

FREQUENCY AND PATTERN OF PRESENTATION OF INFERIOR ALVEOLAR NERVE INJURIES AFTER OPEN REDUCTION AND INTERNAL FIXATION OF BODY OF MANDIBLE FRACTURES

Umair Hussain^{*1}, Asif Nazir², Laiba Rehman³, Faras Asif⁴, Sara Munir⁵, Ayesha Shaukat⁶

^{*1}PGR Oral and Maxillofacial Surgery, Nishtar Institute of Dentistry Multan

²Associate Professor Oral and Maxillofacial Surgery, Nishtar Institute of Dentistry Multan

³House Officer Oral and Maxillofacial Surgery, Nishtar Institute of Dentistry Multan

⁴House Officer Oral & Maxillofacial Surgery, Fatima Memorial Hospital and College of Medicine and Dentistry Lahore

⁵House Officer Oral & Maxillofacial Surgery, Nishtar Institute of Dentistry Multan

⁶Dental Department Thq Hospital Kabirwala

¹umairhossain1@gmail.com, ³laibarehman135@gmail.com, ⁴farasmughal80@gmail.com,

⁵sarahmunir2002@gmail.com, ⁶drayeshashokat@gmail.com

Corresponding Author: *

Umair Hussain

DOI: <https://doi.org/10.5281/zenodo.23392117>

Received	Accepted	Published
01 January 2025	17 February 2025	25 February 2025

ABSTRACT

Mandibular fractures account for one of the most common forms of facial trauma and fractures of the body of the mandible often involve injury to the inferior alveolar nerve (IAN), which has an anatomical association with the inferior alveolar canal. Open reduction and internal fixation (ORIF) is still widely accepted as a treatment method for mandibular fractures, but postoperative sensory disturbances of the inferior alveolar nerve are a major concern which can impact the patients' comfort and quality of life. These injuries to the nerves occur at different frequencies and in different patterns depending on several factors related to the patient, fracture and surgery. The objective of this study is to determine the frequency and pattern of presentation of inferior alveolar nerve injuries after open reduction and internal fixation of body of mandible fractures. This study is conducted in patients with fractures to the body of mandible who undergo open reduction and internal fixation. Some of the sensory disturbances evaluated in clinical examination of inferior alveolar nerve function are numbness, paresthesia, altered sensation, dysesthesia, pain, and complete sensory loss. Factors associated with inferior alveolar nerve injury are assessed based on patient demographics, fracture characteristics and surgical factors. This study provides evidence of inferior alveolar nerve injuries after ORIF of body of mandible fractures. Affected patients have different types of sensory disturbances: numbness, tingling sensation, altered sensation, pain or sensory loss. The incidence and extent of nerve injury vary by age, sex, fracture characteristics and surgical factors. Sensory recovery was observed to be different in patients with nerve related complications, with postoperative follow-up assessment. Injury to the inferior alveolar nerve is one of the potential complications of open reduction and fixation of fractures of the body of mandible. These factors are critical in minimizing complications and optimizing outcomes of surgical procedures, so appropriate surgical planning, careful handling of anatomical structures and frequent postoperative neurosensory assessment are essential.

Keywords: Inferior alveolar nerve injury, Mandibular body fracture, Open reduction and internal fixation of mandible (ORIF), Neurosensory disturbance, Mandibular fracture, Paresthesia, Sensory impairment, Oral and maxillofacial surgery.

INTRODUCTION

Mandibular fractures are among the most frequent injuries of the maxillofacial area, and make up a large percentage of facial trauma cases. Due to the remarkable anatomical location, the mandible is often subjected to traumatic forces, and the most frequent sites of fractures are the body, angle, symphysis and condyle. Of these locations, fractures of the body of the mandible are particularly problematic as the fracture line is in close proximity to the inferior alveolar nerve (IAN) that runs in the mandibular canal. Damage to this nerve will cause sensory dysfunction of the lower lip, chin and related oral structures. (Monarchi et al., 2023)

The inferior alveolar nerve is a major sensory branch of the mandibular division of the trigeminal nerve that transmits sensation to the mandibular teeth, lower lip and chin via its terminal mental nerve branch. The nerve is always at risk during trauma to the mandible and in surgery as it is situated within the mandibular canal. Nerve dysfunction can be temporary or permanent causes of compression, stretching, displacement of fracture segments, direct trauma, drilling procedures or fixation screw placement. Injury to the inferior alveolar nerve can manifest itself in several ways: numbness, paresthesias, hypoesthesias, dyesthesias, pain, and even complete loss of sensation, causing disability and reduced quality of life. (Kwon and Hohman, 2023)

Open reduction and internal fixation (ORIF) is now the recommended treatment for displaced mandibular fractures due to the benefits of accurate anatomical reduction, restoration of occlusion and early functional recovery. In spite of the advances in surgical procedures and fixation systems, however, inferior alveolar nerve disturbances are one of the most frequent complications after ORIF. Manipulation around the mandibular canal during surgery may place a greater risk of nerve injury especially in fractures of the body and angle regions of the mandible. (Sulistiyani et al., 2022)

The incidence of inferior alveolar nerve injury following mandibular fracture treatment reported in the literature varies according to fracture site, trauma severity, surgical

technique, timing of surgery, and neurosensory assessment technique. Inferior alveolar nerve damage is one of the most common complications encountered after open reduction and internal fixation of mandibular fractures, as reported by Alamgir et al. (2023), which emphasizes the need for meticulous surgical care and management of the postoperative period. Likewise, Tariq et al. (2023) highlighted the importance of assessing nerve injury after fixation surgery to ensure that sensory deficits do not occur, as they can negatively impact patient satisfaction and recovery.

Inferior alveolar nerve injury is presented in various ways by patients. A few people have mild changes in sensation that get better over time, while some have ongoing sensation problems. The authors of the study by de Assis Santos et al. (2022) emphasized that the clinical evaluation of the nerve function, through sensory testing, is still essential for assessing the severity and evolution of the nerve lesions, to understand the patterns of nerve recovery and to better manage the patient.

Background of the Study

Mandibular fractures are a significant part of maxillofacial trauma, and often result from road traffic accidents, falls, interpersonal violence and sporting injuries. The mandible is the only bone of the facial skeleton that is mobile and it is so exposed due to its anatomical position. The most important and clinically significant fracture sites in the mandible are fractures of the body, because it is in close proximity to the inferior alveolar nerve (IAN) which goes through the mandibular canal.

The inferior alveolar nerve is a sensory nerve that supplies the mandibular teeth, lower lip, chin and adjacent soft tissues. This nerve may be injured during surgery for managing a fracture, or during trauma to the mandible, causing sensory changes. These disturbances can be as numbness, tingling, altered sensitivity, pain or complete loss of sensation.

Open reduction and internal fixation (ORIF) is regarded as the preferred method of treatment for displaced mandibular fractures, which offers anatomic reconstruction, stable

fixation and rapid restoration of function. The risk for injury of the inferior alveolar nerve is higher, however, when segments of the fracture are manipulated, when drilling is performed, when screws are inserted, and when surgical exposure is done near the inferior alveolar nerve. One of the significant postoperative complications that impact patient recovery and quality of life is nerve dysfunction.

Inferior alveolar nerve injuries that occur after ORIF vary in frequency and severity depending upon several factors such as fracture displacement, fracture location, surgical technique, fixation method, and

patient-related factors. Thus, assessment of the incidence and distribution of neuro injuries following ORIF of BOM fractures is crucial for enhancing the surgical outcomes and reducing the complications.

Anatomy of Inferior Alveolar Nerve

The inferior alveolar nerve is one of the largest branches of the third division of the trigeminal nerve, the mandibular nerve. It comes from the mandibular nerve following the foramen ovale and descends between the lateral pterygoid muscle and the medial side of the mandibular ramus.

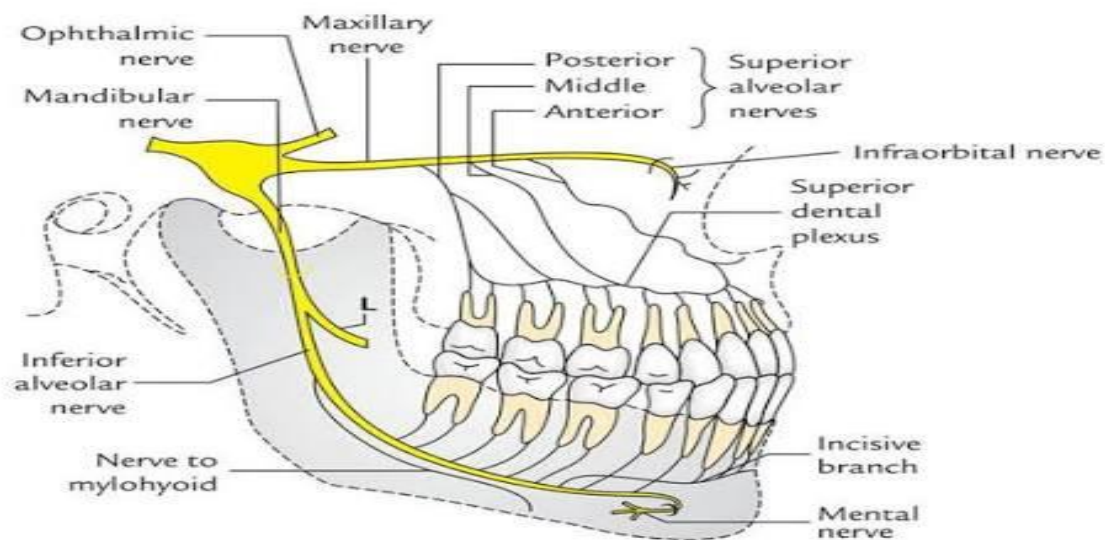


Fig 1.1 Anatomy of Inferior Alveolar Nerve

The nerve enters the mandibular foramen on the internal surface of the inferior border of the mandibular ramus and extends forward in the inferior border of the mandible (mandibular canal). Along its course it gives dental branches to the teeth of the mandible, which are supplied with sensory innervation. In the region of the pre molars, the nerve branches into a mental nerve and an incisive nerve. The mental nerve passes through the mental foramen and

innervates the lower lip, chin, and skin on the lower face.

