"ASSESSMENT OF NEUROSENSORY DISTURBANCES OF INFRAORBITAL NERVE FOLLOWING SURGICAL AND CONSERVATIVE MANAGEMENT OF ISOLATED ZYGOMATICOMAXILLARY COMPLEX FRACTURES: A PROSPECTIVE STUDY"

By

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DISSERTATION

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ABSTRACT

Title: Assessment of neurosensory disturbances of infraorbital (ION) nerve following surgical and conservative management of isolated zygomaticomaxillary complex (ZMC) fractures: A prospective study.

Aim: This study aims to evaluate the recovery of ION neurosensory deficits following surgical and conservative management of ZMC fracture in patients presenting to KLES Dr. Prabhakar Kore Hospital

Objective: To assess the recovery of ION dysfunction following surgical and conservative management of isolated ZMC fracture, and compare the recovery rates in both modes of management.

Methods: 60 patients with isolated ZMC fracture and ION dysfunction were studied. Patients were divided into two groups based on the treatment modality used. Group A (surgical management), and Group B (conservative management), with each group having 30 subjects (n=30). Both groups were evaluated for sensory function using the brushstroke technique, Semmes-Weinstein pressure test, and Pinprick test. The evaluation was done on Day 0, Day 10, and at 6-week follow-up.

Results: By the end of the 6-week follow-up period, both groups showed complete recovery concerning mechanoreception (brushstroke test). Recovery of proprioception and nociception was better in group A when compared to group B. However, the difference between both groups was not significant.

Conclusion: The effect of surgical management on recovery of ION is not vastly different from conservative management. The choice to surgically operate a ZMC fracture should be guided by the patient's esthetic and functional needs. When ION dysfunction is the only symptom that needs to be treated, it's unnecessary to treat the patient surgically, when conservative management can give similar results.

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INTRODUCTION

The Zygomaticomaxillary Complex (ZMC) serves as a buttress in the midface [(1),] formed by the confluence of zygomatic bone, sphenoid, maxilla, frontal and temporal bone. Of all facial bone fractures, ZMC fractures make up 5.7%–44.3% of cases[(2)] and are the 2nd most common of all maxillofacial facial fractures[(1).] These fractures often result from high-velocity impacts, such as those sustained in road traffic accidents, falls, or assaults.

The relationship between zygomatic bone, sphenoid, and maxilla is important as it forms the thin orbital floor. The orbital floor is a site of weakness because it contains the infraorbital groove or canal that houses the infraorbital nerve (ION) [(1),] making it prone to be involved in the path of the fracture line. Being in the vicinity of the fracture line, the ION becomes susceptible to damage leading to associated symptoms, among the myriads of other complications associated with ZMC fractures.

Part of the second division of the trigeminal nerve, the infraorbital nerve acts as a terminal branch, providing sensory supply to the cheeks, ala of the nose, upper lip, maxillary incisors, canines, and premolars, gingiva, and lower eyelid[(3)]The infraorbital nerve (ION), which originates from the maxillary nerve, passes through the inferior orbital fissure to reach the orbital cavity. It then follows an upward and lateral path through the infraorbital canal or groove until it emerges through the infraorbital foramen[(4).]

Post-traumatic dysfunction of ION occurs in up to 80% of mid-face fractures and can be attributed to the displaced nature of the fractured segments, post-traumatic edema, hematoma formation, traction, or severance of direct injury to the nerve[(5).] The nerve damage manifests itself in the form of hyperesthesia, hypoesthesia,

paraesthesia, or anesthesia of the areas supplied by ION [(3)]. Even while these symptoms might not result in a functional handicap for the person, they can nevertheless negatively affect the patient's psychological health and quality of life in general.

To assess the level of damage done to a peripheral nerve, multimodal testing needs to be done. Sensory nerve testing can be done as proprioceptive testing and nociceptive testing. Proprioceptive testing assesses touch and pressure perception, while nociceptive testing assesses response to pain and temperature stimuli. Multiple standardized testing protocols are in place for such examinations. Directional brush stroke tests, two-point discrimination, and Semmes Weinstein pressure tests are appropriate for touch and pressure testing, while nociceptive testing employs the use of pinprick and thermal perception tests. The rationale behind these tests is to examine the fibers that are damaged at a microscopic level (Aβ, Aδ, and C fibers).

Numerous reports indicate that mild to moderately displaced ZMC fractures often lead to mild to moderate nerve injuries (Sunderland grade I/II), with recovery typically observed within a few months[(3).] However, many studies have indicated the need for decompression of ION for its complete recovery, while others have expressed that treatments that are conservative or least invasive were adequate to resolve the associated neurosensory deficits in fracture of ZMC[(5)]

It is imperative to recognize that the primary objective of surgically reducing and fixing tripod fracture is to restore both functions and aesthetics. However, in cases that present with minimally displaced fractures, and negligible aesthetic and functional limitations, but show the presence of ION dysfunction, the choice of management can be controversial.

Despite the prevalence of ZMC fractures and their associated neurosensory disturbances, there remains a paucity of comprehensive prospective studies evaluating the effectiveness of different management strategies on infraorbital nerve function. By elucidating the outcome of this research, the authors aim to provide valuable insights into the optimal management strategies for preserving and restoring infraorbital nerve function in patients with ZMC fractures.

AIM AND OBJECTIVES

Aim

This study aims to evaluate the recovery of ION neurosensory deficits following surgical and conservative management of ZMC fracture in patients presenting to KLES Dr. Prabhakar Kore Hospital.

Objective

- To assess the recovery of ION disturbances after surgical management of ZMC fractures that report to KLES Dr. Prabhakar Kore hospital
- To assess the recovery of infraorbital nerve disturbance after conservative management of ZMC fractures that report to KLES Dr. Prabhakar Kore hospital.
- To compare the recovery rates of infraorbital nerve deficit between patients undergoing conservative and surgical management.

REVIEW OF LITERATURE

13 patients with unilateral ZMC fractures with impairments in the infraorbital nerve participated in a study conducted in 2015 by *Asish Kumar Das et al.* The patients received treatment in one of three ways: open reduction and fixation, closed reduction, or conservative therapy. They came to the conclusion that, in comparison to cases where only conservative care was used, surgical reduction and fixation, and closed reduction of ZMC fractures demonstrated a faster rate of recovery of ION.*Husain Dhabaria et al* observed, in a 2023 published study, that out of 13 patients that were diagnosed with unilateral ZMC fracture and infraorbital nerve damage and treated with surgical reduction followed by internal fixation, 84.62% had recovered their tactile sensation while 76.92% had recovered their pain perception by the end of follow up period of six months In 2005, *Rafael Benoliel and colleagues* talked about the neurosensory alterations in the infraorbital nerve that happen after tetrapod fractures. When compared to a group that received conservative care, they found that decompressing the nerve with surgical reduction and fixation resulted in a better recovery of nerve function in a 6-month follow-up.

Jongweon Shin. et al studied 26 patients diagnosed with unilateral isolated anterior maxillary wall fractures and infraorbital nerve dysfunction in 2020. They segregated patients into a conservative group (control) and a surgical decompression group (study) and evaluated the nerve recovery over 6 months. They concluded that the nerve recovery rate in either group was not significantly different, and hence infraorbital nerve dysfunction should not be considered as the lone rationale for surgical fixation of ZMC fractures.

In 2020, Reza Tabrizi et al. conducted a cross-sectional study to gauge the effect on the repair of infraorbital nerve damage in cases with tripod fractures of the time lag between trauma and surgical repair. 73.6% of the 40 individuals who underwent examination had impairment of the infraorbital nerve. According to the study, the incidence of self-reported paraesthesia increased by 0.44 for every extra day that therapy was postponed. Thus, it was determined that the probability of infraorbital nerve dysfunction increases with increasing delay in the therapy of tetrapod fractures.

A research by *Samy Saeed El Naas Farag Allah et al.* on ten patients with unilateral ZMC fractures and infraorbital nerve injury was published in 2020. The patients were classified into two groups at random: Group I received traditional treatment without the use of a stereolithographic model and was treated with mirror imaging. Group II received traditional treatment without the use of a stereolithographic model. They came to the conclusion that there was no discernible benefit of computer-assisted surgical planning over conventional approaches to care.

Kathia Dubron et al retrospectively reviewed 272 patients with a history of unilateral and bilateral ZMC fractures to correlate incidence, etiology, and related fracture patterns with infraorbital nerve damage in zygomaticomaxillary complex fractures. In this 2022 study, they observed, that out of all the ZMC fracture cases, only 37.3% cases were associated with infraorbital nerve damage. Out of those, 74% were significantly associated with Zing type B fractures. They also concluded that infraorbital nerve hypoesthesia was most often reported when the line of fracture involved the ION canal and was less reliant on the fracture site's displacement.

S. Arun et al, in a 2022 study, identified 103 patients with isolated malar bone fractures that were opted to be managed conservatively. The patients were segregated based on Zing type classification and were observed over a course of 6 months, for resolution of their symptoms. Type A and type B fractures were seen to show better resolution of infraorbital nerve paraesthesia. Type A fracture was concluded to be a better candidate for conservative management, while Type B needed more long-term follow-ups to fabricate a protocol of treatment for severe fracture displacement in Type C fractures necessitated surgical intervention.

Jouko Peltomaa et al, retrospectively evaluated 128 patients, in a study conducted in 2000, with a history of blowout orbital fracture and ZMC fractures. They were sent questionnaires a mean of 2.2 years after their treatment to evaluate the resolution of their infraorbital nerve dysfunction post-treatment. There were a total of 41 subjects with blowout fractures and 87 with ZMC fractures. 27 blow-out fracture patients and 29 ZMC fracture patients were treated with observation. At the follow-up period end, patients treated with observation had fewer complications than those treated surgically. However, this difference was not significant.

Yaser Ishaq et al published their observations in 2018. They studied patients with ZMC fractures and infraorbital nerve damage. Two groups (surgical reduction and fixation, and closed reduction) with 50 participants each were compared, based on its effect on infraorbital nerve recovery. It was concluded that surgical reduction and fixation improved neurosensory recovery better than closed reduction mode of management.

