Is the magnitude of mandibular movement a risk factor for inferior alveolar nerve neurosensory disturbance after bilateral sagittal split osteotomy?

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Aim
To investigate the effect of the magnitude of mandibular movement during bilateral sagittal split osteotomy (BSSO) on the incidence of inferior alveolar nerve neurosensory disturbance (NSD).
Patients and methods
The present cohort study included patients presented to the Maxillofacial Unit, General Surgery Department, Assiut University Hospital, Egypt. All patients underwent BSSO to correct class II malocclusion. Patients were divided into two groups; the first group included patients with mandibular movement less than 7 mm, and the second group included patients with mandibular movement more than 7 mm. Then, we investigated the incidence of NSD in both groups.
Results
The study included 32 patients (64 sides). The first group included 24 patients (48 sides), and the second group included eight patients (16 sides). The incidence of permanent NSD that lasted for more than 1 year in all patients was 9.375%. The incidence among the first group was 4.166%, whereas among the second group was 25%. A statistically significant difference is present between them, with *P* value of 0.013.
Conclusion
Magnitude of mandibular movement more than 7 mm during BSSO is considered to be a risk factor for inferior alveolar nerve NSD.

Keywords:
bilateral sagittal split osteotomy, inferior alveolar nerve injury, neurosensory disturbance, orthognathic surgery

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Introduction

Bilateral sagittal split osteotomy (BSSO) is considered as one of the most common surgical procedures done for mandibular skeletal deformities [1]. It is indicated for correction mandibular excess, deficiency, or asymmetry [2].

Sagittal split osteotomy was first described by Schuchardt [3] in 1942 where he made a cut in the body of the mandible and performed an advancement. Trauner and Obwegeser [4] described another procedure in 1957 in which they made a medial horizontal cut located medially in the ramus above the level of mandibular foramen and a vertical cut located on the anterior border of the mandibular ramus. Another oblique cut was made on the mandibular angle. Their technique was considered to be a good procedure but claimed to have poor bone to bone contact, which may lead to aseptic necrosis. Dal [5] applied his modification by making a longer oblique cut in the molar region. Nowadays, the technique described by Trauner and Obwegeser with Dal modification is the most accepted maneuver done for BSSO.

Although BSSO is considered to be a safe procedure, it is associated with specific postoperative complications. One of the most common complications of BSSO is the alteration of inferior alveolar nerve (IAN) somatosensory function, with an incidence ranging from 36 to 47% of the operated cases [6–9].

The osteotomy in BSSO is performed in close proximity to the IAN, and thus, it may easily result in postoperative neurosensory disturbance (NSD) of the lower lip [10]. Apart from the fact that BSSO is the most versatile technique, NSD remains a major disadvantage of it [11].

Owing to its elective nature, it is important to reduce the risk of complications following BSSO as much as possible. Therefore, great concerns are present in the recent research studies to investigate its outcomes and its most common complications, namely, the IAN NSD [12].

There are many research studies done to identify the incidence of NSD of the IAN following BSSO and the risk factors that may contribute to it. Age was found by different authors to be the most important single variable affecting the incidence of IAN NSD [13–15].

The aim of our study is to investigate the 'magnitude of mandibular movement' during BSSO as a risk factor for IAN NSD.

Patients and methods

The current cohort study was done on patients presented to the Maxillofacial Unit, General Surgery Department at Faculty of Medicine in Assiut University Hospital, Egypt. A formal written consent for the procedure, as well as for the need of medical photography, was explained to each patient and signed one day before the surgery and any inquiries, concerns or doubts were discussed with the patient and a first degree relative (upon the patients request). The ethical review board of Assiut Faculty of Medicine approved the study. The group of cases consisted of all patients operated by BSSO to correct class II malocclusion deformity in maxillofacial surgery unit during the period between January 2014 and December 2018. All patients were followed up for the IAN NSD for at least 12 months, and scheduled on four occasions:

(1) 48 h postoperative (T1).
(2) One-month postoperative (T2).
(3) Six-month postoperative (T3).
(4) Twelve-month postoperative (T4).

Persistent NSD for more than 12 months is considered to be permanent.

Eligible participants

The study included patients operated by BSSO for correction of class II malocclusion during the period between January 2014 and December 2018. The age of the patients ranged between 20 and 30 years old. The study excluded patients who have undergone previous mandibular surgery and patients in whom IAN injury occurred intraoperative. The net result was 32 patients for whom each side was analyzed separately.

