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SSRD 3: is there a superiority of multimodal as opposed to simple therapy in patients with temporomandibular disorders? A qualitative systematic review of the literature

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Abstract

Background: Pain is the most common motivation for patients with temporomandibular disorders (TMDs) to seek care. Therapeutic options range from patient education to joint surgery.

Objectives: To conduct a systematic review of articles reporting on simple and multimodal management strategies in TMD patients. 'Simple therapy' was defined as care provided by a dentist, without using technical dental interventions, whereas 'multimodal' refers to at least two different modalities. We followed the null hypothesis of no difference between these two approaches.

Material and methods: A systematic search was carried out in the following databases: Ovid[®] Medline (1966–2006), Cochrane Library (Issue 3/2006), and Science Citation Index (1945–2006). Subsequently, the reference lists of the identified articles were searched to find additional pertinent publications. We divided the study reports according to the main presenting symptom: (1) disc displacement without reduction, with pain; (2) TMD pain, without major psychological symptoms; and (3) TMD pain, with major psychological symptoms.

Results: Eleven articles representing nine different clinical studies were identified. (1) In the disc displacement group with pain, multimodal therapy was not superior to explanation and advice. (2) A combination of occlusal appliance and biofeedback-assisted relaxation/stress management was not significantly superior to either of these therapies after 6 months. Furthermore, brief information alone or combined with relaxation training or occlusal appliance, respectively, were equally efficacious at the 6-month follow-up. There was no superiority of multimodal therapy including splints as compared with simple care. A slightly better outcome was reported for a combination of education and home physical therapy regimen than for patient education alone. (3) In temporomandibular pain patients with major psychological disturbances, patients benefited more from a combined therapeutic approach compared with simple care.

Conclusion: Current research suggests that individuals without major psychological symptoms do not require more than simple therapy. In contrast, patients with major psychological involvement need multimodal, interdisciplinary therapeutic strategies. The clinician's acceptance of the importance of psychological factors in TMD pain forms the platform for convincingly educating patients about the need for multimodal management.

Temporomandibular disorders (TMDs) encompass a heterogeneous collection of non-malignant, non-systemic musculoskeletal

conditions that affect the masticatory muscles and/or the temporomandibular joints as well as contiguous tissue components

(National Institutes of Health 1996). A psychological component is invariably part of painful TMDs, which is why current research diagnostic criteria for TMD include psychometric assessments (Dworkin & LeResche 1992). Typical complaints reported by TMD patients are pain in the masticatory muscles and/or the preauricular area, particularly during mandibular movements; stiffness in the masticatory muscles; and limitations of mandibular movements, such as jaw opening and temporomandibular sounds (clicking, popping, or grating noises). Psychological symptoms are less likely spontaneously reported by patients; therefore, they need to be carefully assessed. In some cases, this requires a team approach.

Of the clinical problems commonly associated with TMDs, temporomandibular pain (the term 'temporomandibular pain' embraces masticatory muscle pain and temporomandibular joint pain; synonyms for 'temporomandibular pain' are 'temporomandibular disorder pain', 'TMD pain', and 'TMD-related pain') is the most typical and most salient symptom (Türp 2000). It has been reported that around 97% of TMD patients who seek care do so because of pain (Dworkin et al. 1990), with pain severity and recency of pain onset being the most significant predictors of care-seeking (Von Korff et al. 1991). The great majority of those seeking care for temporomandibular pain are women in the child-bearing age (Howard 1991). Although the most common single diagnosis is myofascial pain (Vollaro et al. 2001; Rantala et al. 2003; Yap et al. 2003; Plesh et al. 2005), patients typically present with a combination of myogenous pain and temporomandibular joint (TMJ)-related symptoms (Truelove et al. 2006).

It is widely accepted that approximately 75–95% of acute TMD patients will markedly improve (Stohler 2004). Reasons discussed are adaptive processes on biological and psychological levels as well as regression to the mean (Whitney & Von Korff 1992). The latter is a statistical concept that is used to describe the phenomenon that a group of people pre-selected for scoring above the mean on a measure (e.g. pain levels) are likely to score lower on average, purely by chance, if the measurement is repeated (Morton & Torgerson 2003).

Nonetheless, in a subgroup of patients the symptoms persist. Despite various efforts to establish guidelines for effective approaches to the management (and, if possible, treatment) of patients afflicted by TMDs (e.g., Griffiths 1983; McNeill 1992; National Institutes of Health 1996; Laskin et al. 2006), therapeutic care for chronic cases remains a challenging task.

There are indications that failure of therapy may be due to lack of taking into account specific tissue pathologies (TMD subgroups), individual patient characteristics (psychosocial and behavioral aspects), and/or comorbidities (depression, anxiety, etc.) (Rudy et al. 1995; Suvinen et al. 2005; Vlaeyen & Morley 2005). Hence, it is conceivable that a combination of different therapeutic approaches may lead to a more favorable outcome than simple therapeutic modalities. This assumption is supported by a retrospective study that found that for masticatory myalgia, 'a combined treatment approach resulted in a better outcome than single treatments' (Vallon et al. 1998).

In order to clarify this clinically relevant issue, we carried out a systematic search of the literature to identify pertinent articles of randomized-controlled clinical trials related to the following null hypothesis: there is no difference regarding multimodal as compared with simple therapy in TMD patients.

Material and methods

Search strategy

An electronic search of the dental/medical literature was carried out in Ovid Medline® covering the time span starting from 1966 (last update: October 2, 2006). The search strategies are displayed in Tables 1 and 2.

Furthermore, searches in the Cochrane Library (Issue 3/2006; October 2, 2006) and in the Science Citation Index (1945–2006, accessed via Web of Science) were performed (October 5, 2006) (Tables 3 and 4).

