



Non-invasive procedure implementation for enhanced smile facial muscle movement after orthognathic surgery: a case report

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Abstract: This study examined the case of 27-year-old female who underwent orthognathic surgery to correct class 3 malocclusion, resulting in an unnatural smile. The research aimed to assess the efficacy of non-invasive treatment in enhancing facial muscle movement during smiling to achieve a natural smile. The patient received eight sessions of treatment using non-invasive devices, and facial assessment were conducted using three-dimensional scanner (Morpheus 3D Scanner) to evaluate facial features in both relaxed and maximum smile states pre- and post-treatment. The results demonstrated improvements in the symmetry of the lower lip height during smiling, along with increases in mouth width and volume in the upper central area. Subjectively, the patient also reported enhanced comfort while smiling. These findings suggest that non-invasive procedures can effectively improve unnatural smiles following orthognathic surgery, contributing to a more aesthetically pleasing smile presentation.

Key words: Non-invasive procedure, Orthognathic surgery, Facial muscles, Smile

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Introduction

Orthognathic surgery is acknowledged for its capacity to improve facial aesthetics, in improving smile characteristics [1, 2]. However, an optimal smile is not guaranteed solely through surgical interventions. Smile training, expected as a part of post-surgical physical therapy, involves self-exercises conducted within 1 to 4 months after surgery before complete attachment of muscles around the mouth and healing of soft tissues occur. Such timing is critical to maximize the

rehabilitative outcomes and is strongly recommended for effective implementation [3].

For individuals with unnatural or asymmetrical smile due to the imbalance movements of the facial muscle, botulinum toxin injection has been proposed as a treatment [4]. However, there is a risk of unintended movement of surrounding muscles if injected improperly [5].

In this study, we utilized the EMFACE (BTL Industries, Inc.) device, which uses radio frequency (RF) and high intensity facial electromagnetic stimulation (HIFES) as a non-invasive method. This device activates muscles by generating heat through RF and inducing the muscle contraction via HIFES [6]. Moreover, the HIFES energy delivered by the applicator selectively targets elevating muscles, specifically the zygomaticus minor (Zmi), zygomaticus major (ZMj), and risorius muscles [7]. These muscles collectively contribute to elevating the corners of the mouth and upper lip laterally

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and superiorly.

The aim of this study is to evaluate the effectiveness of the EMFACE device, a non-invasive method, in modifying facial expression muscles following complete post-surgical healing of muscles and soft tissues.

Case Report

A 27-year-old female presented with symptoms of unnatural smiling, characterized by asymmetry where her left lower lip appeared lower than her right during smiling. The patient's lips were symmetric at rest, but the asymmetry became noticeable only when the patient smiled. The patient had undergone orthognathic surgery one year earlier to improve class 3 malocclusion (Fig. 1). After surgical correction, the patient reported difficulty in achieving muscle movements around her mouth resulting discomfort and unnatural smile appearance, which was visually apparent. The written informed consent was obtained from the patient.

Given the observed muscle weakness post-surgery, a rehabilitation approach aimed at strengthening the facial muscles was needed. To address this problem, the EMFACE (BTL Industries, Inc.) device was employed. The treatment consisted of eight sessions, each lasting 20 minutes, administered at intervals of 3 to 7 days. The initial session was conducted in April 2024, with the patient positioned reclined at 180-degree angle in a dental chair. Disposable applicators were applied to forehead and both cheeks, following the manufacturer instructions. The entire surface of the applica-

tor adhered completely to the skin and targeted the specific muscles: the frontal muscle of the forehead, Zmi, ZMj, and risorius muscles. The Zmi, ZMj, and risorius muscles are interconnected, all contributing to smiling.