H.J Seddon published his work on peripheral nerve injuries in 1943, classifying nerve damage at 3 levels: Neuropraxia, Axonemetesis, and Neuroemetesis. This was determined by looking at the degree, prognosis, and length of the nerve injury.

Sydney Sunderland further expanded on Seddon's work in 1951, and stratified nerve damage into five levels.

Albin A. John et al, systematically reviewed 66 articles in 2022, discussing the efficiency of various sensory assessment tools for peripheral nerve damage. The authors found the Semmes- Weinstein test to be an appropriate alternative for the 2-point discrimination test for mechanoreceptive testing of peripheral nerves

A W Chan et al evaluated the efficacy of using a weighted pin prick test to assess diabetic neuropathy and found it to be a reliable and rapid alternative to thermal testing, for evaluation of the nociceptive perception of peripheral nerves.

MATERIAL AND METHODS

STUDY DESIGN: A hospital-based prospective study.

DATA SOURCE: The study was managed in the Department of OMFS, KLE VKIDS, Belagavi, Karnataka with due permission of the institutional ethical committee. Each patient will receive an explanation of the process and sign an informed consent form.

LABORATORY DETAILS*:*

Patients will undergo routine investigations when admitted to the hospital

- Complete blood picture
- Blood group
- Coagulation profile
- Chest X-ray
- Electrocardiogram
- Mini renal panel
- Serological investigation: HIV, HCV, HBsAg
- Pre Anesthetic evaluation

RADIOGRAPHS: CT SCAN

INFRAORBITAL NERVE EVALUATORS

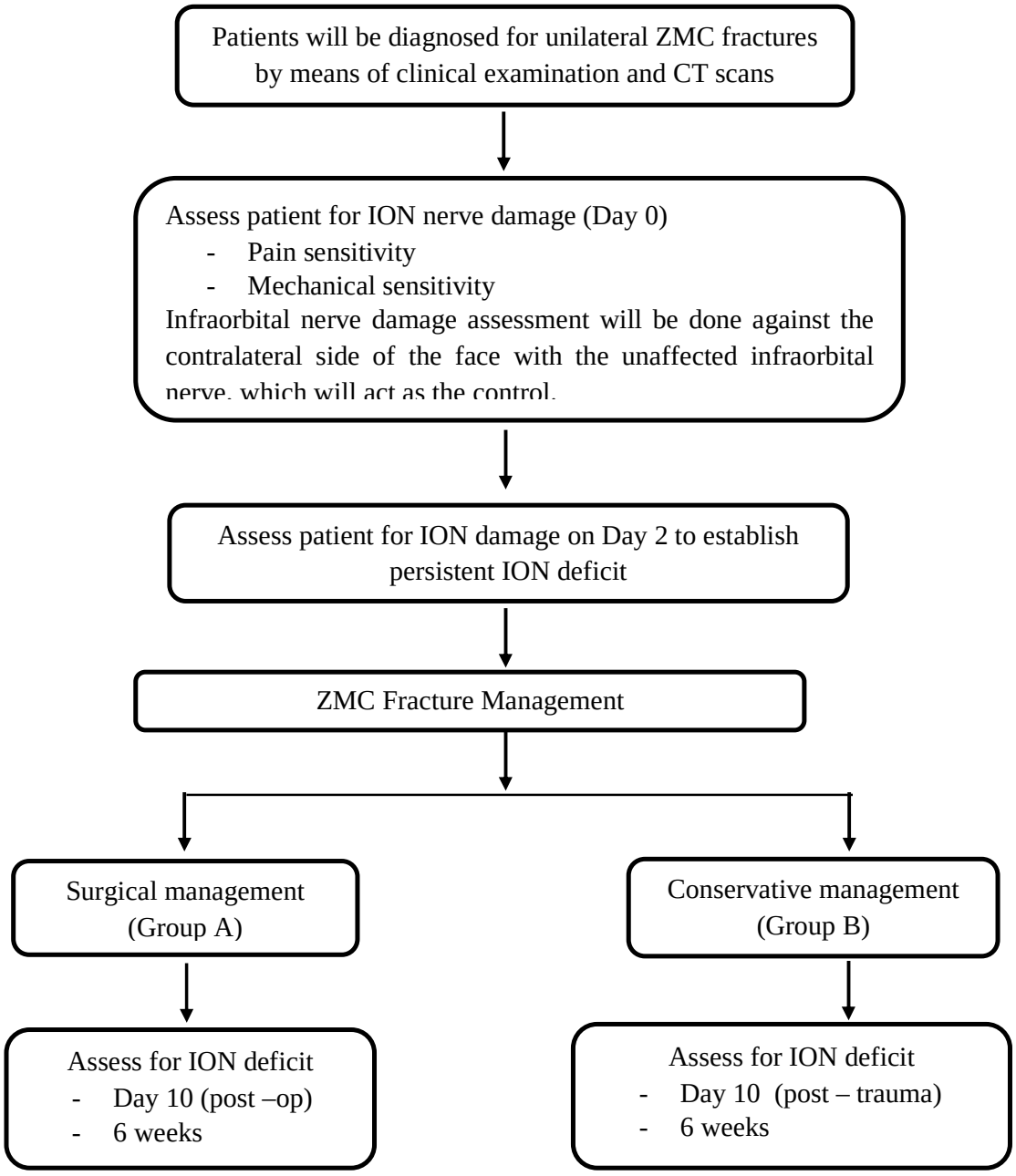
- Paintbrush
- Semmes-Wienstein Pressure Test kit
- Acupuncture needle

INCLUSION CRITERIA*:*

- Patients willing to participate and sign the consent form
- Individuals that are older than 18
- Patients with unilateral fracture of ZMC or Unilateral Lefort II and III fractures, with fracture lines involving, or in the vicinity (2x2 cm) of the infraorbital foramen.
- Patients with infraorbital nerve disturbances
- Conscious and oriented patients
- Patient with no previous history of maxillofacial trauma

EXCLUSION CRITERIA

- Patients unwilling to participate or sign the consent form.
- Medically compromised patients that can alter neurosensory perceptions.
- Patients with only isolated zygomatic arch fracture.
- Patients with damage to infraorbital nerve before trauma.
- Patients unwilling to undergo treatment.


Patients will be diagnosed for unilateral ZMC fractures by means of clinical examination and CT scans
Assess patient for ION nerve damage (Day 0)
- Pain sensitivity
- Mechanical sensitivity
Infraorbital nerve damage assessment will be done against the contralateral side of the face with the unaffected infraorbital nerve, which will act as the control.
Assess patient for ION damage on Day 2 to establish persistent ION deficit
ZMC Fracture Management
Surgical management (Group A)
Conservative management (Group B)
Assess for ION deficit
- Day 10 (post –op)
- 6 weeks
Assess for ION deficit
- Day 10 (post – trauma)
- 6 weeks

RESULTS

Statistical analysis –

The acquired data was sorted and entered into Microsoft Excel (v. 2013).

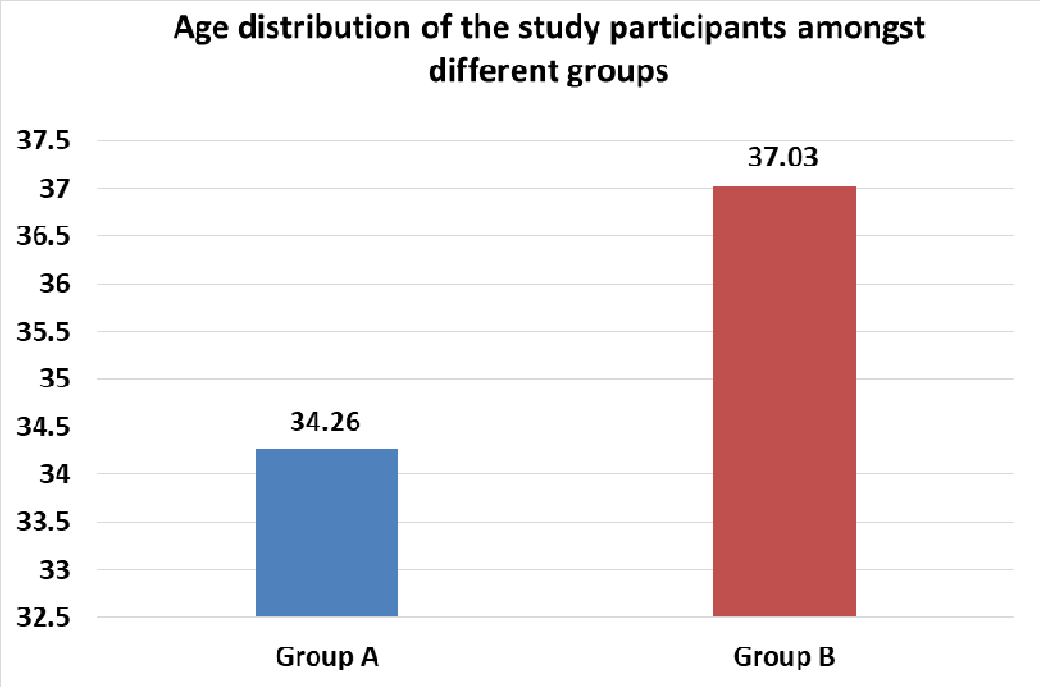
- The Statistical Package for Social Sciences (SPSS) program (IBM Corp.) (v.21.0) was used to do statistical analysis.
- For each of the many parameters the study evaluated, descriptive and inferential statistics were run.
- To ascertain whether the information had a normal distribution, a data normalcy test was run.
- The Mann Whitney-U test was used for discrete variables and the Independent samples t-test/Unpaired t-test for continuous variables when conducting intergroup comparisons. The significant differences between the two groups were ascertained using these tests.
- Repeated measure ANOVA and the Kruskal-Wallis test were used for intragroup comparison to determine whether there were significant differences between the groups.
- 95% confidence intervals were used for all statistical tests.

1) Demographic

- The study analyzed a total of 60 participants. Group A consisting of 30 patients, underwent surgical management, while Group B, also comprising 30 patients, received conservative management.
- The average age of all patients included in the study was 35.645 years, with ages ranging from 18 years to 63 years old.
- The age range in Group A was 18 to 52 years old, with an average age of 34.26 years.
- The age range in Group B was 22 to 63 years old, with an average age of 37.03 years.