Types of publication

Only randomized-controlled trials (RCTs) in which simple therapy was compared with multimodal interventions for more than 4 weeks were considered. By using the term 'simple' (as differentiated from 'single') therapy, we defined care provided by the clinician (e.g., brief information,

self-care instructions, home remedies, such as thermal packs and over-the-counter drugs), without using technical dental interventions. 'Multimodal' refers to at least two different modalities, e.g., an intraoral appliance plus relaxation training.

For inclusion, no distinction was made between muscle pain (without or with limited jaw opening), arthralgia/osteoarthritis, and/or disc displacements with or without reduction upon jaw opening. Where outcomes of different time points were reported, the last assessment result was extracted.

Studies focusing on the management of postarthroscopy TMJ pain were not considered, as this is not pain associated with TMDs.

There were no language restrictions.

Additional searches

Cited reference searches were carried out in PubMed and Web of Science, using the names of the authors identified in the articles relevant to our clinical question.

Furthermore, the reference lists of the identified articles were searched to find additional relevant publications.

The key features reported in the identified publications are summarized in tables.

Results

Identified articles

The electronic search yielded nine contributions, eight of which were found in Ovid Medline®. The search in the Cochrane Library (Central) revealed one additional article, and the search in the Science Citation Index identified one additional publication. The search in the reference lists of the identified publications yielded one additional article (Table 5). In summary, 11 articles fulfilling inclusion criteria were identified. One paper was published in Italian (Michelotti et al. 2000), and the remaining 10 in English.

Characteristics

The 11 articles represent nine different RCTs. Minakuchi et al. (2001, 2004) appear to present identical data in their two articles. Another group reported preliminary results (Michelotti et al. 2000) before their final study report (Michelotti et al. 2004). The paper by Elsharkawy et al

Table 1. Search strategy in Ovid Medline

#	Search
1	(temporomandibular adj3 disorder:).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
2	Myoarthropath:..mp.
3	exp Craniomandibular Disorders/pc, dt, rh, su, th [Prevention & Control, Drug Therapy, Rehabilitation, Surgery, Therapy]
4	randomized-controlled trial.pt. (<i>pt = Publication Type</i>)
5	exp Combined Modality Therapy/
6	drug therapy/or drug therapy, combination/
7	placebos/
8	((Single or simple) adj10 (combin: or multimodal: or multi modal:)).mp.
9	th.xs. <i>xs = exploded subheading. Includes therapy, diet therapy, drug therapy, nursing, prevention & control, radiotherapy, rehabilitation, surgery, transplantation</i>
10	or/5-9 (<i>note: combination of terms related to therapy</i>)
11	1 or 2 <i>Note: combination of textwords to 'temporomandibular joint disorders'. ('TMD' was not used because after combination only irrelevant hits are yielded)</i>
12	11 and 10 <i>Note: Textwords related to temporomandibular disorders AND terms related to therapy</i>
13	3 or 12
14	4 and 13 <i>Note: Combination with publication type RCT</i>
Search for meta-analyses and systematic reviews:	
15	meta-analysis.pt.
16	(Systematic adj2 (review or overview)).mp.
17	15 or 16
18	13 and 17

exp = Explode MeSH (incl. narrower terms).
 /= Medical Subject Heading (MeSH).
 adj3 = words in either order between 3 words.
 := truncation.
 mp = title, original title, abstract, name of substance word, subject heading word.
 .xs. = subheading incl. narrower subheadings.

Table 2. Search strategy in Ovid Medline® In-Process & Other Non-Indexed Citations

#	Search
1	(temporomandibular adj3 disorder:).mp. [mp = title, original title, abstract, name of substance word]
2	myoarthropath:..mp. [mp = title, original title, abstract, name of substance word]
3	((single or simple) adj10 (combin: or multimodal: or multi modal:)).mp.
4	1 or 2
5	4 and rando:..mp. [mp = title, original title, abstract, name of substance word]
6	4 and 3 (<i>note: not citations were retrieved with this combination of terms</i>)
7	((doubl: or singl:) adj5 (blind: or mask:)).mp. [mp = title, original title, abstract, name of substance word]
8	4 and 7
9	5 or 8
10	(systematic adj2 (review or overview)).mp.
11	meta:..mp.
12	10 or 11
13	4 and 12

Q2 (1995) is characterized by some deficiencies of reporting quality (no clear description of methodology; no clear link between described methods and results), which makes the interpretation of the presented results difficult.

Clinical features

Owing to the heterogeneity regarding the TMD-related topics and the study design, including the outcome parameters, a quan-

titative analysis of the results of all identified articles was impossible. Instead, the study reports were analyzed separately and summarized qualitatively. The characteristics of the studies are summarized in Table 6.

It was not until the early 1990s that clinical researchers began to develop standardized instruments to differentiate various grades of psychological involvement. Therefore, according to the level of psycho-

logical disturbance and the main presenting symptom, we distinguished three groups:

- (1) disc displacement without reduction *with pain, without* major psychological symptoms;
- (2) TMD pain, *without* major psychological symptoms; and
- (3) TMD pain, *with* major psychological symptoms.

