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Evaluation Of Intraoperative Inferior Alveolar Nerve Exposure During And Postoperative Neurosensory Disturbances After Bilateral Sagittal Split Osteotomy: A Prospective Cross-Sectional Study In Iran

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ABSTRACT

Introduction: Inferior alveolar nerve (IAN) exposure and neurosensory disturbances (NSDs) following bilateral sagittal split osteotomy (BSSO) of the mandible are paramount. We aimed to assess intraoperative IAN exposure during and NSDs after BSOO surgery using different clinical assessment methods in a prospective study in a local setting.

Materials and Methods: The present study was a prospective cross-sectional study. We monitored the nerve exposure status during the BSSO. Our time points were: before surgery, one day after, one month later, three months after and six months after the BSSO surgery. We performed two-point discrimination test, static light touch test and pinprick test on both mental regions of the cases.

Results: We included seven women and eight men. The average age of the participants was 25.13±3.27 years. The results of the two-point discrimination test showed the following: the day after the BSSO compared to before the surgery, the sensation is significantly impaired in both mental regions. In addition, it is noted that during our study, the two-point discrimination test results showed a gradient healing, though not reaching the point before the surgery ($P>0.05$). The results of the Pinprick test also showed a gradual resolution of the NSDs; however, a significant sensation difference remained between six months after the BSSO and before the surgery.

Conclusion: The BSSO surgery significantly impairs the IAN sensation, causing intraoperative IAN exposure and postoperative NSDs for the patients. A gradient resolution of the NSDs was observed in all the cases, though; the sensation of the mental region did not reach the pre-surgical levels.

Keywords: Alveolar nerve; Nerve exposure; Neurosensory disturbance; Sagittal split osteotomy surgery.

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Introduction

Bilateral sagittal split osteotomy (BSSO) is one of the most effective surgical methods for correcting mandibular asymmetry, prognathism, and retrognathism [1]. One of the most prominent complications after this procedure is a neurosensory disturbance (NSD) of the inferior alveolar nerve (IAN) and its terminal branch, the mental nerve. The disturbances may include anesthesia, neuropathic pain, altered sensation, or a combination of all three in the lower lip and chin area [2]. Lower lip paraesthesia is the most common NSD after BSSO and is primarily a neuropraxia type of nerve injury [3]. While most NSD instances are reversible, permanent sensory alterations have also been reported [4]. Though many have strived to lower the NSD incidence after BSSO by applying modifications, the issue still remains clinically paramount [5,6]. These modifications aim not only to lower the postoperative NSDs but also to increase the bone contact surface during the surgery, enhance the stability and subsequent bone healing process, and reduce the risk of trauma to alveolar and neural networks and iatrogenic bone fractures during the BSSO surgery [7,8]. The resolution of the NSDs related to the IAN depends on the healing process of the nerve, the extent of the primary damage, and the inherent risk factors associated with the NSDs in patients undergoing BSSO surgery [9]. Several methods are available to assess the postoperative NSDs, ranging from purely subjective (e.g., questionnaires) to more objective tests (e.g., static light touch, brush directional discrimination, two-point discrimination, and pinprick test) to purely objective ones, namely, trigeminal somatosensory evoked potentials, sensory nerve action potential, and blink reflex [10].

Data on nerve exposure during the BSSO surgery and postoperative NSDs are solicited in Iran. Many studies have reported a quite high frequency of IAN exposure during the BSSO in Iran. Accordingly, we aimed to evaluate intraoperative nerve exposure during and postoperative NSDs after the BSSO surgery and their resolution in a sample of patients undergoing BSSO surgery at the Oral & Maxillofacial Surgery Department, Isfahan University of Medical Sciences from 2021 to 2022.

Materials and Methods

Our sample comprised all the patients undergoing BSSO surgery at the Oral & Maxillofacial Surgery Department, Isfahan University of Medical Sciences, from 2021 to 2022. We used a convenient sampling method. Patients with a previous history of any injury to the trigeminal and facial nerves and genioplasty candidates were excluded. To ensure the intact status of the trigeminal and facial nerves, we examined the patients before the surgery using the static light touch test, two-point discrimination test, and pinprick test. This was also done to have a reference point for future comparisons in our study. An informed consent form was obtained from all the subjects before study enrollment. Patients were all hospitalized under similar conditions at the Alzahra and Kashani hospitals affiliated with the Oral & Maxillofacial Surgery Department of Isfahan University of Medical Sciences. The surgical procedures were performed according to Epker's modified technique [11].