Table 1 – Descriptive statistics of Age of the study participants amongst different groups

Age (in yrs)	N	Min	Max	Mean	SD
Group A	30	18.00	52.00	34.26	9.94
Group B	30	22.00	63.00	37.03	9.53

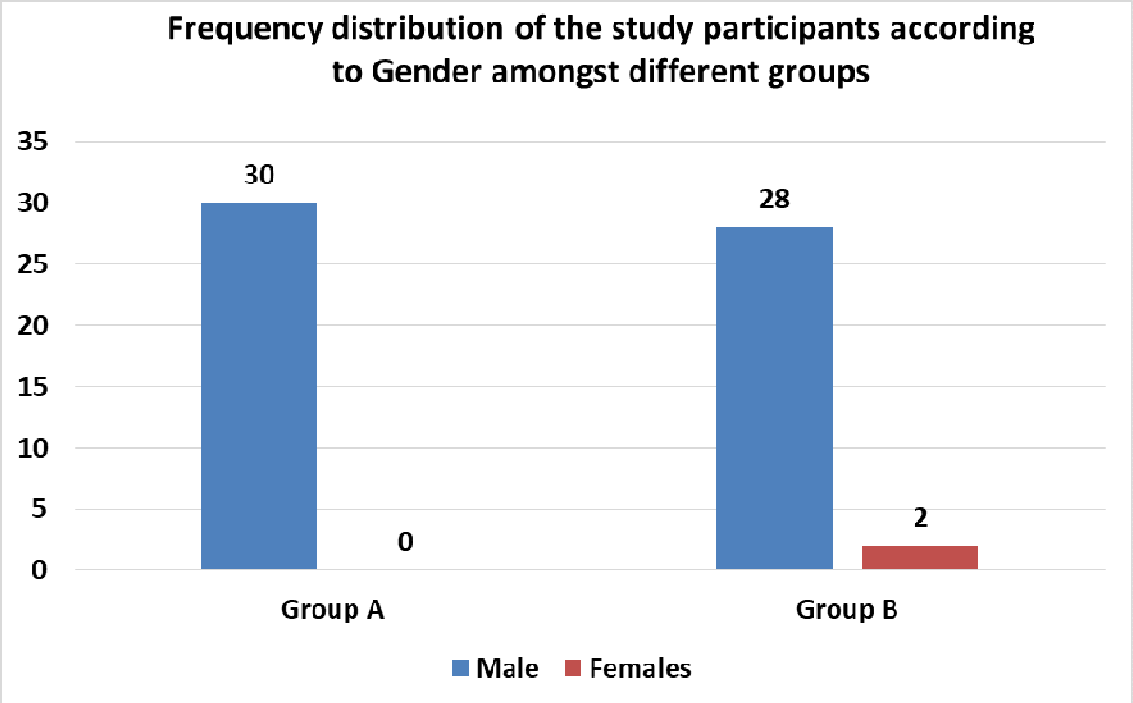


- 58 male patients and 2 female patients made up the total number of participants evaluated for this study.

- Of the patients in Group B, two were female and the remaining 28 were male. In Group A, all 30 patients were male.

Table 2 –Frequency distribution of the study subjects according to Gender amongst different groups

Gender	Group A		Group B	
	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
Male	30	100.0	28	93.3
Females	-	-	2	6.7
Total	30	100.0	30	100.0



2) Pin Prick Test

- The test was performed using acupuncture needles, to assess nociceptive perception in patients.
- A pain scale with numerical values was used to quantify the patients' level of discomfort. The unaffected side of all the participating patients was assessed on Day 0. This score was used as a baseline to compare the recovery of the contralateral affected side.
- On the unaffected side, the mean pain score in Group A was 5.36.
- The average value of pain score on the affected site was 2.66 on Day 0, 3.20 on Day 10, and 4.70 at the 6-week follow-up.

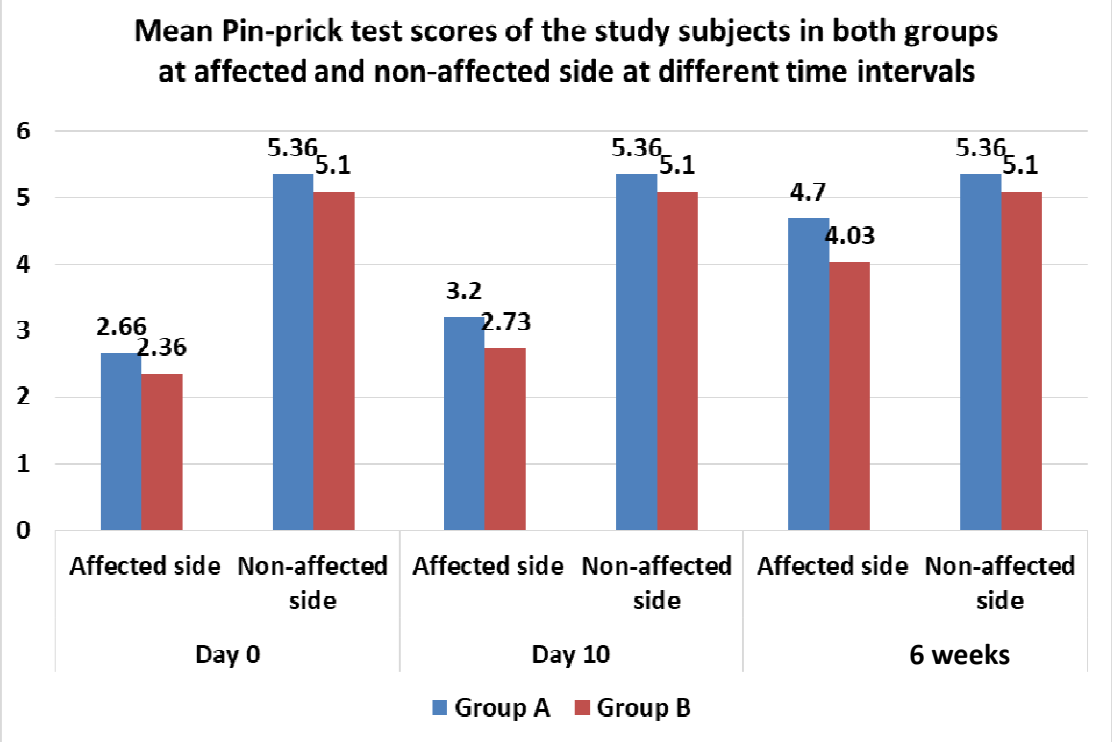
Table 3 – Descriptive statistics of Pin-prick test scores of the study participants in Group A at affected and non-affected sides at different time intervals

Side	Time interval	N	Mean	Std. Deviation
Affected side	Day 0	30	2.66	1.18
Non-affected side		30	5.36	0.55
Affected side	Day 10	30	3.20	1.03
Non-affected side		30	5.36	0.55
Affected side	6 weeks	30	4.70	0.59
Non-affected side		30	5.36	0.55

- In Group B, the average value of the score of pain was 5.10 on the unaffected side.
- The mean value of pain score on the affected site was 2.36 on Day 0, 2.73 on Day 10, and 4.03 at the 6-week follow-up.

Table 4 – Descriptive statistics of Pin-prick test scores of the study participants in Group B at the affected and non-affected sides at different time intervals

Side	Time interval	N	Mean	Std. Deviation
Affected side	**Day 0**	30	2.36	1.12
Non-affected side		30	5.10	0.54
Affected side	**Day 10**	30	2.73	0.78
Non-affected side		30	5.10	0.54
Affected side	**6 weeks**	30	4.03	0.71
Non-affected side		30	5.10	0.54



3) Brush Stroke Test

- The directional brush stroke test was done to assess touch perception in participating patients.
- The result of the test was evaluated as Yes or No.
- All patients were able to correctly assess the direction of the brush stroke on the unaffected side**.**
- In Group A (affected side), 17 patients could correctly assess the brush stroke direction on Day 0, 25 patients on Day 10, and all 30 patients at 6-week follow-up.
- While, 13 patients on Day 0, and 5 patients on Day 10 could not assess the direction of the brush stroke on the affected side
- However, all patients were correctly able to identify the direction of the brush stroke by the 6-week follow-up, on the affected side.

Table 5 –Frequency distribution of the study participants according to the Brushstroke test in Group A at the affected side at different time intervals

Group A	**Day 0**		**Day 10**		**6 weeks**	
Affected side	**Frequency (n)**	**Percent (%)**	**Frequency (n)**	**Percent (%)**	**Frequency (n)**	**Percent (%)**
Yes	17	56.7	25	83.3	30	100.0
No	13	43.3	5	16.7	-	-
Total	30	100.0	30	100.0	30	100.0

Table 6 –Frequency distribution of the study participants according to Brushstroke test in Group A at the non-affected side at different time intervals

Group A Non- Affected side		Frequency (n)	Percent (%)
Day 0, Day 10, and 6 weeks	Yes	30	100.0