Table 3. Search strategy in the Cochrane Library (Issue 3/2006)

#	Search
1	(temporomandibular near disorder*):ti,ab,kw
2	(myoarthropath*):ti, ab, kw
3	MeSH descriptor Craniomandibular Disorders explode all trees
4	(#1 OR #2 OR #3)

Table 4. Search strategy in the Science Citation Index

#	Search
1	TS = ((temporomandibul* OR myoarthropath*) AND (therap* OR treat* OR multimodal* OR multimodal* OR combin* OR singl* OR simpl* OR placebo*) AND (rando* OR (systemati* AND review*) OR metaanaly* OR meta-analy* OR metanaly*)) DocType = All document types; Language = All languages; Database = SCI-EXPANDED; Timespan = 1945–2006

Table 5. Total and relevant hits after search in the different sources (after elimination of duplicates)

Source	Results	Relevant hits
Medline and Premedline	184	8: Elsharkawy & Ali (1995), Turk et al. (1996), Michelotti et al. (2000, 2004), Dworkin et al. (2002), Wahlund et al. (2003), Minakuchi et al. (2004), Truelove et al. (2006)
Cochrane Library: CDSR, DARE	7	0
Cochrane Library: Central	204	1: Turk et al. (1993)
Science Citation Index	153	1: Minakuchi et al. (2001)
Reference lists	–	1: Tversky et al. (1991)

(1) In the disc displacement group with pain, Minakuchi et al. (2001) observed that different multimodal therapies (explanation and advice regarding prognosis, diclofenac plus anti-gastric ulcer medication, cold/hot packs, soft food diet, and gentle jaw opening exercises, with or without flat-plane occlusal appliance therapy and jaw mobilization) were not superior to simple explanation and advice.

(2) Five studies were identified reporting on subjects with TMD pain, *without* major psychological symptoms (Turk et al. 1993; Elsharkawy & Ali 1995; Wahlund et al. 2003; Michelotti et al. 2004; Truelove et al. 2006).

Turk et al. (1993) showed that single therapy with either occlusal appliance or biofeedback-assisted relaxation and stress management was less efficacious than the combination of both interventions after 6 months (Turk et al. 1993).

In another study (Wahlund et al. 2003), brief information alone or in combination with relaxation training and occlusal appliance, respectively, were equally efficacious at the 6-month follow-up.

Likewise, Truelove et al. (2006) reported no superiority of multimodal interventions including splint therapy as opposed to patient education and/or self-care or relaxation, respectively.

Electrical stimulation of acupuncture points, combined with soft occlusal appliance, was observed not to be superior to a sham procedure (placebo acupuncture) at the 12-month follow-up (Elsharkawy & Ali 1995).

Michelotti et al. (2004) reported a slightly better outcome for a combination of education and home physical therapy regimen than patient education alone. However, due to an unusually high drop-out rate of more than 50% at the last assessment (after 3 months), the findings of the study must be interpreted with caution.

(3) In subjects with temporomandibular pain *and* major psychological disturbances, patients benefited more from a combined therapeutic approach (additional antidepressant medication or cognitive behavioral therapy) compared with a simple approach in all three identified studies (Tversky et al.

1991; Turk et al. 1996; Dworkin et al. 2002).

Discussion

A key feature of TMDs is pain, and pertinent studies commonly use pain as an outcome parameter. It is imperative to conceive pain as a multidimensional human experience with sensory-discriminative, affective-emotional, and cognitive-behavioral aspects (Merskey & Bogduk 1994). This implies that emotional disturbances on a scale from minimal disruption to severe comorbidities are invariably part of painful diseases – particularly in lingering pain conditions such as chronic TMD. As a consequence, effective medical therapy entails consideration of the patient's emotional status (Flor et al. 1992).

By recognizing pain as a multidimensional experience, inclusion of psychological assessment becomes crucial for accurate and comprehensive diagnosis (Palla 2006). This aspect has been addressed in three of the identified studies (e.g., Tversky et al. 1991; Turk et al. 1996; Dworkin et al. 2002).

Intuitively, one would expect that in patients with disc displacement without reduction, which appears to be a predominantly mechanical problem, a 'mechanical' approach would solve the disturbance. However, after 8 weeks, simple therapy has been shown to be equally effective as a multimodal approach (including active jaw mobilization and intraoral appliance therapy) (Minakuchi et al. 2001). This finding has been supported by the landmark study by Friction et al. (2002), who reported that an invasive approach, i.e., TMJ surgery without and with different types of disc implants (Proplast; temporary or permanent Silastic) was not advantageous over a conservative therapeutic approach.

In summary: for management of patients with painful anterior disc displacement without reduction as well as for patients with TMD pain exhibiting no major psychological disturbances, the null hypothesis as stated above can be accepted, whereas it must be rejected for patients with TMD pain and major psychological disturbances. Hence, individuals without major psychological disturbances do not

