Muscular diagnostics and the feasibility of microsystem acupuncture as a potential adjunct in the treatment of painful temporomandibular disorders: results of a retrospective cohort study

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ABSTRACT

Aims To investigate the effect of microsystem acupuncture on painful temporomandibular disorders (TMD).

Methods We retrospectively analysed 887 treatments in 407 TMD-patients (mean age 45±1.5 years), who received microsystem acupuncture (mouth, scalp or fingers) with a focus on oral acupuncture. All patients systematically underwent palpation of specific muscular tender points and their pain rating was assessed on a four-point Likert scale (no pain to strong pain) before and after treatment. In 42 cases, the pain intensity was determined using a visual analogue scale (0–100 mm). As the data were normally distributed, analysis was performed with unpaired t-tests.

Results The pterygoid muscles were most painful to palpation, with the lateral pterygoid rated moderate to strong by 76% of patients and the medial pterygoid by 48% of patients. The palpation of microsystem acupuncture points revealed the strongest sensitivity (moderate or strong pain) of the oral retromolar points at the upper jaw (83%). After treatment, the pain intensity of all tender points had significantly decreased (P<0.001). The proportion of moderate to strong pain ratings was below 3% at most tender points. Overall pain intensity of the subjects (n=42) before treatment was 55.5±19.7 mm on the VAS scale and was significantly reduced to 29.6±20.9 mm (P<0.001) post-treatment.

Conclusions This analysis suggests microsystem acupuncture could reduce the pain intensity of TMD in the short term. Considering the increased local muscular tenderness, further investigations regarding the key role of myofascial trigger points in the occurrence of TMDs are warranted and could lead to new comprehensive treatment strategies.

INTRODUCTION

One of several definitions of temporomandibular disorders (TMDs) originates from the 1970s, describing a syndrome complex of functional temporomandibular joint (TMJ) disturbances or disorders.[1] Later, the definition was expanded to 'myo-arthro-occlusion-neuropsychopathy', summarising all known aetiological causes.[2] Thus, TMDs are a collection of conditions affecting the TMJ, muscles of mastication and/or associated structures.[3] The aetiology comprises inflammatory, traumatic, infectious, congenital, developmental and neoplastic diseases.[4] Among the most prevalent signs and symptoms are pain, joint sounds and irregular or impaired mandibular function.[5]

According to Schiffman,[6] TMDs are a significant public health problem. They affect 5–12% of the US population and are the second most common musculoskeletal condition resulting in pain and disability (after chronic low back pain[7]). They have a significant impact on affected individuals' daily activities, psychosocial functioning and quality of life. About 15% of all TMDs will become chronic, with an overall annual cost estimate of US$4 billion in the USA.

Carvalho *et al* recently summarised that the worldwide prevalence of one sign of TMD is 33–86%, and the prevalence of at least one symptom is 16–59%.[5] TMDs are probably one of the most prevalent orofacial pain complaints.

Acupuncture is a treatment method derived from Traditional Chinese Medicine (TCM). One of its main and most studied indications is the treatment of pain.[8] Several theories regarding its physiological effects and mechanisms on a cellular level have been proposed.[9] Over time the traditional Chinese style has been modified and several other approaches have been developed. One of these approaches is microsystem acupuncture. It has been suggested that systematic point patterns are found on circumscribed parts of the body—for example, the auricle, the scalp, the oral cavity and other areas.[10] Beside physiological mechanisms proposed for traditional acupuncture,[9] microsystems have been reported to have a greater influence on the vegetative nervous system.[11] The microsystem approach for TMD has been previously studied in randomised trials.[12]

The ear is probably the most widely known microsystem.[13] In 2009 a German article described the use of microsystems in the field of otorhinolaryngology,[14] highlighting the system in the oral mucosa (mouth microsystem). A previous study investigated the effects of auricular and oral acupuncture on pain relief in TMD.[12] However, larger trials have not been published so far.

The aim of the present study is to describe an approach combining needling at acupuncture points corresponding to an intraoral microsystem and the auricle, as well as classical TCM acupuncture points, by retrospective analysis of treatments in a routine care setting.

