Importance of Standardized Palpation of the Human Temporomandibular Joint

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Aims: To test whether standardized palpation around the lateral pole of the condyle can influence mechanical sensitivity and unpleasantness and evoke referred sensations/pain in healthy individuals. **Methods:** Palpometers (0.5, 1.0, and 2.0 kg) with spherical extensions were applied around the lateral pole of the condyle in relaxed and protruded positions of the mandible for 2, 5, and 10 seconds in 30 healthy participants. Mechanical sensitivity, unpleasantness, and referred sensations/pain were assessed using a 0 to 100 numeric rating scale (NRS) for each palpation. The NRS scores were compared using analysis of variance and McNemar test. **Results:** Participants reported significantly higher mechanical sensitivity and unpleasantness scores for the 2.0-kg stimulus compared to the 0.5- and 1.0-kg stimuli for 2, 5, and 10 seconds (mean NRS > 50; $P < .001$). Application of a 1.0-kg stimulus was significantly different from the 0.5- and 2.0-kg stimuli applied for 5 seconds (mean NRS < 50; $P < .001$). One-third of participants reported referred sensations/pain. **Conclusion:** Application of a 2.0-kg stimulus around the lateral pole of the condyle is painful and unpleasant regardless of time of palpation. Application of a 1.0-kg stimulus for 5 seconds was found to be nonpainful and not unpleasant in healthy participants. Thus, this study supports the Diagnostic Criteria for TMD recommendation for standardized examination of the TMJ and indicates that referred sensation/pain is a common finding in healthy individuals. *J Oral Facial Pain Headache 2019;33:220–226. doi: 10.11607/ofph.2235*

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Temporomandibular disorders (TMD) are a group of complex disorders affecting the masticatory muscles, the temporomandibular joint (TMJ), or both.[1,2] An important part of the clinical examination of TMD is the assessment of deep pain sensitivity in muscles and joints using manual palpation.[1,2] Several other techniques have been advocated to evaluate deep pain sensitivity, such as using different types of pressure algometers, finger-tip adjustable palpometers, and standard palpometers.[3–6] In a series of studies by Futarmal et al, it was shown that a palpometer had low test-retest variability under variable conditions and provided a more accurate and reproducible pressure stimulus than manual palpation.[6,7] Thus, this device can be reliably used to assess mechanical sensitivity of the musculoskeletal tissues.

Arthralgia is one of the most common pain-related TMD conditions. TMJ pain on palpation is one of the cardinal clinical findings in arthralgia.[1,8] Importantly, for a diagnosis of TMJ arthralgia, the pain evoked by palpation must replicate the patient's pain complaint.[2] Several factors, such as amount of force applied during palpation, duration of palpation, area of palpation, training, and calibration, can have an influence on the outcome of palpation.[9,10] The Diagnostic Criteria for TMD (DC/TMD), which is a standardized, reliable, and validated protocol, constitutes a

diagnostic method that is widely used for clinical and research purposes[2] that provides a standardized description of palpation of muscles and joints for the diagnosis of TMDs. Accordingly, to diagnose arthralgia, one of the recommendations of this protocol is to apply a 1.0-kg stimulus for 5 seconds around the lateral pole of the condyle while the mandible is in a protruded position in addition to the application of a 0.5-kg stimulus for 2 seconds at the lateral pole with the mandible in a relaxed position.[11] However, there is no scientific evidence to support the recommendation of application of a 1.0-kg stimulus for 5 seconds around the lateral pole of the condyle. It is possible that this recommended description of palpation may be painful in healthy individuals, thus making it difficult to differentiate from symptomatic patients. Furthermore, Cunha et al suggested the application of a pressure pain threshold (PPT) cut-off value of 1.36 kg cm^{-2} at the lateral pole to differentiate TMJ arthralgia patients from asymptomatic individuals,[8] but did not provide a cut-off value for palpation around the lateral pole of the condyle.