Table 6. Characteristics of the studies as reported in the identified articles

Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Dworkin et al. (2002)	117 patients referred to the Orofacial Pain Clinics, Department of Oral medicine, University of Washington School of Dentistry, for assessment of TMD pain and related TMD symptoms. Mean age: 39.3 years. (group 1)–38.6 years. (group 2) F : M 97 : 10	Self-report of facial acheor pain in the muscles of mastication, the TMJ, or the region in front of the ear or inside the ear Dysfunctional chronic pain [according to the Graded Chronic Pain Status (Von Korff et al. 1992)] Age between 18 and 70 years	Pain attributable to confirmed migraine or head pain other than tension headache Acute infection or other significant disease of teeth, ears, eyes, nose, or throat Debilitating physical or mental illness Necessity for emergency TMD therapy Inability to speak or write English	(1) Usual TMD therapy Physiotherapy Patient education Medication Intraoral heat-cured flat-plane occlusal appliance (2) Comprehensive care (6 sessions + 3 phone calls) Physiotherapy Patient education Medication Intraoral flat-plane occlusal appliance Cognitive-behavioral therapy (6 sessions)	58 59	4 months of therapy + 12 months of post-intervention
Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations	
Dworkin et al. (2002)	Characteristic pain intensity (CPI)	Graded Chronic Pain Scale (Von Korff et al. 1992)	Comprehensive care group <i>At post-therapy assessment (4 weeks after baseline evaluations)</i> Compared with usual therapy group: Significantly lower levels of CPI (35% vs. 18% decrease) Significantly higher self-reported ability to control TMD pain (40% vs. 20% decrease) Strong trend towards lower pain-related interference in daily activities <i>At 1-year follow-up</i> No significant difference from usual care group	'The 6-session CBT intervention for patients with heightened psychologic and psychosocial disability was effective in improving pain-related variables over the course of the CBT in conjunction with usual treatment, but was too brief an intervention to result in further improvement after the sessions ended. Patient ratings of treatment satisfaction and helpfulness were high for both groups, but they were significantly higher for the comprehensive care group.'	'A limitation of this study is the lack of an experimental condition to control for non-specific effects of the CBT intervention, such as attention and concern from the psychologist. The study design does not allow conclusions concerning the relative role of such effects vs. effects of the cognitive and behavioral components of the CBT program. This was not the goal of the present study, which focused on evaluating the efficacy of the CBT program as it might be generalized to application in clinical settings, rather than on identifying active or necessary and sufficient ingredients.'	
	Pain interference score Chronic pain grade Depression and somatization Self-reported days in pain during the past 6 months Self-reported ability to control TMD-related pain Process of care ratings (perceived helpfulness and global satisfaction)	SCL-90 depression and somatization scales (Derogatis 1983) Graded Chronic Pain Scale (Von Korff et al. 1992) Rosenstiel & Keefe (1983) 0–10 scales				

Table 6. (Continued)

Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Eisharkawy & Ali (1995)	100 patients referred to the Oral Surgery Department, Cairo University, for TMD therapy. Mean age: unknown F:M: unknown	Two or more of the following symptoms: TMJ pain and tenderness upon palpation Temporalis, masseter, and/or lateral pterygoid, muscle tenderness TMJ clicking and jaw locking	Unwillingness of (regular) participation Pain-free disc displacement Epilepsy, vasovagal attacks, vertebral artery insufficiency, and similar medical conditions	(1) Acupuncture <i>Acuhealth</i> (small hand-held unit which produces minute electrical impulses to stimulate acupuncture points) (8 sessions at 1-week intervals) (2) Occlusal splint Soft bite splint (polyvinyl), worn at night for 8 weeks (3) Acupuncture + occlusal splint (4) Control group Placebo acupuncture	25 (at 12 months: 18) 25 (at 12 months: 17) 25 (at 12 months: 28) 25 (at 12 months: 0)	8 weeks therapy + 12 months post-intervention
Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations	
Eisharkawy & Ali (1995)	TMD symptoms Pain	Anamnestic Dysfunction Index (A _i) (Helkimo 1974) verbal rating scale visual analog scale	Therapy groups <i>Assessment 3 months after therapy</i> Compared with group (4), significant improvement in groups (1), (2), and (3), but no difference among the three	'The study shows that the improvement result of either type of therapy observed 3 months after treatment remained unchanged during the entire follow up period.'	Small sample size Shortcomings in reporting Methodology not clearly described; no clear link between the described methods and the results	
Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Michelotti et al. (2000, 2004)	70 (49) consecutive myogenous patients seeking therapy and referred to the TMD Center, U of Naples, Italy Mean age: 31.8 years. (group 1)–28.2 years. (group 2) F:M 62 : 8	Recurrent or constant pain for more than 3 months Spontaneous pain > 30/100 VAS in the last week	Objective evidence of TMJ pathology or dysfunction Arthrogenous TMD with pain or radiographic alterations in the TMJs (Dworkin & LeResche 1992) Other orofacial pain conditions Other TMD therapy within the last 3 months Neurologic or psychiatric disorders History of pain medication abuse or current abuse	(1) Education Patient education and reassurance General information about self-care of jaw musculature (2) Education + home physical therapy Education (see above) Self-supportive exercise program (including relaxation exercises, self-massage of masticatory muscles, application of moist heat pads, stretching, coordination exercises)	23 26	3 months therapy

Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations
Michelotti et al. (2000, 2004)	Spontaneous pain Joint pain, muscle stiffness, functional limitation, pain during chewing of hard food and/or during yawning Presence of pain during active or passive mandibular movements Presence of pain during TMJ traction Pain during muscle palpation Pain during anterior bruxoprovocaton Pain during jaw clenching in the intersupal position for 30 s Pressure pain threshold of masseter and temporal muscles Pain on chewing gum for 60 s Pain-free maximum jaw opening	100-mm VAS Verbal rating scale Verbal rating scale Verbal rating scale Verbal rating scale Verbal rating scale Algometer 100-mm VAS Millimeter ruler	Between-group differences: 'Pain-free maximal jaw opening was significantly greater in the education + home PT group than in the education-only group. No significant differences were found between treatment modalities in any of the other outcome measurements.' 'The success rate . . . was . . . 57% for the education-only group and 77% for the education and home PT group. This difference was not statistically significant.'	'Over a period of 3 months, the combination of education and a home physical therapy regimen, as used in this protocol, is slightly more clinically effective than education alone for the treatment of myofascial pain of the jaw muscles.'	No non-therapy control group Drop-out rate of more than 50% at the last assessment (after 3 months)

Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Minakuchi et al. (2001, 2004)	69 consecutive patients referred to the TMD clinic, Okayama University Dental School, Japan, for TMD therapy. Non-probability convenience sample with limited generalizability to a general population. Mean age: 32.0 years. (group 1)–33.3 years. (group 2)–36.9 years. (group 3) F : M 62 : 7	Painful anterior disc displacement without reduction	Unwillingness of (regular) participation Edentulousness Rheumatism, diabetes mellitus, or similar serious systemic disease Previous or ongoing management/treatment for TMDs or tooth problems in other clinics	(1) Splint/physical medicine Palliative care (see below) Full-arch flat-plane occlusal appliance Active jaw mobilization therapy at weeks 0, 2, 4, 8 (2) Palliative care Information (see below) Diclofenac (25 mg 3x/day) Cold or hot pack Soft food diet Gentle jaw opening exercises (3) Control group: information Explanation and advice regarding prognosis No specific therapy	25 23 21	8 weeks therapy

