



Original Article

Effects of short-term acupuncture treatment on occlusal force and mandibular movement in patients with deep-bite malocclusion



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KEYWORDS

Deep-bite malocclusion;
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Mandibular border movement

Abstract *Background/purpose:* Acupuncture is well known to be effective for pain relief and muscle relaxation, and hence it is feasible that acupuncture treatment could change the occlusal forces and mandibular movements in subjects with deep-bite malocclusion. The purpose of this research was to determine the distribution of occlusal force and the border movement of the mandible in patients with deep-bite malocclusion before and after acupuncture treatment.

Materials and methods: This study involved 17 volunteers with deep-bite malocclusion and aged 20–30 years. Before and after acupuncture treatment, the distribution of the occlusal-force percentage at each tooth was measured and the percentage biting force in the first molar area during maximal clenching was recorded. Additionally, the mandibular movements including the maximum mouth opening and maximum lateral border movement were also evaluated. All of the data were analyzed statistically using the Wilcoxon signed-rank test.

Results: The percentage biting force at the first molar differed significantly between before and after the acupuncture treatments ($P = 0.017$). However, no treatment effects were seen for the maximum mouth opening and the maximum lateral border movement. *Conclusion:*

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Although the mandibular border movements did not change significantly, this study has confirmed that acupuncture treatment may become an alternative choice on improving the occlusal force of deep-bite patients.

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Introduction

Orthodontic appliances are widely applied to patients with occlusal malocclusion to improve their aesthetics, pronunciation, and masticatory functions. Malocclusions can be divided into vertical- and horizontal-plane malocclusions. Deep-bite malocclusion can be considered as an abnormal vertical-plane malocclusion, referring to a condition where there is an irregular vertical relationship between the teeth of upper and lower dental arches. A deep bite appears in almost 10% of male Asians.¹ Deep-bite malocclusion caused by jaw stiffness may be difficult to treat using orthodontics due to these patients possibly having muscle disorders² and muscle tension. Deep-bite malocclusion can cause palatal mucosa trauma and occlusal teeth wearing due to excessive overlapping of the incisors. It is also a risk factor for temporomandibular joint disorder (TMD).^{2,3}

In 1952, Posselt⁴ found that not only the size of the bounds but the smoothness of moved trajectory of the lower incisors were related to the jaw function. That finding suggested that the movement of the lower incisors could represent the range of motion of the mandible. The range of mandibular motion is influenced by many factors, including age, body height, and craniofacial pattern.⁵ Limitation of the mandibular movement might be a sign of TMD or masticatory muscle dysfunction.^{6–8}

Occlusal splint therapy, physical rehabilitation, and muscle relaxant drugs are commonly applied for masticatory muscle relaxation in clinics. Acupuncture is a traditional medical intervention that has been reported to influence the neuromuscular activity of a stimulated muscle,⁹ and hence it has the potential to change the tension within the muscle and thereby allow the muscle to relax and elongate.^{10,11} In addition, the effects of acupuncture in TMJ disorder and myofascial pain have been investigated thoroughly by several studies.^{8,12–17} For the purpose of improving the mobility of the mandible in patients with TMD, applying acupuncture could well be complementary to stomatognathic treatment in achieving full neuromuscular rehabilitation and reducing the need to apply occlusal splints.¹⁸

Acupuncture is well known to be effective for muscle relaxation, pain relief, and the treatment of TMD, and so it is feasible that acupuncture treatment could change the occlusal forces and jaw motion in deep-bite patients. Since there has been no previously reported research on this topic, the purpose of the present study was to determine the occlusal force distribution and mandibular border movement in subjects with deep bite before and after short-term acupuncture therapy.

Materials and methods

Subjects

The study population comprised 17 subjects (12 males and 5 females) with deep-bite malocclusion involving tooth contact in centric occlusions, and having (1) angle class I and angle class II malocclusions of the first molars, and (2) overlap between the maxillary and mandibular incisors that was greater than half the tooth length. Subjects with periodontal disease, TMD, orthodontic treatment, needle phobia, bleeding disorders, or allergy to metal needles were excluded in order to minimize errors. All of the subjects were aged between 20 and 30 years (the mean age was 25.3 years) and participated in testing at the China Medical University Hospital under the approval of the Institutional Review Board of China Medical University Hospital (project number: CMUH104-REC2-063).

Acupuncture therapy

Acupuncture therapy was applied in this study by an experienced practitioner of traditional Chinese medicine. The acupuncture points used in this study were ST6 (Jiache), GB20 (Fengchi), and LI4 (Hegu) (Fig. 1a–c, respectively), which are commonly used for the relaxation of masticatory muscles. These three points were punctured bilaterally using sterile disposable acupuncture needles (34G, 0.25 mm in diameter and 40 mm long), resulting in six acupuncture points for each patient. Each needle was kept in the acupuncture point for 15 min.

