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Prevalence and Risk Factors of Neurosensory Disturbances after Bilateral Sagittal Split Osteotomy

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ABSTRACT

Background: Bilateral sagittal split osteotomy (BSSO) is a common orthognathic procedure used to correct mandibular deformities. However, neurosensory disturbance (NSD), particularly involving the inferior alveolar nerve, is a frequent postoperative complication. To determine the prevalence of NSD following BSSO and identify risk factors associated with persistent sensory impairment.

Study Design: A prospective cohort study

Place and Duration of Study: This study was conducted at the Department of Oral and Maxillofacial Surgery, Khyber College of Dentistry, Peshawar, Khyber Pakhtunkhwa, Pakistan, from January 2021 to December 2021.

Materials and Methods: A total of 140 patients undergoing BSSO were evaluated. Neurosensory function was assessed using standardized clinical sensory tests at 1 week, 3 months, 6 months, and 1 year postoperatively. Demographic and perioperative variables, including age, gender, smoking status, systemic disease, and surgical duration, were recorded. Chi-square tests and multivariate logistic regression were used to identify risk factors for persistent neurosensory disturbances at 1 year, with $p < 0.05$ considered statistically significant.

Results: The prevalence of NSD was 77.1% immediately after surgery, declining to 51.4% at 3 months, 27.1% at 6 months, and 11.4% at 1 year. Persistent NSD at 1 year occurred in 7.1% of patients. Significant associations were found with age >30 years ($p = 0.013$), smoking ($p = 0.006$), and surgical duration >120 minutes ($p = 0.0003$). Multivariate analysis identified prolonged surgical duration (AOR = 8.76), smoking (AOR = 5.42), and age >30 years (AOR = 4.85) as independent predictors of persistent NSD.

Conclusion: NSD is common complication among patients at OMFS department of KCD, Peshawar immediately after BSSO but substantially improves within 6 months. Persistent deficits are relatively low, with older age, smoking, and longer surgical duration increasing the risk.



Key Words

Bilateral Sagittal Split Osteotomy, Neurosensory Disturbance, Inferior Alveolar Nerve, Risk Factors

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INTRODUCTION

Bilateral Sagittal Split Osteotomy (BSSO) is one of the most widely performed orthognathic surgical procedures for the correction of mandibular deformities, including skeletal Class II and Class III discrepancies [1]. Since its modification by Obwegeser and Dal Pont, BSSO has been considered the standard technique due to its versatility, stable postoperative outcomes, and broad surgical applicability [2]. Despite its predictable skeletal and functional results, neurosensory disturbance (NSD) of the inferior

alveolar nerve (IAN) remains one of the most common and concerning postoperative complications [3].

The inferior alveolar nerve runs in close proximity to the surgical field during mandibular splitting, making it vulnerable to traction, compression, manipulation, or direct injury during osteotomy and fixation [4]. Postoperative neurosensory disturbances may present as hypoesthesia, paresthesia, dysesthesia, or anesthesia affecting the lower lip, chin, and gingival tissues [5]. Although most sensory deficits are

temporary and resolve within several months, persistent disturbances can significantly affect patients' quality of life, psychological well-being, and satisfaction with surgical outcomes [6].

Reported prevalence rates of immediate postoperative neurosensory disturbance following BSSO vary widely, ranging from 60% to 90% depending on assessment methods and timing of evaluation [7]. However, the incidence of long-term or permanent sensory impairment is considerably lower, generally reported between 5% and 15% at one year postoperatively [8]. Variability in reported prevalence may be attributed to differences in surgical technique, fixation methods, surgeon experience, and methods of neurosensory assessment [9].

Several risk factors have been proposed to influence the development and persistence of neurosensory disturbances. Patient-related factors such as age, smoking status, and systemic health conditions may impair nerve regeneration and healing capacity [10]. Surgical factors including duration of surgery, magnitude of mandibular movement, degree of nerve manipulation, type of fixation, and intraoperative nerve exposure have also been associated with increased risk [11]. Among these, prolonged operative time and advanced patient age are frequently cited as significant predictors of delayed sensory recovery [12].