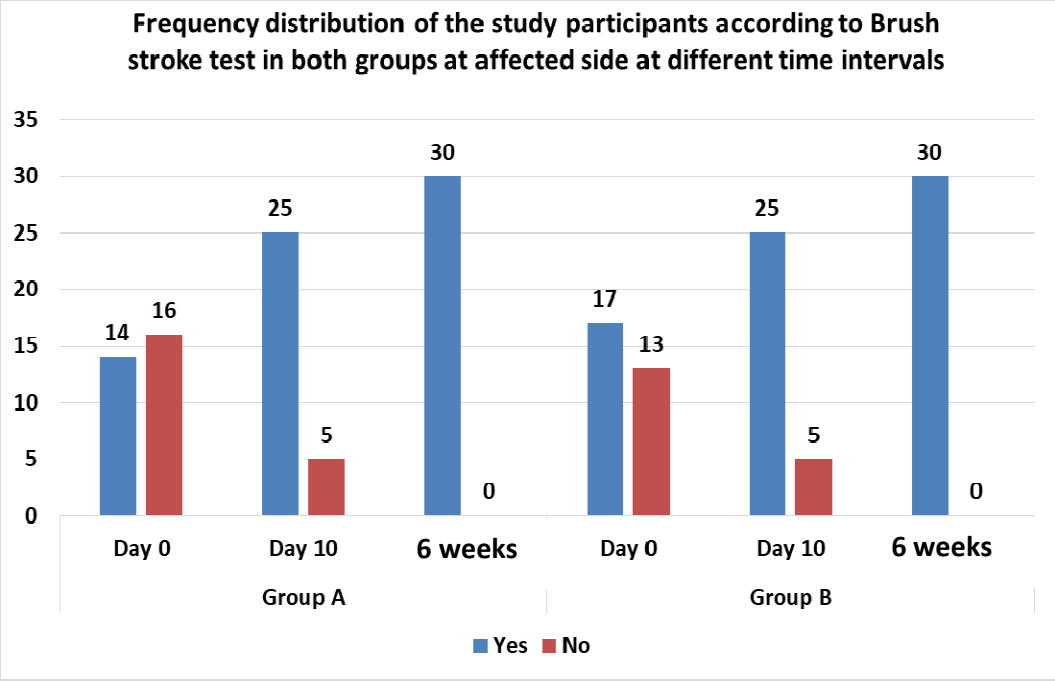
- In Group B (affected side), 14 patients could correctly assess the brush stroke direction on Day 0, 25 patients on Day 10, and all 30 patients at 6-week follow-up.
- While, 16 patients on Day 0, and 5 patients on Day 10 could not assess the direction of the brush stroke on the affected side
- However, all patients were correctly able to identify the direction of the brush stroke by the 6-week follow-up, on the affected side.

Table 7 –Frequency distribution of the study participants according to the Brushstroke test in Group B at the affected side at different time intervals

Group B	**Day 0**		**Day 10**		**6 weeks**	
Affected side	**Frequency (n)**	**Percent (%)**	**Frequency (n)**	**Percent (%)**	**Frequency (n)**	**Percent (%)**
Yes	14	46.7	25	83.3	30	100.0
No	16	53.3	5	16.7	-	-
Total	30	100.0	30	100.0	30	100.0

Table 8 –Frequency distribution of the study participants according to Brushstroke test in Group B at the non-affected side at different time intervals

Group B Non- Affected side		Frequency (n)	Percent (%)
Day 0, Day 10, and 6 weeks	Yes	30	100.0



4) Semmes – Weinstein Test

- Semmes- Weinstein test was performed to evaluate the pressure perception in patients with infraorbital nerve damage.
- The Semmes- Weinstein kit used was graded at 0.07gm, 0.4gm, 2.0gm, 4.0gm, and 300gms
- In both the groups, the non-affected side was able to feel a pressure of 0.07 gms, which was used as a baseline for comparing the contralateral affected side.
- In Group A, the affected side, 13 patients were able to perceive 300gm force on Day 0, 13 patients perceived 4.00gm, and only 2 patients perceived 2.00gm.
- On Day 10, only 5 patients could feel 300gm pressure, 13 patients perceived 4.00gm and 12 patients perceived 2.00gm.
- By the 6-week follow-up, 15 patients could feel 2.00gm pressure, 12 patients perceived 0.4 gm, and 3 patients showed recovery of pressure perception, being able to perceive 0.07gm pressure.

Table 9 –Frequency distribution of the study participants according to Semmes Weinstein test in Group A at the affected side at different time intervals

Group A Affected side	Day 0		Day 10		6 weeks	
	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
0.07 gm	0	0	0	0	3	10.0
0.4 gm	0	0	0	0	12	40.0
2.00 gm	4	13.3	12	40.0	15	50.0
4.00 gm	13	43.3	13	43.3	0	0
300 gm	13	43.3	5	16.7	0	0
Total	30	100.0	30	100.0	30	100.0

Table 10 –Frequency distribution of the study participants according to Semmes Weinstein test in Group A at non-affected side at different time intervals

Group A Non- Affected side		Frequency	Percent
Day 0, Day 10, and 6 weeks	0.07 gm	30	100.0

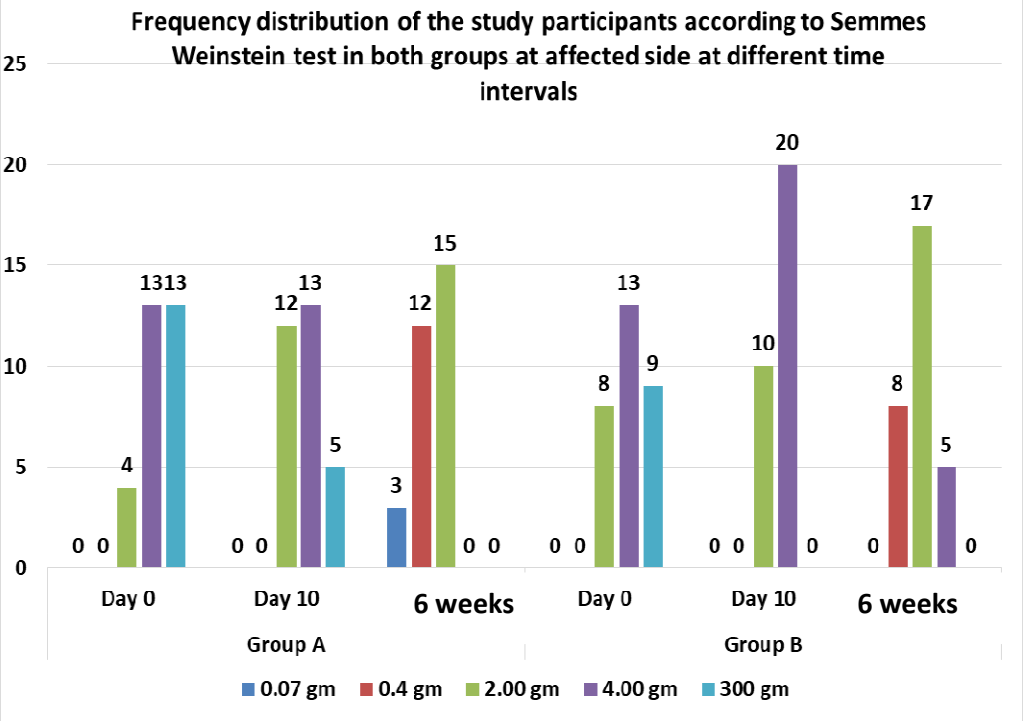
- In Group B, the affected side, 9 patients were able to perceive 300gm force on Day 0, 13 patients perceived 4.00gm, and 8 patients perceived 2.00gm pressure.
- On Day 10, 20 patients perceived 4.00gm and 10 patients perceived 2.00gm.
- By the 6-week follow-up, 5 patients could feel 4.00gm pressure, 17 patients perceived 2.00 gm, and 8 patients showed pressure perception of 0.4gm pressure.

Table 11 –Frequency distribution of the study participants according to Semmes Weinstein test in Group B at the affected side at different time intervals

Group B	**Day 0**		**Day 10**		**6 weeks**	
Affected side	**Frequency (n)**	**Percent (%)**	**Frequency (n)**	**Percent (%)**	**Frequency (n)**	**Percent (%)**
0.4 gm	0	0	0	0	8	26.7
2.00gm	8	26.7	10	33.3	17	56.7
4.00gm	13	43.3	20	66.7	5	16.7
300 gm	9	30.0	0	0	0	0
Total	30	100.0	30	100.0	30	100.0

Table 12 –Frequency distribution of the study participants as per Semmes Weinstein test in Group B at non-affected side at different time intervals

Group B Non- Affected side		Frequency (n)	Percent (%)
Day 0, Day 10, and 6 weeks	0.07 gm	30	100.0



5) Intragroup Analysis

Table 13- Intergroup comparison of the Pin Prick test between 2 groups at different time intervals at affected and non-affected side

Time Interval and Side	Groups	N	Mean	Mean difference	t value	P value
Day 0 Affected side	**Group A**	30	2.6667	.30000	1.004	.319
	Group B	30	2.3667			
Day 0 non-affected side	**Group A**	30	5.3667	.26667	1.871	.066
	Group B	30	5.1000			
Day 10 Affected side	**Group A**	30	3.2000	.46667	1.973	.05*
	Group B	30	2.7333			
Day 10 non-affected side	**Group A**	30	5.3667	.26667	1.871	.066
	Group B	30	5.1000			
6 weeks Affected side	**Group A**	30	4.7000	.66667	3.912	.000*
	Group B	30	4.0333			
6 weeks non-affected side	**Group A**	30	5.3667	.26667	1.871	.066
	Group B	30	5.1000			

Interpretation – In our study, an Intergroup comparison of the Pin Prick test between 2 groups at different time intervals at affected and non-affected sides was performed using an Independent samples t-test/Unpaired t-test. The two groups' differences were found to be statistically significant (p-value <0.05) in this comparison. at Day 10 and 6 weeks on the affected side for the pinprick test.

Table 14 - Intergroup comparison of the Brushstroke test between 2 groups at different time intervals at affected and non-affected side

Time Interval and Side	Comparison Groups	N	Mean Rank	p value
Day 0 Affected side	**Group A**	30	29.00	0.442
	Group B	30	32.00	
Day 0 Non-affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	
Day 10 Affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	
Day 10 Non-affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	
6 weeks Affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	
6 weeks Non-affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	

Interpretation – In our study, an Intergroup comparison of the Brushstroke test between 2 groups at different time intervals at affected and non-affected sides was performed using Mann Whitney U test. In terms of the brush stroke test, there were no statistically significant differences (p-value <0.05) between the two groups according to this comparison.

Table 15- Intergroup comparison of the Semmes Weinstein test between 2 groups at different time intervals at affected and non-affected side

Time Interval and Side	Comparison Groups	N	Mean Rank	P value
Day 0 Affected side	**Group A**	30	33.37	0.171
	Group B	30	27.63	
Day 0 Non-affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	
Day 10 Affected side	**Group A**	30	31.17	0.738
	Group B	30	29.83	
Day 10 Non-affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	
6 weeks Affected side	**Group A**	30	25.35	0.011*
	Group B	30	35.65	
6 weeks Non-affected side	**Group A**	30	30.50	1.000
	Group B	30	30.50	

Interpretation – In our study, an Intergroup comparison of the Semmes-Weinstein Test between 2 groups at different time intervals at affected and non-affected sides was performed using Mann Whitney U test. In terms of the brush stroke test, there were no statistically significant differences (p-value <0.05) between the two groups according to this comparison.