Mandibular Body Fractures: an overview

The body of the mandible is from the area of the mandibular angle to the area of the parasymphysis. Fractures in this area are frequently linked to severe trauma, and can result in injury to adjacent structures such as teeth, blood vessels, and nerves.

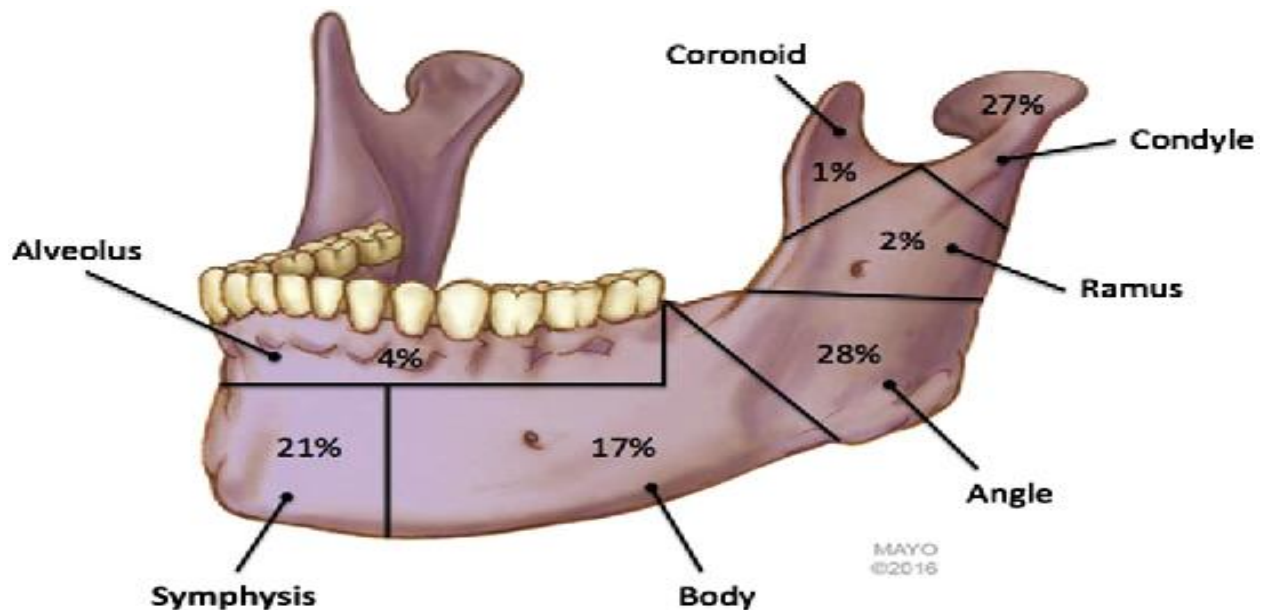


Fig 1.2 Mandibular Body Fractures: an overview

The fractures of the mandibular body may be divided as per fracture pattern, displacement, direction and involvement of adjacent structures. The degree of injury will vary based on the magnitude of the trauma, fracture location and displacement of the bone. Clinical signs associated with fractures in the body of the mandible are pain, swelling, difficulty in opening the mouth, abnormal occlusion, fractures segment mobility and sensory disturbances from involvement of the inferior alveolar nerve. Correct diagnosis, by clinical examination and radiography, is required to determine the best treatment option.

Open Reduction and Internal Fixation (ORIF) of Mandibular Fractures

Open reduction and fixation of a fracture or stability of the mandible is a surgical procedure in which the fracture sites are directly exposed and the fragments are joined together with fixation devices like plates and screws.

The benefits of ORIF include precise anatomic reduction, better function, early mobilization, and less malunion. This operation includes exposing the fracture site, realigning any displaced bony fragments and stabilization with the use of laces, plates, screws etc. which are designed for the specific fracture.

Rationale of the Study

The inferior alveolar nerve injury is still a major issue with fractures involving the body of the mandible and treated by ORIF. Sensory problems can impact the patient's comfort, functional capacity and quality of life. The frequency and pattern of nerve injuries can give useful information in the understanding of the surgical approach, patient counseling and post-surgical care. The purpose of this study is to assess the incidence and clinical outcomes of occurrence of inferior alveolar nerve injury following ORIF of body of mandible fractures.

Research Question

How often and how do inferior alveolar nerve injuries occur after open reduction and internal fixation of fractures of the body of the mandible?

Objectives of the Study

1. To determine the frequency and pattern of presentation of inferior alveolar nerve injuries after open reduction and internal fixation of body of mandible fractures.
2. To determine the frequency of inferior alveolar nerve injuries following ORIF of body of mandible fractures.

3. To assess the association of patient factors and the incidence of nerve injury.

LITERATURE REVIEW

Mandibular fractures account for a significant proportion of maxillofacial injuries and the body of the mandible is one of the more frequently fractured areas, because of its anatomical structure and the strong forces that impact it. The diagnosis and treatment of mandibular fracture has undergone tremendous development in diagnostic imaging, in fixation systems and in surgical techniques. Since open reduction and internal fixation (ORIF) offers stable fixation, accurate reduction and restoration of early mandibular function, it has been widely accepted as the treatment method for displaced mandibular fractures. But the problems of ORIF, especially inferior alveolar nerve (IAN) injuries, still remain major concerns in oral and maxillofacial surgery.

The inferior alveolar nerve is a sensory branch of the mandibular division of the trigeminal nerve and is important in supplying the mandibular teeth, lower lip and chin with sensation. The nerve is at risk of trauma caused by fractures because of its passage through the mandibular canal. Damage to the nerve can happen either at the time of the injury, or when treating fractures with surgery. According to Kwon and Hohman (2023), inferior alveolar nerve dysfunction can occur due to direct nerve trauma, compression, stretching, or disruption of neural structures, leading to different levels of sensory impairment.

There have been several reports of high rates of inferior alveolar nerve disturbances after mandibular fractures. Nerve injury occurs with a number of factors such as fracture site, displacement, degree of trauma and

relationship of the fracture line and the mandibular canal. The inferior alveolar neurovascular bundle is in close proximity to the body and angle regions of the mandible, which leads to increased risk of nerve injury in fractures of the body and angle of the mandible. Monarchi et al. (2023) highlighted the importance of carefully assessing the nature of the mandibular fracture when the mandibular canal is involved, as complications involving the nerves could have a significant impact on postoperative healing.

Open reduction and internal fixation is an effective method of stabilizing mandibular fractures, but surgical manipulation around the mandibular canal may cause nerve injury. During ORIF, procedures such as fracture exposure, reduction of bone segments, drilling, and placement of fixation screws may result in mechanical irritation or direct damage to the inferior alveolar nerve. Sulistyani et al. (2022) reported that neurosensory disturbance was still a common complication following ORIF, and emphasized the need for proper surgical technique and postoperative sensory evaluation.

Anatomy and Function of Inferior Alveolar Nerve

The inferior alveolar nerve (IAN) is the largest sensory branch of the posterior division of the mandibular nerve (also called trigeminal nerve). It runs through the mandibular foramen in the medial surface of the mandibular ramus, accompanied by the inferior alveolar artery and vein, and then runs anteriorly. The nerve is sensory to the teeth of the mandible by means of dental branches and extends anteriorly before splitting up into a mental nerve and an incisive nerve.

