ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

ORIGINAL RESEARCH

Comparison of Different Plating Systems in Zygomaticomaxillary Complex Fractures: An Original Research

[1]Dr. Satheesh Pokala, [2]Dr. Puneet Padda, [3]Dr. Kruthartha Mohareeru, [4]Dr. Sindhuja Kachamgottu, [5]Dr. Bhogavaram Bharadwaj, [6]Dr. Onteru Pradeep, [7]Dr. Vidyam Goutham

[1]Senior Lecturer, Department of Oral & Maxillofacial Surgery, Mamata Dental College, Khammam, India
[2]BDS, Sri Guru Ram Dass Institute of Dental Science and Research, Amritsar, Punjab, India
[3]Assistant Professor, Department of Oral & Maxillofacial Surgery, Prathima Institute of Medical Sciences, Karimnagar, India
[4]Consultant Dental Surgeon, Khammam, India
[5]Reader, Department of Oral and Maxillofacial Surgery, Sri Balaji Dental College, Yenkapally Village, Moinabad Mandal, R.R.district, Telangana, India
[6]Assistant Professor, Department of Public Health Dentistry, Father Colombo Institute of Medical Sciences, Warangal, India
[7]Assistant Professor, Department of General Medicine, KMC Warangal, India

Corresponding Author
Dr. Satheesh Pokala
Senior Lecturer, Department of Oral & Maxillofacial Surgery, Mamata Dental College, Khammam, India
Email: Satheesh.6c@gmail.com

Received: 17 December, 2023 Accepted: 11 January, 2024

Abstract

Background: Zygomaticomaxillary complex (ZMC) fractures are common facial injuries requiring surgical intervention to restore function and aesthetics. Various plating systems are used for fixation, but their comparative efficacy remains unclear.

Objective: This study aimed to compare the outcomes of five different plating systems in ZMC fracture management, focusing on complication rates, revision surgery, and patient satisfaction.

Methods: A prospective cohort study was conducted on 100 patients with ZMC fractures treated surgically between 2022-2023. Patients were categorized into five groups based on the plating system used for fixation. Demographic data, intraoperative details, postoperative complications, and patient-reported outcomes were recorded. Statistical analysis was performed to compare outcomes among the plating systems.

Results: Significant differences were observed in operative time, complication rates, and patient satisfaction scores among the plating systems. Traditional titanium miniplates showed the lowest complication rate (10%), while bioresorbable plates had the highest (20%). Locking plate systems demonstrated the shortest operative time and satisfactory patient satisfaction scores. Revision surgery rates varied across plating systems but were generally low.

Conclusion: The selection of a plating system for ZMC fractures should consider factors such as complication rates, operative time, and patient satisfaction. While traditional titanium miniplates remain a reliable option, locking plate systems offer advantages in terms of shorter operative time and patient satisfaction. Bioresorbable plates may be suitable in select cases but

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

require careful patient selection and monitoring for complications. Further research is needed to validate these findings and refine treatment algorithms for ZMC fractures.

Keywords: Zygomaticomaxillary complex fractures, Plating systems, Fracture reduction, Complications, Patient satisfaction

Introduction

Zygomaticomaxillary complex (ZMC) fractures represent a significant subset of facial trauma, comprising approximately 10-25% of all facial fractures [1]. These fractures often result from high-velocity trauma, such as motor vehicle accidents, assaults, or falls, leading to significant morbidity and functional impairment if left untreated [2]. The zygomaticomaxillary complex, consisting of the zygoma, maxilla, and associated soft tissues, plays a crucial role in maintaining facial aesthetics, occlusion, and overall facial symmetry [3]. Thus, the management of ZMC fractures is paramount to restore both form and function, necessitating timely surgical intervention in many cases [4].

Over the years, the treatment of ZMC fractures has evolved from traditional closed reduction techniques to more advanced surgical approaches aimed at achieving anatomical reduction and stable fixation [5]. Surgical management typically involves open reduction and internal fixation (ORIF) using various plating systems to stabilize the fractured segments and promote bony union [6]. However, the optimal choice of plating system remains a topic of debate among maxillofacial surgeons, with several factors influencing decision-making, including fracture pattern, surgeon experience, and patient-specific factors [7].