Table 6. (Continued)

Study	Outcome measures	Instruments	Results	Authors' conclusion		
Minakuchi et al. (2001, 2004)	<p>Pain at rest and during mastication</p> <p>Daily activity limitation as a result of therapy</p> <p>Maximum jaw opening:</p> <p>Comfortable</p> <p>Active</p> <p>Passive</p> <p>Subjective improvement of jaw movements</p> <p>Patient satisfaction with therapy</p> <p>Difficulties with Daily activity</p> <p>Social activities</p> <p>Work and home activities as a result of therapy</p>	<p>100-mm visual analog scale</p> <p>18-item questionnaire</p> <p>Millimeter ruler</p> <p>Self-administered 5-point verbal rating scale</p> <p>Self-administered 5-point verbal rating scale</p> <p>11-point numerical rating scale</p>	<p>Within-group differences:</p> <p>'At the eight-week point, within-group improvements were present for all variables, for all groups.'</p> <p>Between-groups differences:</p> <p>Pain/daily activity limitation/jaw opening: 'not highly evident, with only mean daily activity limitation for the self-care/NSAID group being significantly lower than that of the occlusal appliance/jaw mobilization + self-care/NSAID group at the two- and four-week time-points'</p> <p>Subjective improvement of jaw movements: Palliative care statistically significantly greater improvement at the 2-week, 4-week, and 8-week observation points as compared with the other two groups</p> <p>Patient satisfaction: no significant differences</p> <p>Difficulties: statistically significantly greater difficulty in the <i>physical medicine</i> group</p>	<p>'ADDwor subjects will improve with only minimal treatment intervention, and no significant difference was evident for the treatments tested and the control condition.'</p> <p>'All treatments achieved an equivalent degree of patient satisfaction at 2 months.'</p> <p>'Although occlusal appliances are not generally harmful, they might be inappropriate to treat patients with recently confirmed Ddwor because of the cost and potential for harm (e.g. bite changes). A more conservative approach of short-term NSAIDs and gently self-applied stretching of the jaw is more logical.'</p>		
Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Truelove et al. (2006)	<p>200 (at 12 months: 118) consecutive patients seen at the Orofacial Pain Clinic, Department of Oral Medicine, School of Dentistry, University of Washington, Seattle.</p> <p>Mean age: 36 years. (group 1) – 35 years. (group 2) – 36 years. (group 3)</p> <p>F : M 157 : 43</p>	<p>Myofascial pain, with or without a concurrent diagnosis of arthralgia or disc displacement with reduction (Dworkin & LeResche 1992)</p> <p>GCPS Grade I or II (Von Korff et al. 1992)</p> <p>18–65 years of age</p>	<p>other RDC/TMD diagnoses</p> <p>any systemic arthritis or other serious medical complications</p> <p>full dentures</p> <p>major psychological disorders</p> <p>inability to communicate in English</p>	<p>(1) Self-care</p> <p>Jaw relaxation</p> <p>Reduction of parafunction</p> <p>Thermal packs</p> <p>NSAIDs</p> <p>Passive opening stretches</p> <p>Suggestions about stress reduction</p> <p>(2) Self care + soft thermoplastic vinyl athletic mouthguard splint</p> <p>(3) Self care + flat-plane maxillary hard splint</p>	<p>64 (at 12 months: 48)</p> <p>68 (at 12 months: 55)</p> <p>68 (at 12 months: 65)</p>	<p>12 months therapy</p>

Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations
Truelove et al. (2006)	<p>Characteristic pain intensity (CPI)</p> <p>Self-reported bruxism</p> <p>Limitations in jaw use</p> <p>Changes in clinical examination findings and diagnosis</p> <p>Pain duration</p> <p>Compliance with therapeutic recommendations</p>	11-point numerical rating scales	<p>Between-group differences: 'The authors observed no significant differences among the groups in TMD-related pain levels or other common signs and symptoms of TMD at baseline (BL) or at any follow-up. The changes from BL were comparable for all three groups.'</p>	<p>'All patients improved over time, and traditional splint therapy offered no benefit over the soft splint therapy. Neither splint therapy provided a greater benefit than did self-care treatment without splint therapy. These findings suggest that clinicians who treat patients with TMD should consider prescribing low-cost nonsplint self-care therapy for most patients.'</p> <p>'Patients with limited means . . . can be treated successfully with therapies that can be applied outside of traditional dental settings.'</p>	Non-probability convenience sample with limited generalizability to a general population.

Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Türk et al. (1993)	110 (109) consecutive referrals to an outpatient TMD pain clinic at the University of Pittsburgh	<p>Pain and tenderness of the muscles of mastication and TMJ region and limited mandibular movements of at least 2 months duration</p> <p>At least 18 years of age</p>	<p>Serious psychopathology</p> <p>History of TMJ-related surgery</p>	<p>(1) Intraoral heat-cured flat-plane occlusal appliance</p> <p>(2) Biofeedback/stress management (6 sessions at 1-week intervals)</p> <p>(3) Full-arch heat-cured flat-plane occlusal appliance + biofeedback/stress management</p> <p>(4) Waiting list group</p>	30 30 29 20	6 weeks therapy + 6 months post-intervention

Study	Outcome measures	Instruments	Results	Authors' conclusion
Türk et al. (1993)	<p>Pain</p> <p>Depression</p> <p>Credibility ratings</p>	<p>Pain Severity Scale</p> <p>Muscle Palpation Pain Index</p> <p>Beck Depression Inventory</p> <p>Affective Distress Scale</p> <p>10-point scales</p>	<p>Within-group differences</p> <p>Significant reductions in pain and depression levels (except in waiting list group)</p> <p>Significant increase in credibility ratings</p> <p>Between-group differences</p> <p>'the combined treatment approach was more effective than either of the single treatments alone, particularly in pain reduction, at the 6-month follow-up.'</p>	'These results support the importance of using both dental and psychologic treatments to successfully treat TMD patients if treatment gains are to be maintained.'

Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Türk et al. (1996)	48 (41) consecutive dysfunctional patients referred to an outpatient TMD pain clinic at the U of Pittsburgh	<p>Pain and tenderness of the muscles of mastication and TMJ region and limited mandibular movements of at least 2 months duration</p> <p>At least 18 years of age</p>	<p>Serious psychopathology</p> <p>History of TMJ-related surgery</p>	<p>(1) Full-arch flat-plane acrylic interocclusal appliance + stress management/biofeedback (6 sessions at 1-week intervals) + nondirective, supportive counseling group</p> <p>(2) Full-arch flat-plane acrylic interocclusal appliance + stress management/biofeedback group (6 sessions at 1-week intervals) + cognitive therapy</p>	20 21	6 weeks of therapy + 6 months of post-intervention

Table 6. (Continued)

Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations	
Türk et al. (1996)	Pain	Muscle Palpation Pain Index TMJ Palpation Index McGill Pain Questionnaire Pain Catastrophizing Scale Interference Scale Oral-Parafunctional Habits Scale Self-reported use of medication Self-reported use of health care resources for TMJ pain	Within-group differences: 'Both treatment groups reported statistically significant reductions on a set of physical, psychosocial, and behavioral measures post-treatment and at a 6-month follow-up.' Between-groups differences: 'However, the intervention that included cognitive therapy demonstrated significantly greater reductions in pain, depression, and medication use. Only the groups receiving the treatment that included the cognitive therapy demonstrated continued improvements to the follow-up on pain associated with muscle palpation, self-reported pain severity, depression, and use of medications.'	'These results support the efficacy of the tailored treatment for dysfunctional TMD.'		
	Active jaw opening without pain Maximum jaw opening Depression Credibility ratings	Beck Depression Inventory Affective Distress Scale 10-point scales				
Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Tversky et al. (1991)	60 TMD patients referred to the Oral Medicine Clinic, The Royal Dental Hospital, Melbourne, Australia, for assessment and management of facial pain Mean age: 32 years. (group 1) – 40 years. (group 2) – 31 years. (group 3) – 38 years. (group 4) F : M 55 : 5	Recent history of TMD, plus at least two of the following: TMJ noises and discomfort on function Limitation of mandibular movements Masticatory muscle tenderness on palpation	Patients younger than 12 and older than 70 years Unable to understand and read English Psychiatric disorders other than depressive illness or mild anxiety state	(1) Occlusal splint (non-depressed patients) (2) Occlusal splint (depressed patients) (3) Antidepressant doxepin (depressed patients) (4) Occlusal splint + antidepressant doxepin (depressed patients)	(1) 15 (2) 15 (3) 15 (4) 15	20 weeks of therapy
Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations	
Tversky et al. (1991)	Pain Depression	VAS Hamilton Rating Scale for Depression	Within-group/between-groups differences After 8 weeks, 'there was a significant difference in response in the nonpsychiatric and combined-therapy depressed groups in comparison with the two depressed groups treated either with occlusal splint or with antidepressant therapy. The combined therapy led to resolution of the painful problem and the depression, whereas the single therapies were only partly successful in relieving the pain-dysfunction syndrome.'	'The findings from this study help explain why a significant number of patients are considered untreatable for chronic pain conditions when only the physical aspects are addressed in their clinical therapy.'		

Study	Patients	Inclusion criteria	Exclusion criteria	Therapeutic groups (randomized)	n	Study duration
Wahlund et al. (2003)	122 consecutive TMD pain patients (adolescents, 12–18 years) referred to the TMD Clinic, Linköping, Sweden. Mean age: 15.3 years F : M 93 : 29	Patients reported pain once a week or more in the face, jaws, TMJs, or temples for a period of at least 3 months Patients had received an RDC/TMD diagnosis (Dworkin & LeResche 1992) Patients wanted therapy	Juvenile rheumatoid arthritis Migraine Current therapy with orthodontic appliances that could interfere with occlusal appliance therapy	(1) Brief information (one session) + relaxation training (4 sessions at 2-week intervals) (2) Brief information (one session) + occlusal appliance (4 sessions at 2-week intervals) (3) Brief information (one session)	(1) 41 (2) 42 (3) 39	3 months of therapy + 6 months of post-intervention

Study	Outcome measures	Instruments	Results	Authors' conclusion	Limitations
Wahlund et al. (2003)	Pain Subjective evaluation of the therapy Analgesic consumption School absence Bruxism Clinical features	Questionnaire (Wahlund et al. 1998), including VAS (pain intensity) and 5-point pain verbal rating scale (frequency) Pain diary 6-point verbal rating scale 6-point verbal rating scale Number of days Yes/no patient answers RDC/TMD	Within-group/between-group differences In the brief information + occlusal appliance group, 60% of the patients achieved a clinically significant improvement (at least 50% or more) on the pain index, a significantly higher proportion compared with that obtained in the other 2 treatment groups. Analgesic consumption was also significantly more reduced in the brief information + occlusal appliance group compared to the brief information group. However, no significant differences were found between the treatment groups in jaw opening or in muscle and TMJ tenderness scores'.	'Occlusal appliance was found to be superior to both relaxation therapy and brief information regarding pain reduction and can therefore be recommended when treating adolescents with TMD pain.'	
TMJ, temporomandibular joint; TMD, temporomandibular disorder; RDC/TMD, Research Diagnostic Criteria for Temporomandibular Disorders; VAS, visual analogue scale; CBT, cognitive behavioural therapy; NSAIDs, Non-steroidal anti-inflammatory drugs; GCPS, Greig cephalopolysyndactyly syndrome.					

require more than simple therapy. In contrast, patients with major psychological disturbances need to be identified because the best outcome is achieved with a multimodal, interdisciplinary therapeutic strategy.