METHODS

Study design

We undertook a retrospective analysis of the clinical records and prospectively collected structured report forms of a private dental clinic in Bregenz, Austria, between October 2000 and January 2014. Reporting of these data adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.[15] Besides routine care, the clinic specialises in the treatment of TMDs with acupuncture. Patients included in this analysis were referrals from other healthcare professionals and self-scheduled appointments for the treatment of TMD. Decision criteria of the clinic to perform acupuncture were age 18–75 years and the presence of TMD; patients with rheumatoid arthritis or fibromyalgia were included. Exclusion criteria were TMJ disc displacements, neoplasms, congenital abnormality or defects of the head/neck, previous TMJ surgery and confirmed osteoarthritis/osteoarthrosis of the TMJ, acute psychiatric illnesses and pregnancy. Adverse events were defined as soft tissue or joint infections and peripheral nerve injury.

All patients in the observational period had undergone a standardised diagnostic and therapeutic procedure, as well as standardised documentation. TMD was diagnosed according to the RDC/TMD Consortium Network; the assessment includes the confirmation of pain in masticatory muscles and familiar pain in masticatory muscles upon either muscle palpation or maximum opening.[16]

The most widely used diagnostic tool for TMD is the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD[17]). The RDC/TMD is a set of diagnostic criteria in TMD research based on a clinical (Axis I) and a psychological (Axis II) assessment. A less complex tool was published in 2007 by the European Academy of Craniomandibular Disorders (EACD[18]). They conceived a four-item questionnaire to detect symptoms of TMD. Patients who respond affirmatively to any of the items are further assessed for TMD. This instrument is an effective screening tool for patients reporting TMD symptoms.[5]

Patients corresponded either to group Ia, Ib or IIIa of TMD. Beside the RDC/TMD clinical examination, their assessment included distinction between the medial and lateral pterygoid area, the palpation of additional cervical muscles (sternocleidomastoid) and the craniocervical junction, as well as the recording of pain radiation. In addition, intraoral areas for potential treatment by microsystem acupuncture were assessed. Based on the findings, patients received individual treatment at the discretion of the treating dentist. Muscles and joints were re-assessed before discharge 15 min after treatment. All cases were documented on a standardised form and we retrospectively analysed the anonymised clinical records and data collected in the consultations over the study period. The study was approved by the Cantonal Ethics Committee, Bern, Switzerland (reference 2016–01206) and was conducted in full compliance with the Declaration of Helsinki (Fortaleza 2013).[19]

Intervention

Oral acupuncture was performed by means of superficial injection of physiological saline 0.9% using 0.33 × 12.7 mm micro cannulas (29G, BD Micro-Fine Ultra Pen Needle, Becton Dickinson GmbH, Heidelberg, Germany). All other acupuncture was performed with 0.2 × 15 mm conventional sterile acupuncture needles (Seirin.B-type, Seirin Corp, Shizuoka City, Japan).

The so-called 'very-point' technique was used for point localisation and subsequent needle insertion. This technique, according to its original description by Jochen Gleditsch, is supposed to enable the acupuncturist to target points with maximum accuracy using very fine and sharp injection or acupuncture needles.[12] The technique is performed by tapping gently and tangentially at an angle about 45° to the area of the acupuncture point with a thin cannula. The focus is to retrieve the most sensitive spot within this area according to the patient's perception. This point of greatest sensitivity and tenderness, the 'very point', forms, as a rule in this concept, the centre of the area