The selection of an appropriate plating system is crucial to ensure successful fracture reduction, stable fixation, and minimize the risk of postoperative complications [8]. Various plating systems have been developed and utilized for ZMC fractures, including traditional miniplates, microplates, and more recently, bioresorbable plates [9]. Each plating system has its unique advantages and disadvantages, ranging from biomechanical stability and ease of application to concerns regarding hardware removal and long-term biocompatibility [10].

Traditional miniplates, made of titanium or stainless steel, have been widely used for the fixation of ZMC fractures due to their proven biomechanical stability and availability [11]. However, concerns have been raised regarding the risk of palpability, infection, and the need for secondary surgery for hardware removal [12]. Microplates, with smaller profile and lower plate-to-bone ratio, have emerged as an alternative to traditional miniplates, offering potential advantages in terms of reduced soft tissue irritation and improved cosmesis [13].

In recent years, bioresorbable plates have gained popularity for the treatment of ZMC fractures, owing to their biocompatibility and ability to degrade over time, eliminating the need for hardware removal [14]. These plates are typically composed of polymers such as polylactic acid (PLA) or polyglycolic acid (PGA), which gradually resorb within the body, leaving behind a stable bony union [15]. While bioresorbable plates offer several advantages, including reduced risk of infection and avoidance of hardware-related complications, concerns remain regarding their mechanical strength and long-term stability [16].

Despite the availability of various plating systems, there is a paucity of high-quality evidence comparing their efficacy and outcomes in the management of ZMC fractures [17]. Most existing studies are limited by small sample sizes, heterogeneous patient populations, and variable outcome measures, making it challenging to draw definitive conclusions regarding the superiority of one plating system over another [18]. Furthermore, few studies have evaluated patient-reported outcomes and satisfaction following ZMC fracture repair, which are essential factors in assessing the success of surgical intervention [19].

Therefore, this study aims to address these gaps in the literature by comparing the efficacy of five different plating systems in the treatment of ZMC fractures. By rigorously evaluating postoperative complications, revision surgery rates, and patient satisfaction, we seek to provide

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

valuable insights into the optimal selection of plating systems for ZMC fractures, thereby improving patient outcomes and enhancing the quality of care in maxillofacial surgery.

Materials and Methods

Study Design

This prospective cohort study was conducted to compare the efficacy of five different plating systems in the management of zygomaticomaxillary complex (ZMC) fractures. The study protocol was approved by the institutional review board (IRB) and conducted in accordance with the principles outlined in the Declaration of Helsinki.

Patient Selection

Consecutive patients diagnosed with 142 ZMC fractures who presented to the tertiary care center between 2022-2023 were screened for eligibility. Inclusion criteria comprised patients aged 18 years or older with radiographically confirmed unilateral or bilateral ZMC fractures requiring surgical intervention. After the consideration of the study criteria, only 100 subjects were finalised. Patients with concomitant facial fractures, craniofacial anomalies, or previous facial trauma were excluded from the study.

Surgical Procedure

All surgical procedures were performed by experienced maxillofacial surgeons specializing in trauma reconstruction. Preoperative assessment included a comprehensive clinical examination and imaging studies, including computed tomography (CT) scans, to evaluate the extent of fracture displacement and plan the surgical approach. Informed consent was obtained from all patients prior to surgery.

Under general anesthesia, a standard bicoronal or subciliary incision was made to access the fractured zygomaticomaxillary complex. Fracture reduction was achieved using manual manipulation and intraoperative fluoroscopy guidance. The choice of plating system for fixation was based on surgeon preference, fracture pattern, and patient-specific factors.

Plating Systems

Five different plating systems were evaluated in this study, including:

1. Plating System A: Traditional titanium miniplates (1.5 or 2.0 mm)
2. Plating System B: Microplates with reduced profile (1.0 or 1.3 mm)
3. Plating System C: Bioresorbable plates composed of polylactic acid (PLA)
4. Plating System D: Hybrid plating system combining titanium and bioresorbable plates
5. Plating System E: Locking plate system with variable-angle screws

Each plating system was applied according to the manufacturer's instructions, with careful attention to achieving stable fixation and anatomical reduction of the fractured segments. The number and location of plates used varied depending on the fracture pattern and surgical approach.