Pain located at the source of pain is termed local pain, whereas pain felt in a different region or structure away from the source of pain is termed referred pain.[12] Although the DC/TMD protocol has several strengths, it also has some limitations. It classifies muscle pain into three types—local myalgia, myofascial pain, and myofascial pain with referral.[2] However, no entity such as arthralgia with referral exists for joint pain. This might be because no referred pain/sensation from the joint occurs with the recommended palpation technique. Recently, a study showed that referred sensation/pain occurred on application of different stimulus intensities for different durations at the masseter muscle in healthy participants.[13] Therefore, it is possible that application of different stimulus intensities of varied durations at the TMJ might also evoke referred sensations/pain in healthy participants. Furthermore, this might provide information on normal physiology regarding the referred sensations/pain; ie, referred sensation/pain could simply be an epiphenomenon to painful stimulation of musculoskeletal tissues.

Therefore, the aim of this study was to test whether standardized palpation around the lateral pole of the condyle can influence mechanical sensitivity and unpleasantness and evoke referred sensations/pain in healthy individuals. It was hypothesized that the application of a 2.0-kg stimulus intensity around the lateral pole of the condyle would result in increased mechanical sensitivity and unpleasantness regardless of the duration of palpation and that application of the 1.0-kg stimulus intensity for 5 seconds around the lateral pole of the condyle would be nonpainful and not unpleasant in healthy individuals.

Fig 1 Palpometer with spherical extension.

Materials and Methods

Participants

A total of 30 healthy volunteers (13 women and 17 men) with a mean ± standard deviation (SD) age of 30.9 ± 5.6 years were included. All participants reported to be in good general and oral health. The exclusion criteria were: orofacial pain; painful TMD (ruled out using a TMD pain screener and self-reports of any TMJ sounds); musculoskeletal and rheumatologic diseases; fibromyalgia; pregnancy; and use of analgesics 48 hours prior to the study. All participants gave their written informed consent prior to participation. This study was approved by the local ethics committee in Denmark and was conducted in accordance with the Declaration of Helsinki II.

Palpometer

Three palpometers (Palpeter; Sunstar Suisse) calibrated to 0.5, 1.0, and 2.0-kg intensities were used in the experiments. The palpometers (USPTO#61/293,299) used in this study were the same as those used by Futarmal et al,[6] except that the tip to apply pressure was adapted to a nonresilient plastic spherical shape end (10-mm diameter) (Fig 1) instead of a circular metal stamp. This sphere was in contact with the surface of the structure to be palpated. When the correct force was applied, the examiner could detect the tapering end with the index finger.[6] The palpometers were intended to be held perpendicular to the skin surface with the thumb and the middle finger and were designed to have a spherical shape end so that the lateral pole of the TMJ could be palpated following the DC/TMD protocol.[2]

Experimental Protocol

This study was performed as a randomized single-blinded study. At first, the lateral pole of the condyle of the left TMJ was identified with manual palpation in both the relaxed and maximum protrusive positions. The lateral pole was identified by placing the index finger just anterior to the tragus of the ear and on the skin overlying the participant's TMJ. To confirm location, the participant was asked to open or protrude slightly until the examiner felt the lateral pole of the condyle translated forward.[11] For the relaxed position, the participants were first asked to close the mouth with the posterior teeth completely touching together in order to guide the mandible into the relaxed position, then were asked to keep the mandible in the same position without the teeth in contact. The other position was the maximum protrusive position, which was the position in which the mandible was in a maximum protruded position. Each position of the condyle was marked with a pen. Palpometers calibrated to 0.5, 1.0, and 2.0 kg were applied around the lateral pole of the left condyle of the TMJ in the relaxed and maximum protrusive positions for 2, 5, and 10 seconds. To stabilize the head during palpation, the opposite side of the jaw was supported by the left hand. At first, the lateral pole was identified as described above. Starting at the posterior aspect of the lateral pole, the palpometer was first rolled in a "C" fashion over the superior aspect of the condyle and then anterior; ie, from the 9:00 position to the 3:00 position.[11] The movement was continued to complete one smooth circular movement around the lateral pole of the condyle while maintaining contact with the pole. Vaseline was also applied over the area of palpation to avoid friction and facilitate the rolling movement of the palpometer. Each palpometer was rolled in a clockwise movement around the lateral pole using the right hand in both mandibular positions. The duration of the single palpation was 2, 5, or 10 seconds. Each palpation was considered complete after it completed one circle around the lateral pole without losing contact with the underlying skin. After each palpation, the participants gave scores for mechanical sensitivity and unpleasantness using numeric rating scales (NRS). Two separate NRSs ranging from 0 to 100 were used to score mechanical sensitivity (where 0 = no pain; 1 to 49 = a sensation that is not painful; 50 = barely painful [ie, the pain threshold, when the pressure changed to pain]; and 100 = worst pain imaginable[14,15]) and unpleasantness (where 0 = not at all unpleasant and 100 = worst unpleasantness imaginable[16,17]). NRS scores were given for palpation at each position (relaxation and maximum protrusive) for each time (2, 5, and 10 seconds) and stimulus intensity (0.5, 1.0, and 2.0 kg). Time was controlled by a metronome.[18] The order in which palpometers were applied at different stimulus intensities, positions, and durations was randomized using the website www.randomization.com to avoid the sequence effects. In addition, participants were also asked to rate for referred sensations/pain for each palpation using the same NRS scale used for measuring mechanical sensitivity. The participants also mapped the areas of referred sensations/pain.