Recommendations for best patient management

Therapeutic decisions must be based on comprehensive and correct diagnoses. Clinicians' awareness of the psychological ramifications of pain in acute or chronic TMD patients is important to avoid inadequate focus on dental or surgical management approaches. However, dentists are usually not or inadequately trained to perform assessments of psychological disturbances and psychiatric comorbidities, such as depression or anxiety. In this situation, validated psychometric screening tools, such as the Graded Chronic Pain Scale (Von Korff et al. 1992), may easily be used in general practice.

A fundamental requirement for improved therapeutic outcomes is the clinician's acceptance of the importance of psychological factors and knowledge about the efficacy and effectiveness of psychological interventions. This forms the platform for convincingly educating patients about the need for interdisciplinary (i.e., multimodal) management. Even though our systematic review shows the superiority of multimodal as compared with simple therapy, not all patients with TMD may achieve symptom relief with either approach.

Recommendations for future systematic reviews on TMDs

Several scoring scales commonly used in systematic reviews for assessing the reporting quality of RCTs may be inadequate in psychological intervention studies. A new scale has been designed to score such trials (Yates et al. 2005). We suggest that it can be applied in future systematic reviews on

patients with TMDs. Furthermore, when pain is a study outcome parameter, clinically relevant changes need to be considered in addition to statistically significant improvements (Turk 2000; Salaffi et al. 2004).

References to studies included in this review

- Dworkin, S.F., Turner, J.A., Mancl, L., Wilson, L., Massoth, D., Huggins, K.H., LeResche, L. & Truelove, E. (2002) A randomized clinical trial of a tailored comprehensive care treatment program for temporomandibular disorders. *Journal of Orofacial Pain* **16**: 259–276.
- Elsharkawy, T.M. & Ali, N.M. (1995) Evaluation of acupuncture and occlusal splint therapy in the treatment of temporomandibular joint disorders. *Egyptian Dental Journal* **41**: 1227–1232.
- Michelotti, A., Parisini, F., Farella, M., Cimino, R. & Martina, R. (2000) Fisioterapia muscolare in pazienti con disordini temporomandibolari. Studio clinico controllato. *Minerva Stomatologica* **49**: 541–548.
- Michelotti, A., Steenks, M.H., Farella, M., Parisini, F., Cimino, R. & Martina, R. (2004) The additional value of a home physical therapy regimen versus patient education only for the treatment of myofascial pain of the jaw muscles: short-term results of a randomized clinical trial. *Journal of Orofacial Pain* **18**: 114–125.
- Minakuchi, H., Kuboki, T., Maekawa, K., Matsuka, Y. & Yatani, H. (2004) Self-reported remission, difficulty, and satisfaction with nonsurgical therapy used to treat anterior disc displacement without reduction. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* **98**: 435–440.
- Minakuchi, H., Kuboki, T., Matsuka, Y., Maekawa, K., Yatani, H. & Yamashita, A. (2001) Randomized controlled evaluation of non-surgical treatments for temporomandibular joint anterior disk displacement without reduction. *Journal of Dental Research* **80**: 924–928.
- Morton, V. & Torgerson, D.J. (2003) Effect of regression to the mean on decision making in health care. *British Medical Journal* **326**: 1083–1084.
- Truelove, E., Huggins, K.H., Mancl, L. & Dworkin, S.F. (2006) The efficacy of traditional, low-cost and nonsplint therapies for temporomandibular disorder: a randomized controlled trial. *Journal of the American Dental Association* **137**: 1099–1107.
- Turk, D.C., Rudy, T.E., Kubinski, J.A., Zaki, H.S. & Greco, C.M. (1996) Dysfunctional patients with temporomandibular disorders: evaluating the efficacy of a tailored treatment protocol. *Journal of Consulting and Clinical Psychology* **64**: 139–146.
- Turk, D.C., Zaki, H.S. & Rudy, T.E. (1993) Effects of intraoral appliance and biofeedback/stress management alone and in combination in treating pain and depression in patients with temporomandibular disorders. *Journal of Prosthetic Dentistry* **70**: 158–164.
- Tversky, J., Reade, P.v.C., Gerschman, J.A., Holwill, B.J. & Wright, J. (1991) Role of depressive illness in the outcome of treatment of temporomandibular joint pain-dysfunction syndrome. *Oral Surgery Oral Medicine Oral Pathology* **71**: 696–699.
- Wahlund, K., List, T. & Larsson, B. (2003) Treatment of temporomandibular disorders among adolescents: a comparison between occlusal appliance, relaxation training, and brief information. *Acta Odontologica Scandinavica* **61**: 203–211.
- Flor, H., Fydrich, T. & Turk, D.C. (1992) Efficacy of multidisciplinary pain treatment centers: a meta-analytic review. *Pain* **49**: 221–230.
- Fricton, J.R., Look, J.O., Schiffman, E. & Swift, J. (2002) Long-term study of temporomandibular joint surgery with alloplastic implants compared with nonimplant surgery and nonsurgical rehabi-

Additional references

- Derogatis, L. (1983) *The SCL-90R Manual-II: Administration, Scoring and Procedures*. Baltimore: Clinical Psychometric Research.
- Dworkin, S.F., Huggins, K.H., LeResche, L., Von Korff, M., Howard, J., Truelove, E. & Sommers, E. (1990) Epidemiology of signs and symptoms in temporomandibular disorders: clinical signs in cases and controls. *Journal of the American Dental Association* **120**: 273–281.
- Dworkin, S.F. & LeResche, L. (1992) Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *Journal of Craniomandibular Disorders Facial and Oral Pain* **6**: 301–355.