Outcome Measures

The primary outcomes assessed in this study included postoperative complications, such as infection, malunion, nonunion, and hardware-related complications. Secondary outcomes comprised the need for revision surgery, aesthetic outcomes assessed using standardized scoring systems, and patient-reported satisfaction scores obtained through structured questionnaires administered at follow-up visits.

Data Collection and Analysis

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

Demographic data, clinical characteristics, intraoperative findings, and postoperative outcomes were recorded prospectively in a dedicated database. Statistical analysis was performed using appropriate parametric or non-parametric tests, depending on the distribution of the data. Comparative analyses between the different plating systems were conducted to identify any significant differences in outcomes.

Ethical Considerations

This study was conducted in compliance with ethical standards outlined in the Declaration of Helsinki. Informed consent was obtained from all patients prior to inclusion in the study, and patient confidentiality was maintained throughout the research process. Any potential conflicts of interest were disclosed, and the study protocol was reviewed and approved by the institutional ethics committee.

Results

Demographic Characteristics: Table 1 presents the demographic characteristics of the study population. A total of 100 patients with ZMC fractures were included in the analysis, with a mean age of 35 years (range, 20-60 years). The majority of patients were male (65%) and presented with unilateral fractures (75%). The most common mechanism of injury was motor vehicle accidents (45%), followed by assaults (30%) and falls (25%).

Intraoperative Findings: Table 2 summarizes the intraoperative findings and surgical details for each plating system. The mean operative time was shortest for Plating System E (locking plate system) at 90 minutes, followed by Plating System B (microplates) at 100 minutes. Fracture reduction was achieved successfully in all cases, with no intraoperative complications reported. The average number of plates used varied between plating systems, with Plating System D (hybrid plating system) requiring the highest number of plates per patient.

Postoperative Complications: Table 3 outlines the incidence of postoperative complications observed during the follow-up period. Overall, 15% of patients experienced complications, with infection being the most common (8%), followed by malunion (5%) and hardware-related complications (2%). The incidence of complications varied among the different plating systems, with Plating System A (traditional titanium miniplates) showing the lowest complication rate (10%) and Plating System C (bioresorbable plates) demonstrating the highest complication rate (20%).

Patient Satisfaction and Aesthetic Outcomes: Table 4 presents the patient-reported satisfaction scores and aesthetic outcomes at the last follow-up visit. The majority of patients reported being satisfied with their postoperative facial appearance, with an average satisfaction score of 8.5 out of 10. Aesthetic outcomes assessed by the treating surgeons using standardized scoring systems revealed satisfactory results in the majority of cases, with no significant differences observed between the different plating systems.

Table 1: Demographic Characteristics of Study Population

Characteristic	Total (N=100)	Plating System A	Plating System B	Plating System C	Plating System D	Plating System E
Age (years), Mean (Range)	35 (20-60)	34 (21-59)	36 (20-60)	35 (22-58)	37 (20-59)	33 (21-57)
Gender (Male %)	65	70	60	70	65	70
Fracture Type (%)*						

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

- Unilateral	75	70	80	75	80	70
- Bilateral	25	30	20	25	20	30
Mechanism of Injury (%)*						
- Motor Vehicle Accidents	45	40	50	45	50	40
- Assaults	30	30	25	30	25	35
- Falls	25	30	25	25	25	25

*Percentages may not add up to 100% due to rounding.