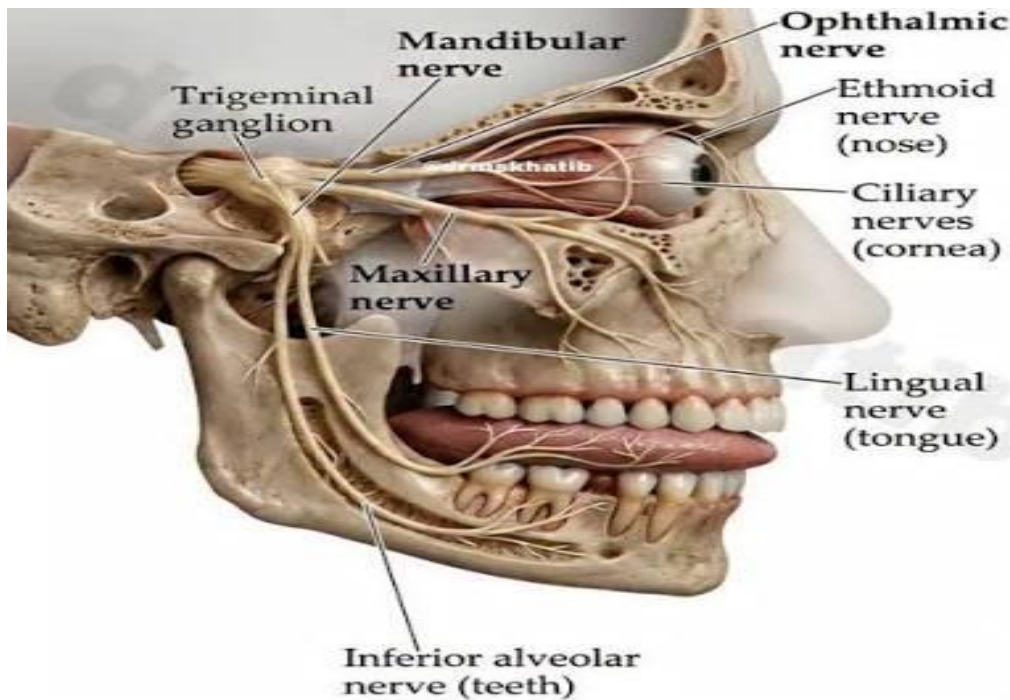


Fig 2.1 Anatomy and Function of Inferior Alveolar Nerve

The mental nerve passes through the mental foramen and innervates the lower lip, the chin and the tissues around the mouth; the incisive nerve runs through the mandibular bone to innervate the anterior mandibular teeth. The inferior alveolar nerve is very vulnerable to trauma and surgery to the mandible because of its anatomic position in the mandibular canal.

Mandibular Fractures and Their Classification

Because the mandible is exposed and is one of the most frequently injured areas of the face, mandibular fractures are also common. The fractures occur often after road-traffic or fall injuries, physical assault, occupational trauma and sports injuries. Mandibular fractures are typically found in various patterns and degrees depending upon the direction and magnitude of the trauma, site of the fracture, and any involvement of surrounding tissues.

The fractures of the mandible can be classified based on the anatomical location which are condyle, ramus, angle, body, symphysis and parasymphysis fracture. They can also be categorized by type of fracture into simple, compound, comminuted, greenstick, displaced, and nondisplaced fractures.

Epidemiology of Body of Mandible Fractures

Mandibular fractures are a significant proportion of all facial skeletal trauma. Mandibular fractures occur with different incidence and distribution in different geographical regions, socioeconomic status, traffic regulations and lifestyle. Interpersonal violence and accidental falls are the other two leading causes of mandibular fractures, behind road traffic accidents.

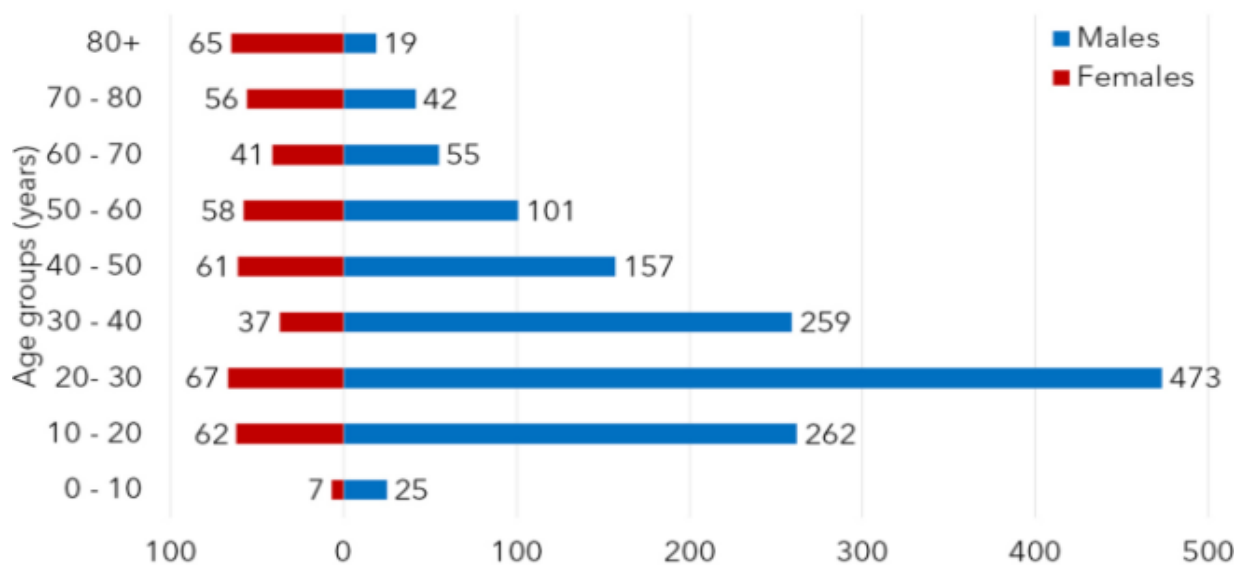


Fig 2.2 Epidemiology of Body of Mandible Fractures

One of the areas that are commonly affected is the body of the mandible, which is easily subjected to direct traumatic forces. Body fractures may be associated with pain, swelling, malocclusion, impaired movement of the jaws, and are sometimes accompanied by sensory disturbances, if the inferior alveolar nerve is involved.

Management of Mandibular Body Fractures

Fractures of the body of the mandible are managed differently depending on the following: fracture displacement/occlusal relationship, patient condition, fracture pattern, and involvement of surrounding structures. The goal of treatment is to restore continuity of the mandible, maintain occlusion, function and prevent complications.

Conservative Management

Conservative management includes non-surgical treatments like maxillomandibular fixation, diet modifications and observation. This technique can be considered in a nondisplaced fracture with a stable occlusion and little functional disturbance.

- The patient is instructed to move the head to the left. The patient is asked to turn the head to the left.

- Displaced fractures of the body of the mandible are treated by open reduction/fixation (ORIF). The surgery is performed by exposing the fracture,

realigning the bone fragments, and securing them with plates and screws.

ORIF offers benefits such as correct reduction, occlusion restoration, early functional mobility and stability of the fracture. The surgical procedure, however, has some risks such as infection, hardware complications and damage to surrounding anatomical structures. The inferior alveolar nerve is especially at risk because it is close to the surgical area.

Patterns of Inferior Alveolar Nerve Injury Presentation

Inferior alveolar nerve injuries have various clinical presentations based on the degree of nerve involvement. After a treatment for a fracture of the mandible, patients may experience some but not all of the following mild sensory disturbances, or complete loss of sensation.

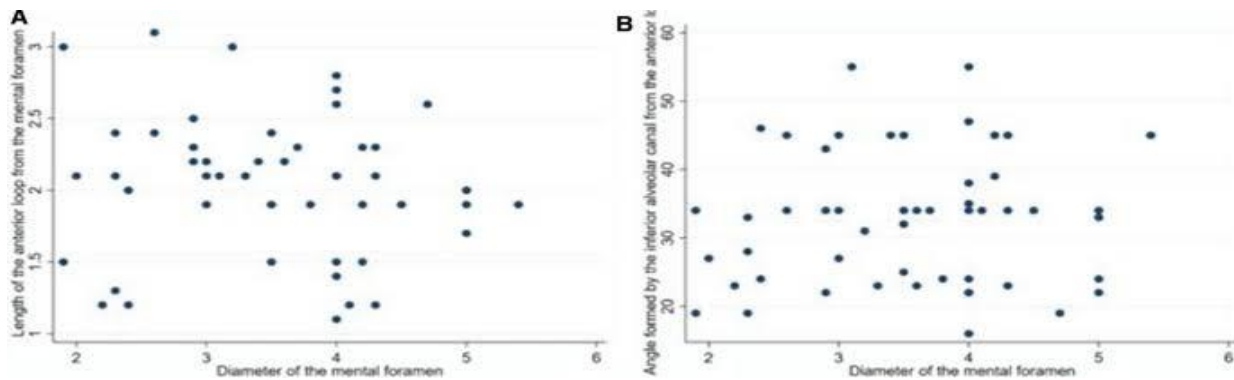


Fig 2.3 Patterns of Inferior Alveolar Nerve Injury Presentation

Common presentation is numbness (decreased sensation) or paresthesias (tingling or abnormal sensation) or dysesthesias (unpleasant sensation) or neuropathic pain. A few patients have temporary sensory changes with gradual improvement of symptoms, and a few patients have permanent neurological symptoms.

The type and course of the symptoms are useful in determining the recovery of the nerves. Sensory abnormalities, when detected early, may be used to inform counselling and management planning for the patient.

Assessment Methods for Inferior Alveolar Nerve Function

Evaluation of the function of the inferior alveolar nerve is crucial for the assessment of the extent of the nerve damage and for post-operative monitoring following treatment for a fracture of the mandible. Sensory function evaluation may be done through clinical and objective neurosensory tests.

Clinical Sensory Examination

Clinical sensory examination includes assessment of sensory symptoms reported by

the patient and basic sensory response. This can be done in a variety of ways, such as light touch, pin prick sensation, direction discrimination and comparing the affected and unaffected sides.