Statistical Analyses

The NRS scores for mechanical sensitivity and unpleasantness were compared between the positions at different stimulus intensities and durations using three-way analysis of variance (ANOVA). The factors in the ANOVA were: position (relaxation and maximum protrusive), stimulus intensity (0.5, 1.0, and 2.0 kg), and time (2, 5, and 10 seconds). When appropriate, ANOVA was followed by Tukey post hoc test with adjustment for multiple comparisons. The NRS scores for mechanical sensitivity at different positions, stimulus intensities, and durations were compared between genders using unpaired *t* tests. McNemar test was used to test differences in the number of participants reporting referred pain/sensations for the three different intensities and time durations during the relaxed and protrusive positions. The level of significance was set at $P < .05$.

Results

Mechanical Sensitivity and Unpleasantness

The ANOVA for mechanical sensitivity showed that there were main effects of position, stimulus intensity, and time ($P < .001$). There was also a significant interaction between stimulus intensity and time ($P = .014$). Post hoc analyses showed that the participants reported significantly higher mechanical sensitivity scores in the maximum protrusive position compared to the relaxed position ($P < .001$). Participants also reported significantly higher mechanical sensitivity scores to the 2.0-kg stimulus compared to the 1.0- and 0.5-kg stimuli ($P < .001$), with a mean NRS score > 50 (Fig 2). Palpation with the 1.0-kg stimulus resulted in higher sensitivity scores than the 0.5-kg stimulus ($P < .001$), but the mean NRS score was below the pain threshold. Furthermore, participants reported significantly higher sensitivity scores to 10-second palpation than 2- and 5-second palpations ($P < .001$), and 5-second palpation resulted in higher scores than 2-second palpation ($P < .001$). Post hoc test for interaction showed that the participants reported significantly higher mechanical sensitivity scores to the 2.0-kg stimulus compared to the 1.0- and 0.5-kg stimuli for all time durations (NRS scores > 50; $P < .001$). There was also a significant difference between the 0.5-kg and 1.0-kg stimuli for

