patients with myofascial pain dysfunction syndrome. *Gen Dent.* 1987;35:502–506.
88. Dao TT, Lavigne GJ, Charbonneau A, Feine JS, Lund JP. The efficacy of oral splints in the treatment of myofascial pain of the jaw muscles: a controlled clinical trial. *Pain.* 1994;56:85–94.
89. Ekberg EC, Vallon D, Nilner M. Occlusal appliance therapy in patients with temporomandibular disorders. A double-blind controlled study in a short-term perspective. *Acta Odontol Scand.* 1998;56:122–128.
90. Ekberg E, Vallon D, Nilner M. The efficacy of appliance therapy in patients with temporomandibular disorders of mainly myogenous origin. A randomized, controlled, short-term trial. *J Orofac Pain.* 2003;17:133–139.
91. Ekberg E, Nilner M. Treatment outcome of appliance therapy in temporomandibular disorder patients with myofascial pain after 6 and 12 months. *Acta Odontol Scand.* 2004;62:343–349.
92. Jokstad A, Mo A, Krogstad BS. Clinical comparison between two different splint designs for temporomandibular disorder therapy. *Acta Odontol Scand.* 2005;63:218–226.
93. Wassell RW, Adams N, Kelly PJ. The treatment of temporomandibular disorders with stabilizing splints in general dental practice: one-year follow-up. *J Am Dent Assoc.* 2006;137:1089–1098.
94. Conti PC, Dos Santos CN, Kogawa EM, De Castro Ferreira Conti AC, De Araujo Cdos R. The treatment of painful temporomandibular joint clicking with oral splints: a randomized clinical trial. *J Am Dent Assoc.* 2006;137:1108–1114.