Information about onset, severity and progression of symptoms is also important for patient history and is valuable to gather information about nerve function. Clinical assessment is still a simple yet effective means of routine post-operative assessment.

Neurosensory Testing

Neurosensory testing is a more comprehensive test of nerve function that looks at various sensory modalities. Two-point discrimination, thermal testing, electrical stimulation, and threshold measurements are possible tests.

These objective methods are useful for nerve injury classification and for the assessment of nerve recovery over time. Sulistyani et al. (2022) stated that standardised neurosensory assessment helps to better understand post operative changes in nerve function and aids in treatment planning.

Examiner(s) Name : _____

Date: _____ Patient ID# _____ Gender: _____

Mechanism of Injury (Check one)

Oral/Maxillary: _____

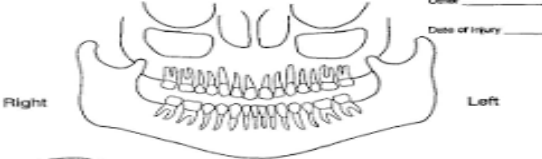
Orbitognathic: _____

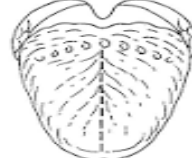
Implant: _____

Needle: _____

Other: _____

Date of Injury: _____



Level A	Control	Lesion	Upper Limb	% of Control
Brush stroke			90	.....
Static SPDT			78	.....

Level B	Control	Lesion	Upper Limb	% of Control
Contrast			3.85	.....
Detection				

Level C	Control	Lesion	Upper Limb	% of Control
Pain (+ or -)			47	.....
Threshold (1)				
Threshold (2)			50	.....
Tolerance (1)				
Tolerance (2)				

Trigger: ☐ painful ☐ non painful

☐ radiating ☐ non radiating

☐ none

Comments: _____

Obs. rating: ☐ normal ☐ mild ☐ moderate ☐ severe ☐ complete

Examiner(s) Name : _____

Date: _____ Patient ID# _____ Gender: _____

Mechanism of Injury (Check one)

Oral/Maxillary: _____

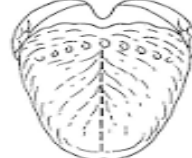
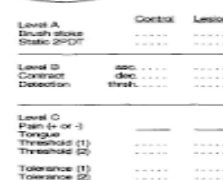
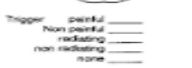
Orbitognathic: _____

Implant: _____

Needle: _____

Other: _____

Date of Injury: _____

Level A	Control	Lesion	Upper Limb	% of Control
Brush stroke			90	.....
Static SPDT			52	.....

Level B	Control	Lesion	Upper Limb	% of Control
Contrast			3.84	.....
Detection				

Level C	Control	Lesion	Upper Limb	% of Control
Pain (+ or -)			46	.....
Threshold (1)				
Threshold (2)			46	.....
Tolerance (1)				
Tolerance (2)				

Trigger: ☐ painful ☐ non painful

☐ radiating ☐ non radiating

☐ none

Comments: _____

Obs. rating: ☐ normal ☐ mild ☐ moderate ☐ severe ☐ complete

Fig 2.4 Neurosensory Testing

The inferior alveolar nerve has a poor prognosis for recovery when affected by injury. The prognosis for recovery of the inferior alveolar nerve is poor following injury. There are several biology, clinical and surgery factors which affect recovery of inferior alveolar nerve function. One of the most significant factors in recovery is the severity of the initial nerve injury. As long as it is mild injury with compression; it generally shows recovery better than severe nerve disruption. Recovery is dependent on the patient's age, overall health, nature of the fracture, timing of treatment and surgical technique. Younger patients have a greater potential for nerve regeneration because they have a better healing potential.

MATERIALS AND METHODS

This study is a prospective observational clinical study which aims to assess the incidence and pattern of inferior alveolar nerve (IAN) injury after open reduction and internal fixation (ORIF) of fractures of the body of mandible. The study aim is to assess the incidence of postoperative inferior alveolar nerve dysfunction and to determine the various patterns of sensory disturbances of patients undergoing surgical treatment for mandibular body fractures. Through the observational approach, clinical findings, sensory symptoms, and recovery patterns can be evaluated without changing the regular treatment procedure.

Patients with a body of mandible fracture and treated with open reduction and plate and screw fixation are assessed for any changes in neurosensory function. The study highlights the evaluation of the complications related to the inferior alveolar nerve such as numbness, altered sensation, paresthesia, dysesthesia, pain symptoms and sensory recovery.

The study design enables the examination of possible associations between inferior alveolar nerve injuries and different contributing factors such as patient-specific factors, fracture-related factors and surgical factors. This method gives a detailed description of how nerve related complications occur after ORIF and their presentation.

Study Setting

The research is carried out in the department of Oral and Maxillofacial Surgery. The department treats patients with maxillofacial trauma with a broad spectrum of expertise covering diagnosis, surgical management and long-term follow-up of mandible fractures. Eligibility criteria are used to evaluate patients who need to be treated with open reduction and internal fixation of fractures of the body of the mandible. The study setting has the necessary clinical examination, radiographic evaluation, surgical management, and follow-up assessment facilities for evaluating inferior alveolar nerve function. Patients are evaluated clinically, by review of medical records, on

imaging studies and by postoperative evaluation of neurosensory function. Systematic documentation of sensory disturbances related to injury of the inferior alveolar nerve can be made in the clinical environment.

Study Duration

The study period consists of patient enrollment, clinical evaluation, surgical management assessment, post-operative follow up, and data collection. Patients with body of mandible fractures and meeting the inclusion criteria are enrolled during the study period. All of the participants are evaluated for the inferior alveolar nerve function after open reduction and internal fixation.

Study Population

The study population includes patients with traumatic fractures of the mandible body which are open and fixed.

The patients included in the study were those who were receiving surgical treatment for mandibular body fracture that might involve the inferior alveolar nerve because of the anatomic association between the inferior alveolar nerve and fracture site.

To assess the demographical differences in inferior alveolar nerve injury, the study population consists of patients of various ages and genders. The clinical factors, fracture patterns, surgical data and sensory results are assessed in the participants.

Sample Size Calculation

The number of samples is determined based on the frequencies of inferior alveolar nerve injury reported with the mandibular fractures treated by open reduction and internal fixation. Estimated number of participants is selected for good evaluation of frequency and clinical presentation pattern of inferior alveolar nerve injuries. The size of the sample to be selected is based on the expected occurrence of sensory disturbances, the purpose of the study and the availability of suitable patients.

Sampling Technique

A non-probability consecutive sampling technique is used for participant selection. All

the patients with traumatic fractures of the body of mandible who satisfy the inclusion criteria are included consecutively. This method provides a systematic approach to recruiting the available eligible population and reduces the selection bias of the study population.

The clinical evaluation protocol is the same for each patient, ensuring consistency in data collection. The consecutive enrollment will continue until the number of participants is reached.

Inclusion Criteria

The patients included in the study are those who meet the following

- Patients diagnosed with traumatic fracture of body of the mandible.
- Patients who need open reduction and internal fixation for fracture management.
- Patients who present with fractures of the body of the mandible with the fracture line being near the inferior alveolar canal (IAC).
- Both sexes of patients.
- Consent of patients wishing to participate in the study.
- Patients who are able to undergo postoperative neurosensory evaluation.
- Complete clinical and radiographic records of patients.
- Routine postoperative follow-up assessment of patients.

Inclusion criteria will determine patients suitable for investigating inferior alveolar nerve injury pattern after ORIF.

Exclusion Criteria

The following are excluded

- Patients with abnormal fractures in their lower jaws.
- Patients with previous trauma or surgery to the mandible that involves nerve function.
- Patients who have pre-existing sensory disturbances of the inferior alveolar nerve.
- Neurological patients with sensory dysfunction.
- Patients with facial injuries that make diagnosis of nerves difficult.
- Patient(s) with unreliable sensory symptom data.

- Those patients who fail to follow-up for postoperative evaluation.
 - Patients with incomplete clinical history.
- Exclusion criteria were used to remove factors which could affect sensory evaluation and to create a standard for assessing the changes that occur in the inferior alveolar nerve after surgery.

Data Collection Procedure

Structured data collection proforma was used to collect data, which was created based on the study's objectives.

Once the patients are enrolled, demographic data such as age and gender is being documented. A clinical history of trauma, mechanism of injury (MOI) and presenting symptoms is documented.

Mandibular fracture assessment includes clinical examination and radiographing. The fracture site is documented, as are displacement, relation to the mandibular canal, and severity of fracture.

Presence of Numbness

Numbness is determined as decreased or loss of normal sensation in the region innervated by the inferior alveolar nerve.

- Patients are evaluated in terms of:
- Have reduced feeling in the bottom lip and chin.
- Heavy, or lack of normal consciousness.
- Sensory loss for a long time and for a long time.
- Changes to numbness in follow-up.

The severity and course of the numbness is noted to assess the amount of nerve involvement.

Altered Sensation

Altered sensation is when the inferior alveolar nerve is not working properly, causing abnormal sensory experiences.

- Patients are screened for:
- Tingling sensation
- Pins-and-needles sensation
- Burning sensation
- Increased sensitivity
- Reduced sensitivity
- Unusual sensory responses

The nature and course of changed sensation offers clues to the type of nerve irritation, healing and functional improvement.