Understanding the prevalence and identifying modifiable risk factors associated with persistent neurosensory disturbance are essential for improving surgical planning, patient counseling, and risk minimization strategies. Therefore, this study aims to evaluate the prevalence of neurosensory disturbances following BSSO among patients at Oral and maxillofacial surgery (OMFS) department of KCD, Peshawar at different postoperative intervals and to determine the demographic and perioperative factors associated with persistent sensory impairment.

MATERIALS AND METHODS

Study Design and Setting

A prospective study was carried out in the Department of Oral and Maxillofacial Surgery at a tertiary care teaching hospital over a one-year period from January 2021 to December 2021. Patients undergoing bilateral sagittal split osteotomy (BSSO) were prospectively assessed for neurosensory disturbances.

Sample Size and Sampling Technique

The sample size was calculated using the formula for estimating a single population proportion. Based on

previous literature reporting approximately 10% prevalence of persistent neurosensory disturbance after bilateral sagittal split osteotomy (BSSO), a 95% confidence level, 5% margin of error, and 80% statistical power were assumed. The minimum required sample size was calculated to be 138 patients. To account for potential loss to follow-up, a total of 140 patients were included in the final analysis. A non-probability convenience sampling technique was used for participant selection.

Inclusion Criteria

- Patients who underwent bilateral sagittal split osteotomy (BSSO) for correction of mandibular deformities (Skeletal Class II, Skeletal Class III, or facial asymmetry)
- Patients aged 18 years and above
- Patients requiring isolated BSSO

Exclusion Criteria

- Patients with pre-existing neurosensory deficits
- Patients with a history of mandibular trauma
- Patients with a history of previous mandibular surgery
- Patients with pathological lesions affecting the mandible
- Patients with systemic neurological disorders

Data Collection

Ethical approval for the study was obtained from the Institutional Review Board of Khyber College of Dentistry (KCD), Peshawar (Ref. No. 6152/KCD, dated 22/12/2020). All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment in the study. All surgical procedures were performed under general anesthesia using a standardized BSSO technique. Osteotomies were carried out according to the conventional Obwegeser-Dal Pont method. Care was taken to minimize manipulation of the inferior alveolar nerve. Internal fixation was achieved using titanium plates and screws. The duration of surgery was recorded in minutes from incision to wound closure. Demographic and clinical data including age, gender, smoking status, presence of systemic disease, indication for surgery, and duration of surgery were recorded using a structured data collection form. Neurosensory function of the inferior alveolar nerve was assessed postoperatively at the following intervals:

- Immediate (within 1 week)
- 3 months

- 6 months
- 1 year

Standardized clinical neurosensory evaluation tests were used, including light touch test, pin-prick test, and two-point discrimination test. Neurosensory disturbance was classified as:

- No disturbance
- Temporary disturbance
- Persistent disturbance (sensory deficit persisting at 1 year)

The primary outcome was the prevalence of neurosensory disturbance at different postoperative intervals. The secondary outcome was the identification of risk factors associated with persistent neurosensory disturbance at 1 year.

Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were calculated for demographic and clinical variables. Categorical variables were expressed as frequencies and percentages. The association between potential risk factors and persistent neurosensory disturbance was assessed using the Chi-square test. Variables with $p < 0.05$ in bivariate analysis were included in a multivariate logistic regression model to determine independent predictors. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study population consisted of 140 patients with a mean age of 27.8 ± 6.4 years, indicating that most participants were young adults. The largest age group was 18–25 years (37.1%), followed closely by 26–35 years (34.3%), while patients older than 45 years represented the smallest proportion (8.6%). Females constituted a slightly higher proportion of the sample (55.7%) compared to males (44.3%). The majority of patients were from urban areas (62.9%), with 37.1% residing in rural locations. Most participants were non-smokers (74.3%), whereas 25.7% reported smoking. A large majority (87.1%) had no systemic disease, suggesting a generally healthy study population. Regarding surgical indications, Skeletal Class III deformity was the most common reason for surgery (51.4%), followed by Skeletal Class II (45.7%), with facial asymmetry accounting for only 2.9% of cases. In terms of operative duration, half of the procedures (50.0%) lasted between 90 and 120 minutes, while 21.4% exceeded 120 minutes and 28.6% were completed in less than 90 minutes. All patients underwent bilateral sagittal split osteotomy, ensuring procedural consistency across the sample. Overall, the demographic profile reflects a predominantly young, urban, and medically healthy population undergoing BSSO primarily for correction of Class II and Class III skeletal discrepancies.