A senior surgeon supervised all the surgeries, while a postgraduate senior resident (main surgeon) performed the operations and obtained the surgical data. A horizontal bone cut was made above the lingula, while the vertical cut was made between the first and second mandibular molars. The bone sections were separated using a fine osteotome. We observed and monitored the IAN exposure status during the procedure and managed any injuries to the nerve accordingly. Finally, using the transbuccal approach, we fixated the bone sections using three titanium screws (two mm diameter, 13 to 15mm length) on each side. Neurosensory disturbances were evaluated using three methods: static light touch and two-point discrimination for the mechanoceptive sense, and Pinprick test for the nociceptive sense. We performed all the tests preoperatively, one day after the surgery, and after one-, three-, and six-month follow-up periods. We abided by the standard test procedures for each test [12,13].

One practitioner (F.M.) clinically examined and expounded the test details to all the included patients. Each patient was seated in a relaxing ambiance and required to gently close their lips. The tests were then performed on the left and right sides of the lower lip area (mental regions) to assess the mandibular branch of the IAN. The static light touch test was done using a cotton pellet. First, the supraorbital and supratrochlear nerves were evaluated in the upper eyebrow area for each side of the face to get a reference point for the test. Then the test was done on each side of the chin, asking the patient to report their sense with a number from 0 (no sense at all), 1 (disturbed sense), or 2 (normal sense). The test results were recorded for each site. The two-point discrimination test was performed using a spring divider (compass) with two identical legs.

We started the test with the compass legs opened for 10mm; thereafter, the legs were gradually closed (1mm in each step) till the patient could not distinguish the two points anymore. If the patient was not able to distinguish the legs at the reference point (10mm), we then opened the legs 1mm in each step till they provided us with a positive response. The test results were recorded for each site in millimeters afterward. The Pinprick test was performed using a 22- or 23-gauge needle. We established a reference point by asking the patient to close their eyes, while gently touching the patient's upper eyebrow area with the needle. Afterward, we did the same procedure on each side of the patient's chin. We asked the patient to report their sense with a number from 0 (no sense at all), 1 (disturbed sense), or 2 (normal sense). The test results were recorded for each site.

We recorded the following parameters from our patients: age, gender, skeletal malocclusion classification, nerve exposure state, and the results of the sensory tests. We used the Paired-sample T-test for the continuous parameters (the sensory test results) to calculate their mean and standard deviations (SD) that needed to be compared before and after the surgical procedure. To compare the sensory test results of each side of the mandible, we used the Independent Samples T-test. Additionally, to compare the sensory test results among the patients based on different skeletal malocclusion or nerve exposure during the surgery, we used the Independent Samples T-test and One-way ANOVA, respectively. All the analyses were done using the SPPS v.22 software. This study was approved by the ethics committee of the Isfahan University of Medical Sciences under the ethics code of IR.MUI.RESEARCH.REC.1401.345.

Results

We enrolled 15 patients (30 nerves) in this study: seven men (46.7%) and eight women (53.3%). The mean age of the patients was 25.13±3.27 (mean, SD). Nine patients (60%) were classified as class III skeletal malocclusion, while six (40%) were class II. Table 1 shows the IAN exposure status during the BSSO surgery in these patients. No nerve cuts occurred in our patients. Table 2 shows the raw results of the two-point discrimination test for all the patients. All the cases (100%) reported a gradient reduction of the test score when comparing the first post-operative day to the later follow-up points (positive results). Our results showed that the IAN sensation was significantly disturbed the day after the BSSO surgery. The NSDs resolved on both sides from day one to the sixth month, though, the sensation did not reach the pre-operative levels ($p<0.05$) (Figure 1). Our results also showed no significant difference in both mental regions in all the follow-ups of our study (Additional Tables 1 and 2). Figure 1 illustrates the results of the two-point discrimination test during our follow-ups. The two-point discrimination test results for mean scores of the patient groups showed no significant difference among different nerve injury types on the pre-operative day compared to one day, one month, three months, and six months after the BSSO surgery. This was true except for the Partial proximal position compared to the Distal position six months after the surgery on the left mental region (meaning more NSD in the Partial proximal position group compared to the distal group). (Additional tables 3 and 4).

For analyzing the results of the static light touch and Pinprick test (Likert type), we used the Wilcoxon test. The results of the static light touch test showed no significant difference between the pre-operative and six-month post-operative IAN sensation on both sides of the mental region ($p=0.32$ for both sides). The results of the Pinprick test showed a significant difference between the pre-operative and six-month post-operative IAN sensation on both sides ($p=0.001$, 0.025 on the right and left mental regions, respectively).

Table 1. The exposure status of the Inferior Alveolar Nerve during the bilateral sagittal split osteotomy surgery in our patients.

		Distal position[*]	*Partial proximal position*	*Full proximal position*
Nerve exposure status	*Right*	*7 (46.7%)*	*6 (40%)*	*2 (13.3%)*
	Left	*8 (53.3%)*	*5 (33.3%)*	*2 (13.3%)*

[*] Distal nerve position includes two occasions: the IAN being covered with and without spongy bone in the distal segment.