Table 16- Intragroup comparison of the Pin Prick test between different time intervals at the affected side in Group A and Group B

Groups	Comparison time intervals	(J) Groups	Mean Difference (I-J)	p value
Group A	**Day 0**	Day 10	-.53333	.090
		6 weeks	-2.03333*	.000*
	Day 10	Day 0	.53333	.090
		6 weeks	-1.50000*	.000*
	6 weeks	Day 0	2.03333*	.000*
		Day 10	1.50000*	.000*
Group B	**Day 0**	Day 10	-.36667	.257
		6 weeks	-1.66667*	.000*
	Day 10	Day 0	.36667	.257
		6 weeks	-1.30000*	.000*
	6 weeks	Day 0	1.66667*	.000*
		Day 10	1.30000*	.000*

Interpretation – In our study, the Intragroup comparison of the Pin Prick test between different time intervals at the affected side in Group A and Group B was performed using Repeated measures ANOVA. The comparison between the various time intervals did not reveal statistically significant differences (p-value <0.05)., mainly at Day 0 and 6 weeks and Day 10 and 6 weeks for Group A and Group B.

Table 17- Intragroup comparison of the Brushstroke test between different time intervals at the affected side in Group A and Group B

Groups	Comparison time intervals	N	Mean Rank	Chi-square value	p value
Group A	Day 0	30	56.00	17.718	0.000*
	Day 10	30	44.00		
	6 weeks	30	36.50		
Group B	Day 0	30	59.00	24.692	0.000*
	Day 10	30	42.50		
	6 weeks	30	35.00		

Interpretation – In our study, an Intragroup comparison of the Brushstroke test between different time intervals at the affected side in both groups was performed using the Kruskal Wallis test statistical significance of the discrepancies was demonstrated by this comparison (p-value <0.05). between the Day 0, Day 10, and 6 weeks for Group A and Group B.

Table 18- Intragroup comparison of the Semmes Weinstein test between different time intervals at the affected side in Group A and Group B

Groups	Comparison time intervals	N	Mean Rank	Chi-square value	p value
Group A	Day 0	30	65.23	52.509	0.002*
	Day 10	30	51.77		
	6 weeks	30	19.50		
Group B	Day 0	30	59.82	30.262	0.001*
	Day 10	30	50.33		
	6 weeks	30	26.35		

Interpretation – In our study, the Intragroup comparison of the Semmes-Weinstein Test between different time intervals at the affected side in both groups was performed using the Kruskal-Wallis test. There were statistically evident differences (p-value <0.05) between the two groups' Day 0, Day 10, and 6-week results.

DISCUSSION

Anatomy of ION and ZMC:

Zygomaticomaxillary Complex fractures have been one of the most common fractures encountered in midface fractures. A 10-year review of craniomaxillofacial trauma of 9543 cases, attributed 38% of cases to daily life activities, 31% to sports, 12% to violence, 12% to road traffic accidents, 5% to work accidents, and 2% to other causes[6]. It is imperative to know the anatomy of the ZMC, to understand the mechanism of the fracture that occurs at ZMC[7]. This can be attributed to the four articulations of zygoma: frontal, sphenoid, maxilla, and zygomatic process of temporal bone. For the scope of our study, the zygoma-sphenoid and zygoma-maxillary bone articulation is important. They contribute to the anatomy of the IO rim and foramen, and disjunction at these suture points is what makes the infraorbital nerve prone to injury.

The infraorbital nerve is a sensory nerve, originating from the trigeminal nerve. It's a peripheral nerve transporting mechanoreception (touch, pressure) and nociception (pain and temperature). Nerve fibers are classified as Aα, Aβ, AϒAδ, B, and C fibers. For the scope of this study, Aδ, Aβ, and C fibers are the main focus. Seddon studied and classified peripheral nerve damage as neurotemesis, axonotemesis, and neuropraxia[8] This was based on the anatomical degree of damage to the nerve. However, Sunderland further expanded on this classification grading the three types of nerve injury into 5 grades[9] This classification helped in giving the prognosis of the damaged nerve, and an insight into the right treatment plan for its management.

Evaluators:

Appropriate modalities are needed to assess the level of nerve damage to arrive at a treatment plan. In our study, we opted to study the patient's perception of the injured infraorbital nerve's recovery from pain, pressure, and touch. 3 tests were chosen for evaluation: the brush stroke test (touch perception), Semmes- Weinstein test (pressure perception), and Pinprick test (pain perception).

Semmes- Weinstein test is a semiquantitative testing technique to assess the amount of pressure a patient can perceive. 0.05g is the lightest filament in the test and can be easily perceived by a healthy individual [10,11]. The Semmes-Weisnstein apparatus used in this study was graded at 0.07g, 0.4g, 2.0g, 4.0g and 300g.

A pinprick test was performed for the assessment of pain perception. The pinprick test results were quantified using the numeric pain scale The scale is rated from 0 to 10, where 0 represents no pain, 1-3 denotes mild pain, 4-6 denotes moderate pain, and 7–10 denotes severe pain. [11,12]

A brush stroke test was used to evaluate if the patient could perceive light touch. The patient was asked to identify the direction of the brush stroke.

These tests are proven to be beneficial in the study of various neurological disorders and their management, including but not limited to the maxillofacial region [11–13].

Demographic Analysis:

The average age of patients presenting with ZMC fractures was 35.645, with most patients belonging to the 2nd and 3rd decade of life. Similar observations have been made in the literature [1]. A common etiology for ZMC cases seen in our study

was road traffic accidents, which has been known to be a common observation in other studies as well. [1,2,7,14]

Males showed a higher incidence of presenting with ZMC fractures, when compared to females, with only 2 females presenting with ZMC fractures in a total of 60 subjects that were studied. A similar trend was seen in multiple studies, where male predilection was observed to be higher than females [6,7,14–18]

Comparative Analysis

This study aimed to compare the use of surgical management and conservative management of ZMC fractures and their effects on infraorbital nerve damage. The rationale behind the treatment modality was based on the stability of the fracture, degree of displacement, facial asymmetry, and hamper of function. Cases, where these criteria were satisfactory, with patients' main complaint being only the infraorbital nerve damage, were opted for conservative management. While others were managed using surgical reduction and internal fixation.

Pin Prick Test:

The pain perception in the patients who were treated with surgical management showed an improving trend. The same trend was also seen in those managed conservatively. Nonetheless, at different time points, the results between the two groups were not significantly different, and it seemed that their rates of recovery were comparable.

Semmes-Weinstein test:

In comparison to Group B, pressure perception demonstrated a greater rate of recovery in Group A, with statistically significant results. At the 6-week follow-up, this difference was still noteworthy.

Brush Stroke test:

Touch perception showed similar recovery rates in both groups and was statistically insignificant. However, the improvement within both groups was statistically significant when comparing Day 0 and 6 weeks of follow-up.

Fracture Pattern and ION dysfunction:

Previous studies have suggested that minimally displaced benefited the most from conservative management of ZMC fracture and also showed maximum recovery over a period of 6 months when assessing ION damage [(14).] This partially supports the results of our study, showing that nerve recovery in both groups was not much different. Some studies credit iatrogenic damage to be the reason behind a relatively slower recovery of ION in surgical groups [(14),] thus suggesting that surgical intervention if required, should be carefully managed. However, there was no iatrogenic damage done to the ION in any of the cases in Group A during the surgical procedure. This is proven by a steady recovery in ION responses of all cases in Group A, with no case showing a deterioration in nerve response.

ION hypoesthesia has been observed to be often associated with Type B fractures, when the fracture line crosses the infraorbital foramen, involves the orbital floor, or there is dislocation of the fracture segments often associated with high-velocity impacts[(2).] A similar trend was seen in our study, where all cases showed

involvement of the IO foramen along the line of fracture, or dislocation of the fracture segments, associated with road traffic accidents. Only group B with minimally displaced fractures showed an association with lower-intensity impacts such as self-fall.

Role of Medical Management in ION recovery:

ION nerve damage was conservatively managed using Neurobion Forte, a Vitamin B complex supplement containing Thiamine, Riboflavin, Pyridoxine, Cyanocobalamine, Nicotinamide, and Calcium Pantothenate. A systematic review article published in 2021, concluded in their study That Thiamine (Vitamine B1) acts in the role of a coenzyme in carbohydrate metabolism and helps provide energy within the nerve fibers, allowing for its regeneration while also preventing oxidative damage to the nerve, acting as an antioxidant. Pyridoxine (Vit. B6) plays a vital role in the formation of neurotransmitters and inhibits the neurotoxic action of glutamate. Cobalamine is important for myelin formation and upregulation of nerve growth factors. Based on this literature, we opted to use Vitamin B complex as a suitable treatment option for seeing nerve recovery in Group B[19,20].

However other conservative treatment modalities exist to improve nerve recovery such as Topiramate, a second-generation anti-epileptic drug which has given good results when seeing nerve recovery in ZMC fractures treated with ORIF[21].

Group A was treated with dexamethasone perioperatively in our study. The rationale was to reduce edema and inflammation at the surgical site. This could also help in relieving pressure from the ION and improving its recovery post-operatively. However, the literature reports that the rate of recovery in cases where dexamethasone is given is not significantly different from cases where is it not administered[22].

Surgical Management or Conservative Management?

Our study's analysis revealed that both groups' recovery of ION function had improved, although there was no discernible difference in either group's recovery rate. We can infer from this, that ION dysfunction should not be the sole factor when planning a treatment action for any patient presenting with ZMC. However, it does provide insight into ZMC fracture cases, where ION dysfunction is the only symptom.

It is imperative while evaluating and diagnosing a patient with ZMC fracture, to understand the classification of ZMC fracture that the patient is presenting with. The primary aim while surgically approaching a ZMC fracture is restoration of function and aesthetics. If a fractured segment is stable, with the patient showing no signs of facial deformity, it would be unnecessary to put the patient through the risk of undergoing general anesthesia, and the associated financial burden that comes with the procedure.