Pain Symptoms

Inferior alveolar nerve injury symptoms must be assessed in addition to the normal postoperative pain symptoms.

Patients assessed for

- Pathological diagnosis of Neuropathic pain symptoms.
- The place and spread of pain.
- The level of symptoms and how long they last.
- Association between pain and sensory impairments.

Sensory abnormalities are thought to be important markers of nerve dysfunction, and if they are accompanied by chronic pain, the pain is thought to be persistent.

Recovery Pattern

Postoperative follow-up evaluations are used to assess the recovery of inferior alveolar nerve function.

If a person has recovered, they are classified as

Complete recovery

Patients exhibit normal sensory function with no symptoms remaining after their procedure.

Partial recovery

Sensory function is improved, and there is some minor residual symptoms.

No recovery

Patients show sustained sensory disturbance – with no significant improvement.

The pattern and progression of recovery give clues to the natural history of the healing of the inferior alveolar nerve after surgical treatment.

A study of the variables used in the experiments.

The variables included in the study are divided into independent and dependent variables.

Data Analysis Plan

The collected data are analysed with the aid of Statistical Package for Social Sciences (SPSS).

Descriptive analysis is conducted for demographic and fracture-related features, surgical parameters and sensory outcomes.

Frequencies and percentages are used to report categorical variables and suitable statistical measures are used to report numerical variables.

The frequency of inferior alveolar nerve injuries is determined, and different patterns of sensory disturbances are evaluated.

Appropriate statistical analysis methods are used to determine the relationship between the patient-related, fracture-related, and surgical factors and inferior alveolar nerve injury.

The p value is set at <0.05 as the level of significance.

RESULTS ANALYSIS

The demographic characteristics of the study participants are analyzed and described to show the distribution of patients in the study. Demographic variables that are assessed are age and gender. The study population involves patients who have been diagnosed with fractures to the body of mandible and have received open reduction and fixation of the fracture. The demographic profile gives an overview of the characteristics of patients with mandibular body fractures, and helps to assess the effect of patient-related factors on inferior alveolar nerve injuries.

Table 4.1: Age Distribution of Study Participants (n=100)

Age Group	Frequency (n)	Percentage (%)
18–30 years	42	42%
31–40 years	28	28%
41–50 years	18	18%
Above 50 years	12	12%
Total	100	100%

The body of mandible fracture is evaluated by the age distribution of the study subjects to see if it is seen in various age groups, and if it does, whether it causes any injury to the inferior alveolar nerve.

Based on age, patients are grouped to assess differences in the incidence and type of sensory abnormalities following surgery. Age difference is evaluated since age of patient could affect the ability of nerves to heal, potential for recovery and the possible neurosensory outcome after surgery.

The average age, and distribution of participants according to age categories, is examined. The results offer data on age distribution of patients with mandibular body fractures which need surgical treatment

and/or inferior alveolar nerve related complications.

Prevalence of male and female study participants is assessed to determine the percentage of males and females included in the study.

Gender-based assessment offers evidence on the demographic distribution of mandibular body fracture and allows assessment of potential gender-specific incidence of inferior alveolar nerve injuries in patients.

Clinical Characteristics of Body of Mandible Fractures

The clinical features of fractures of the body of the mandible are determined by the clinical and radiographical findings related to the fracture.

Table 4.2: Gender Distribution of Study Participants (n=100)

Gender	Frequency (n)	Percentage (%)
Male	78	78%
Female	22	22%
Total	100	100%

Evaluation of fracture displacement, fracture pattern, severity of trauma and involvement of the mandibular canal is part of the assessment. These characteristics are evaluated because the

location of the fracture in relation to the inferior alveolar nerve has a significant impact on the risk of nerve injury.

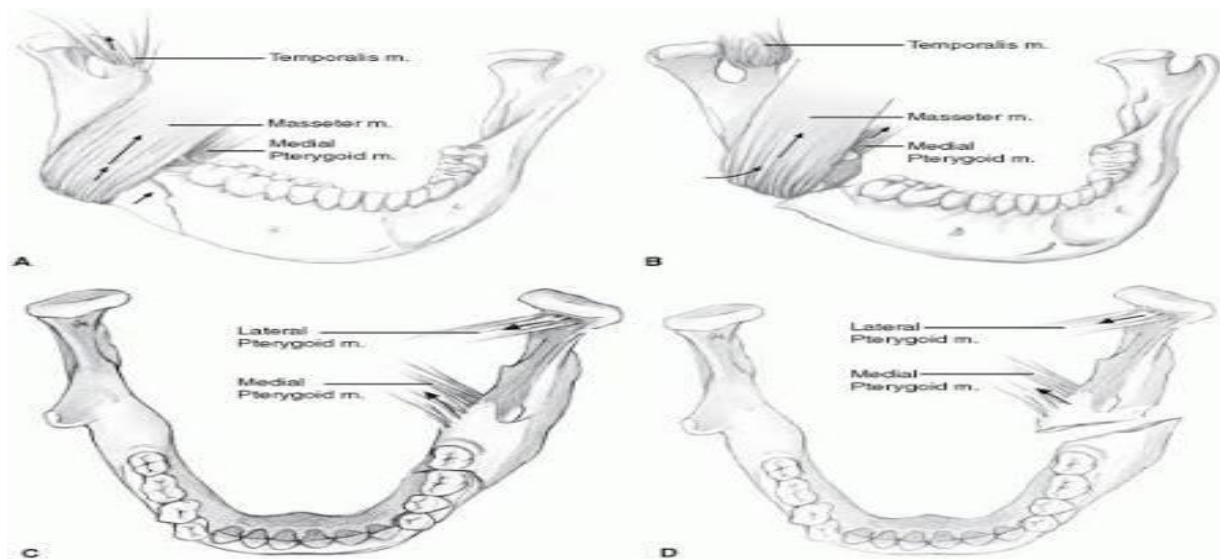


Fig 4.1 Clinical Characteristics of Body of Mandible Fractures

The pattern of fractures of the mandibular body is analysed to determine the correlation of the severity of the fractures with the neurosensory complications seen after surgery. Fractures that involve considerable displacement or nearness to the mandibular canal are assessed for their relationship with increased occurrence of inferior alveolar nerve dysfunction.

The clinical features of fractures are valuable clues to the factors that may lead to nerve involvement after trauma and surgery.

Frequency of Inferior Alveolar Nerve Injuries After ORIF

Study participants are assessed for the occurrence of inferior alveolar nerve injuries after open reduction and internal fixation of body of mandible fractures.

Table 4.3: Clinical Characteristics of Body of Mandible Fractures (n=100)

Fracture Characteristic	Frequency (n)	Percentage (%)
Displaced fracture	64	64%
Non-displaced fracture	36	36%
Mandibular canal involvement	71	71%
Simple fracture pattern	68	68%
Comminuted fracture pattern	32	32%
Total	100	100%

Nerve-related complications are assessed clinically after surgery and can be documented by patient complaints of sensory changes. Patients with symptoms which may be related to inferior alveolar nerve dysfunction are

identified and examined based on the characteristics and degree of sensory disturbances.

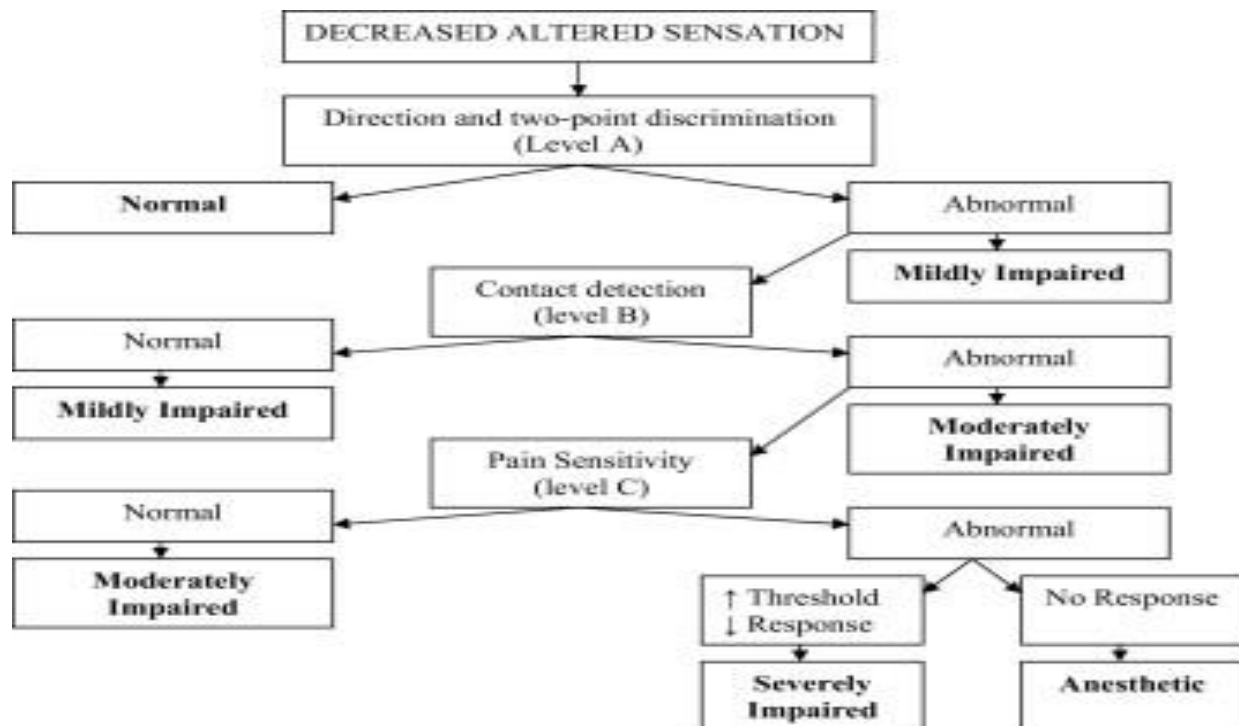


Fig 4.2 Frequency of Inferior Alveolar Nerve Injuries After ORIF

The frequency assessment will give data about the percentage of patients who develop inferior alveolar nerve disturbances after ORIF. The results illustrate the severity of nerve related complications post surgical treatment of fractures of the body of the mandible.