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Table 2. The raw results of the two-point discrimination test (in millimetres).

	Before surgery	*One day after surgery*	*One month after surgery*	*Three months after surgery*	*Six months after surgery*
Right	*4.20±0.94*	*20.20±5.10*	*11.33±1.76*	*9.66±0.48*	*5.93±1.22*
Left	*4.40±1.18*	*18.66± 3.92*	*11.80±2.24*	*8.46±1.30*	*7.00±1.13*
P-value	*-*	*<0.001*	*<0.001*	*<0.001*	*<0.001*

Discussion

We aimed to evaluate the neurosensory disturbances of the inferior alveolar nerve after the bilateral sagittal split osteotomy surgery for patients with class II and III skeletal malocclusion. More than half (53%) of our participants were women in their mid-twenties. IAN was fully exposed in only 13.3% of our patients (refer to Table 1 for further inspection). We performed both the mechanoceptive and nociceptive neurosensory examinations. Each of our selected tests targeted a specific NSD: the static light touch test assessed the status of A-α myelinated fibers and giant axons. The two-point discrimination test assessed the status of versatile A-α myelinated fibers. The pinprick test assessed the status of A-δ myelinated and C fibers [14]. The repeated testing at pre-operative, one day, one month, three months, and six months post-operative aimed at assessing the clinical course and resolution of the NSDs. The first type of sensory disturbance after IAN injury is the loss of light touch, caused by damage to the A-α and A-β fibers.

According to the literature, six months of follow-up is more than enough for assessing the resolution of NSDs after BSSO surgery. If the disturbance lingers for more than three months, a neurotmesis or nerve transection is often suspected, causing the nerve healing to significantly drop three months after the injury [15,16]. Others like Becelli et al. believe the six-month post-operative period to be the most important time frame for neuropraxia and axonotmesis nerve recovery [17]. Ferdousi and Macgregor found that nearly half of BSSO patients showed significant resolution of their NSDs within the first three months after the surgery [18]. The two-point discrimination test results showed that there were significant NSDs on both sides the day after the BSSO surgery compared to the pre-operative point. Additionally, the results showed a healing process of the nerve injuries from the day after the BSSO to the six-month post-operative point on both left (from 18.66±3.9 to 7.00±1.1) and right (from 20.2±5.1 to 5.93±1.2) sides in all the cases (100%). However, the sensation never reached the pre-operative levels on either side (p<0.05) On the left mental region, there was no significant difference among various nerve exposure groups for the two-point discrimination scores on the pre-operative, one-day, one-month, and three-month postoperative time points. Ylikontiola et al. observed similar findings showing no difference between the left and right mental regions in their follow-ups [19]. The static light touch test results showed no significant difference between the sensation of the mental region (right and left) on the pre-operative and six-month postoperative follow-up (p=0.32). These results mean a resolution of the NSDs and nerve injury healing during the study follow-ups. Our results align with those of a previous study by Haghighat et al. in 2003, reporting significant nerve healing during a six-month follow-up period [20].

The results of the Pinprick test showed a notable NSD resolution on both the left and right mental regions. This healing, however, was significantly different when comparing the six-month post-operative to the one-day post-operative point for the right and left sides (p=0.014 and 0.025, respectively). This indicates the long time needed for the recovery of A-α and A-β fibers. Shaban et al. reported a mean score of the two-point discrimination test equal to 3.81mm before the BSSO surgery, 6.9mm three months after, and 5.2 mm six months after the surgery [21]. These results, like ours, showed a gradient nerve healing and NSD resolution over six months. Schultze et al. reported a similar healing pattern using the two-point discrimination test: 8mm on the three-month and 6 mm on the six-month post-operative follow-up [22].

We only used somewhat subjective tests to assess the NSDs in this study. No pure objective method was applied (e.g., electromyography, trigeminal nerve somatosensory evoked potential, electronic thermography, etc.); accordingly, subjective tests might yield different outcomes on repetition. Be that as it may, our tests are considered valid and reliable [23,24]. Additionally, though verified to have at least 80% statistical power with α=0.05, our sample was limited and the findings must be interpreted with caution. Several confounding factors were not excluded in our study as well, for instance: the surgery time and complexity per case, bleeding, anesthesia technique, mandibular adjustment and movement (in mm) during the advancement or setback and nerve manipulation during the BSSO.

Conclusion

Our results highlight a gradient resolution of the NSDs in BSSO patients over six months after their surgeries. However, the nerve healing was not adequate to reach the pre-operative sensation in both mental regions. Future prospective studies and clinical trials are recommended to assess the effects of various interventions on this healing process. Longer follow-up periods can highlight new nerve healing phases as well.

Conflict of Interest

There is no conflict of interest to declare.

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