Masakazu Kurita et al, in a questionnaire-based study, tried to evaluate patient satisfaction in patients undergoing ORIF for ZMC fracture. Of 24 patients who had residual paraesthesia postoperatively, 12 patients felt no change or increase in paraesthesia, while the rest 12 reported diminished hypoesthesia of ION. 15 patients also reported post-op pain with frequency ranging from multiple times per week to multiple times per month, and increased pain based on seasonal changes[(16)]

Matthew Louis also discusses midface fractures and recommends a surgical approach for ZMC fractures when there is a cosmetic deformity, orbital floor fractures, herniation, muscle entrapment, or unstable fractures. However, no comment was made on the relevance of ION nerve dysfunction in the surgical planning of ZMC fractures [(7)]. This was also supported by Howard D. Wang and et al.[(17)]

Jouko Peltoma et al in a questionnaire-based study of individuals with minimally displaced fracture of ZMC observed that 64% of the subjects in the untreated group showed complete recovery of ION function when compared to 52% of patients in the treated group, and concluded that there is a tendency for more post-operative dysfunction due to iatrogenic damage to the nerve [23]. While the role of iatrogenic injury to ION cannot be commented on based on our study, it does support the ideology of avoiding surgical approach to ZMC fracture when ION dysfunction is the only presenting symptom[14,24].

However, some studies support the need for ORIF of ZMC fractures in the management of ION dysfunction [3, 25]. Rafael Benoliel et al, strongly recommends ORIF for ZMC fractures when managing ION damage, as observed in his study, where plate fixation provided better recovery for ION [18].

CONCLUSION

As oral and maxillofacial surgeons, we need to have the skills to be able to assess, diagnose, and plan a treatment protocol for any maxillofacial-related trauma. ZMC fractures happen to be among the common facial fractures presented to an OMF surgeon, and we need to understand its etiology, associated fracture patterns, and its effect on function, esthetic, and neurosensory perception.

The treatment should be planned to improve the patient's life quality. We concluded in our study, that there is not much difference in the recovery rate of ION when treated surgically or conservatively. However, there are plenty of studies that suggest that ION is prone to more iatrogenic injury and can worsen the dysfunction postoperatively. Hence, we recommend weighing the benefits and risks of treating a ZMC fracture when the objective is to treat ION injury only. However, a surgical approach is beneficial when restoration of function and esthetic is the main objective, provided the operator avoids iatrogenic injury to the ION.

LIMITATIONS

Due to low patient compliance, the follow-up period to assess neurosensory recovery was kept at 6 weeks. This however did not allow us to measure the full recovery of the impact of different treatment modalities on neurosensory recovery must be fully understood over the course of a prolonged follow-up period.

The apparatus used in this study to perform the Semmes- Weinstein pressure test was not uniformly calibrated, hence the test was not sensitive enough to give an accurate measure of recovery of pressure perception in the patients. The use of intraoperative dexamethasone in Group A can interfere with this study, allowing a faster recovery of nerve, hence creating a bias in the obtained results.

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ANNEXURE – I -PHOTOGRAPHS

Group A Patients

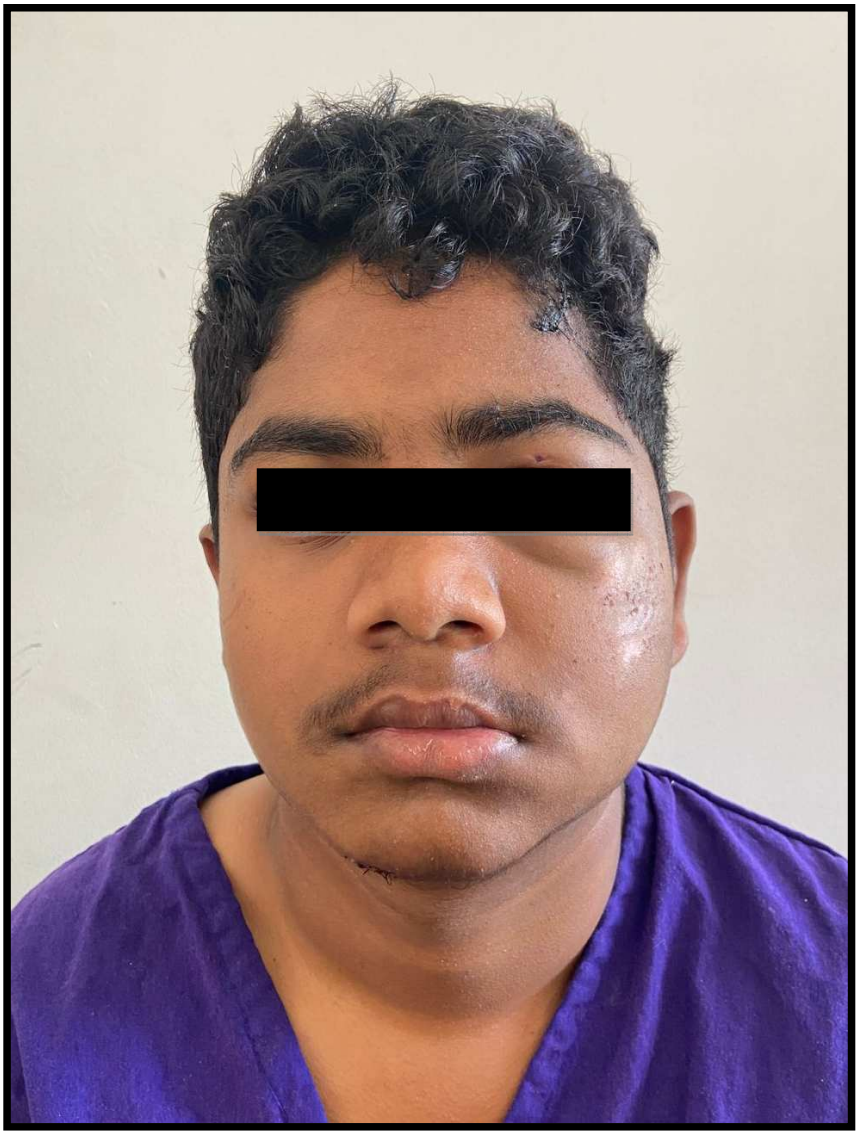


Fig 1: 18-year-old male, with a history of fall from a bicycle, presenting with clinically diagnosed left ZMC fracture, and associated infraorbital nerve paraesthesia. Notice the facial asymmetry concerning the left side of the midface

Fig 2: Computed tomography scan of the patient confirming the left ZMC fracture diagnosis. Fracture line involves the infraorbital foramen indicating damage to the infraorbital nerve.