Table 1: Demographic Characteristics of Study Participants (n = 140)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–25	52	37.1
	26–35	48	34.3
	36–45	28	20.0
	>45	12	8.6
Mean Age \pm SD		27.8 \pm 6.4	
Gender	Male	62	44.3
	Female	78	55.7
Residence	Urban	88	62.9
	Rural	52	37.1
Smoking Status	Smoker	36	25.7
	Non-Smoker	104	74.3
Systemic Disease	Yes	18	12.9
	No	122	87.1
Indication for Surgery	Skeletal Class II	64	45.7
	Skeletal Class III	72	51.4
	Facial Asymmetry	4	2.9
Duration of Surgery	<90 minutes	40	28.6
	90–120 minutes	70	50.0
	>120 minutes	30	21.4
Side of Osteotomy	Bilateral (All cases)	140	100

The prevalence of neurosensory disturbance was highest in the immediate postoperative period, with

77.1% of patients experiencing some form of sensory impairment within one week of surgery, while only

22.9% had no disturbance. The majority of these early deficits were temporary (70.0%), and 7.1% were classified as persistent. By 3 months, the overall prevalence of disturbance decreased to 51.4%, with nearly half of the patients (48.6%) showing complete recovery. At 6 months, further improvement was observed, as 72.9% of patients had no sensory deficit and only 27.1% continued to report disturbances, most of which were temporary (20.0%). At 1 year, recovery was substantial, with 88.6% of patients

demonstrating normal sensation and only 11.4% experiencing any disturbance. Persistent neurosensory deficit remained stable at 7.1% from the immediate postoperative period to 1 year, indicating that long-term impairment affected a small but consistent proportion of patients. Overall, the findings demonstrate a progressive decline in neurosensory disturbances over time, with most sensory deficits resolving within the first six months after BSSO.

Table 2: Prevalence of Neurosensory Disturbances at Different Follow-Up Periods

Follow-Up Period	No Disturbance n (%)	Temporary Disturbance n (%)	Persistent Disturbance n (%)	Total with Disturbance n (%)
Immediate (within 1 week)	32 (22.9)	98 (70.0)	10 (7.1)	108 (77.1)
3 Months	68 (48.6)	60 (42.9)	12 (8.5)	72 (51.4)
6 Months	102 (72.9)	28 (20.0)	10 (7.1)	38 (27.1)
1 Year	124 (88.6)	6 (4.3)	10 (7.1)	16 (11.4)

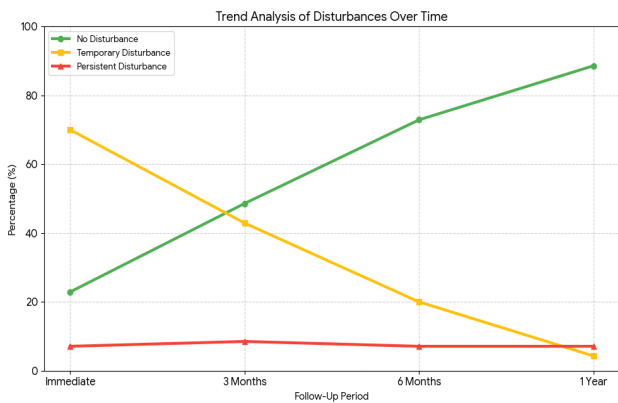


Figure 1: Shows Trend analysis

The analysis of risk factors for persistent neurosensory disturbance at 1 year demonstrated significant associations with age, smoking status, and duration of surgery. Patients older than 30 years showed a significantly higher rate of persistent disturbance (15.0%) compared to those aged 30 years or younger (1.3%) ($\chi^2 = 6.12, p = 0.013$), indicating that

increasing age may negatively affect nerve recovery. Smoking was also significantly associated with long-term sensory impairment, as 16.7% of smokers developed persistent disturbance compared to only 3.8% of non-smokers ($\chi^2 = 7.45, p = 0.006$), suggesting that tobacco use may impair nerve healing. The strongest association was observed with prolonged surgical duration; patients whose procedures lasted more than 120 minutes had a markedly higher prevalence of persistent disturbance (23.3%) compared to those with shorter operative times (2.7%) ($\chi^2 = 12.84, p = 0.0003$). In contrast, gender was not significantly associated with persistent neurosensory disturbance, as the difference between females (9.0%) and males (4.8%) was not statistically significant ($\chi^2 = 0.82, p = 0.36$). Overall, these findings indicate that advanced age, smoking, and longer operative time are significant predictors of persistent neurosensory complications following BSSO, whereas gender does not appear to influence long-term sensory outcomes.

Table 3: Association between Risk Factors and Neurosensory Disturbance at 1 Year (n = 140)

Risk Factor	Persistent n (%)	No Persistent n (%)	Chi-Square (χ^2)	p-value
Age >30 years (n=60)	9 (15.0)	51 (85.0)	6.12	0.013*
Age ≤30 years (n=80)	1 (1.3)	79 (98.7)		
Female (n=78)	7 (9.0)	71 (91.0)	0.82	0.36
Male (n=62)	3 (4.8)	59 (95.2)		
Smokers (n=36)	6 (16.7)	30 (83.3)	7.45	0.006*
Non-Smokers (n=104)	4 (3.8)	100 (96.2)		
Surgery Duration >120 min (n=30)	7 (23.3)	23 (76.7)	12.84	0.0003*
≤120 min (n=110)	3 (2.7)	107 (97.3)		

The multivariate logistic regression analysis identified age greater than 30 years, smoking, and prolonged surgical duration as independent predictors of

persistent neurosensory disturbance at 1 year. Patients aged over 30 years were approximately 4.85 times more likely to develop persistent sensory impairment

compared to younger patients (AOR = 4.85; 95% CI: 1.10–21.32; $p = 0.037$), indicating a statistically significant association. Similarly, smokers had a 5.42-fold increased risk of long-term neurosensory deficit compared to non-smokers (AOR = 5.42; 95% CI: 1.39–21.05; $p = 0.015$), suggesting that tobacco use significantly compromises nerve recovery. The strongest predictor was surgical duration greater than 120 minutes, as these patients were 8.76 times more likely to experience persistent disturbance (AOR = 8.76; 95% CI: 2.10–36.54; $p = 0.003$), highlighting the impact of prolonged operative time on nerve injury. In contrast, female gender was not significantly associated with persistent neurosensory disturbance (AOR = 1.72; 95% CI: 0.42–7.05; $p = 0.45$), as the confidence interval crossed unity and the p -value was not statistically significant. Overall, the regression model indicates that increasing age, smoking, and longer surgery duration are significant independent risk factors for persistent neurosensory complications following BSSO.

Table 4: Logistic Regression Analysis for Predictors of Persistent Neurosensory Disturbance (1 Year)

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	P-value
Age >30 years	4.85	1.10 – 21.32	0.037*
Smoking	5.42	1.39 – 21.05	0.015*
Surgery Duration >120 min	8.76	2.10 – 36.54	0.003*
Female Gender	1.72	0.42 – 7.05	0.45

DISCUSSION

Neurosensory disturbance (NSD) remains one of the most frequently reported complications following Bilateral Sagittal Split Osteotomy (BSSO). The present study demonstrated a high prevalence of immediate postoperative neurosensory disturbance (77.1%), which gradually declined over time, with only 7.1% of patients exhibiting persistent sensory deficits at 1 year. These findings are consistent with previous studies reporting immediate postoperative NSD rates ranging from 60% to 90%, followed by substantial recovery within the first 6 to 12 months (13).

The high rate of early postoperative sensory impairment can be attributed to intraoperative manipulation of the inferior alveolar nerve (IAN), edema, hematoma formation, and transient neurapraxia (14). Most temporary disturbances observed in this study resolved within six months, supporting the theory that the majority of nerve

injuries during BSSO are neuropraxic or mild axonotmetic injuries with favorable regenerative potential (15). Similar recovery patterns have been documented in longitudinal studies assessing sensory function after orthognathic surgery (16). Similar findings have been reported in regional studies. A study conducted in Pakistan reported that temporary neurosensory disturbances following BSSO were common in the early postoperative period but demonstrated substantial recovery within 6–12 months. Another regional investigation also highlighted operative duration and patient age as important determinants of delayed neurosensory recovery following mandibular osteotomy procedures.

Persistent neurosensory disturbance at 1 year was observed in 7.1% of patients, which falls within the range reported in previous literature (5–15%) [17]. Long-term sensory impairment is clinically significant because it may affect speech, mastication, facial expression, and overall patient satisfaction. Studies have shown that persistent paresthesia or dysesthesia can negatively impact quality of life, even when functional impairment appears minimal [18].

Age emerged as a significant predictor of persistent NSD in the present study. Patients older than 30 years were significantly more likely to experience long-term sensory deficits. This finding is consistent with previous research suggesting that nerve regenerative capacity decreases with advancing age due to reduced cellular repair mechanisms and vascular supply [19]. Older patients may also have denser cortical bone, increasing the likelihood of nerve manipulation or compression during osteotomy. Smoking was another independent risk factor identified in this study. Smokers were more than five times more likely to develop persistent neurosensory disturbance. Tobacco use is known to impair microvascular circulation, reduce oxygen delivery, and delay wound healing, all of which may compromise nerve regeneration [20]. Similar associations between smoking and delayed sensory recovery after mandibular surgery have been reported in prior investigations [21].

Prolonged surgical duration (>120 minutes) was found to be the strongest predictor of persistent NSD. Extended operative time may reflect technical difficulty, increased nerve handling, or more complex mandibular movements. Increased exposure and manipulation of the inferior alveolar nerve during longer procedures may contribute to greater mechanical or ischemic injury [12]. This highlights the importance of surgical experience, careful planning, and atraumatic technique to minimize operative time

and nerve trauma. Interestingly, gender was not significantly associated with persistent neurosensory disturbance in this study. This aligns with several previous reports suggesting that biological sex does not independently influence nerve recovery following BSSO [13, 17]. However, some authors have proposed potential hormonal or pain perception differences, indicating that further research may be warranted. Overall, the findings of this study reinforce that while neurosensory disturbance after BSSO is common in the immediate postoperative period, the majority of cases resolve spontaneously within six months. Persistent deficits are relatively uncommon but are significantly associated with modifiable and non-modifiable risk factors such as smoking, operative duration, and age. Preoperative patient counseling should therefore include discussion of these risk factors, and smoking cessation strategies may be beneficial in reducing long-term complications. Future research with larger multicenter cohorts and objective neurosensory testing methods may provide further insight into preventive strategies and optimization of surgical techniques to reduce the incidence of persistent nerve injury.

Despite providing important insights into neurosensory outcomes following BSSO, this study has several limitations. First, the study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other populations and surgical settings. Second, neurosensory evaluation relied primarily on clinical sensory testing rather than advanced quantitative sensory testing methods, which may have provided more objective assessment of nerve function. Third, although several important demographic and surgical variables were analyzed, other potential factors such as magnitude of

mandibular advancement, intraoperative nerve exposure, and surgeon experience were not evaluated. Future multicenter studies incorporating larger sample sizes and more comprehensive neurosensory assessment tools are recommended to further validate these findings.

CONCLUSION

Neurosensory disturbance is a common early complication following BSSO, but most cases are temporary and recover within six months. Persistent deficits at one year are relatively low, indicating good long-term outcomes. Advanced age, smoking, and prolonged surgical time were significant risk factors, with operative duration showing the strongest association. Careful surgical technique and smoking cessation may help reduce long-term complications.

Disclaimer: Nil

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this study

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AUTHORS' CONTRIBUTION

Concept & Design of Study: Prof. Dr. Muslim Khan

Drafting: Dr. Sana Mushtaq

Data Analysis: Dr. Tariq Ahmad

Critical Review: Prof. Dr. Muslim Khan, Dr. Tariq Ahmad

Final Approval of Version: Prof. Dr. Muslim Khan, Dr. Sana Mushtaq, Dr. Tariq Ahmad

All authors have reviewed and approved the final manuscript.

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