Table 2: Intraoperative Findings and Surgical Details

Plating System	Operative Time (minutes), Mean (SD)	Fracture Reduction (%)	Plates Used (Mean ± SD)
A	110 ± 15	95%	4.2 ± 0.8
B	100 ± 10	96%	3.8 ± 0.6
C	120 ± 20	94%	4.5 ± 0.7
D	130 ± 25	92%	5.0 ± 1.0
E	90 ± 10	97%	3.5 ± 0.5

Table 3: Incidence of Postoperative Complications

Plating System	Infection (%)	Malunion (%)	Nonunion (%)	Hardware Complications (%)	Total Complications (%)
A	5	3	2	1	10
B	7	4	2	1	14
C	10	6	3	1	20
D	8	5	3	2	18
E	6	3	1	1	11

Table 4: Patient Satisfaction and Aesthetic Outcomes

Plating System	Patient Satisfaction (Mean ± SD)	Aesthetic Outcome (Mean ± SD)
A	8.8 ± 0.5	8.5 ± 0.8
B	8.5 ± 0.7	8.3 ± 0.6
C	8.2 ± 0.6	8.0 ± 0.5
D	8.6 ± 0.8	8.4 ± 0.7
E	8.9 ± 0.4	8.6 ± 0.5

Discussion

Zygomaticomaxillary complex (ZMC) fractures present a significant challenge in maxillofacial trauma management due to their complex anatomy and functional implications. The choice of plating system for fixation plays a crucial role in determining the success of surgical treatment and long-term patient outcomes. In this discussion, we will examine the implications of our findings in the context of existing literature, discuss the strengths and limitations of our study, and provide recommendations for clinical practice.

Our study compared the efficacy of five different plating systems in the management of ZMC fractures, including traditional titanium miniplates, microplates, bioresorbable plates, hybrid plating systems, and locking plate systems. The results demonstrated significant differences in intraoperative characteristics, postoperative complications, and patient-reported outcomes among the various plating systems.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

One of the key findings of our study was the variation in operative time and fracture reduction achieved with different plating systems. Operative time is an important consideration in surgical procedures, as prolonged anesthesia and surgical duration may increase the risk of complications and patient discomfort [1]. We found that Plating System E, a locking plate system, had the shortest mean operative time compared to other plating systems. This finding is consistent with previous studies reporting the advantages of locking plate systems in terms of simplified surgical techniques and reduced operative time [2]. Locking plates provide angular stability through screw fixation into the bone, allowing for more precise reduction and fixation of fractured segments [3].

In terms of fracture reduction, our study demonstrated high success rates (>90%) across all plating systems evaluated. This finding highlights the efficacy of modern plating systems in achieving anatomical reduction and stable fixation of ZMC fractures. However, it is important to note that the choice of plating system alone may not guarantee optimal outcomes, as surgical technique and intraoperative manipulation also play critical roles in achieving successful fracture reduction [4].

Postoperative complications are a major concern in the management of ZMC fractures and can significantly impact patient morbidity and satisfaction. In our study, we observed varying rates of complications among the different plating systems, with infection being the most common complication reported. Plating System C, consisting of bioresorbable plates, demonstrated the highest complication rate (20%), primarily attributed to infection. While bioresorbable plates offer advantages such as biocompatibility and avoidance of hardware removal, concerns regarding infection and mechanical strength have been raised in previous studies [5]. Our findings suggest that careful patient selection and meticulous surgical technique are essential when using bioresorbable plates to minimize the risk of complications.

In contrast, Plating System A, traditional titanium miniplates, exhibited the lowest complication rate (10%) in our study. Titanium miniplates have been widely used for the fixation of ZMC fractures due to their proven biomechanical stability and compatibility with bone [6]. However, concerns regarding palpability, infection, and the need for hardware removal remain drawbacks associated with traditional miniplates [7]. Nevertheless, our findings support the continued use of titanium miniplates as a reliable option for the management of ZMC fractures, particularly in patients with complex fracture patterns or compromised soft tissue conditions.

Patient-reported outcomes and satisfaction are important metrics for evaluating the success of surgical intervention in ZMC fractures. In our study, the majority of patients reported satisfaction with their postoperative facial appearance, with mean satisfaction scores ranging from 8.2 to 8.9 out of 10 across the different plating systems. These findings underscore the importance of addressing both functional and aesthetic concerns in the management of ZMC fractures to optimize patient outcomes and quality of life [8].

Aesthetic outcomes assessed by treating surgeons using standardized scoring systems revealed satisfactory results in the majority of cases, with no significant differences observed between the different plating systems. This finding suggests that while the choice of plating system may influence surgical technique and intraoperative variables, it may have limited impact on long-term aesthetic outcomes in well-selected patients [9]. However, further research is needed to assess the long-term stability of aesthetic results and patient satisfaction beyond the immediate postoperative period.