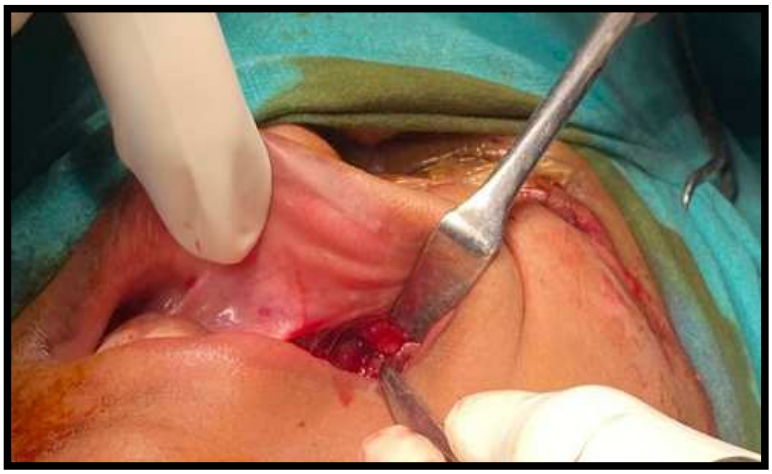


Fig 3a: Intraoral vestibular incision given for exposure of left ZM buttress

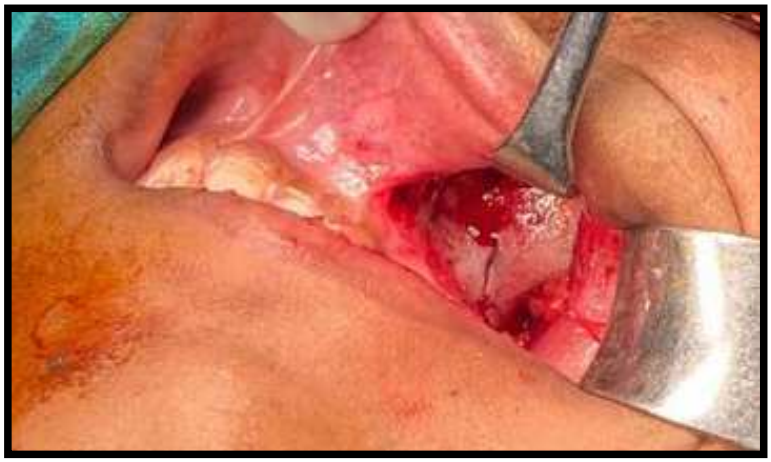


Fig 3b: Fracture site exposed

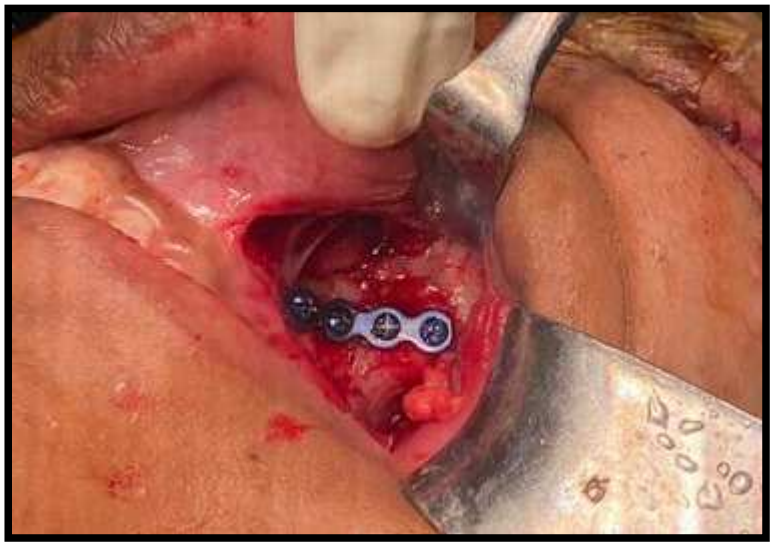


Fig 3c: Fixation done using titanium miniplates

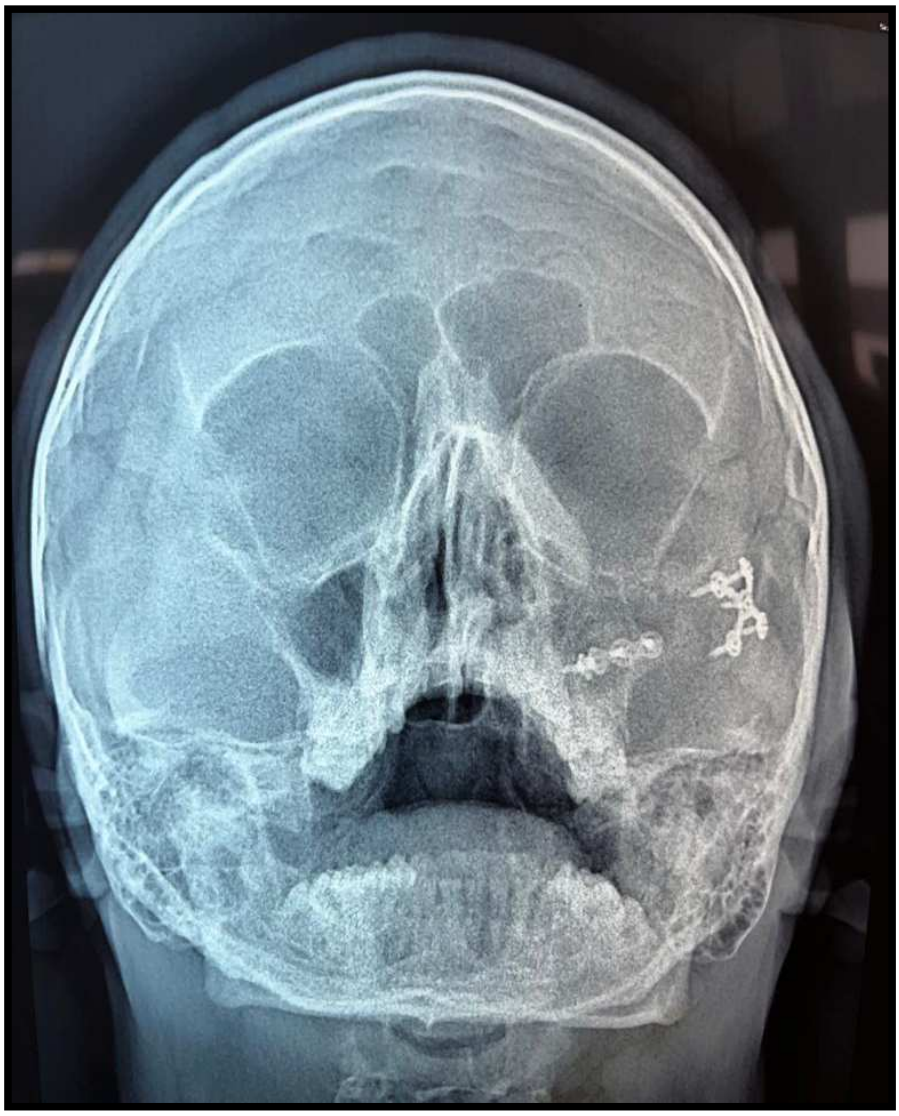


Fig 4: Post operative PNS X-ray showing fixation sites.

GROUP-B PATIENTS

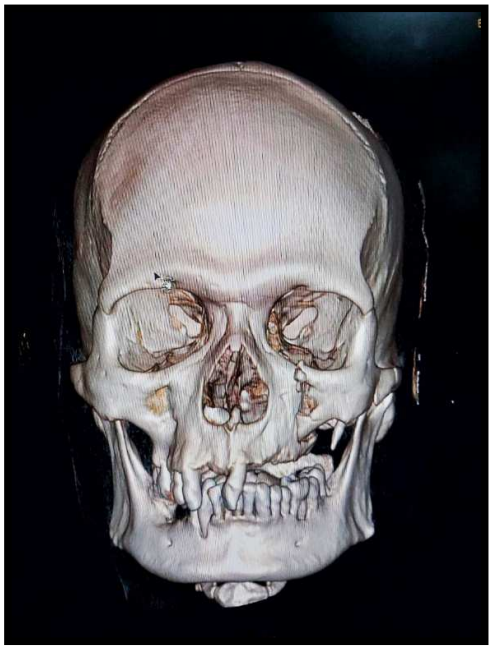


Fig 5a

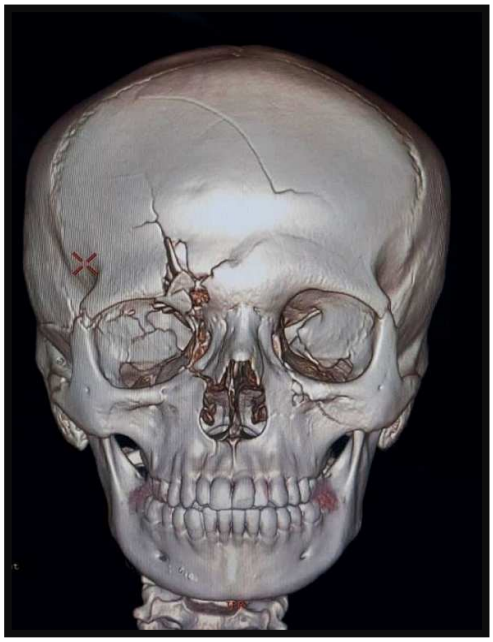


Fig 5b

Fig 5a-b: Computed tomography of two patients that were treated with conservative management. Fig 5a was a 63-year-old male patient, presenting with a left ZMC fracture following a fall in the bathroom. The patient had no esthetic or functional abnormality, apart from the ION dysfunction. Fig 5b was a 37-year-old male patient presenting with a left ZMC fracture after experiencing a fall from two wheeler. The patient opted for conservative management for all fractures due to poor financial status. In both cases, one can observe the fracture line passing through the infraorbital nerve foramen**.**

ARMAMENTARIUM

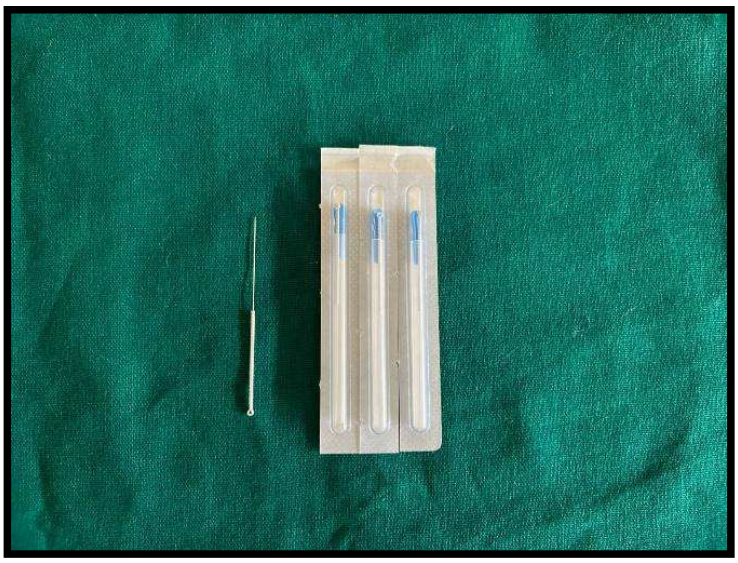
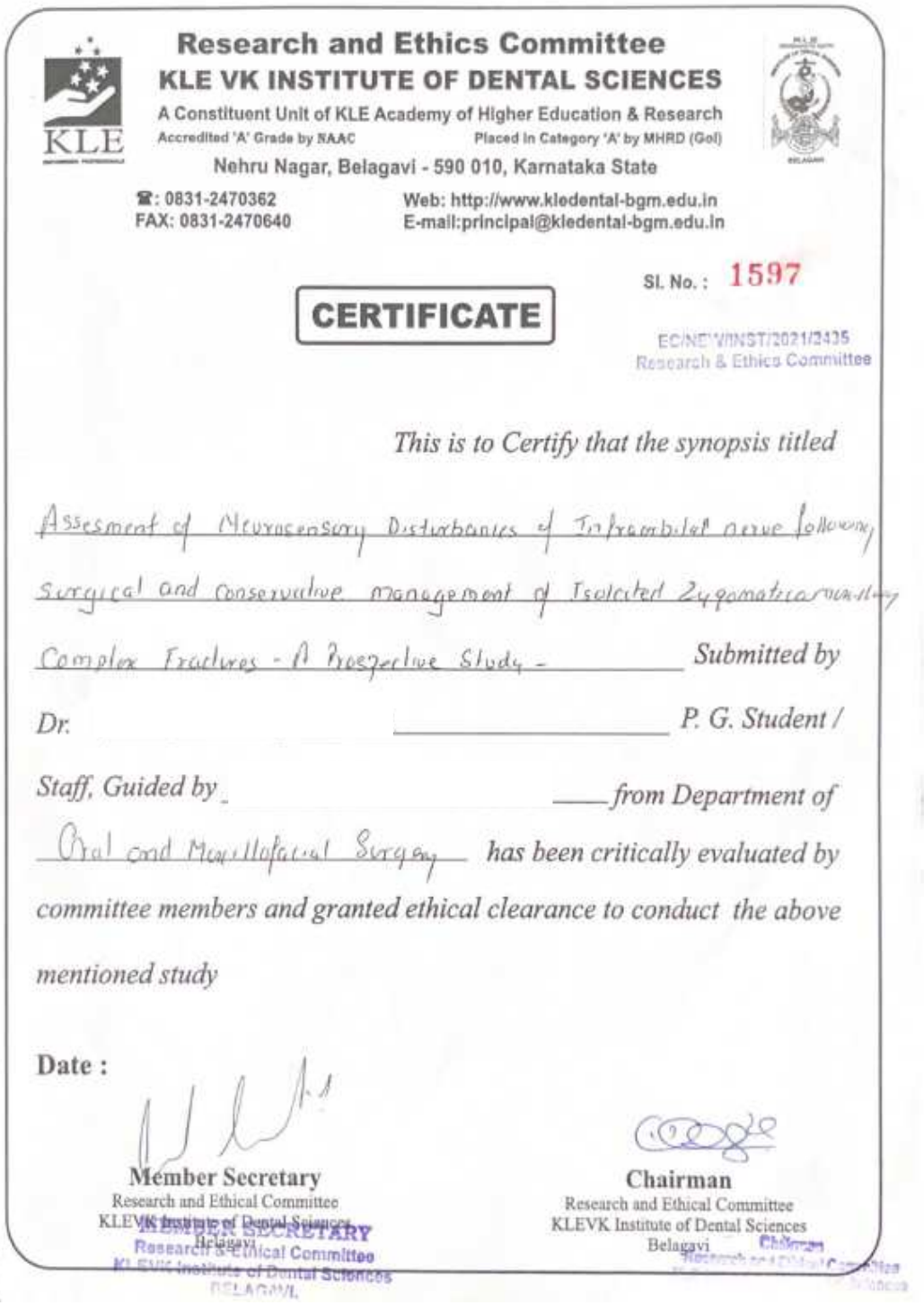