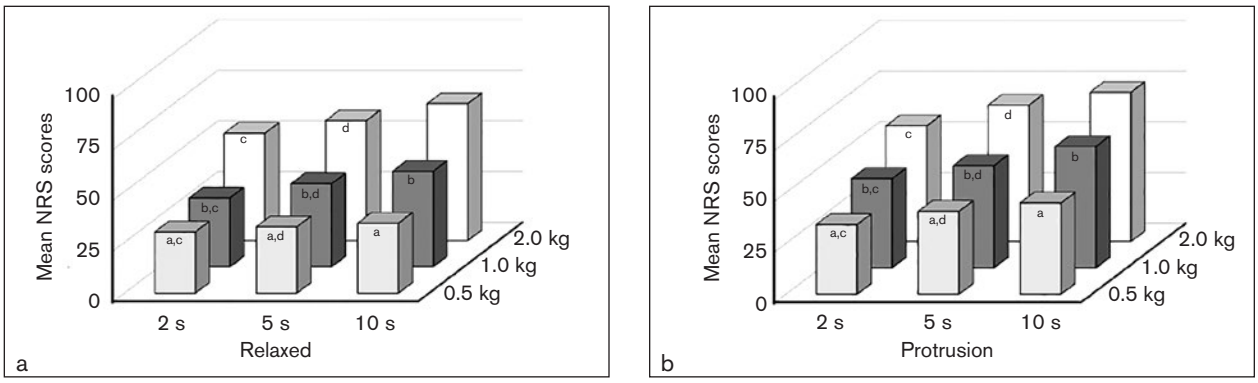

Fig 2 Mean numeric rating scale (NRS) scores for mechanical sensitivity during palpation around the lateral pole of the condyle at different forces and time during **(a)** relaxed and **(b)** protruded positions of the mandible. Standard deviations (SD) are not shown on the bar graphs in order to maintain the clarity of the figure. The SD range was 17.8 to 20.8 and 17.5 to 20.4 for the relaxed and protruded positions, respectively. [a]Significantly different from 1.0 and 2.0 kg. [b]Significantly different from 2.0 kg. [c]Significantly different from 5 seconds and 10 seconds. [d]5 seconds significantly different from 10 seconds.

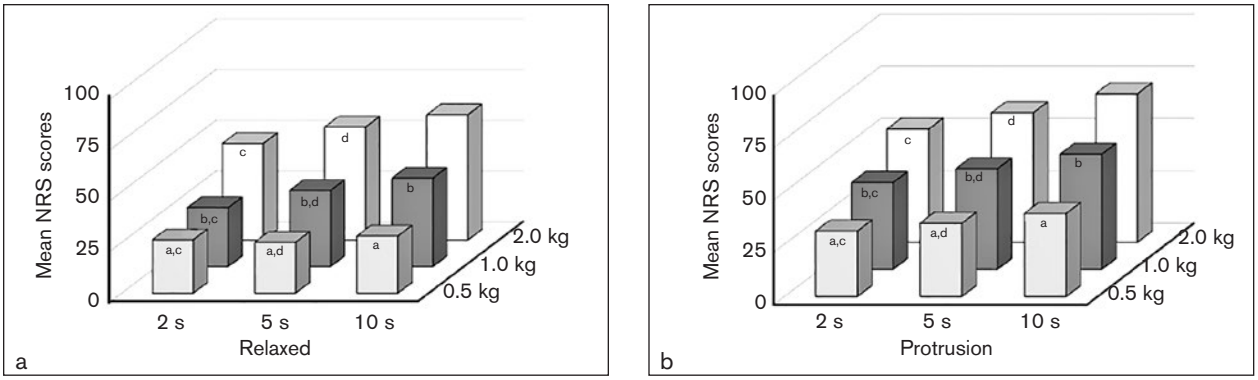

Fig 3 Mean numeric rating scale (NRS) scores for unpleasantness during palpation around the lateral pole of the condyle at different forces and durations during **(a)** relaxed and **(b)** protruded positions of the mandible. Standard deviations (SD) are not shown on the bar graphs in order to maintain the clarity of the figure. The range of SD was 18.6 to 24.2 and 20.3 to 21.8 for the relaxed and protruded positions, respectively. [a]Significantly different from 1.0 and 2.0 kg. [b]Significantly different from 2.0 kg. [c]Significantly different from 5 seconds and 10 seconds. [d]Significantly different from 10 seconds.

all time durations ($P < .001$); however, except for the palpation with 1.0 kg for 10 seconds (mean NRS = 54), the mean NRS scores were < 50. The proportion of participants with an NRS score above the pain threshold for 1.0- and 2.0-kg stimulus intensities at different time durations were, respectively: 2 seconds = 37% and 70%; 5 seconds = 50% (mean NRS = 50) and 80%; and 10 seconds = 73% and 87%. There were no significant differences between genders for the NRS mechanical sensitivity scores ($P > .114$).