According to the manufacturer's product information, the HIFES technology of the EMFACE device has a depth of penetration is up to 20 mm. Therefore, it can effectively target superficial layer muscles. During each session, the intensity of HIFES was gradually intensified to the maximum planned for that session, within a 0 to 100 intensity range, while the RF intensity was fixed at 100 for all sessions. The intensity of HIFES ranged from 60 to 80 for session 1 to 4,

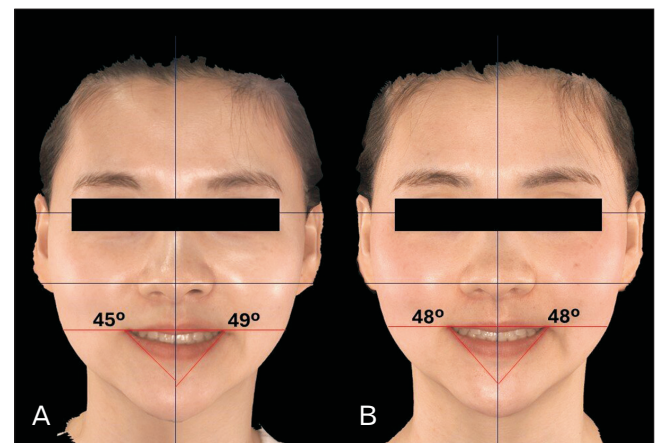


Fig. 2. Comparison of smile photographs before and after EMFACE (BTL Industries, Inc.) treatment. (A) Before treatment, with the left lower lip positioned lower than the right, indicating asymmetry. (B) After the 6th session, showing a symmetrical smile.



Fig. 1. Comparison of smile photographs before and after orthognathic surgery. (A) Pre-surgery, (B) post-surgery, illustrating the left lower lip positioned lower than the right during smiling.

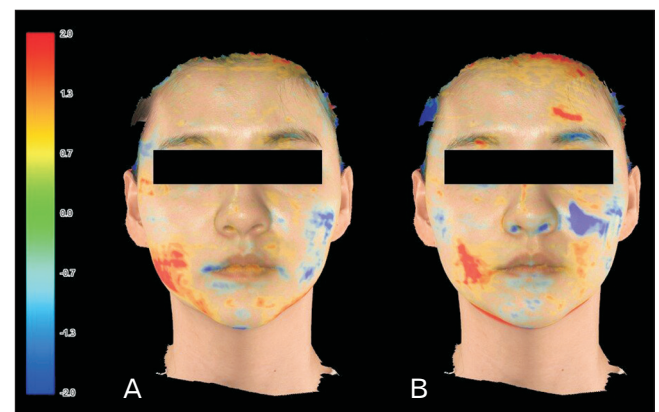


Fig. 3. Three-dimensional scanning image superimposed before and after the procedure in a resting state. (A) First comparison after initial session, (B) comparison after the 5th session. Red indicates an increase in volume, while blue indicates a decrease. The increase in volume on the left side suggests muscle strengthening and a transition toward a more symmetrical smile.

Table 1. Measurement of horizontal lip length while smiling

	Baseline		After the first session		After the second session		After the third session		After the fourth session		After the fifth session		After the sixth session	
	R	L	R	L	R	L	R	L	R	L	R	L	R	L
Half mouth width (mm)	26.4	25.6	26.5	25.5	27.5	27.6	27.1	27.5	27.2	25.5	27.9	25.7	27.8	25.6

R, right; L, left.

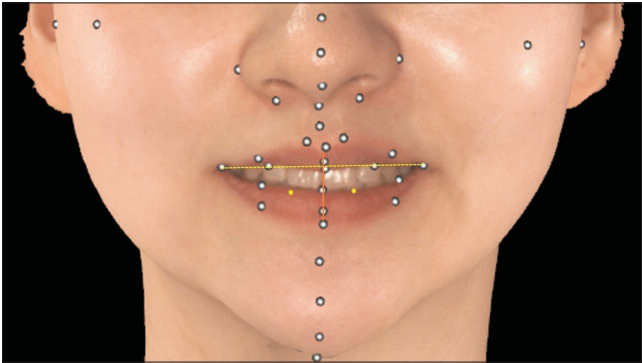


Fig. 4. Landmark for measuring horizontal length of the lips. The length was measured from each cheilion to the midpoint of the stomion along the line connecting them for both left and right sides in smiling photographs.

and was set to 100 for session 5 to 8. EMFACE utilizes magnetic fields and is contraindicated in the presence of metal implants; however, the patient used a titanium fixation devices from orthognathic surgery and encountered no complications during the treatment sessions.