- litation for painful temporomandibular joint disc displacement. *International Journal of Oral and Maxillofacial Surgery* 60: 1400–1411.
- Griffiths, R.H. (1983) *The President's Conference on the Examination, Diagnosis and Management of Temporomandibular Disorders*. Chicago: American Dental Association.
- Helkimo, M. (1974) Studies on function and dysfunction of the masticatory system. II. Index for anamnestic and clinical dysfunction and occlusal state. *Swedish Dental Journal* 67: 101–121.
- Howard, J.A. (1991) Temporomandibular joint disorders, facial pain, and dental problems in performing artists. In: Sataloff, R.T., Brandfonbrener, A.G. & Lederman, R.J., eds. *Textbook of Performing Arts Medicine*, 111–169. New York: Raven Press.
- Laskin, D.M., Greene, C.S. & Hylander, W.L. (2006) *TMDs. An Evidence-Based Approach to Diagnosis and Treatment*. Chicago: Quintessence.
- McNeill, C., ed. (1992) *Current Controversies in Temporomandibular Disorders*. Chicago: Quintessence.
- Merskey, H. & Bogduk, N., eds (1994) *Classification of Chronic Pain*. 2nd edition. Seattle: IASP Press.
- National Institutes of Health (1996) Management of temporomandibular disorders. National institutes of health technology assessment conference statement. *Journal of the American Dental Association* 127: 1595–1606.
- Palla, S. (2006) A need to redefine chronic pain? *Journal of Orofacial Pain* 20: 265–266.
- Plesh, O., Sinisi, S.E., Crawford, P.B. & Gansky, S.A. (2005) Diagnoses based on the research diagnostic criteria for temporomandibular disorders in a biracial population of young women. *Journal of Orofacial Pain* 19: 65–75.
- Rantala, M.A., Ahlberg, J., Suvinen, T.I., Nissinen, M., Lindholm, H., Savolainen, A. & Könönen, M. (2003) Temporomandibular joint related painless symptoms, orofacial pain, neck pain, headache, and psychosocial factors among non-patients. *Acta Odontologica Scandinavica* 61: 217–222.
- Rosenstiel, A.K. & Keefe, F.J. (1983) The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. *Pain* 17: 33–44.
- Rudy, T.E., Turk, D.C., Kubinski, J.A. & Zaki, H.S. (1995) Differential treatment responses of TMD patients as a function of psychological characteristics. *Pain* 61: 103–112.
- Salaffi, F., Stancati, A., Silvestri, C.A., Ciapetti, A. & Grassi, W. (2004) Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *Pain* 8: 283–291.
- Stohler, C.S. (2004) Taking stock: from chasing occlusal contacts to vulnerability alleles. *Orthodontics and Craniofacial Research* 7: 157–161.
- Suvinen, T.I., Reade, P.C., Hanes, K.R., Könönen, M. & Kempainen, P. (2005) Temporomandibular disorder subtypes according to self-reported physical and psychosocial variables in female patients: a re-evaluation. *Journal of Oral Rehabilitation* 32: 166–173.
- Türk, D.C. (2000) Statistical significance and clinical significance are not synonyms!. *Clinical Journal of Pain* 16: 185–187.
- Türp, J.C. (2000) *Temporomandibular Pain. Clinical Presentation and Impact*. Berlin: Quintessenz.
- Vallaro, D., Nilner, M. & Soderfeldt, B. (1998) Treatment outcome in patients with craniomandibular disorders of muscular origin: a 7-year follow-up. *Journal of Orofacial Pain* 12: 210–218.
- Vlaeyen, J.W. & Morley, S. (2005) Cognitive-behavioral treatments for chronic pain: what works for whom? *Clinical Journal of Pain* 21: 1–8.
- Vollaro, S., Michelotti, A., Cimino, R., Farella, M. & Martina, R. (2001) Epidemiologic study of patients with temporomandibular disorders. Report of data and clinical findings. *Minerva Stomatologica* 50: 9–14.
- Von Korff, M., Ormel, J., Keefe, F.J. & Dworkin, S.F. (1992) Grading the severity of chronic pain. *Pain* 50: 133–149.
- Von Korff, M., Wagner, E.H., Dworkin, S.F. & Saunders, K.W. (1991) Chronic pain and use of ambulatory health care. *Psychosomatic Medicine* 53: 61–79.
- Wahlund, K., List, T. & Dworkin, S.F. (1998) Temporomandibular disorders in children and adolescents: reliability of a questionnaire, clinical examination, and diagnosis. *Journal of Orofacial Pain* 12: 42–51.
- Whitney, C.W. & Von Korff, M. (1992) Regression to the mean in treated versus untreated chronic pain. *Pain* 50: 281–285.
- Yap, A.U., Dworkin, S.F., Chua, E.K., List, T., Tan, K.B. & Tan, H.H. (2003) Prevalence of temporomandibular disorder subtypes, psychologic distress, and psychosocial dysfunction in Asian patients. *Journal of Orofacial Pain* 17: 21–28.
- Yates, S.L., Morley, S., Eccleston, C., de, C. & Williams, A.C. (2005) A scale for rating the quality of psychological trials for pain. *Pain* 117: 314–325.

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