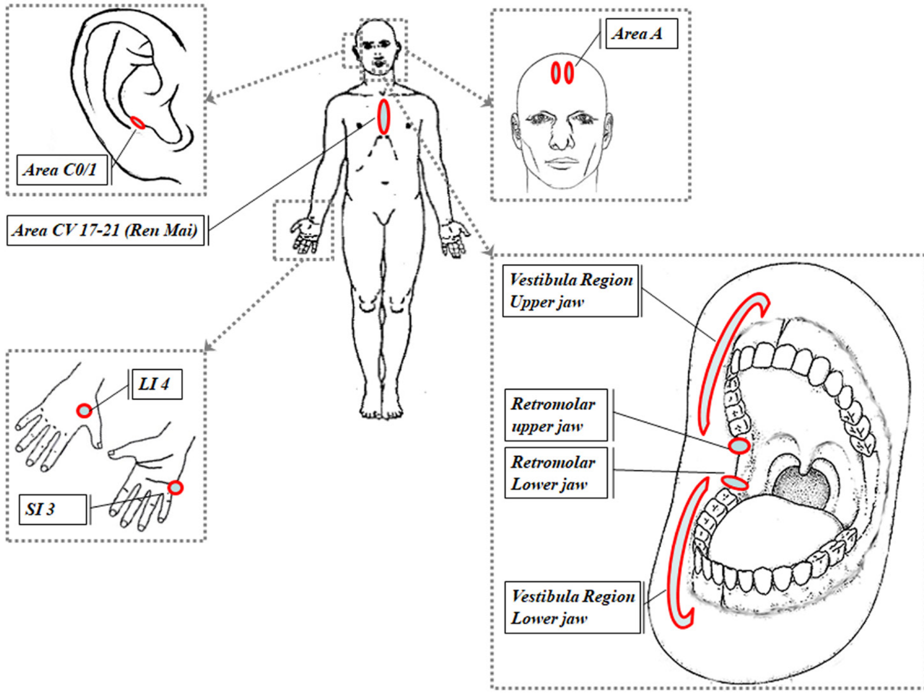

Figure 1 Overview of the different acupuncture treatment areas (highlighted in red). C0/1 belongs to the corresponding zone for the occipito-cervical junction. Area CV17-21 refers to the sternal midline. The acupuncture points LI4 and SI3 are located at the hands. Area A, corresponding to the cervical spine according to Yamamoto, lies bilaterally next to the midline of the forehead. The intraoral areas comprise the retromolar and vestibular regions as indicated. All areas are encircled with a red line.

of irritation. The patient reacts accordingly by mimic expression and/or verbal affirmation and the needle or cannula is inserted in the superficial mucosa with the aim of provoking a stimulus. In the case of intraoral treatment, the cannula is withdrawn immediately after injecting 0.5 mL of normal saline. Re-examination took place 15 min after the treatment, determined by the organisational structure of the clinic.

Oral treatment areas included the bilateral retromolar and vestibular regions of the upper and lower jaw (in total 8 points). Extraoral treatment areas included the auricular microsystem (the area representing segments C0 and C1, bilaterally on the antihelix), the scalp according to Yamamoto new scalp acupuncture (two points), classical acupuncture points SI3 and LI4 and over the sternum (the area between CV21 and CV17); see figure 1.

Outcome measures

All patients were examined for the prevalence of tender points. Thereafter the 10 predominant muscles of the TMJ were palpated (see table 1) bilaterally. The examiners identified the muscle spasm (taut-band) first and then localised the tender spots. If more than one tender spot was present, the most painful was scored in the examination. Pain on palpation was noted on a four-point Likert scale (with 0=no pain, 1=low pain, 2=moderate pain and 3=strong pain). In addition, the two leading junctions (atlanto-occipital and cranio-mandibular) were both palpated for tenderness.

Feasibility and verification of the palpation of the lateral pterygoid muscles has recently been described in depth.[20] It is performed intraorally with the patient deviating his or her mandible laterally toward the side to be assessed. The direction of palpation drives along the oral vestibule parallel to the superior section of the alveolar process of the maxilla, onto the maxillary tuberosity, and then further until the lateral plate of the pterygoid process is reached.[20] At this point, the superior section of the medial pterygoid muscle is crossed. This is important, as anatomists state that the main difficulty in reliably identifying this muscle is due to the fact that the medial pterygoid muscle must be passed before palpating the lateral pterygoid muscle. During the course of palpation, the indexing finger must make a terminal craniomedial movement; meanwhile the person being examined is opening and closing his or her mouth.[20]

Table 1 Bilateral palpation points (10 muscles and two junctions)

M. temporalis anterior	M. temporalis medialis
M. temporalis posterior	M. masseter
M. pterygoideus lateralis	M. pterygoideus medialis
M. digastricus	M. suprahyoidalis
M. infrahyodalis	M. sternocleidomastoideus
Cranio-mandibular junction	Atlanto-occipital junction

Treatment points (see above) were examined and palpated in the same style. The provider examined the respective tissue applying the very point technique with a thin cannula (see above), and the pain score was recorded using the Likert scale as described above.

In 42 cases the pain intensity was assessed by applying a visual analogue scale (VAS) ranging from 0–100 mm (with 0=no pain and 100=maximum possible pain).

Data analysis

Data analysis was performed using the Statistical Package for the Social Sciences version 21.0 (SPSS Inc, Chicago, IL, USA) by scientists that were independent of the setting and data collection at the dental clinic.

Depending on the tests for normal distribution, parametric data were analysed by applying paired t-tests; ordinate and nominate distributed data were analysed using the X^2 test.

RESULTS

Eight hundred and eighty-seven datasets were obtained from 407 patients (92 male, 315 female; mean age 45±1.5 years) with an average of 2.3±1.5 visits. One hundred and seventy-nine patients attended once (44.0%), 101 patients visited twice (24.9%), and 28 (6.9%) visited more than three times. One single patient attended nine times.