95. Truelove E, Huggins KH, Mancl L, Dworkin SF. The efficacy of traditional, low-cost and nonsplint therapies for temporomandibular disorder: a randomized controlled trial. *J Am Dent Assoc.* 2006;137:1099–1107.
96. Olson RE, Malow RM. Effects of biofeedback and psychotherapy on patients with myofascial pain dysfunction who are nonresponsive to conventional treatments. *Rehabil Psychol.* 1987;32:195–204.
97. Gatchel RJ, Stowell AW, Wildenstein L, Riggs R, Ellis E III. Efficacy of an early intervention for patients with acute temporomandibular disorder-related pain. A one-year outcome study. *J Am Dent Assoc.* 2006;137:339–347.
98. Stowell AW, Gatchel RJ, Wildenstein L. Cost-effectiveness of treatments for temporomandibular disorders: biopsychosocial intervention versus treatment as usual. *J Am Dent Assoc.* 2007;138:202–208.
99. Michelotti A, De Wijer A, Steenks M, Farella M. Home-exercise regimes for the management of non-specific temporomandibular disorders. *J Oral Rehabil.* 2005;32:779–785.
100. Feine J, Lund JP. An assessment of the efficacy of physical therapy and physical modalities for the control of chronic musculoskeletal pain. *Pain.* 1997;71:5–23.
101. Dao TT, Lavigne GJ. Oral splints: the crutches for temporomandibular disorders and bruxism? *Crit Rev Oral Biol Med.* 1998;9:345–361.
102. Klasser GD, Greene CS. Oral appliances in the management of temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2009;107:212–223.
103. Greene CS, Laskin DM. Long-term evaluation of conservative treatment for myofascial pain-dysfunction syndrome. *J Am Dent Assoc.* 1974;89:1365–1368.
104. Greene CS, Laskin DM. Long-term evaluation of treatment for myofascial pain-dysfunction syndrome: a comparative analysis. *J Am Dent Assoc.* 1983;107:235–238.
105. Cohen SR. Follow-up evaluation of 105 patients with myofascial pain-dysfunction syndrome. *J Am Dent Assoc.* 1978;97:825–828.
106. Mejersjo C, Carlsson GE. Long-term results of treatment for temporomandibular joint pain-dysfunction. *J Prosthet Dent.* 1983;49:809–815.
107. Mejersjo C, Carlsson GE. Analysis of factors influencing the long-term effect of treatment of TMJ pain-dysfunction. *J Oral Rehabil.* 1984;11:289–297.
108. Okeson JP, Hayes DK. Long-term results of treatment for temporomandibular disorders: an evaluation by patients. *J Am Dent Assoc.* 1986;112:473–478.
109. Okeson JP. Long-term treatment of disk-interference disorders of the temporomandibular joint with anterior repositioning occlusal splints. *J Prosthet Dent.* 1988;60:611–616.
110. Greene CS, Laskin DM. Long-term status of TMJ clicking in patients with myofascial pain and dysfunction. *J Am Dent Assoc.* 1988;117:461–465.
111. Garefis P, Grigoriadou E, Zarifi A, Koidis PT. Effectiveness of conservative treatment for craniomandibular disorders: a 2-year longitudinal study. *J Orofac Pain.* 1994;8:309–314.
112. De Leeuw R, Boering G, Stegenga B, De Bont LGM. Radiographic signs of TMJ osteoarthritis and internal derangement 30 years after non-surgical treatment. *Oral Surg Oral Med Oral Pathol.* 1995;79:382–392.
113. List T, Axelsson S. Management of TMD: evidence from systematic reviews and meta-analyses. *J Oral Rehabil.* 2010;37:430–451 Review.
114. Chambers DW. Evidence based dentistry. *J Am Coll Dent.* 2010;77:68–80.
115. Manchikanti L, Datta S, Smith HS, Hirsch JA. Evidence-based medicine, systematic reviews, and guidelines in interventional pain management: part 6. Systematic reviews and meta-analyses of observational studies. *Pain Physician.* 2009;12:819–850.
116. Available at: <http://www.patheos.com/blogs/unreasonablefaith/2009/06/non-scientific-vs-scientific-thinking/>, accessed 29 October 2012.
117. Clark GT, Seligman DA, Solberg WK, Pullinger AG. Guidelines for the examination and diagnosis of temporomandibular disorders. *J Craniomandib Disord.* 1989;3:7–14.
118. Clark GT, Seligman DA, Solberg WK, Pullinger AG. Guidelines for the treatment of temporomandibular disorders. *J Craniomandib Disord.* 1990;4:80–88.
119. McNeill C, Mohl ND, Rugh JD, Tanaka TT. Temporomandibular disorders: diagnosis, management, education, and research. *J Am Dent Assoc.* 1990;120:253, 55, 57 passim.
120. Foreman PA. The changing focus of chronic temporomandibular disorders: management within a hospital-based, multidisciplinary pain centre. *N Z Dent J.* 1998;94:23–31 Review.
121. Laskin DM. Temporomandibular disorders: the past, present, and future. *Odontology.* 2007;95:10–15 Review.
122. Greene CS, Hinderstein B, Konzelman J, Sollecito TP, Clark GT, Greenberg MS. Temporomandibular disorders: myogenous and arthrogenous conditions. In: Brown RS, Arm RN, Epstein JB, eds. *Chronic orofacial pain.* 2nd ed. Hamilton (ON): B.C. Decker; 2008:21–37.
123. Cairns B, List T, Michelotti A, Ohrbach R, Svensson P. JOR-CORE recommendations on rehabilitation of temporomandibular disorders. *J Oral Rehabil.* 2010;37:481–489.
124. de Leeuw R, ed. *Orofacial pain: guidelines for assessment, diagnosis, and management*, 4th edn. American Academy of Orofacial Pain. Chicago (IL): Quintessence; 2008:131.
125. De Boever JA, Nilner M, Orthlieb J-D, Steenks MH. Recommendations for examination, diagnosis, management of patients with temporomandibular disorders and orofacial pain by the general dental practitioner. *J Orofac Pain.* 2008;22:266–278.
126. Management of temporomandibular disorders. National Institutes of Health Technology Assessment Conference Statement, November 1, 1996. *J Am Dent Assoc.* 1996;127:1595–1606.
127. National Institutes of Health Technology Assessment Conference Statement. Management of temporomandibular disorders, April 29–May 1, 1996. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1997;83:177–183.

128. NIDCR pamphlet: TMJ (Temporomandibular Joint and Muscle Disorders). Available at: <http://www.nidcr.nih.gov/OralHealth/Topics/TMJ/TMJDisorders.htm>, accessed 31 October 2012.
129. Royal College of Dental Surgeons of Ontario. Guidelines: diagnosis and management of temporomandibular disorders & related musculoskeletal disorders. Revised 2009. Available at: www.rcdso.org/pdf/guidelines/Guidelines_TMD_Jul09.pdf, accessed 28 July 2010.
130. American Association for Dental Research temporomandibular disorders policy statement revision. Approved by AADR Council March 3, 2010. Available at: <http://www.aadronline.org/i4a/pages/index.cfm?pageid=3465>. See website for supporting references, accessed 29 October 2012.
131. Gross R. Decisions and evidence in medical practice. St. Louis (MO): Mosby; 2001.

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