The ANOVA for unpleasantness scores also showed that there were main effects of position, stimulus intensity, and time ($P < .001$). There was also a significant interaction between stimulus intensity and time ($P = .003$). Post hoc analyses showed that the participants reported significantly higher unpleasantness scores in the maximum protrusive position compared to the relaxed position ($P < .001$). Participants gave significantly higher unpleasantness scores for the 2.0-kg stimulus compared to the 0.5- and 1.0-kg stimuli ($P < .001$) (Fig 3). Participants also reported significantly higher unpleasantness scores for the 1.0-kg compared to the 0.5-kg stimulus ($P < .001$) and for 10-second palpation compared to 2-second and 5-second palpations ($P < .001$). Moreover, 5-second palpations resulted in higher NRS unpleasantness scores than 2-second palpation ($P < .001$). Post hoc test for interactions revealed that there were significant differences in NRS unpleasantness scores between 0.5-, 1.0-, and 2.0-kg stimulus intensities for 2, 5, and 10 seconds of palpation ($P < .030$). Participants reported higher unpleasantness scores to 2.0-kg palpations compared to 1.0- and 0.5-kg palpation for all time durations ($P < .001$) (Fig 3).

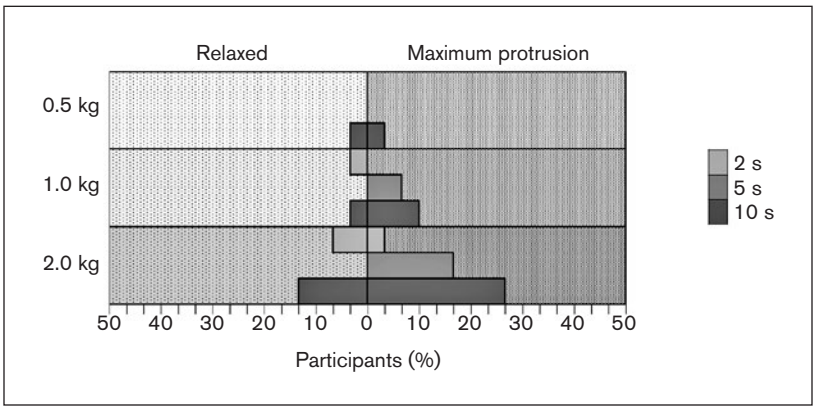

Fig 4 *(left)* Percentage of participants reporting referred sensations/pain during palpation around the lateral pole of the condyle at different positions, forces, and durations.