The results and effects before and after treatment were evaluated using a three-dimensional scanner (Morpheus 3D Scanner; Morpheus Co., Ltd.). Horizontal lines were drawn from the left to right cheilion, and the angles formed where the lower lip intersects the midline were measured and compared. Before treatment, the angles were 45° on the left and 49° on the right, indicating a 4° asymmetry. Following six sessions of treatment, the angles improved to 48° on both sides, resulting in a symmetrical smile (Fig. 2). Initially, the patient used the depressor labii inferioris muscle to exert force on the lower lip when smiling. Strengthening the Zmi, ZMj, and risorius muscles shifted the muscle activity towards elevating the upper lip and the corners of the mouth, leading to a more symmetrical smile (Fig. 3). This improvement was further evidenced by the analysis of lip width. The half mouth width increased from 26.4 mm and 25.6 mm on the right and left, respectively, before treatment, to a maximum of 27.9 mm on the right and 27.6 mm on the left by the 6th session (Table 1, Fig. 4). Additionally, the nasolabial angle

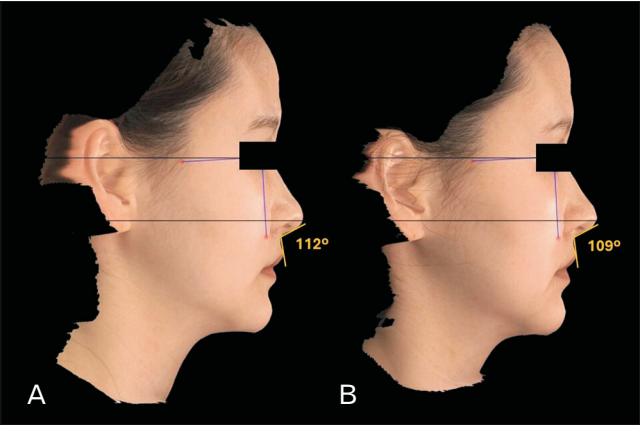


Fig. 5. Comparison of nasolabial angles. (A) 112° before EMFACE (BTL Industries, Inc.) treatment, (B) 109° after eight sessions of EMFACE. The reduction in angle indicates an increase in the volume of the central part of the upper lip.

was measured at 112° before treatment and at 109° after eight sessions, indicating a 3° increase in volume. The comparison of central line before and after the procedure was based on pupil center and alare (Fig. 5). The patient reported a greater comfort in smiling post-treatment compared to pre-treatment.

Discussion

The patient in this study experienced unnatural muscle movements when smiling after orthognathic surgery, accompanied by an asymmetry where the left lower lip was located lower than the right lower lip. This asymmetry is presumed to be a side effect resulting from the altered positional relationship between soft tissue and bone during orthognathic surgery [2]. Currently, effective rehabilitation methods to alleviate these side effects are largely limited to physical therapy involving self-exercise [3]. This study is the first to demonstrate that facial muscles can be rehabilitated post-orthognathic surgery through a non-invasive method utilizing high frequency and electromagnetic fields. This method has potential to assist patients in achieving a more natural smile,

and thereby developing effective rehabilitation method and improving overall quality of life after orthognathic surgery.

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Conceptualization: HJK. Data acquisition: SJK, SBK, YRH. Data analysis or interpretation: SJK, SBK, YRH, HJK. Drafting of the manuscript: SJK, SBK, HJK. Critical revision of the manuscript: SJK, SBK, HJK. Approval of the final version of the manuscript: all authors.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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