Patient assessment

History of the patients was taken regarding the main complaint of the patients (esthetic and/or functional), the onset of the condition, previous orthodontic management, and any other dental complaints. Extraoral examination was done to assess the facial profile and type of deformity, as well as maxillary and mandibular position, size, or asymmetry. Intraoral examination was done to identify the class of occlusion, teeth inclination or size discrepancy, and third molar eruption. Imaging studies including lateral cephalometry and panorex were done for all patients. This helps in determining the type of deformity, the affected jaw (mandible alone or mandible and maxilla), and the extent of deformity to determine the magnitude of mandibular movement needed.

Interventions

Presurgical dental management

The objectives of dental management is to treat any dental caries or fractured teeth, for management of periodontal or gingival diseases, and for extraction of unerupted third molars.

Presurgical orthodontic management

This aims at decompensation of the compensated teeth before surgery, to eliminate dental interferences that would prevent achieving the desired final occlusion and to address tooth size discrepancies that would prevent interdigitation at the desired postoperative overjet and overbite.

Prefabricated dental wafers

After the treatment plan is set, it is applied by mock surgery, which demonstrates the treatment plan of the patient by means of dental models and casts. The dental models originated by mock surgery are used to fabricate the surgical splints, which will be used in the operation to reposition the segments before the internal fixation is performed.

Operative technique

The operative technique was done according to the technique described by Trauner and Obwegeser [4] in their original article in 1957 with Dal [5] modification in 1961.

An intraoral mucosal incision is made at the anterior border of the ramus and the external oblique mandibular ridge. A cuff of tissue should be preserved medial to the incision to facilitate closure (Fig. 1).

Figure 1

Mucosal incision, preserving a cuff of tissue medially to facilitate the closure.

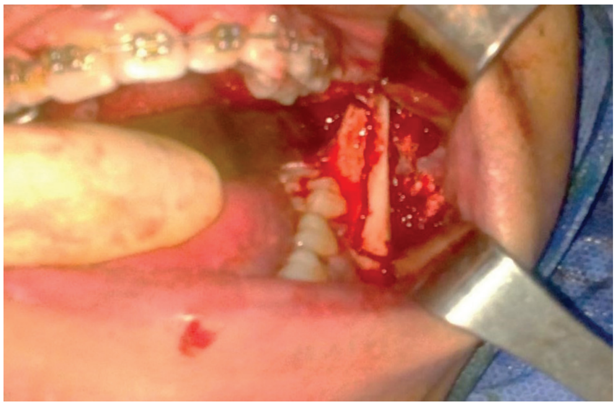
Figure 2

Flap elevation and mandibular ramus exposure.

Mucoperiosteal stripping buccally with partial elevation of the masseter muscle from the buccal side of the ramus was done. Mucoperiosteal elevation at the lingual side of the ramus above the level of the lingual was done (Fig. 2).

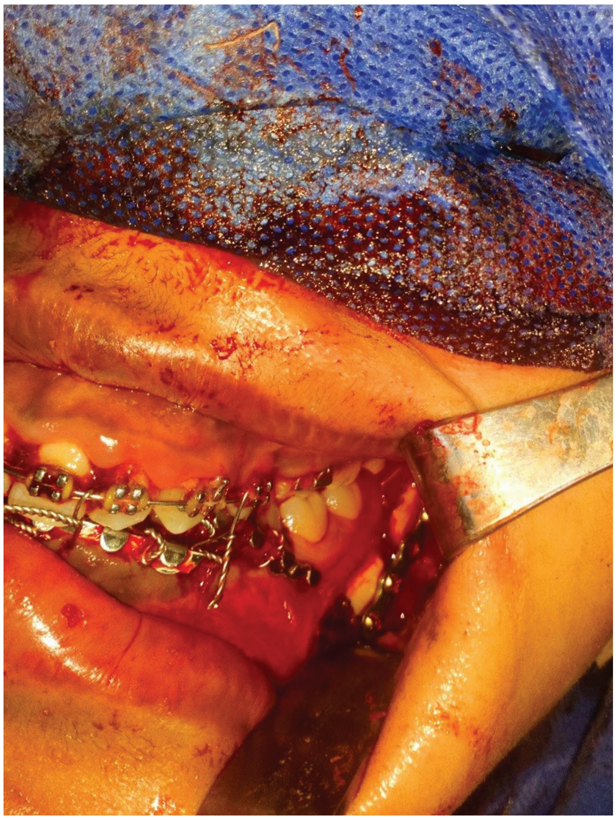
After the soft tissue dissection has been completed, we start to perform the osteotomies. Using a fissure bur, starting at the lingual side of the mandibular ramus parallel to the occlusal plane and superior to the lingula, osteotomy starts from posterior to anterior horizontally in the ramus. The cut then turns downward along the external oblique ridge of the mandible to the level of the second molar. The final cut is then done vertically along the buccal surface at the level of the second molar down to the inferior border of the mandible. The cut must be made completely through the cortical bone till reaching the inferior border.