Summing up all the examinations (n=887), the pterygoid muscles appeared to be most painful; the pain intensity was rated as moderate or strong in 76% on both sides of the lateral pterygoid (strong pain 33% right and 32% left), and in 46% on the right and 49% on the left side of the medial pterygoid (strong pain 12% right and 13% left). In this sample, the least affected muscle was the temporal muscle group with no pain or low levels of pain on palpation in more than 95% of cases—that is, the temporalis anterior (96%/95%), the temporalis lateralis (97%/99%) and the temporalis posterior (99/98%). See figure 2 for details.

Overall, left sided tender points scored higher in pain intensity. The muscles showed an increased proportion of tender points rated with 'low pain'—that is, the digastric muscle (29% right vs 59% left; X^2 $P<0.001$), but also suprahyoidalis (27% vs 56%), infrahyoidalis (28% vs 55%), masseter (24% vs 33%) and sternocleidomastoideus (46% vs 56%); all $P<0.001$. Similar differences in laterality were noted in palpation of the cranio-mandibular junction (low pain 17% vs 35%, $P<0.001$) and the atlanto-occipital junction (moderate pain 13% vs 54%, $P<0.001$).

When compared to patients at their first visit only (n=407), there were no remarkable differences. The pterygoid muscle group was most painful, with the

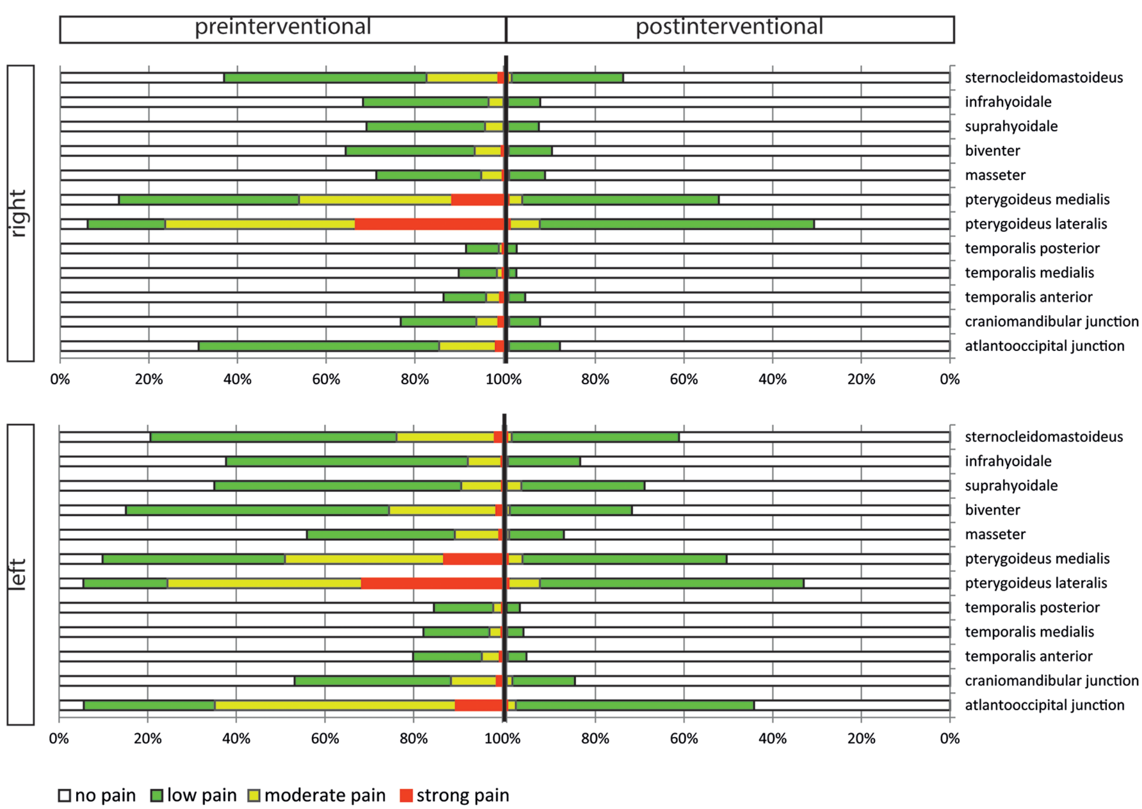

Figure 2 Pain ratings for the right (upper panel) and left (lower panel) body side. Pre-interventional ratings are displayed on the left of the accentuated black midline, and post-interventional ratings on the right. Pre-interventional ratings before treatment were pronounced on the left body side, and predominant in the pterygoid muscles. After treatment the pain ratings significantly decreased ($P<0.001$); the fraction of yellow (moderate pain) and red (strong pain) horizontal bars is notably decreased. The green bars indicate low pain and the white bars indicate no pain.