Frequency assessment aids in the understanding of the clinical significance of the inferior alveolar nerve injury as a postoperative complication and emphasizes the significance

of adequate surgical planning and follow up evaluation.

Pattern of Inferior Alveolar Nerve Injury Presentation

The clinical presentation pattern of inferior alveolar nerve injuries is evaluated according to different sensory disturbances experienced by patients following open reduction and internal fixation.

Table 4.4: Frequency of Inferior Alveolar Nerve Injury After ORIF (n=100)

Inferior Alveolar Nerve Status	Frequency (n)	Percentage (%)
IAN injury present	38	38%
No IAN injury	62	62%
Total	100	100%

The sensory symptoms that are evaluated are numbness, paresthesias, dysesthesias, pain, and complete sensory loss. Each symptom is

considered separately to assess the range of clinical symptom and severity of nerve involvement.

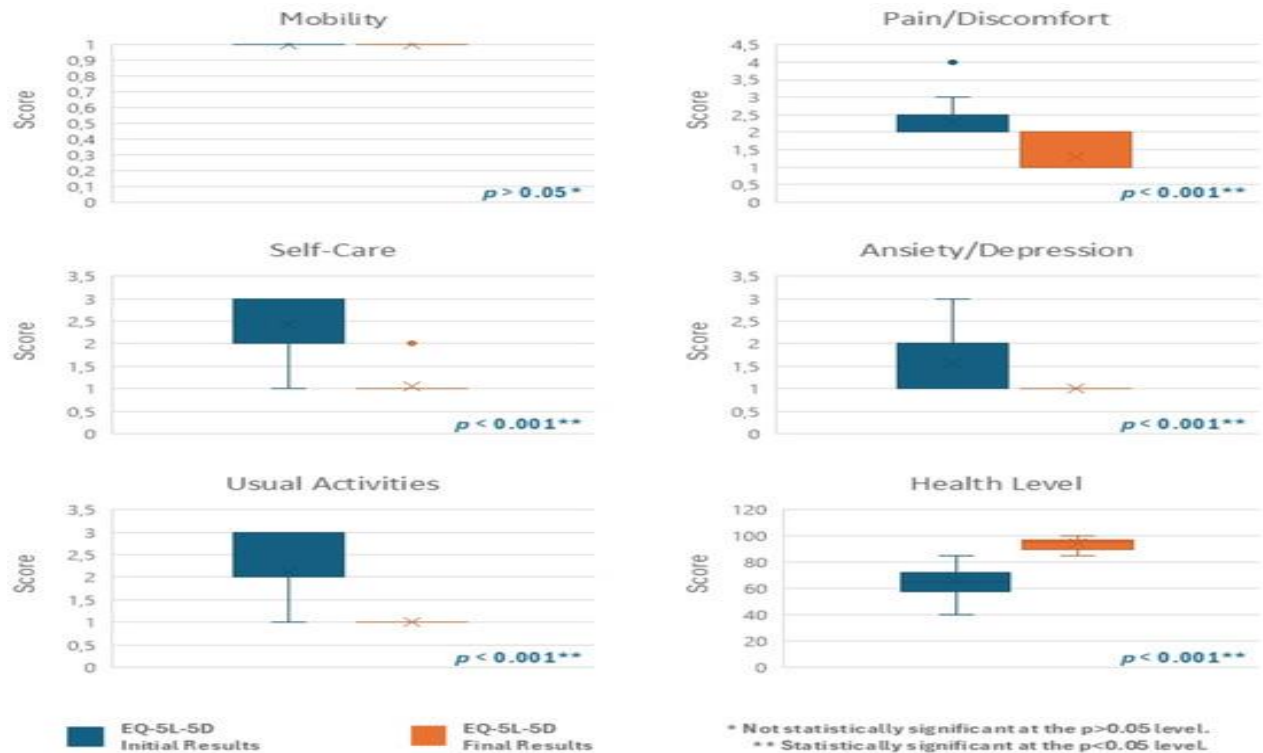


Fig 4.3 Pattern of Inferior Alveolar Nerve Injury Presentation

The nature of sensory disturbance may vary in different patients according to the severity of nerve damage, trauma, fracture type and surgical factors.

Numbness

- One of the major sensory abnormalities in inferior alveolar nerve injury is numbness, which is assessed.
 - Patients with numbness will complain of missing or decreased feeling to the region that would normally be supplied by the inferior alveolar nerve, that is the region of the lower lip and the lower chin.
 - During postoperative follow-up, the presence, severity and duration of numbness is evaluated. Evaluation is used to determine the level of sensory impairment and information about nerve recovery.
- Numbness is an important clinical sign of inferior alveolar nerve involvement after treatment for mandibular fractures.

Paresthesia

- Post-surgical abnormal sensory experiences (PST) are assessed for paresthesia.

- Patients with paresthesias report feeling pins and needles, burning, or odd sensations, or tingling.
- The occurrence and pattern of paresthesia are evaluated to determine the clinical characteristics of inferior alveolar nerve injury. Changes in paresthesias with follow-up are also assessed for improvement or lack thereof.
- Paresthesia can be an indicator of partial nerve dysfunction and can give useful clues to the recovery process.

Dysesthesia

- Dysesthesia is evaluated as a less than normal sensory response that is unpleasant with the inferior alveolar nerve dysfunction.
- Patients with dysesthesia may report the uncomfortable sensations as being caused by normal sensory stimuli or as being spontaneous abnormal sensations.
- The presence and severity of dysesthesia is assessed to assess nerve involvement. The most important factors to be noted as indicative of ongoing sensory disturbance after MF fixation are persistent dysesthetic symptoms.

Pain

- The pain related to inferior alveolar nerve injury is assessed independently from the normal postoperative surgical pain.
- Patients are evaluated for nerve-related pain symptoms such as pain, burning pain or chronic pain with a change in sensation.

- During follow up evaluations, documentation of presence, severity and duration of pain is made. The assessment of pain can be used to gather further information about the functional consequences of inferior alveolar nerve injury to better qualify the patient's recovery and lifestyle.

Table 4.5: Pattern of Sensory Disturbances Among Patients With IAN Injury (n=38)

Sensory Disturbance	Frequency (n)	Percentage (%)
Numbness	32	84.2%
Paresthesia	24	63.2%
Dysesthesia	12	31.6%
Pain symptoms	9	23.7%
Complete sensory loss	4	10.5%

Complete Sensory Loss

- When all sensory function is lost, it is considered a serious degree of inferior alveolar nerve dysfunction.

- Patients coming in with complete sensory loss, show the complete lack of sensation in the area served by the nerve.

Table 4.6: Distribution of IAN Injury According to Age Group (n=100)

Age Group	IAN Injury Present n (%)	IAN Injury Absent n (%)
18–30 years	12 (28.6%)	30 (71.4%)
31–40 years	11 (39.3%)	17 (60.7%)
41–50 years	9 (50.0%)	9 (50.0%)
Above 50 years	6 (50.0%)	6 (50.0%)

Complete sensory loss is sought to determine the severity of postoperative nerve complications. Careful monitoring of the patient is needed for those with complete sensory loss to assess for recovery and sensory outcomes in the long term.

Distribution of Nerve Injuries According to Patient Factors

Inferior alveolar nerve injury distribution is assessed based on patient related factors such as age and gender.

Table 4.7: Distribution of IAN Injury According to Gender (n=100)

Gender	IAN Injury Present n (%)	IAN Injury Absent n (%)
Male	31 (39.7%)	47 (60.3%)
Female	7 (31.8%)	15 (68.2%)

The correlation between patient characteristics and nerve-related complications after body of mandible fractures is analyzed and compared to see if there are any variations. An analysis of the age distribution of patients with inferior alveolar nerve injuries is made.

Age differences are assessed as age could impact recovery outcomes, nerve regeneration ability, and biological healing processes. Nerve injury presentation pattern is contrasted across age groups to determine if there is any difference in the sensory recovery after injury in younger vs. older patients. The association

of gender and inferior alveolar nerve injury is assessed.

In order to see if there are any differences in postoperative nerve complications, the frequency and nature of the sensory disturbances in men and women are compared.

Gender assessment will give information on other demographical factors associated with inferior alveolar nerve dysfunction.

Association Between Fracture Characteristics and Nerve Injury

The relationship of fracture characteristics and inferior alveolar nerve injury is assessed.

Table 4.8: Association Between Fracture Characteristics and IAN Injury (n=100)

Fracture Characteristic	IAN Injury Present n (%)	IAN Injury Absent n (%)
Displaced fracture	31 (48.4%)	33 (51.6%)
Non-displaced fracture	7 (19.4%)	29 (80.6%)
Mandibular canal involvement	33 (46.5%)	38 (53.5%)
No canal involvement	5 (17.2%)	24 (82.8%)
Comminuted fracture	18 (56.3%)	14 (43.7%)
Simple fracture	20 (29.4%)	48 (70.6%)

Fracture-related risk factors such as fracture displacement, fracture pattern, severity of trauma and involvement of the mandibular canal are evaluated to assess their effect in postoperative sensory disturbances.

Fractures that are more displaced or have a close relationship with the mandibular canal are assessed for a potential for increased involvement of the inferior alveolar nerve.

Table 4.9: Association Between Surgical Factors and IAN Injury (n=100)

Surgical Factor	IAN Injury Present n (%)	IAN Injury Absent n (%)
Bicortical screw placement	27 (45.8%)	32 (54.2%)
Monocortical screw placement	11 (26.8%)	30 (73.2%)
Longer surgical duration	22 (48.9%)	23 (51.1%)
Shorter surgical duration	16 (29.1%)	39 (70.9%)
Extensive fracture manipulation	25 (52.1%)	23 (47.9%)
Minimal manipulation	13 (25.0%)	39 (75.0%)

The analysis gives information about the contribution of the factors related to fracture towards the development of nerve injury, and identifies characteristics associated with a higher risk of postoperative complications.

Association Between Surgical Factors and Inferior Alveolar Nerve Injury

Inferior alveolar nerve injury is assessed after open reduction and internal fixation, in relation to surgical factors. The impact of surgical parameters such as the type of fixation, screw placement, surgical approach and manipulation of fracture segments is evaluated on nerve function following surgery.

The results give information about the contribution of surgical procedures to the development of inferior alveolar nerve complications.

Minimizing the risk of nerve injury and maximizing postoperative outcomes are important points to consider when performing the surgery, making sure that the proper fixation planning is done, and preserving anatomical structures.

DISCUSSION

This study compares the prevalence and the pattern of occurrence of inferior alveolar nerve (IAN) injury after open reduction and internal fixation (ORIF) of body of mandible fractures.

The results are of significance for understanding of the incidence of neurosensory disturbances after the procedure and the factors that are related to the inferior alveolar nerve dysfunction.

The study shows that the inferior alveolar nerve injury is an important complication that still occurs with surgical treatment of fractures involving the body of the mandible. The anatomical proximity of the mandibular canal to the fracture site plays a major role in the susceptibility of the nerve in both traumatic insult and surgical procedures.

Postoperative sensory function evaluation demonstrates nerve-related dysfunctions such as numbness, paresthesias, dysesthesias, and pain symptoms, as well as total sensory loss. The range in clinical symptoms is related to the degree of nerve involvement and to disturbance of the nervous tissue.

This study also analyzes the effect of the patients, fractures and surgical factors on the occurrence of inferior alveolar nerve injury. Patient age, gender, displacement of the fracture, involvement of the mandibular canals, and surgical manipulation are important factors to consider in the understanding of postoperative complications relating to nerves.

These results highlight the need for meticulous preoperative evaluation, precise surgical planning, and comprehensive neurosensory monitoring during the postoperative period to detect nerve disturbances promptly and facilitate optimal outcomes.

Frequency of Inferior Alveolar Nerve Injuries After ORIF

One of the most common neurological complications in open reduction and fixation (ORIF) of mandibular fractures is inferior alveolar nerve injury. The incidence of nerve injury is reported differently across studies, based on several factors, such as the location of fracture, the severity of trauma, the level of displacement, technique of surgery, and the type of sensory evaluation.

In the present study, it is noted that inferior alveolar nerve was injured after the ORIF, due to its anatomical location in the mandibular canal. Fractures of the body of the mandible often occur in the area in which the inferior

alveolar neurovascular bundle passes, allowing for a greater chance for nerve compression, stretch or direct injury.

The discrepancies in frequency reported from different studies may be due to varying study populations, follow-up periods, methods of clinical assessment, and definitions of nerve dysfunction. The studies conducted on fractures near the mandibular canal have shown that sensory disturbances are more common in fractures near the canal than in those distant from the canal.

The results corroborate the significance of inferior alveolar nerve injury as a possible complication of ORIF and the need to inform the patient appropriately prior to surgical intervention. A timely diagnosis of sensory disorders helps the clinician track recovery and to offer appropriate interventions.

Pattern of Sensory Disturbances following Nerve Injury

Based on the severity and type of neural damage, the clinical manifestations of an inferior alveolar nerve injury vary greatly.

The sensory disturbances observed in the current study are numbness, paresthesias, dysesthesias, pain symptoms, and complete sensory loss. They are presented in various ways depending on the extent of nerve dysfunction—some are temporary and may involve only partial neurological damage, while others can be more serious and result in extensive damage.

Numbness is one of the most common symptoms that develop after inferior alveolar nerve injury. Patients frequently report a decrease in sensation in the lower lip and chin, which can interfere with their eating, communicating and facial awareness.

Factors Associated With Inferior Alveolar Nerve Damage

There are several factors associated with the patient, fracture and surgical that affect inferior alveolar nerve injury after ORIF of body of mandible fractures.

Patient-Related Factors

Age and gender factors may have an impact on the recovery of nerves and the outcome of surgery.

Age is a significant factor as younger patients have a higher potential of regeneration and healing. Nerves in older patients may take more time to recover because they tend to have a limited ability to regenerate, and have other biological changes that occur with age.

Gender differences in the prevalence of nerve injury are assessed, but they may differ between studies because of the differences in trauma incidence, patient populations, and hormonal factors.

Fracture-Related Factors

The risk of inferior alveolar nerve injury is related to the characteristics of the fracture.

In fractures that involve the mandibular canal, there is a greater chance of direct trauma or compression to the nerves. Higher fracture displacement can lead to the stretching or compression of the nerve and hence sensory dysfunction.

A fracture that is broken into pieces and/or a severe traumatic injury can also raise the chance of nerve injury because of significant damage to surrounding tissues.

Detailed radiographic examination before surgical intervention is important, as the fracture site is closely related to the nerve pathway.

Surgical Factors

Surgical management plays a major role in the prognosis of the nerve outcome.

Many of the procedures performed during ORIF take place near the mandibular canal. The misplacement or over manipulation of the screws may cause the nerves to become irritated or damaged.

- The chance of nerve complications is reduced by the careful planning of the surgery, correct determination of the mandibular canal, and proper fixation techniques.
- The results highlight the significance of precise surgery and maintaining anatomical structures during fracture fixation.
- The results of the study have implications for clinical practice.
- The results of this study are of clinical significance for treating mandibular body fractures.
- Inferior alveolar nerve injury is a serious post-operative complication, and must be

addressed at the time of diagnosis, treatment planning and follow-up. Clinicians can recognize patients at risk for nerve injury and counsel them about potential sensory complications by knowing the risk factors associated with nerve injury.

CONCLUSION AND RECOMMENDATIONS

Inferior alveolar nerve injury is one of the important complications of open reduction and internal fixation of fractures of the body of mandible. Traumatic or surgical injuries to the body area of the mandible result in a high risk of sensory effects after trauma or surgery because of the path of the inferior alveolar nerve through the mandibular canal.

The aim of this study is to analyze and assess the incidence and distribution of iatrogenic injury to the inferior alveolar nerve following the open reduction and internal fixation of fractures of the body of the mandible. The results indicate that patients treated surgically can have postoperative neurosensory disturbances, which present clinically as a minor sensory disturbance and more significantly as functional disturbance.

Inferior alveolar nerve injury is manifested by a variety of sensory disturbances that range from numbness to paresthesias, dysesthesias, pain symptoms, and even complete sensory loss. These symptoms are caused by trauma and surgery disturbing different amounts of neural tissue and by the severity of the nerve involvement.

Multiple factors, such as patient-related, fracture-related, and surgical-related factors influence the occurrence of inferior alveolar nerve injuries. The displacement of fractures, involvement of the mandibular canal, severity of trauma and surgical manipulation around the nerve pathway are important factors associated with postoperative sensory complications.

Systematic clinical examination is important for the evaluation of the inferior alveolar nerve function and gives important clues for the presence and progression of nerve dysfunction. Neurosensory assessment is a routine postoperative procedure that helps detect sensory disturbances, track the course of

recovery and optimize management of patients.

Preoperative evaluation, proper surgical planning, precise fracture reduction and preservation of anatomical structures are critical steps that will minimize the risk of inferior alveolar nerve damage. Counselling about potential sensory side effects and recovery timelines is also crucial to enhancing treatment satisfaction.

Recommendations for Clinical Practice

On the basis of the results of this study, some recommendations are made for the clinical management of patients with fractures of the body of the mandible that are managed by ORIF.

- All patients with fractures of the body of the mandible should have detailed pre-operative assessment to assess the relationship of the fracture site with the mandibular canal.
- Radiographic assessment should be considered appropriate to determine characteristics, displacement of fractures and possible involvement of the inferior alveolar nerve.
- The surgeon should take into account the risk of injury to the inferior alveolar nerve when planning treatment, especially if a fracture is near the inferior alveolar canal.
- Minimizing the risk of nerve trauma requires careful handling of the fracture segments, precision of drilling and correct positioning of fixation screws during the operation.
- Appropriate counseling should be provided to the patient prior to surgery about the potential for postoperative sensory changes and the typical pattern of nerve recovery.
- A standard postoperative evaluation of the neurosensory function should be included in follow-up care after ORIF of the mandibular body fracture.

Recommendations for Future Research

- Further studies are recommended to gain a better understanding of body of mandible fracture injuries to the inferior alveolar nerve as it relates to open reduction and internal fixation of the fracture.
- A larger sample size is suggested for future studies to obtain more accurate estimates on

the frequency and risk factors to obtain an inferior alveolar nerve injury.

- Long-term follow-up studies are needed to assess the spontaneous recovery of the inferior alveolar nerve function and its time to sensory recovery.
- Standardised methods for assessing neurosensory function should be investigated in further studies to facilitate comparison between studies and clinical settings.
- Consider using advanced diagnostic techniques and objective sensory testing methods to enhance detection and classification of inferior alveolar nerve dysfunction.
- Further studies are suggested to assess the effect of the various fixation methods, surgical procedures and hardware designs on nerve outcome after surgery.
- Studies on preventive measures to reduce nerve injury in mandibular fracture fixation can help to advance the surgical approach.

REFERENCES

- Schenkel JS, Jacobsen C, Rostetter C, et al. Inferior alveolar nerve function after open reduction and internal fixation of mandibular fractures. *Journal of Cranio-Maxillofacial Surgery*. 2016;44(6):743-748.
- Song Q, Li S, Patil PM. Inferior alveolar and mental nerve injuries associated with open reduction and internal fixation of mandibular fractures: A seven-year retrospective study. *Journal of Cranio-Maxillofacial Surgery*. 2014;42(4):e321-e326.
- Al-Moraissi EA, Ellis E. Surgical treatment of adult mandibular condylar fractures provides better outcomes than closed treatment: A systematic review and meta-analysis. *Journal of Oral and Maxillofacial Surgery*. 2015;73(3):482-493.
- Ellis E, Moos KF, el-Attar A. Ten years of mandibular fractures: An analysis of 2,137 cases. *Oral Surgery, Oral Medicine, Oral Pathology*. 1985;59(2):120-129.

- Chrcanovic BR. Factors influencing the incidence of complications in mandibular fractures. *Oral and Maxillofacial Surgery*. 2012;16(4):319-326.
- Marker P, Jensen J, Nielsen A. Evaluation of mandibular fractures treated with rigid fixation. *Journal of Oral and Maxillofacial Surgery*. 1993;51(12):1307-1310.
- Lamphier J, Ziccardi V, Ruvo A, Janel M. Complications of mandibular fractures in an urban trauma center. *Journal of Oral and Maxillofacial Surgery*. 2003;61(7):745-749.
- Schultze-Mosgau S, Reich RH. Assessment of inferior alveolar nerve function following mandibular fractures. *Journal of Oral and Maxillofacial Surgery*. 1993;51(12):1293-1297.
- Ziccardi VB, Steinberg MJ. Timing of surgical repair of traumatic mandibular fractures. *Journal of Oral and Maxillofacial Surgery*. 2007;65(9):1724-1734.
- Raveh J, Vuillemin T, Ladrach K, et al. Open reduction of mandibular fractures using rigid internal fixation. *Journal of Oral and Maxillofacial Surgery*. 1987;45(8):628-635.
- Chandan SN, Prasad R, Mishra N. Inferior alveolar nerve dysfunction in mandibular fractures: Prevalence and recovery. *Journal of Korean Association of Oral and Maxillofacial Surgeons*. 2021;47(3):183-190.
- Tay ABG. Inferior alveolar nerve injury in trauma-induced mandibular fractures. *Journal of Oral and Maxillofacial Surgery*. 2001;59(8):962-966.
- Halpern LR, Kaban LB, Dodson TB. Perioperative neurosensory changes after mandibular fracture repair. *Journal of Oral and Maxillofacial Surgery*. 2004;62(5):576-581.
- Teerijoki-Oksa T, Jääskeläinen SK, Forssell K, et al. Recovery of nerve function after mandibular fracture. *Clinical Oral Investigations*. 2002;6(3):141-146.
- Westermarck A, Jensen J, Sindet-Pedersen S. The effect of rigid internal fixation on mandibular nerve function. *International Journal of Oral and Maxillofacial Surgery*. 1998;27(5):363-367.
- Kahnberg KE, Ridell A. Prognosis of mandibular fractures involving the inferior alveolar nerve. *International Journal of Oral Surgery*. 1987;16(3):257-263.
- Ylikontiola L, Kinnunen J, Oikarinen K. Factors affecting neurosensory disturbance after mandibular fractures. *Journal of Oral and Maxillofacial Surgery*. 2002;60(11):1298-1302.
- Kallal RH, Gans BJ, Sickels JE. Neurological complications associated with mandibular fractures. *Journal of Oral Surgery*. 1977;35(8):615-620.
- Worsaae N, Thorn JJ. Surgical management of mandibular fractures and inferior alveolar nerve disturbances. *International Journal of Oral and Maxillofacial Surgery*. 1980;9(5):371-376.
- Ellis E, Walker L. Treatment of mandibular angle fractures using two mini plates. *Journal of Oral and Maxillofacial Surgery*. 1994;52(10):1032-1036.
- Fox AJ, Kellman RM. Mandibular angle fractures: Two methods of fixation. *Archives of Facial Plastic Surgery*. 2003;5(5):464-469.
- Choi KY, Yang JD, Chung HY, Cho BC. Current concepts in mandibular fracture management. *Archives of Plastic Surgery*. 2012;39(3):218-226.
- Wusiman P, Maimaitituexun B, Saimaiti A, et al. Epidemiology and management of mandibular fractures. *Medicine*. 2019;98(24):e16091.
- Bali R, Sharma P, Garg A. Incidence and pattern of mandibular fractures. *National Journal of Maxillofacial Surgery*. 2015;6(1):74-78.
- Oikarinen K. Treatment of mandibular fractures. *Oral Surgery Oral Medicine Oral Pathology*. 1990;70(6):683-686.
- Kwon G, Hohman MH. Inferior Alveolar Nerve and Lingual Nerve Injury. StatPearls Publishing. 2023.

- Sulistiyani L, Julia V, Noviantika D, Irfan I, Muskab M, Kawisana P. Evaluation of neurosensory disturbances of the inferior alveolar nerve after ORIF procedure in mandibular fracture: A systematic review. *Journal of Stomatology*. 2022;75(2):130-137.
- de Assis Santos VP, Rocha-Junior WG, Luz JG. Effects of light-emitting diode therapy on sensory changes in the inferior alveolar nerve after surgical treatment of mandibular fractures: A randomized controlled trial. *Oral and Maxillofacial Surgery*. 2022.
- Alamgir A, Ullah A, Tariq A, Mahmud A, Jadoon M, Siraj F. Occurrence of inferior alveolar nerve damage after internal fixation and open reduction in patients visiting Ayub Medical College with mandibular fractures. *International Journal of Health Sciences*. 2023;7(S1):2739-2745.
- Singh A, Lone PA. Evaluation of post traumatic neurosensory disturbances in the distribution of inferior alveolar nerve in case of mandibular fractures and their management. *International Journal of Applied Dental Sciences*. 2021;7:314-321.
- Maqbool H, Abro M, Hassan SG, Yousuf H, Punjabi SK, Shams S. Assessment of post-traumatic and postoperative inferior alveolar nerve function in mandibular angle fracture. *Open Access Journal of Biomedical Science*. 2020.
- Monarchi G, Giroto R, Paglianiti M, Balercia P. A single center experience: A retrospective study over 10-years period on mandible fractures. *Craniomaxillofacial Trauma & Reconstruction*. 2023.
- Cole P, Kaufman Y, Hollier LH. Principles of mandibular fracture management. *Plastic and Reconstructive Surgery*. 2009;124(3):102e-112e.
- Miloro M, Ghali GE, Larsen PE, Waite PD. Peterson's Principles of Oral and Maxillofacial Surgery. 3rd ed. Shelton: PMPH; 2012.
- Fonseca RJ, Barber HD, Powers MP, Frost DE. *Oral and Maxillofacial Trauma*. 4th ed. St Louis: Elsevier; 2013.
- Hupp JR, Ellis E, Tucker MR. *Contemporary Oral and Maxillofacial Surgery*. 7th ed. St Louis: Elsevier; 2019.
- Meara DJ, Jones LC, Van Sickels JE. Management of mandibular fractures. *Oral and Maxillofacial Surgery Clinics of North America*. 2013;25(4):591-603.
- Nasser M, Pandis N, Fleming PS. Interventions for the management of mandibular fractures. *Cochrane Database of Systematic Reviews*. 2013.
- Boffano P, Kommers SC, Roccia F, Forouzanfar T. Current concepts on mandibular fractures: A review of the literature. *Journal of Craniofacial Surgery*. 2015;26(3):e287-e291.