Figure 3



The pattern of osteotomy.

Figure 4



Fixation in the new position by miniplates and screws.

The osteotomy is then finished with small curved osteotomes; the curve of the osteotome should be directed buccally to avoid injury of the inferior alveolar bundle. It is important to ensure that no twisting forces are utilized to prevent a bad split. As the split is opening, we check the position of the IAN (Fig. 3).

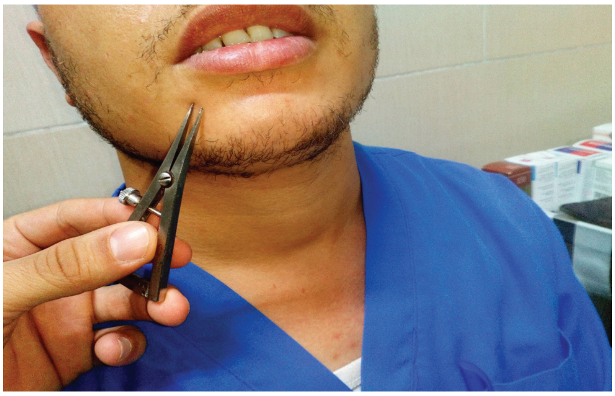
Now, after the distal segment of the mandible has been completely free, the mandible is placed in the desired new position with the aid of a prefabricated occlusal splint. If performing mandibular setback, the intervening bone is removed. The two segments are then fixed with a miniplate and screws with three holes on either side of the osteotomy (Fig. 4).

The incisions are closed with absorbable suture (e.g. 3/0 Vicryl) after copious irrigation and hemostasis.

Assessment of inferior alveolar nerve function

It was done by means of two-point discrimination test. It is the ability to discern that two nearby objects touching the skin are truly two distinct points, not one. The examiner uses calipers to do the test by alternating randomly between touching the patient with one point or with two points on the area being tested (namely the chin and lower lips). The patient is asked to report whether one or two points was felt. Normal values of perception of two stimuli are 2–4 mm on the lips and 4–6 mm on the chin [16] (Fig. 5).

Figure 5



Points discrimination test.

Statistical analysis

Data analysis was accomplished using the Statistical Package for Social Sciences software program (version 21, SPSS Inc., Chicago, Illinois, USA). Statistical significance was accepted at a level of *P* value less than 0.05. Quantitative data represented by mean and SD whereas qualitative data represented by number and percentage. The study outcomes were analyzed using c^2 test.

Results

The study was done on 32 patients (64 sides) operated upon by means of BSSO. Overall, 23 (71.9%) patients were females and nine (28.1%) patients were males. Their age ranged from 20 to 30 years old.

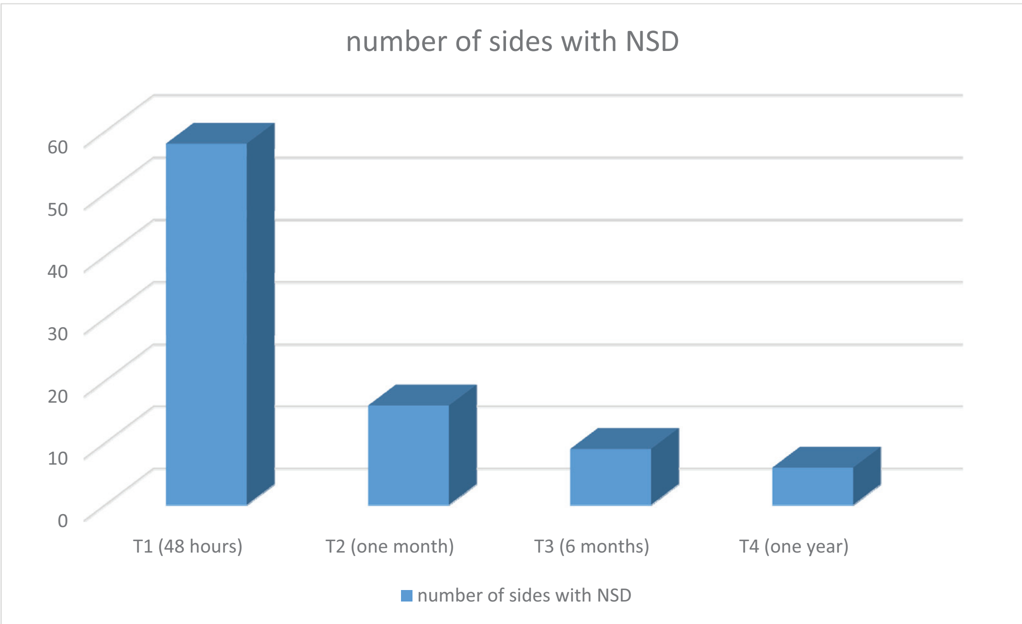
The results of IAN NSD according to time of follow up are shown in Table 1 and Graph 1. Within the first