Table 2 Frequency of treatment points **(%)**, overall and at visit 1

	Overall (n=887)	At visit 1 (n=407)
Upper jaw left	83.6	88.8
Upper jaw right	83.2	88.3
Lower jaw left	69.8	75.0
Lower jaw right	71.2	76.1
LI4 right	37.6	42.5
LI4 left	36.2	40.7
Ear right	36.2	40.9
Ear left	30.8	32.5
Sternum	33.5	35.6
Yamamoto left	28.6	32.2
Yamamoto right	25.3	30.0
SI3 left	18.7	19.0
Lower vestibulum right	17.7	16.6
SI3 right	18.2	19.1
Lower vestibulum left	16.3	15.2
Upper vestibulum right	13.1	12.0
Upper vestibulum left	12.2	10.4

lateralis part rated moderate to strong in 79% on both sides and the medial part in 52% (right) and 54% (left). The temporalis group figured among the least affected areas (93-99% no pain or low levels of pain).

The palpation of microsystems revealed an increased sensitivity (moderate or strong pain) of the retromolar points at the upper jaw (83% on both sides) and lower jaw (43% right, 45% left). The points at the upper jaw had the highest sensitivity ratings (43% right and 45% left). Palpation at LI4 was sensitive in about one third of examinations (right 34%, left 32%). When compared with findings at visit 1, the sensitivity of the respective points was slightly increased: retromolar upper jaw 86% right and 87% left (strong pain in 50%/57%); retromolar lower jaw 46% right and 47% left; LI4 41% right and 40% left.

The most frequently treated points were the retromolar points of the upper (83%) and lower jaw (71%). Points at the ear, the sternum or LI4 were treated in 31–38% of cases (for details see table 2).

After treatment, the pain intensity at all tender points had decreased ($P<0.001$). The proportion of moderate to strong pain ratings was below 3% at the most tender points; pterygoideus lateralis was rated 'strong pain' in 7% (right) and 8% (left) and pterygoideus medialis in 4% (on both sides) of cases (see figure 2).

The overall pain intensity of subjects scored by VAS (n=42) before treatment was 55.5 ± 19.7 mm and this was significantly reduced to 29.6 ± 20.9 mm (paired t-test $P<0.001$) following microsystem acupuncture. The pain intensity was assessed in 28 patients at visit 1, and significantly decreased from 57.3 ± 14.0 mm before treatment to 31.4 ± 20.4 mm ($P<0.001$) after treatment.

There were no adverse events.

DISCUSSION

Herein we present the results of a large observational study in patients with TMDs who were treated in an outpatient setting over a period of 14 years. In the physical examination intra- and extraoral tender points were palpated, and the pterygoid muscles were the most prevalent tender spots. We have observed a reduction of pain intensity in TMD using a combination of microsystem acupuncture points including oral, auricular and scalp acupuncture points.[10]

Limitations regarding our analysis include the retrospective character of this clinical case series. The resulting lack of a control group makes results less generalisable, as non-specific effects cannot be identified and bias cannot be excluded. A prospective randomised controlled study design would definitively strengthen the validity of our findings. Still, we believe that the large sample size, the continuous standardised documentation, and the analysis by investigators not involved in the clinical process are relative strengths that may be considered criteria of good scientific practice in the conduct of retrospective studies.

In addition, due to the reality of a daily routine practice, our observations only reflect the short term. Patient attendance averaged 2.3 ± 1.5 visits, and we frequently observed immediate relief of symptom severity. We are aware that a reassessment after 15 min is a very short observational period, but it was the only feasible approach in the structural organisation of the clinic. We did not scientifically investigate long-term follow-up. The apparent success of this treatment approach could be inferred indirectly, as many colleagues have referred patients to the clinic, and many patients have also consulted the clinic directly, for decades. Patients seemed pleased after their average number of sessions; however, these are not valid arguments that could indicate possible mid- or even long-term effects. We can only conclude from one other study that showed the effects of dry needling of the masseter and temporalis to persist over a 1-week follow-up period.[21] Future studies or data collection should consider this point.

Finally, we were assured of the clinical history of TMD by means of palpation, verifying the respective diagnostic findings. We are aware that this is not yet a guideline-based approach, but it is a commonly used tool in daily practice in Austrian, Swiss and German dentistry.

The strengths of this study are the high number of cases with detailed documentation and the treatments administered by the same provider. All data analysis was performed by researchers that were independent of the needs and the setting within the dental clinic. A further strength (and weakness at the same time) of this study is the analysis of a large sample in clinical day-to-day practice that was not done under laboratory conditions.

As no adverse events occurred in more than 880 treatment sessions the approach seems to be safe.

The results are in line with previous studies: a recent study in 40 female patients showed slightly increased effects when comparing traditional acupuncture to splints.[22] A smaller observational study in 29 treatment-resistant patients showed that laser acupuncture reduced pain after six (acute TMD) or 16 (chronic TMD[23]) sessions, as did a study in 20 patients receiving six sessions of low level laser therapy.[24] A meta-analysis in 2010 confirmed acupuncture to be a reasonable adjunctive treatment, although these studies have methodological deficits in common.[25] In addition, it is a matter of debate whether verum and sham acupuncture can be distinguished, and how specific effects really are.[26 27] Still, these studies share a common shortcoming, namely the lack of any systematic investigation of the manifestation and severity of diagnostic findings, especially muscular function.

The role of the masticatory muscles as a major factor in the development of TMDs has been previously reported.[28] However, to our knowledge a systematic evaluation of all potential muscle groups has not been published yet. In our cohort, the pterygoid muscle seemed to play a key role in the severity of symptoms. Chronic functional pain syndromes of the musculoskeletal system, including myofascial disorders, account for a large number of chronic complaints that are encountered in clinical practice.[29] Myofascial pain syndrome is a chronic muscular pain disorder in one muscle or groups of muscles accompanied by local and referred pain, decreased range of motion, weakness and mainly autonomic phenomena. It is a primary cause of healthcare visits, absenteeism and disability pensions.[30] Myofascial pain affects up to 85% of the general population.[31] Myofascial trigger points (mTrPs) may play a central role in the pathophysiology of common myofascial pain syndromes.[32] In our analysis, we investigated the prevalence and pain intensity of muscular tender spots. It is possible that the exquisitely painful areas (ie, pterygoid muscles) correspond to mTrPs. A recent study showed that deep needling of mTrPs in the lateral pterygoid muscle is effective in reducing pain and improving function in TMD,[33] as did a study of MTrPs in the masseter and temporalis muscle.[21] As our examination did not include all the conventional diagnostic criteria that apply for mTrPs,[34] future trials should be aware of this probable analogy in their methodology. Dry needling could be considered as an additional treatment approach.

Other studies investigating the effects of dry needling demonstrate a decrease in the pressure pain threshold over the masseter muscle and the mandibular condyle[35] or at mTrPs in temporo-mandibular muscles.[36] A prospective case series in 15 patients showed a comprehensive mobilisation protocol with movement, thoracic spine manipulation and dry needling to be effective in a 2-month observation period.[37]

Regarding microsystem acupuncture, in our opinion it is not surprising that the main treatment areas used were retromolar points at the upper jaw. According to Gleditsch, supposedly represent the cervical spine and the muscular system of the head, neck and shoulder.[13] Microsystem acupuncture treatment is less invasive when compared with other techniques.[14] The immediate effects of acupuncture have been described previously, but seem related to highly specific treatment spots such as microsystems.[38] In clinical practice this approach may be used for therapy and also as a screening test. Rapid onset of effects may also help to increase patient compliance and help to gauge whether this treatment approach is appropriate for the individual patient. It might be of interest for future research if TMD patients responding to such treatment have better long-term outcomes.

CONCLUSION

The treatment of TMDs with microsystem acupuncture represents a feasible treatment option. The rapid onset of pain relief typically observed with this approach allows immediate assessment of treatment effects to determine if the method is suitable for an individual patient. Our data suggest that myofascial findings significantly contribute to the occurrence of TMD-associated symptoms, especially pain. Potential combination with muscle-based therapies such as dry needling or advanced manual medicine should be the subject of further research to establish comprehensive protocols for the treatment of TMDs.

Contributors All authors substantially contributed to the conception and design of the study. JF analysed data and wrote the first draft of the manuscript. IS and LS participated in the conduct of the study and critically revised the manuscript for important intellectual content. All authors discussed the results, commented on, read and approved the final version of the manuscript accepted for publication.

Competing interests JF is the Deputy Head of the Scientific Chapter of the German medical acupuncture society DAEGfA. He has received honoraria for academic teaching and counselling.

Patient consent Obtained.

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