Experimental processes

Two- and three-dimensional distributions of the occlusal-force percentage at each tooth (Fig. 2a) were measured using the T-scan III system (Tekscan, Boston, MA, USA) (Fig. 2b). During each measurement (Fig. 2c), the subjects was asked to clench the teeth in his or her habitual position with the maximal bite force for 3 s. Two occlusal bites were recorded for each subject (before and after 15 min of acupuncture therapy), resulting in 34 recordings. The biting-force percentages in the first molar area during 1–2 s of maximal clenching were evaluated before and after acupuncture therapy.

Plastic balls stuck to stainless-steel wires were connected to the tooth surface by dental bonded resin to represent the position of the maxilla and mandible (Fig. 3a). Two digital cameras (D5100, Nikon, Tokyo, Japan) were placed in the frontal and sagittal planes at 1.2 m from

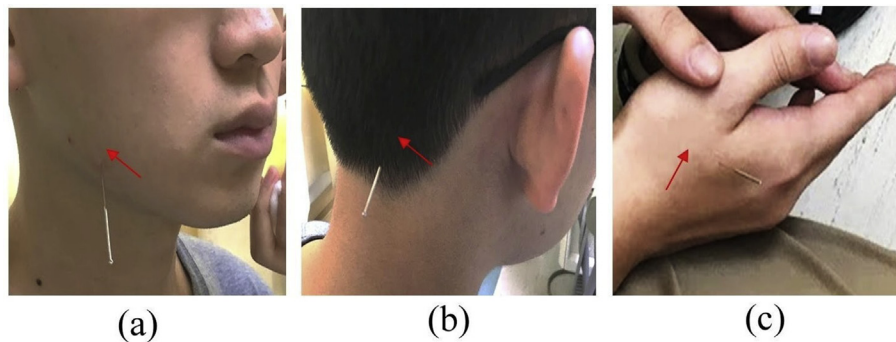


Figure 1 Acupuncture ST6 (a), GB20 (b), and LI4 (c) locations where the acupuncture needles were placed for 15 min (arrows).

the subjects. Images were captured using the camera in autofocus mode at 1920×1080 pixels at 30 frames/second. Mandibular border movements including maximum mouth opening (Fig. 3b) and maximum lateral movements (in the left and right directions) (Fig. 3c) were recorded by DigiGnatho (version 1.3, Rise Corporation, Sendai, Japan) (Fig. 4). In order to avoid errors resulting from muscle exhaustion, each subject was given sufficient rest intervals between the different tests.

After receiving acupuncture therapy for 15 min at the specific points bilaterally (LI4, GB20, and ST6) (Fig. 1), the measurements of the biting-force distribution and mandibular movements were repeated. The differences in the measured data between before and after acupuncture treatment were analyzed statistically using the Wilcoxon signed-rank test. $P < 0.05$ was considered to indicate a significant difference.

Results

Occlusal force distribution

After the acupuncture treatment, all of the biting-force percentages increased on both the left and right sides of the first molar. The percentage biting forces also differed significantly between before and after acupuncture treatment on the left side of the first molar ($P = 0.047$) as well as on both sides of the first molar ($P = 0.017$) (Table 1). The increased amount was about 5.3% on the both sides of the mouth (Table 1).

Mandibular border movement

There was a trend for the maximum mouth opening and the maximum lateral border movement to be slightly smaller after acupuncture treatment. However, there was no significant difference in the total, horizontal, and vertical moved distances between before and after acupuncture treatment (Tables 2 and 3) ($P > 0.05$) except for the vertical movement under maximum mouth opening and the rightward border movement.

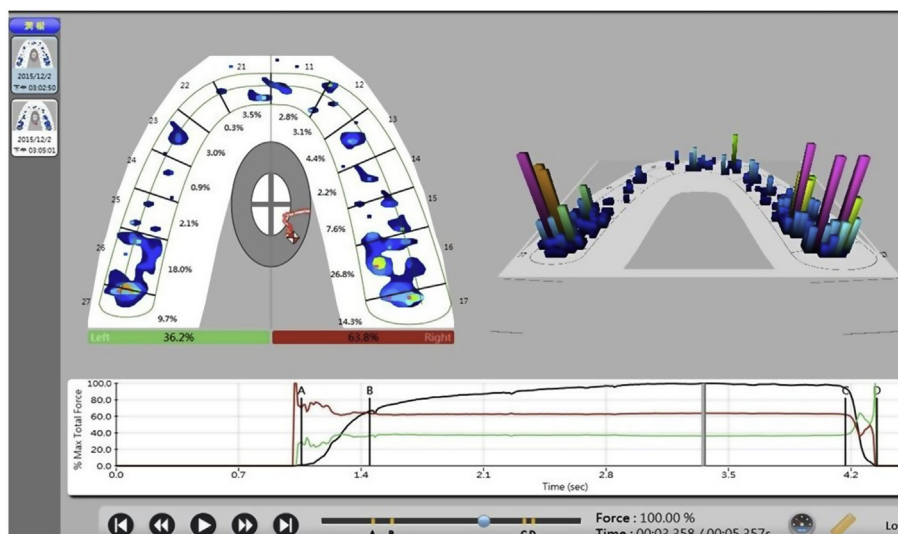
Discussion

Deep-bite malocclusion is often seen in Asian populations,¹ and abnormal vertical-plane malocclusions may cause

occlusal wear of teeth, muscle tenderness,¹⁹ or even TMD.^{2,3} Deep-bite malocclusion is often accompanied with an uncomfortable bite, jaw stiffness, and muscle disorders² that may hinder a patient receiving subsequent orthodontic treatment, and so applying acupuncture therapy may help to relieve masseter muscle tension and even prove beneficial to the mandibular movement and occlusal condition. However, no previous study has investigated the effect of acupuncture therapy on biting force and mandibular movement in patients with deep-bite malocclusion. The present study might therefore be the first to combine technologies for measuring biting forces (the T-Scan III system) and analyzing images of mandibular movement (DigiGnatho system) to explore this topic. The findings of this study might be useful to dental clinicians, especially orthodontists.

A report from 1999 indicated that a greater clenching strength was associated with an increased percentage biting force in the molar area.²⁰ The biting force in the molar area appears to be a suitable index for representing the clenching force. It was previously found that patients suffering from TMD had a greater clenching force after receiving 3 months of acupuncture treatment.²¹ In the present study we found that patients with deep-bite malocclusion had a higher biting-force percentage in the first molar area after short-term acupuncture treatment. Patients with deep-bite malocclusion may have muscle disorders and/or muscle tension that can result in an uncomfortable bite.² The muscle relaxation achieved after a short-term acupuncture treatment might relieve muscle tension so as to allow clenching with a greater force. That greater biting force might improve the efficiency of food chewing. Therefore, the results of the present study revealed that the change in the occlusal force in patients with deep-bite malocclusion is possibly due to improvement of muscle function after a short-term acupuncture treatment.

This study found that the maximum mouth opening and the maximum lateral border movement did not differ significantly between before and after acupuncture treatment, and that the vertical moved distances were actually smaller in some situations after acupuncture treatment. Because mandibular movement is affected by complex muscle groups, the fibrous capsule, and parts of the temporomandibular ligament,^{22–24} applying acupuncture needles at the ST6, GB20, and LI4 locations for a short period (15 min) might not produce effective results and



(a)



(b)



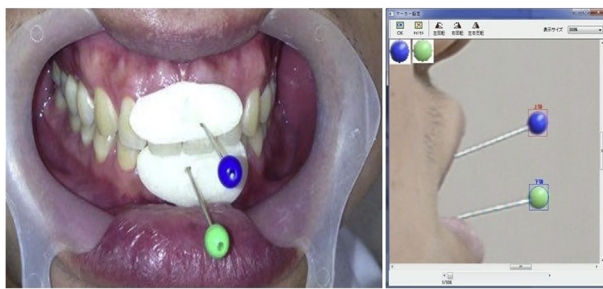
(c)

Figure 2 (a) Occlusal force distribution during the maximal biting force. (b) Components of the T-Scan system. (c) The sensor foils of the T-Scan III handpiece were placed in the mouth of the subject and the maximum individual masticatory force was recorded during clenching.

change the pattern of mandibular movement. Although one previous study have indicated that "after correction of the anterior crossbite there are increases in vertical and horizontal displacements at all kinds of mandibular border movements except for the horizontal displacements at the maximum mouth opening and the maximum protrusion",²⁵ However, another previous study²⁶ also found that while the lateral mandibular movement did not differ significantly between deep-bite and normal-bite subjects, the amount of mandibular protrusion was significant smaller for

the deep-bite subjects due to steep incisal guidance. It is possible that the mandibular border movements of the subjects in the present study remained within the normal range and did not differ significantly between before and after acupuncture treatment due to them not having TMD or muscle syndrome and only a short term of acupuncture treatment being performed.

The main limitation of this study is the smallness of the sample. Future studies should include larger samples in order to strengthen the statistical power and thereby



(a)



(b)



(c)

Figure 3 (a) Blue and green plastic balls attached to the maxillary and mandibular central incisors, respectively, were used as reference points for the positions of the two jaws. (b) Maximum mouth opening. (c) Maximum left-side border movement.

increase the likelihood of identifying significant relationships. In addition, irrespective of whether or not short-term acupuncture treatment could change the occlusal force in patients with deep-bite malocclusion, the effect of long-term acupuncture treatment still needs to be investigated in the future in order to confirm the present findings and perhaps also identify changes in the jaw motion. Nevertheless, the findings of this study can be regarded as general principles for clinicians.

Within the limitations of this study, the following conclusions can be drawn. Firstly, after short-term acupuncture treatment the percentage occlusal forces in deep-bite subjects during maximal biting all increased on the left and right sides of the first molar. Secondly, no obvious changes in the distances of mandibular border movements were

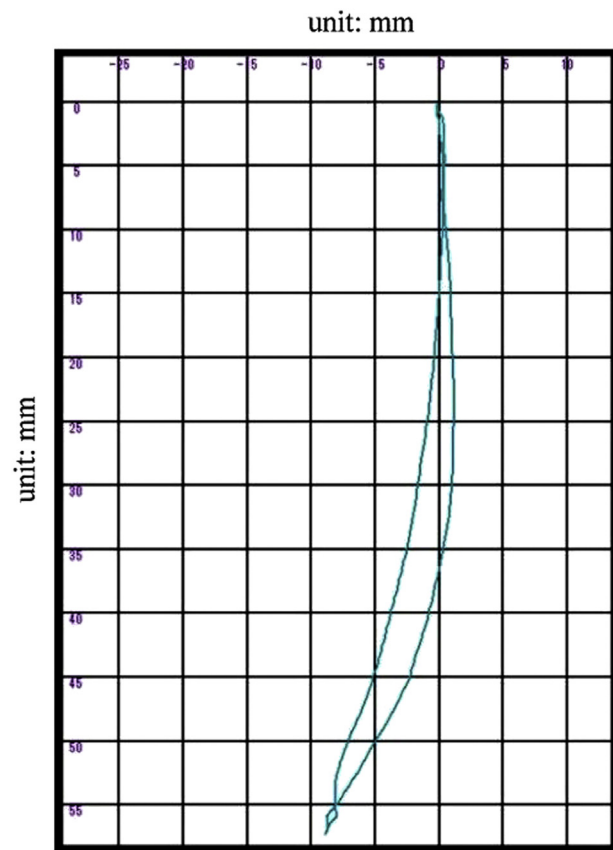


Figure 4 Movement path of maximum mouth opening.

Table 1 Percentage occlusal forces in the first molar area before and after acupuncture treatment (unit: mm).

	Left side	Right side	Total forces of both sides
Before acupuncture therapy	22.9 ± 2.9%	16.4 ± 6.4%	39.4 ± 9.46%
After acupuncture therapy	26.2 ± 6.28%	18.5 ± 8.5%	44.7 ± 4.74%
P value	0.047*	0.098	0.017*

*P value < 0.05 was considered statistically significant.

Table 2 Comparison of the maximum mouth opening before and after acupuncture treatment (unit: mm). 'H' and 'V' indicate horizontal and vertical moved distances, respectively. 'T' indicates the total moved distance.

	H	V	T
Before acupuncture therapy	17.3 ± 5.3	64.6 ± 7.2	67.0 ± 7.4
After acupuncture therapy	19.7 ± 6.1	61.9 ± 7.8	65.3 ± 7.4
P value	0.072	0.019*	0.102

*P value < 0.05 was considered statistically significant.

Table 3 Comparison of the maximum lateral border movement (unit: mm). 'H' and 'V' indicate horizontal and vertical moved distances, respectively. 'T' indicates the total moved distance.

	Left side border			Right side border		
	H	V	T	H	V	T
Before acupuncture therapy	12.2 ± 3.5	9.4 ± 4.7	15.9 ± 4.3	-12.2 ± 3.4	10.2 ± 5.1	16.1 ± 5.4
After acupuncture therapy	11.8 ± 3.7	8.6 ± 3.2	14.9 ± 3.6	-12.1 ± 2.9	8.9 ± 4.3	15.3 ± 4.3
P value	0.357	0.377	0.301	0.564	0.045*	0.121

*P value < 0.05 was considered statistically significant.

found in deep-bite subjects between before and after acupuncture treatment.

Conflicts of interest

All authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jds.2018.11.003>.

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