Table 1 Neurosensory disturbance according to time of follow up

Follow-up time	*n* (%)
T1 (early postoperative within 48 h)	58 (90.6)
T2 (late postoperative after 1 month)	16 (25)
T3 (follow up after 6 months)	9 (14.1)
T4 (follow up after 1 year)	6 (9.4)
Permanent NSD (lasts for more than a year)	6 (9.4)

NSD, neurosensory disturbance.

Graph 1



Incidence of NSD according to time of follow up. NSD, neurosensory disturbance.

postoperative follow-up (T1, 48 h), NSD was found in 58 (90.6%) sides among the 64 sides of the study. One-month postoperatively (T2), it was found that 16 (25%) sides are still affected by NSD. With time, and after 6 months of the surgery (T3), the number of affected sides decreased to nine sides, with a percentage of 14.1% of the cases. Lastly, after 1 year (T4), the affected sides were six (9.375%) sides of the 64 sides, which was considered the number of permanent NSD.

Among the first group (48 sides), only two sides showed permanent NSD, with a percent of 4.166%. However, the second group containing four (25%) sides out of 16 sides that experienced NSD. There is a statistically significant difference between the two groups (P=0.013) (Table 2 and Graph 2).

Table 2 The effect of magnitude of mandibular movement on permanent neurosensory disturbance

Magnitude of mandibular movement	Permanent NSD [*n* (%)]	No NSD	Total
<7 mm	2 (4.16)	46	48
>7 mm	4 (25)	12	16
Total	6 (9.375)	58	64

NSD, neurosensory disturbance. *P* value=0.013.

Discussion

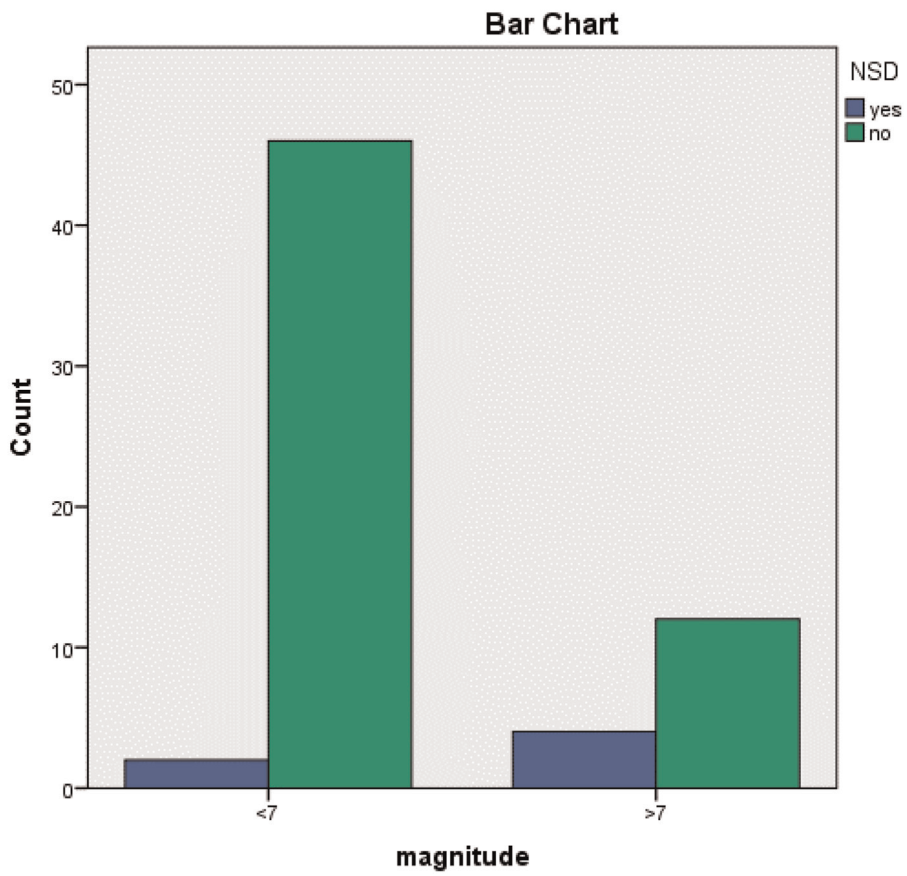
BSSO is an orthognathic procedure used to correct mandibular deformity. It is the most common mandibular surgical procedure used to correct class II and class III malocclusion [17].

The most important complication of this procedure probably is the NSD of the lower lip. If altered sensation in the lower lip lasted for more than 1 year, it is considered as a permanent NSD [18].

IAN injury during surgery usually results from manipulation of the nerve or from direct injury to the nerve during the operation. IAN damage can consist of complete or partial transection, extension, compression, crushing, or ischemia [11].

In our study, within the first postoperative follow up (T1, 48 h), NSD was found in 58 sides among the 64 sides of the study, with a percent of 90.6% of all sides. This is comparable to the results of the study done by

Graph 2



Bar chart showing the effect of the magnitude of mandibular movement on permanent NSD. NSD, neurosensory disturbance.

Antony *et al*. [11], in which 85% of the operated sides were affected by NSD.

According to the work done by Sadakah and Elshall [19], this large percentage of affection at the early postoperative period can be contributed to the manipulation of the IAN during surgery, traction during mobilization of the proximal and distal fragments, or postoperative edema and compression of the nerve.

The NSD was getting improved with the time of follow-up, to reach 25% after 1 month (T2), 14.1% after 6 months (T3), and lastly, 9.4% after 12 months (T4), which represents a permanent NSD in our study.

The incidence of permanent NSD in the literature is extremely variable from 0.0% up to 84.6% of cases as founded by Walter and Gregg [20] in their study. Zaytoun *et al*. [21] observed 68% in 1-year postoperative follow-up. However, Macintosh [22] reported only 9% of patients with residual paresthesia of the lower lip at the end of 1 year.

A literature review and meta-analysis done by Verweij *et al*. [18], concluded that the incidence of NSD after 1 year of BSSO in the recent literatures ranges between 0.0 and 48.8%, with a mean of 21.7% per side.

The wide range of the incidence of NSD after BSSO can be contributed to the fact that there are a lot of variables can affect it, such as age, sex, magnitude of movement, or type of fixation. In our study, we investigated the magnitude of mandibular movement as a risk factor of permanent NSD.While investigating the effect of the magnitude of mandibular movement on the incidence of NSD, the incidence was higher in the second group (with magnitude of movement >7 mm), with a statistically significant difference between the two groups (P=0.013). This can be explained by the stretching exerted over the IAN after wide separation of the proximal and distal segments.

This matches the results obtained from the studies done by Westermark *et al.* [23], and Van Sickels *et al.* [24], where they concluded that large advancements/setbacks (>7 mm) have been reported to increase the risk of NSD by increasing the difficulty of the procedure or the vulnerability of the patient by stretching the nerve.

Moreover, Thygesen *et al*. [25] studied the risk factors affecting somatosensory function after BSSO. They founded that two-point discrimination was significantly impaired (P<0.05) with long surgical movements (6–10 mm) compared with shorter movements (1–5 mm).

The point of strength in the study is that there is a large statistically significant difference between the two groups. The limitation of the study may be the small sample size of the study, and this was limited by the number of the cases presented to our unit during the time of the study.

Implications for future research are to apply this idea on a larger number of patients and with longer time of follow-up.

Conclusion

Increased magnitude of mandibular movement during BSSO more than 7 mm is associated with higher incidence of IAN NSD. Therefore, the bimaxillary surgery approach can be used in conditions where mandibular movement larger than 7 mm is needed.

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Conflicts of interest

There are no conflicts of interest.

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