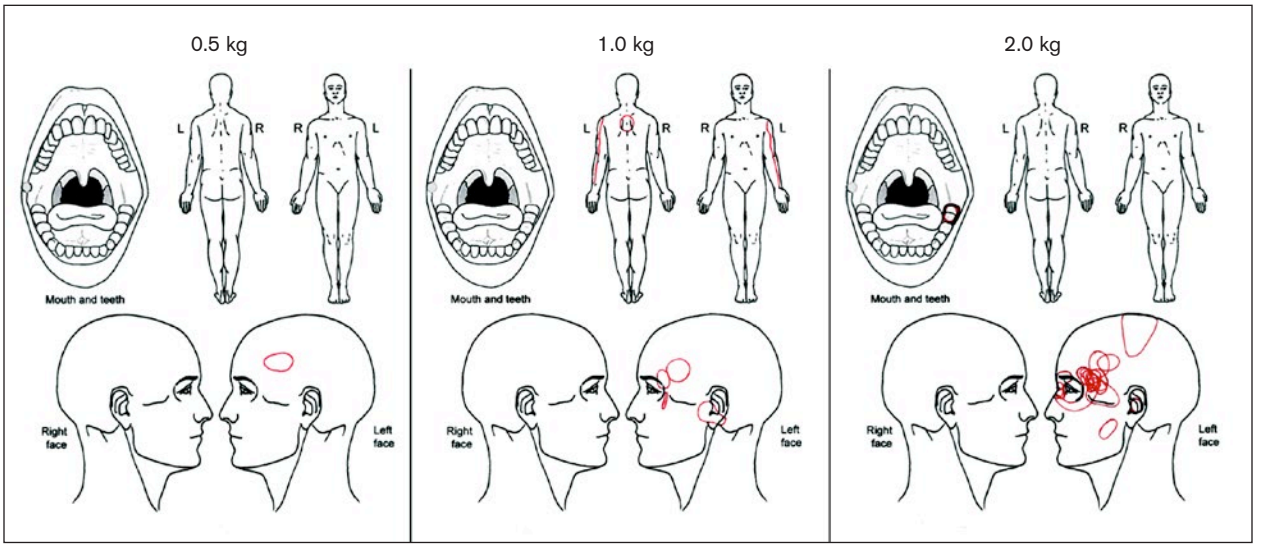

Fig 5 Mapping of the reported referred sensations/pain during palpation around the lateral pole of the condyle at all positions and durations separated by different forces. Copyright International RDC/TMD Consortium Network. Available at http://www.rd-tmdinternation.org. Version 12May2013. No permission required to reproduce, translate, display, or distribute.

Referred Sensations/Pain

A total of 33.3% (10/30) of participants had referred sensations/pain to at least one palpation (Fig 4). Although the frequency of participants reporting referred sensations/pain was higher during the protrusive position compared to the relaxed position, this difference did not reach statistical significance ($P = .073$). However, there was a significant difference in the frequency of participants reporting referred sensations/pain between 0.5-kg and 2.0-kg palpation during protrusion ($P < .013$), although not during other palpations ($P > .133$). Most participants (8/10) reported referred sensations/pain to 2.0-kg palpation applied for 10 seconds. Out of 10 participants with referred sensations, 2 scored above 50 on the NRS scale, indicating referred pain sensations. The body region showing areas of referred sensations/pain during palpation of the lateral pole is shown in Fig 5.

Discussion

The correct diagnosis of articular or muscular TMD is extremely important because it has a great impact on the determination of adequate planning for patient management.[8] Therefore, it is crucial to perform a careful physical examination to aid in providing a correct diagnosis. In addition to other criteria, the diagnosis of TMD involves a physical examination that includes palpation of the masticatory muscles and the TMJ as a measure of deep pain sensitivity.[1] However, the palpation has to be done in a standardized manner. Interestingly, the DC/TMD protocol has standardized descriptions for palpation of muscles and the TMJ in order to arrive at a pain-related TMD diagnosis (ie, myalgia or arthralgia[2]). Accordingly, it is recommended to apply a 1.0-kg stimulus for 5 seconds around the lateral pole of the condyle in a protruded

position of the mandible and a 0.5-kg stimulus for 2 seconds at the lateral pole of the condyle in a relaxed position for the examination of the TMJ to rule in or out the diagnosis of arthralgia.[11] However, there appears to be no scientific studies supporting such a recommendation.

The palpation pressure applied must be high enough to detect TMJ pain in symptomatic patients but low enough to not cause pain in healthy individuals.[19] Accordingly, this study showed that application of a 1.0-kg stimulus for 5 seconds around the lateral pole of the TMJ was not painful or unpleasant in healthy individuals. Thus, the present study provides support and a better justification for why the DC/TMD has proposed such a description of TMJ palpation. Although 50% of participants reported NRS scores to be higher than the pain threshold with application of the 1.0-kg stimulus for 5 seconds around the lateral pole, the mean NRS score was only 50, indicating that the stimulus was barely painful. This is where the importance of familiar pain comes into play: In patients with TMJ pain, inquiry into the familiar pain would provide a clear picture of whether the stimulus is painful. However, application of a 2.0-kg stimulus and palpation for 10 seconds resulted in NRS scores above the pain thresholds and was reported as unpleasant. This finding indicates that the use of a stronger stimulus intensity and a longer duration around the lateral pole of the TMJ may be painful and unpleasant in healthy individuals. Interestingly, participants reported higher NRS scores of mechanical sensitivity to palpation with the 1.0-kg stimulus for 10 seconds, but not for 2 and 5 seconds. Thus, the duration of palpation also plays an important role in determining the mechanical sensitivity. A study suggested application of a PPT cut-off value of 1.36 kg cm^{-2} at the lateral pole for the TMJ clinical manual palpation examination to differentiate TMJ arthralgia patients from asymptomatic individuals.[8] However, the authors did not propose specific criteria for the duration of palpation, which varies according to the threshold determination. Moreover, the cut-off value was provided only for the examination of the lateral pole of the TMJ and not around the lateral pole. This study also showed that the arthralgia patients had a mean PPT value of 1.07 ± 0.44 kg cm^{-2}. Therefore, it would be interesting to assess the mechanical sensitivity after application of 1.5 kg around the lateral pole in future studies. In this study, the TMJ was systematically palpated using three different stimulus intensities for three different stimulus durations in two different positions. Systematic assessment of the mechanical pain sensitivity at and around the lateral pole may contribute to new and crucial information on the characteristics of TMJ pain. Thus, it would be interesting to evaluate the effect of different stimulus intensities at different stimulus durations on mechanical pain sensitivity in TMJ arthralgia patients.

Manual palpation is the most widely used technique for examination of the masticatory muscles and TMJ to assess tenderness and pain.[20,21] Although it is considered to have adequate reliability, manual palpation can be influenced by many confounding factors, such as instructions, patient bias, training, and psychological state.[9] Uses of other techniques, such as algometers, makes it difficult to access the posterior pole of the TMJ.[8] Moreover, with the flat surface of an algometer, it is difficult to replicate the palpation technique as described by the DC/TMD for palpation around the lateral pole. Therefore, in the present study, in order to apply a reliable and accurate pressure stimulus, palpometers calibrated for different stimulus intensities were used. These palpometers were modified with spherical extensions, which made it easy to orbit around the lateral pole without losing contact with it. Furthermore, palpation around the lateral pole of the TMJ in the protruded position of the mandible provided access to the dorsal aspect of the TMJ while retaining access to the anterior aspect as well.

For the palpation of masseter and temporalis muscles, the DC/TMD protocol recommends application of a stimulus intensity of 1.0 kg for the duration of either 2 or 5 seconds. Palpation for 2 seconds is for the diagnosis of myalgia, and 5 for the diagnosis of referred pain.[2] Interestingly, this standardized protocol does not provide such a criterion for TMJ palpation, which means that there is no option for a diagnosis of referred pain from the TMJ. The mechanism for referred pain is believed to be a combination of central sensitization, convergence of sensory afferent nerves from multiple sites, and descending facilitation within the central nervous system.[22–24] In the present study, different stimulus intensities at different durations around the lateral pole were employed, assuming that they might evoke referred sensations/pain as seen with myofascial pain. Out of 30 participants, 10 reported referred sensations, of which only 2 had referred pain. Moreover, most of the participants reported referred sensations/pain on application of the 2.0-kg stimulus intensity for 10 seconds. Thus, application of 2.0-kg stimulus intensity or more for a longer duration might evoke referred pain at the TMJ. This finding supports the notion that referred sensations/pain may be an epiphenomenon to musculoskeletal pain and not necessarily a pathophysiologic condition. Further research should focus on a better understanding of referred sensations/pain in both healthy individuals and patients with painful TMD conditions.

Conclusions

The present systematic study has shown that application of a 2.0-kg stimulus around the lateral pole of the condyle in healthy participants was painful and unpleasant regardless of the duration of palpation. Application of 1.0 kg for 5 seconds around the lateral pole was found to be nonpainful. Also, palpation around the lateral pole with 1.0 kg for 5 seconds was less unpleasant than 1.0 kg for 10 seconds and 2.0 kg in healthy participants. Thus, this study supports the DC/TMD recommendation for palpation around the lateral pole of the condyle for the diagnosis of TMJ arthralgia and indicates that referred sensation/pain is a common finding in healthy individuals.

Acknowledgments

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