Fig 6a- Accupuncture Needle

Fig 6b- Semmes-Weinstein monofilament kit

Fig 6c- Paint Brush

ANNEXURE – I – ETHICAL CLEARANCE LETTER



Research and Ethics Committee
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A Constituent Unit of KLE Academy of Higher Education & Research
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Sl. No.: 1597

CERTIFICATE

EC/NEW/INST/2021/2435
Research & Ethics Committee

This is to Certify that the synopsis titled

Assesment of Neurosensory Disturbances of Inframbilal nerve following Surgical and Conservative management of Isolated Zygomatico maxillary Complex Fractures - A Prospective Study - *Submitted by*

Dr. _____ *P. G. Student /*

Staff, Guided by _____ *from Department of*

Oral and Maxillofacial Surgery *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date :

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

MEMBER SECRETARY
Research & Ethical Committee
KLEVK Institute of Dental Sciences
BELAGAVI

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences

ANNEXURE-II

BIOSTATISTICS CLEARANCE LETTER

KLE V.K. Institute of Dental Sciences
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E-mail: principal@kledental-bgm.edu.in

Biostatistics Clearance Certificate

This is to certify that the Biostatistics aspect of this dissertation/ Thesis work of **Dr. _____,** post-graduate student, under the guidance of **Dr. _____ M.D.S.,** Professor, Department of **Oral and Maxillofacial Surgery**, entitled **"Assessment of neurosensory disturbances of infraorbital nerve following surgical and conservative management of isolated zygomaticomaxillary complex fractures: A prospective study"** has been done under my guidance and completed satisfactorily.

Dr. Asawari Shidhore
MDS (Public health dentistry)
Biostatistician, Pune.

Dr. Asawari Shidhore (MDS, Gold Medalist)

Place: Belagavi

Name & Signature of Biostatistician

Date: 18/4/24

ANNEXURE-III

PLAGIARISM CHECK REPORT

Scientific Correspondence and Review Committee

KLE VK Institute of Dental Sciences
A Constituent Unit of KLE Academy of Higher Education and Research
(Deemed-to-be-University u/s 3 of the UGC Act, 1956)
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Date : 17/04/2024 Serial No. : 181

PLAGIARISM CHECK REPORT

Name of the Applicant :
UG / PG / Ph.D / Staff : Post Graduate Student
Batch & Year : 2021 - 2024
Department : Oral and Maxillofacial Surgery

The soft copy of Research Work / Manuscript by ..... entitled "Assessment of neurosensory disturbance of infraorbital nerve following surgical and conservative management of isolated Zygomaticomaxillary complex fracture. A prospective study" under the guidance of .....has been submitted for Anti-Plagiarism check to the Scientific Correspondence & Review Committee of KLE VK Institute of Dental Sciences using "Turn-it-in" software.

The scan has been carried out and the scanned output reveals a Similarity Index of ..... 5 %, which is **within / not within** the acceptable limits of 10% as per the UGC guidelines.

17/04/2024

Member Secretary
Scientific Correspondence and Review Committee
KLEVK Institute of Dental Sciences
KAHER-Belagavi

Chairman
Scientific Correspondence and Review Committee
KLEVK Institute of Dental Sciences
KAHER - Belagavi

ANNEXURE-IV PATIENT CONSENT FORM

K.L.E.'s V.K. Institute of Dental Sciences

Department of Oral and Maxillofacial Surgery, Belgaum

CONSENT TO SURGERY & ANAESTHETICS

Date: Time:

a.m./ p.m.

1. I,_____aged__years have been informed about my involvement in the study
2. I agree to give my personal details like name, age, sex, address, history of treatment taken and any other details required for the study to the best of my knowledge.
3. I will cooperate with the surgeon for examination and also for various investigations.
4. I permit the surgeon to utilize the information given by me and the results obtained from this study for presentation and publication.
5. I permit the surgeon to take my photographs to utilize it for the study and presentation purpose.
6. I am participating in this study with my own wish and will and the surgeon has explained the nature of the assessments that will be performed on me.
7. The nature and purpose of the management, surgical or conservative, use of general anesthesia, antibiotic therapy, possible alternative methods of treatment, the risk involved and the possibility of complications have been fully explained to me in my vernacular tongue. No guarantee or assurance has been given by anyone as to the results that may be obtained.
8. I have read and understood the above information given by surgeon about the study and willingly agree to participate in the study and willingly agree to come for follow up on the 10^{th} day, 1 month, and 6 weeks.

Name: Date:

Signature: Mob. No:

Name of the Doctor: Dr.

Doctor's contact:

Hospital contact:

ANNEXURE-V - PATIENT INFORMATION SHEET

KLE Vishwanath Katti Institute of Dental Sciences, Belagavi

Department of Oral and Maxillofacial Surgery

"Assessment Of Neurosensory Disturbances Of Infraorbital Nerve Following Surgical And Conservative Management Of Isolated Zygomaticomaxillary Complex Fractures: A Prospective Study"

Dear Patient,

You are invited to take part in a research study related to assessment of recovery of infraorbital nerve deficit following management of zygomaticomaxillary complex fractures. I would like to interview you to ask you about the symptoms of the condition and also perform the evaluation procedure on you. This research is a part of a MDS, main dissertation at KLE Academy of Higher Education and Research.

Before you decide whether to take part in the study it is important that you understand what the research is for and what you will be asked to do. Please take time to read the following information and discuss it with others if you wish. It is up to you to decide whether or not to take part in this study. If you decide to take part you will be given this information sheet to keep. You will be also asked to sign a consent form. You can change your mind at any time and withdraw from the study without giving any reason. The standard of care you receive will not change whether or not you decide to participate in this study. You are welcome to contact me (@7977553007) if you would like any further information.

The purpose of this research study is to evaluate and compare the recovery of infraorbital nerve deficit following surgical or conservative management of Zygomaticomaxillary complex fracture.

You have been chosen because you have been diagnosed with unilateral zygomaticomaxillary complex fracture with damage in infraorbital nerve. The study will involve 60 participants who will be examined and be given appropriate management for the zygomaticomaxillary complex fracture. During this procedure participants will undergo four neurosensory evaluations, to assess the sensitivity of infraorbital nerve. You will be asked to report for a review and follow-up visit on Day 10, and 1month and 6 weeks after the procedure.

The information gained from this research will be used to publish in scientific platforms/ journals without revealing your identity to make recommendations for the best practice and the results of the study may also lead onto further studies into infraorbital nerve damage and its management in ZMC fracture cases.

I, _____, age _____ years, have been explained the details of the study undertaken. I am fully satisfied with the procedure and instructions given by Dr._____ and hereby give my permission to participate in this study.

Place: Signature of participant:

Contact no: Date:

ANNEXURE-VI - PATIENT INFORMATION PORFORMA

NAME: **AGE:**

SEX:

OCCUPATION: **O.P.NO.:**

ADDRESS: **DATE:**

CONTACT NO:

CHIEF COMPLAINT:

HISTORY OF PRESENTING ILLNESS:

PAST DENTAL HISTORY:

PAST MEDICAL HISTORY:

DRUG ALLERGY:

PERSONAL HISTORY: Smoking/ Alcohol/ Tobacco chewing

GENERAL EXAMINATION:

- **General condition**
- **Vitals**
- **Glassgow Coma Scale**

EYE EXAMINATION:

- **Pupils**
- **Vision**
- **Range of eye movement**

ORAL AND MAXILLOFACIAL EXAMINATION

- Extra oral examination:
    - On Inspection
    - On Palpation
        - Compression test
        - TMJ examination
        - Infraorbital nerve examination
- Intraoral examination
    - On inspection:
        - Mouth Opening
        - Occlusion
        - Soft tissue injury
    - On palpation
        - Zygomaticomaxillary buttress
        - Inferior border of mandible
        - Dentoalveolar segmental mobility

PROVISIONAL DIAGNOSIS:

INVESTIGATIONS:

- **CT SCAN**
- **PA MANDIBLE**
- **PARANASAL SINUS VIEW**
- **SUBMENTOVERTEX VIEW**
- **B/L NASAL**

RADIOGRAPH AND CLINICAL CORRELATION:

FINAL DIAGNOSIS:

TREATMENT PLAN

INFRAORBITAL NERVE EVALUATION

Brush Stroke Test

Did the patient correctly identify the direction of the brush stroke?

	Yes	No
Affected side		
Non-Affected side		

Semmes- Weinstein Test

Wt	0.07gm	0.4gm	2.0gm	4.0gm	300gm
Affected side					
Non- Affected side					

- **Numeric pain scale (1-10)**
    - Affected side:
    - Non- Affected side: