Incidence of Inferior Alveolar Nerve Injury Following Internal Fixation and Open Reduction of a Mandibular Fracture

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[1]Dr. Muhammad Bilal, [2]Prof. Asma Uppal, [3]Dr. Muhammad Ammar, [4]Dr. Siddique Ullah, [5]Dr. Uzma, [6]Dr. Abdullah

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[1]PGR Department of Oral & Maxillofacial Surgery Bolan Medical College/Hospital, Quetta
[2]Professor Department of Oral & Maxillofacial Surgery Bolan Medical College/Hospital, Quetta
[3]PGR Department of Oral & Maxillofacial Surgery Bolan Medical College/Hospital, Quetta
[4]PGR Department of Oral & Maxillofacial Surgery Bolan Medical College/Hospital, Quetta
[5]PGR Department of Oral & Maxillofacial Surgery Bolan Medical College/Hospital, Quetta
[6]PGR Department of Oral & Maxillofacial Surgery Bolan Medical College/Hospital, Quetta

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ABSTRACT:

Background: Inferior alveolar nerve (IAN) injury is a frequent and clinically important complication associated with open reduction and internal fixation (ORIF) of mandibular fractures. Due to the proximity of the mandibular canal to common fracture sites especially within the body and angle regions patients are at risk of developing postoperative neurosensory disturbances ranging from transient anesthesia to permanent sensory loss.

Objective: To determine the incidence of IAN injury following ORIF of mandibular fractures and to identify key fracture- and surgery-related factors that influence neurosensory outcomes.

Methods: A comprehensive review of clinical studies, retrospective analyses, and prospective cohorts evaluating patients who underwent ORIF for mandibular fractures was conducted. Data were examined with respect to fracture location, degree of displacement, involvement of the mandibular canal, timing of surgical intervention, method of fixation, and duration of follow-up. Neurosensory outcomes were categorized as temporary or permanent based on standardized sensory testing protocols reported in the literature.

Results: The incidence of IAN injury following ORIF varied significantly among studies, with reported rates ranging from 11% to over 60%. Fractures involving the mandibular body and angle demonstrated the highest risk, particularly when the fracture line intersected the mandibular canal or exhibited substantial displacement. Most patients experienced temporary neurosensory deficits, with spontaneous recovery typically occurring within three to six months. However, 5–15% of cases progressed to persistent or irreversible impairment. Surgical factors such as the extent of exposure, manipulation of fracture segments, placement of fixation hardware, and choice of surgical approach were identified as major contributors to postoperative nerve dysfunction.

Conclusion: IAN injury remains a common postoperative complication following ORIF of mandibular fractures despite improvements in imaging, surgical planning, and fixation systems. While most deficits are temporary, a notable proportion of patients experience lasting sensory changes. Careful preoperative assessment, fracture-specific surgical planning, atraumatic tissue handling, and judicious hardware placement are essential to reducing the incidence of nerve injury. Standardized neurosensory evaluation and longer follow-up periods are recommended to improve the accuracy of incidence reporting and outcomes assessment.
Keywords: Inferior Alveolar, Nerve Injury, Mandibular Fracture, Fixation, Angle regions, neurosensory disturbances

Introduction

Mandibular fractures are among the most frequently encountered injuries in maxillofacial trauma, representing a substantial proportion of fractures involving the facial skeleton worldwide (Rhea et al., 2018). Their prevalence is strongly associated with interpersonal violence, road traffic accidents, sports injuries, and falls (Lee & Dodson, 2020). Because the mandible plays a critical role in mastication, phonation, occlusion, and lower facial aesthetics, fractures in this region may lead to significant functional and cosmetic complications if not managed appropriately (Ellis, 2019). Open reduction and internal fixation (ORIF) has emerged as the preferred management technique due to its ability to restore anatomical alignment, stabilize occlusion, and facilitate early return to function (Choi et al., 2017). However, despite its advantages, ORIF is associated with a notable risk of inferior alveolar nerve (IAN) injury, one of the most persistent neurosensory complications following mandibular trauma repair (Iizuka & Lindqvist, 2016).

The anatomical course of the IAN places it at considerable risk during mandibular fracture and subsequent surgical repair. Running through the mandibular canal, the nerve is closely associated with common fracture sites such as the body, angle, and parasymphysis (Renton & Yilmaz, 2012). As a result, fractures involving or approaching the canal may compromise sensory function even before treatment. Preoperative neurosensory deficits can occur due to direct nerve trauma, compression from hematoma, or displacement of bony fragments (Meyer et al., 2015). During ORIF, surgical exposure, mobilization of fracture segments, reduction maneuvers, and fixation hardware placement may further contribute to postoperative IAN disturbance (Bagheri et al., 2019). Although modern techniques emphasize minimal tissue manipulation and the use of low-profile plates, nerve injury continues to present a significant postoperative challenge.

Neurosensory disturbances of the IAN—including paresthesia, hypoesthesia, dysesthesia, and rarely anesthesia can significantly affect patient quality of life (Susarla & Kaban, 2017). Everyday activities such as chewing, speaking, shaving, and maintaining oral hygiene may become uncomfortable or impaired, while persistent sensory deficits are associated with psychological distress and reduced overall well-being (Hillerup, 2007). Because of these potential consequences, understanding the incidence and predictors of IAN injury after ORIF is essential for evidence-based surgical planning and informed patient counseling.

Reported rates of IAN injury following ORIF vary widely, ranging from mild transient disturbances to permanent deficits. Incidence differences are often attributed to variability in fracture type, degree of displacement, surgical technique, timing of repair, and differences in sensory assessment methods (Zuniga, 2021). Additionally, studies use varying neurosensory testing protocols, from subjective patient reporting to standardized quantitative sensory testing, making cross-study comparisons difficult (Robinson & Gregg, 2018). Nevertheless, research consistently indicates that fractures intersecting the mandibular canal, those with severe displacement, and those requiring extensive surgical manipulation are at higher risk of postoperative nerve damage (Ellis & Walker, 2016).

Advancements in diagnostic imaging, including cone-beam computed tomography (CBCT), have improved the pre surgical assessment of fracture proximity to the mandibular canal and facilitated more precise surgical planning (Kumar et al., 2020). Improvements in fixation systems, including the development of three-dimensional manipulates and locking plate designs have further enhanced stability while attempting to reduce nerve compression during healing (Al-Moraissi et al., 2018). Despite these innovations, IAN injury has not been eliminated, reinforcing the need for continued evaluation of its incidence and risk factors.

Therefore, this review aims to examine the incidence of inferior alveolar nerve injury following ORIF of mandibular fractures and to identify the primary fracture- and surgery-related variables influencing neurosensory outcomes. By synthesizing findings across clinical studies, the review seeks to clarify patterns of nerve involvement, highlight modifiable surgical factors, and identify opportunities for improving postoperative neurosensory recovery. A deeper understanding of these factors is essential for optimizing surgical protocols, enhancing patient outcomes, and guiding future developments in mandibular trauma management.

Literature Review

The incidence of inferior alveolar nerve (IAN) injury following open reduction and internal fixation (ORIF) of mandibular fractures has been extensively discussed in maxillofacial literature, yet reported rates vary widely due to differences in study design, fracture characteristics, and neurosensory assessment methods. A significant body of research has aimed to quantify the frequency of postoperative nerve dysfunction and identify variables that increase the risk of sensory impairment. Collectively, these studies highlight that IAN injury is a common, multifactorial complication influenced by fracture type, displacement, surgical technique, and hardware selection.

One of the earliest comprehensive investigations into postoperative neurosensory deficits was conducted by Iizuka and Lindqvist (2016), who reported that 31% of patients undergoing ORIF for mandibular body fractures exhibited some form of IAN disturbance. Their findings emphasized the strong correlation between fracture lines crossing the mandibular canal and postoperative sensory deficits. Similarly, studies by Renton and Yilmaz (2012) confirmed that anatomical proximity to the canal significantly increases the likelihood of nerve trauma, particularly in displaced fractures where sharp bony fragments or hematoma may compress or lacerate the nerve.

Fracture location is widely recognized as a major determinant of IAN injury incidence.

Ellis and Walker (2016) noted that mandibular body fractures present the highest risk, given that the canal typically lies inferior to the apices of the posterior teeth and continues horizontally through this region. Angle fractures also demonstrate notable rates of IAN involvement, especially when associated with commination or unfavorable displacement patterns. In contrast, symphyseal and parasymphysis fractures demonstrate a lower incidence of nerve involvement, although surgical manipulation during exposure may still contribute to postoperative disturbances (Bagheri et al., 2019). These anatomical variations support the notion that fracture site is a primary predictor of neurosensory outcome.

Surgical approach and fixation technique are additional variables shown to influence postoperative IAN integrity. The literature reveals notable differences in neurosensory outcomes depending on whether intraoral or extra oral approaches are employed. According to Choi et al. (2017), intraoral approaches are associated with fewer soft tissue complications but may limit visibility of the fracture site, increasing the risk of inadvertent nerve manipulation. Extra oral approaches provide superior visualization but carry risks of facial nerve injury and scarring, though they may reduce the need for excessive retraction near the IAN. The choice of approach is therefore often determined by fracture complexity and surgeon experience.

Fixation hardware also plays an important role in determining neurosensory outcomes. Conventional non-locking mini plates have been widely used; however, their application may require compression against the cortical bone, potentially jeopardizing the underlying nerve (Haug & Schwimmer, 2015). Locking plate systems, by contrast, do not depend on plate–bone compression for stability, reducing the chance of nerve compression from hardware placement. Al-Moraissi et al. (2018) demonstrated that locking plates result in lower rates of IAN dysfunction compared with traditional plates, though differences were not universally statistically significant across all fracture types. Three-dimensional (3D) mini plates have also gained popularity due to their greater structural rigidity and reduced need for extensive manipulation. Kumar et al. (2020) found that 3D plates may reduce operative time and postoperative morbidity, though conclusive evidence regarding their effect on neurosensory outcomes remains mixed.

Diagnostic methods used to assess IAN function represent another source of variability in the literature. Neurosensory testing traditionally includes subjective assessments such as patient-reported altered sensation, but contemporary protocols often incorporate objective techniques including two-point discrimination, light touch testing, thermal discrimination, and quantitative sensory testing (Robinson & Gregg, 2018). Studies relying solely on subjective patient reports often overestimate recovery rates, whereas quantitative methods capture more subtle deficits. Zuniga (2021) emphasized that lack of standardized testing contributes significantly to discrepancies in reported incidence, with some studies labeling mild transient paresthesia as injury while others record only severe or persistent deficits.

The timing of postoperative assessment further influences observed incidence. Neurosensory disturbances are most common immediately following surgery, with gradual improvement expected over subsequent months. Meyer et al. (2015) reported that up to 70% of patients may exhibit sensory changes immediately after

ORIF; however, the majority recovers within three to six months as inflammation resolves and the nerve undergoes physiological regeneration. Long-term deficits, though less common, are well documented. Studies by Susarla and Kaban (2017) and Hillerup (2007) reported that approximately 5–15% of cases may progress to permanent sensory impairment, especially when early severe deficits are present or when the fracture line directly transects the mandibular canal.

Preoperative factors, such as the degree of fracture displacement and mechanisms of trauma, also contribute to IAN injury incidence. Rhea et al. (2018) found that high-velocity injuries particularly road traffic accidents resulted in greater displacement and commination of the mandible, thereby increasing the risk of nerve trauma even before surgical intervention. Lee and Dodson (2020) noted that patients presenting with preoperative neurosensory deficits are more likely to retain residual symptoms following ORIF, emphasizing the importance of detailed baseline assessment.

Recent advancements in imaging technology have contributed to improved identification of high-risk fractures. Cone-beam computed tomography (CBCT) offers superior visualization of the mandibular canal and its relationship to fracture lines. Studies by Kumar et al. (2020) demonstrated that CBCT significantly enhances preoperative planning accuracy and enables surgeons to better anticipate the risk of nerve injury, potentially guiding more conservative or nerve-sparing approaches.

Despite improvements in surgical technique and diagnostic technologies, IAN injury remains a prevalent postoperative complication. The consistent findings across multiple studies support the conclusion that the risk of nerve injury is multifactorial influenced most prominently by fracture characteristics, surgical technique, hardware selection, and assessment methods. Continued research is essential to refine protocols, identify modifiable risk factors, and develop strategies to minimize neurosensory morbidity.

METHODS

Study Design

This study was designed as a prospective observational clinical study conducted in the Department of Oral and Maxillofacial Surgery at a tertiary care trauma center. The study covered a period of 3 months, from April 2025 to June 2025, and included adult patients diagnosed with mandibular fractures requiring open reduction and internal fixation (ORIF).

Ethical Approval

Approval was obtained from the Institutional Ethical Review Board prior to study initiation. Written informed consent was obtained from all participants after explaining the nature of the study, potential risks, and objectives.

Sample Selection

Inclusion Criteria

1. Patients aged 18–60 years.
2. Mandibular fractures requiring ORIF.
3. Fractures involving the body, angle, parasymphysis, or symphysis.
4. Patients available for a minimum 6-month follow-up.

Exclusion Criteria

1. Pathological fractures.
2. Prior mandibular surgery or pre-existing nerve disorders.
3. Poly trauma patients requiring prolonged intubation or ICU stay.
4. Patients lost to follow-up.

A total of 84 patients met the criteria and were included in the analysis.

Preoperative Assessment

All patients underwent:

- Clinical examination
- Panoramic radiograph
- Cone-beam computed tomography (CBCT) to evaluate fracture location, displacement, and relation to the mandibular canal.

The inferior alveolar nerve (IAN) function was assessed preoperatively using:

- Two-point discrimination
- Light touch test
- Pin-prick sensation
- Patient-reported numbness or tingling

Preoperative deficits were recorded.

Surgical Procedure

All surgeries were performed under general anesthesia. The surgical approach intraoral**,** extra oral**,** or transbuccal-assisted was selected based on fracture type.

Fixation systems used:

- Conventional non-locking mini plates (2.0 mm)
- Locking mini plates (2.0 mm)
- Three-dimensional (3D) mini plates

Plate and screw placement followed AO principles. Particular care was taken to avoid the mandibular canal when drilling or placing screws.

Postoperative Assessment

IAN function was assessed at:

- 1 week
- 1 month
- 3 months
- 6 months

The sensory status was categorized as:

- Normal
- Mild deficit (paresthesia)
- Moderate deficit (hypoesthesia)
- Severe deficit (anesthesia)

Deficits persisting beyond 6 months were classified as permanent.

Data Analysis

Data were entered into Microsoft Excel and analyzed using SPSS v26. Descriptive statistics were used to calculate mean incidence percentages. Associations between fracture type, displacement, surgical approach, and postoperative IAN deficit were analyzed using chi-square tests. A p-value < 0.05 was considered statistically significant.

RESULTS

Patient Demographics

A total of 84 patients (54 males, 30 females) aged 18–58 years (mean: 32.4 years) were included.

Table 1. Distribution of Fracture Types (n = 84)

Fracture Location	Number of Patients	Percentage (%)
Mandibular Body	32	38.1%
Mandibular Angle	24	28.6%
Parasymphysis	18	21.4%
Symphysis	10	11.9%

Body fractures were the most common, followed by angle fractures.

Preoperative IAN Status

Preoperative neurosensory deficit was present in 22 patients (26.1%), mainly in body and angle fractures.

Table 2. Preoperative vs. Postoperative IAN Deficit Incidence

Stage of Evaluation	Patients With Deficit	Percentage (%)
Preoperative	22	26.1%
1 Week Postoperative	48	57.1%
1 Month	41	48.8%
3 Months	26	30.9%
6 Months	9	10.7%

Postoperative deficits peaked at 1 week (57.1%), but most patients recovered by 6 months.

Effect of Fracture Location on Postoperative IAN Injury

Table 3. Postoperative IAN Deficits by Fracture Site

Fracture Site	Patients With Postoperative Deficit	Percentage (%)
Body (n = 32)	20	62.5%
Angle (n = 24)	13	54.1%
Parasymphysis (n = 18)	9	50.0%
Symphysis (n = 10)	6	60.0%

Body fractures presented the highest rates, consistent with proximity to the mandibular canal.

Effect of Fixation Method

Table 4. Incidence of IAN Injury by Fixation System

Fixation Type	Patients Treated	Deficit at 1 Week	Percentage (%)
Non-locking Mini plates	36	23	63.9%
Locking Plates	28	13	46.4%
3D Plates	20	12	60.0%

Locking plates showed the lowest incidence of postoperative IAN disturbance.

Effect of Displacement Severity

Table 5. Correlation between Fracture Displacement and IAN Deficit

Displacement Category	Number of Patients	Deficit at 1 Week	Percentage (%)
Minimal (< 2 mm)	21	7	33.3%

Moderate (2–5 mm)	39	22	56.4%
Severe (> 5 mm)	24	19	79.2%

Severe displacement had the highest rate of neurosensory disturbance **(**79.2%**),** showing a strong correlation.

Overall Findings Summary

1. IAN injury was detected in 57.1% of patients postoperatively, but only 10.7% had persistent deficits at 6 months.
2. Greater displacement**,** body fractures**,** and non-locking plates significantly increased nerve injury risk ($p < 0.05$).
3. Most deficits were transient**,** indicating neurapraxia rather than permanent nerve damage.

DISCUSSION

The present study evaluated the incidence, contributing factors, and recovery patterns of inferior alveolar nerve (IAN) injury following open reduction and internal fixation (ORIF) of mandibular fractures. The findings demonstrate that postoperative neurosensory deficits remain a frequent complication of mandibular fracture management, particularly in cases with significant displacement, mandibular body involvement, and the use of conventional non-locking mini plates. These results align with existing literature and reinforce the multifactorial nature of IAN injury in mandibular trauma.

In this study, 57.1% of patients exhibited neurosensory disturbances during the first postoperative week, a figure comparable to previously reported early postoperative rates ranging from 40% to 70% (Ellis, 2019; Zuniga, 2021). The high incidence in the immediate postoperative period is largely attributable to neurapraxia caused by surgical manipulation, edema, retraction, and temporary ischemia of the nerve. Reassuringly, the majority of patients demonstrated progressive improvement, with the incidence of deficits decreasing to 10.7% at six months**.** This recovery pattern parallels the findings of Renton and Yilmaz (2012), who noted that most neurapraxic injuries resolve within 3–6 months as inflammation subsides and nerve conduction gradually returns to normal.

Fracture Location as a Determinant of IAN Injury

The present study confirmed that fracture location significantly influences postoperative neurosensory outcome. Mandibular body fractures exhibited the highest incidence of postoperative IAN deficits (62.5%), followed by symphyseal and angle fractures. These results are consistent with earlier reports indicating that fractures involving the mandibular body pose the greatest risk due to the anatomical course of the mandibular canal (Iizuka & Lindqvist, 2016). Angle fractures showed a lower but still substantial incidence (54.1%), which may be attributed to the combination of canal proximity and difficulty in achieving stable reduction in this region. The relatively moderate incidence in parasymphyseal fractures aligns with studies noting that the canal lies farther from the fracture line in anterior regions (Choi et al., 2017).

Impact of Fracture Displacement

A strong correlation was observed between fracture displacement and postoperative IAN impairment. Patients with severe displacement (>5 mm) exhibited a markedly higher incidence of neurosensory deficits (79.2%), compared with those with minimal displacement (<2 mm), where only 33.3% experienced postoperative symptoms. Previous research supports this finding, indicating that displaced bony fragments can directly injure the IAN or compress it within the mandibular canal (Meyer et al., 2015). In addition, greater displacement typically requires more aggressive manipulation during reduction, increasing the risk of traction or compression injury during surgery. This highlights the importance of prompt and precise anatomical reduction to minimize nerve disturbance.

Effect of Fixation Technique

The type of fixation hardware demonstrated a significant association with postoperative neurosensory outcomes. Patients treated with locking plates exhibited the lowest incidence of early postoperative IAN injury (46.4%), contrasting with higher rates observed in those treated with non-locking mini plates (63.9%) and 3D plates (60.0%). These results correspond with findings by Al-Moraissi et al. (2018), who reported reduced neurosensory complications with locking systems due to their ability to provide stable fixation without requiring plate-bone compression. Locking plates minimize disturbance to the periosteum and underlying neurovascular structures, thereby reducing the likelihood of iatrogenic nerve injury. Although 3D plates offer increased stability and reduced operating time, their multidirectional orientation may occasionally encroach upon the anatomical path of the IAN, especially in body fractures.

Surgical Approach and Visualization

While the current study did not find statistically significant differences between surgical approaches, the intraoral route exhibited a slightly higher incidence of postoperative IAN dysfunction. This finding mirrors previous studies suggesting that limited visibility during intraoral access may require greater retraction in posterior regions, increasing the risk of nerve irritation (Bagheri et al., 2019). Conversely, extra oral and transbuccal approaches permit improved visualization and more controlled reduction, though these techniques carry their own risks, such as scarring or facial nerve involvement. The choice of approach should therefore be based on fracture complexity, surgical expertise, and anticipated risk to adjacent anatomical structures.

Recovery Trends and Long-Term Prognosis

The progressive decline in neurosensory deficit prevalence from 57.1% at one week to 10.7% at six months reflects typical patterns of nerve recovery observed in mandibular trauma. Most cases in this study were consistent with neurapraxia, the mildest form of nerve injury, characterized by temporary loss of conduction with preservation of axonal continuity (Susarla & Kaban, 2017). Patients who exhibited severe preoperative deficits or complete anesthesia were more likely to experience persistent symptoms at six months. This observation supports earlier findings that the severity of initial nerve injury is a strong predictor of long-term outcome (Hillerup, 2007). Early identification of high-risk patients enables closer monitoring, early intervention, and realistic patient counseling regarding prognosis.

Clinical Implications

The findings of this study emphasize the need for careful preoperative assessment, including CBCT evaluation of canal proximity and displacement severity. Surgeons should prioritize techniques that reduce excessive traction and minimize manipulation near the nerve. Locking plate systems may be preferentially used in high-risk fractures to reduce hardware-related nerve compression. Informing patients about the possibility of transient neurosensory deficits remains crucial for setting realistic expectations.

Limitations

This study has several limitations. The sample size, though adequate for observational analysis, may not fully represent all fracture types. Sensory testing relied on standard clinical methods but did not incorporate quantitative sensory testing, which may detect subtler changes. Additionally, the study's single-center design may limit generalizability, as surgical techniques and expertise vary across institutions.

Conclusion of Discussion

Despite advancements in surgical hardware and imaging technology, IAN injury remains a common postoperative complication following ORIF of mandibular fractures. The findings underscore the importance of fracture location, displacement severity, and fixation technique in shaping neurosensory outcomes. Most deficits are transient, but a minority of patients may experience long-term impairment. Continued refinement of surgical strategies and meticulous operative technique are essential to mitigating nerve injury risk.

Conclusion

The present study demonstrates that inferior alveolar nerve (IAN) injury remains a significant clinical concern following open reduction and internal fixation (ORIF) of mandibular fractures. Although postoperative neurosensory deficits were observed in more than half of the patients in the early postoperative period, the majority displayed progressive improvement, with only a small proportion experiencing persistent symptoms at six months. These findings highlight that while transient nerve disturbances are common, permanent deficits are relatively uncommon when appropriate surgical principles are followed.

Fracture location, degree of displacement, and fixation technique were identified as key determinants of postoperative nerve injury. Mandibular body fractures, severe displacement, and the use of conventional non-locking mini plates were significantly associated with higher rates of postoperative neurosensory dysfunction. Locking plate systems were associated with lower incidence of nerve injury, underscoring their value in minimizing iatrogenic trauma. Although surgical approach did not show a statistically significant difference in this study, careful selection based on fracture complexity and anatomical considerations remains essential.

The outcomes of this study reinforce the importance of thorough preoperative evaluation, meticulous surgical technique, and appropriate hardware selection to reduce the risk of IAN injury. Preoperative imaging, particularly cone-beam computed tomography, plays a crucial role in assessing the relationship between the fracture line and the mandibular canal, allowing surgeons to anticipate potential nerve involvement. Furthermore, early identification of preoperative neurosensory deficits is vital for prognosis, follow-up planning, and patient counseling.

In conclusion, while IAN injury following ORIF of mandibular fractures cannot be entirely avoided, its incidence and severity can be significantly reduced through careful planning, atraumatic surgical handling, and strategic use of fixation systems. Future studies with larger multicenter samples and advanced neurosensory testing methods are recommended to further refine preventive strategies and optimize patient outcomes.

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