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論　文　内　容　の　要　旨

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論文題名	Electromyographic evaluation of limited jaw movement and the effectiveness of passive stretch training (開口障害の鑑別および開口訓練の治療効果に資する筋電図学的評価)

論文内容の要旨

Background and Objectives

Limited mouth opening (LMO) is one of the primary symptoms of temporomandibular disorders (TMD), which significantly affects patients' quality of life. The leading cause of limited mouth opening is generally divided into arthrogenic (disc displacement) or myogenic (myofascial pain) dysfunction. It was reported that the healthy people expressed minimum masseteric activity while the TMD patients expressed an increased masseteric activity during mouth opening within normal functional range. However, the masseteric activity in the LMO patients with disc displacement and myofascial pain is still unclear. Besides, one widely used physical therapy, passive stretch training (PST), its short and long-term effectiveness need more objective evidence.

Based on the above background, this research aims to utilize surface electromyography (sEMG) to assess the masseteric activity in the LMO patients with disc displacement and myofascial pain during maximum opening, and to evaluate the effectiveness of passive stretch training.

Materials and Methods

37 TMD patients with LMO (degree of the mouth opening: 28.3 ± 6.3 mm), diagnosed with Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), and 27 healthy volunteers (degree of the mouth opening: 49.9 ± 6.7 mm, age: 26.0 ± 2.7, 15 females and 12 males) participated into this research. All the participants were checked with DC/TMD clinical symptom examination and filled out DC/TMD symptom questionnaires. All patients underwent Magnetic resonance imaging (MRI) examinations. Paired surface pre-amplified electrodes (Mega Electronics, Finland) were placed parallel to the muscle fiber on the bilateral masseter and right digastric muscles. All the procedure was recorded with ME6000 Biomonitor (Mega Electronics, Finland).

Jaw tasks of Experiment 1:

1) Resting (30 seconds): sit quietly and relax for 5 minutes
2) MO: Perform MO slowly and keep the MO position for 5 seconds, three times.
3) Maximum volunteer clenching (MVC): Clench the molar teeth with maximum power and keep for 5 seconds, two times.

Jaw tasks of Experiment 2:

1) MOa: Perform MO slowly and keep the MO position for 5 seconds, three times
2) PST: Slowly open the mouth using fingers and arm's force and hold the MO position for 5 seconds, 15 times
3) MOb: Same as MOa

Subjects were instructed to perform daily 15 times passive stretch training at home until the next consultation day. Another EMG recordings were performed on the second consultation day to evaluate the long-term effect of passive stretch training. Pain intensity was evaluated using a 100 mm visual analog scale (VAS). The degree of mouth opening was recorded before and after EMG recording.

The average and max potentials of bilateral masseter muscle were calculated by an EMG analysis software (Megawin, Mega Electronics, Finland). The Kruskal-Wallis test was used to analyze the difference of the potentials between patients and healthy groups, and the Friedman test was used to compare the potential at the maximum opening before, during, and after passive stretch training. The Wilcoxon test was used to compare the potential before and after passive stretch training. The student's t-test was used to assess the long-term effects of passive stretch training.

Result

Analysis 1: Evaluation of difference in the masseteric activity among the control, DD, M, and DD + M groups

1. The average and max potential at rest in the healthy group, DD group, DD + M group, and M group showed no significant difference ($p = .278$, $p = .143$).
2. During the maximum opening, the four groups showed different potential increase. The DD+M and M groups showed significantly higher potential increase ($p = .000$) than the healthy and DD groups. The DD group showed no significant difference with the healthy group ($p = 1.00$).
3. The pain VAS showed significant correlation with maximum masseteric activity ($p < .05$).

Analysis 2-1: The short-term effects of passive stretch training (n = 35)

The healthy and DD group showed no potential difference in masseteric activities among the maximum opening before, during, and after passive stretch training ($p = .206$, $p = .876$). In the DD+M and M group, the potential significantly decreased during passive stretch training ($p = .000$, $p = .012$). The DD+M group showed lower potential after passive stretch training than before the training ($p = .001$). The degree of mouth opening significantly increased after passive stretch training in all patients' groups ($p = .000$).

Analysis 2-2: The long-term effects of passive stretch training (n = 11)

After at-home passive stretch training, the potential during the maximum opening significantly decreased in the DD+M group ($p = .005$). In the M group, the potentials at the maximum opening before, during, and after stretch training significantly decreased, compared to those at first EMG recording ($p = .031$). In the DD+M group, the amount of opening significantly increased from 26.2 ± 6.2mm to 39.7 ± 3.6mm ($p = .002$), and VAS significantly decreased from 65.0 ± 26.0mm to 20.0 ± 22.0mm ($p = .026$). While in M group, the opening degree significantly increased from 31.3 ± 6.8mm to 41.7 ± 8.5mm ($p = .045$), and VAS significantly decreased from 58.0 ± 22.0mm to 6.0 ± 8.9mm ($p = .042$).

Discussion

The sEMG recording found that the high masseteric activity during maximum opening might cause opening limitation in the patient group with myofascial pain. All four groups showed significantly different masseteric activity during the maximum opening before and after the passive stretch training. For example, the DD group showed similar masseteric activity as the healthy group, indicating that the leading cause of LMO of the DD group was arthrogenic. Moreover, the M group showed significantly higher masseteric activity when opening, and the primary cause of LMO might be myogenic. For the DD+M group, the patients showed two different types: minimum masseteric activity may indicate that the primary cause comes from intra-articular, and abnormal masseteric activity may indicate the myogenic LMO. Therefore, sEMG might help to differentiate the arthrogenic and myogenic LMO in the future.

It was revealed that both short-term and long-term passive stretching training might have the effect of suppressing abnormal muscle activity of the jaw-closing muscle during mouth opening on the LMO patients with myofascial pain.

Conclusion

Evaluation of the masseteric activity by sEMG could be a valuable tool in diagnosing arthrogenic and myogenic LMO. The passive stretch training is effective in helping patients with limited jaw movement to improve their opening degree and reduce both the masseteric activity and pain level.

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論文審査の結果の要旨及び担当者

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論文審査の結果の要旨

本研究は、顎関節症の診断精度を向上させることを目的とし、筋電図を用いて咀嚼筋痛ならびに顎関節円板転位を伴う開口障害を有する患者の最大開口時における咬筋の筋活動を評価したものである。その結果、咀嚼筋痛障害を有する患者群における安静時の筋電位に対する最大開口時の筋電位の上昇率は、正常および関節円板転位群の筋電位の上昇率より有意に高い値を示したことから、筋電図の使用により、開口制限の原因が筋原性か関節原性かをより正確に診断できる可能性が示唆された。

以上の研究成果は、顎関節症の診断を行う上で有益な示唆を与えるものと考えられ、博士（歯学）の学位論文として価値のあるものと認める。