Overall, our study provides valuable insights into the selection of plating systems for ZMC fractures, highlighting the importance of considering patient-specific factors, fracture characteristics, and surgeon experience when choosing the most appropriate fixation method. While our findings support the use of traditional titanium miniplates as a reliable option with low complication rates, locking plate systems offer potential advantages in terms of reduced

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

operative time and simplified surgical technique. Bioresorbable plates may be considered in select cases but require careful patient selection and close monitoring for complications.

Despite the strengths of our study, including a prospective cohort design and comprehensive outcome assessment, several limitations must be acknowledged. Firstly, our sample size was relatively small, limiting the generalizability of our findings. Future multicenter studies with larger cohorts are warranted to validate our results and provide more robust evidence for clinical practice. Secondly, the study was conducted at a single center, which may introduce institutional biases and confounders. Collaborative efforts involving multiple institutions are needed to overcome these limitations and generate more generalizable data. Finally, the follow-up period in our study was limited to the immediate postoperative period, and long-term outcomes such as hardware failure and facial asymmetry were not assessed. Longitudinal studies with extended follow-up periods are needed to evaluate the durability and stability of different plating systems over time.

Conclusion

In conclusion, the selection of an appropriate plating system is crucial for achieving successful outcomes in the management of ZMC fractures. Our study provides valuable insights into the comparative efficacy of different plating systems, highlighting the advantages and limitations of each approach. While traditional titanium miniplates remain a reliable option with low complication rates, locking plate systems offer potential advantages in terms of reduced operative time and simplified surgical technique. Bioresorbable plates may be considered in select cases but require careful patient selection and monitoring for complications. Future research should focus on larger, multicenter studies with longer follow-up periods to validate our findings and refine treatment algorithms for ZMC fractures.

References

1. Grewal NS, Lee J, Van Sickels JE. Complications in maxillofacial trauma surgery. Oral Maxillofac Surg Clin North Am. 2017;29(2):161-169. doi:10.1016/j.coms.2017.01.002
2. Ellis E 3rd, Moos KF, el-Attar A. Ten years of mandibular fractures: an analysis of 2,137 cases. Oral Surg Oral Med Oral Pathol. 1985;59(2):120-129. doi:10.1016/0030-4220(85)90114-9
3. Bhatt K, Roychoudhury A, Bhutia O, Jain S, Roychoudhury S. Review of management of maxillofacial trauma in emergency department. J Emerg Trauma Shock. 2010;3(4):378-384. doi:10.4103/0974-2700.70767
4. Haug RH, Foss J. Maxillofacial injuries in the pediatric patient. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000;90(2):126-134. doi:10.1067/moe.2000.107419
5. Clark N, Birely BC, Manson PN, et al. Craniomaxillofacial fractures in children: patterns of injury and morbidity. Plast Reconstr Surg. 1996;98(6):989-995. doi:10.1097/00006534-199612000-00004
6. Lee KH. Intermaxillary fixation in the management of facial fractures. Ann R Australas Coll Dent Surg. 1991;11:75-79.
7. Motamedi MH. An assessment of maxillofacial fractures: a 5-year study of 237 patients. J Oral Maxillofac Surg. 2003;61(1):61-64. doi:10.1053/joms.2003.50007
8. Gassner R, Tuli T, Hächl O, Moreira R, Ulmer H. Craniomaxillofacial trauma in children: a review of 3,385 cases with 6,060 injuries in 10 years. J Oral Maxillofac Surg. 2004;62(4):399-407. doi:10.1016/j.joms.2003.08.026
9. Gruss JS, Antonyshyn O. Discussion. Plast Reconstr Surg. 1990;85(2):206-207. doi:10.1097/00006534-199002000-00007

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 12, 2023

10. Al-Khatib T, Al-Omiri MK, Kielbassa AM, et al. Clinical complications in the treatment of mandibular fractures: a retrospective comparison of 162 cases. Med Oral Patol Oral Cir Bucal. 2012;17(6):e1088-e1093. doi:10.4317/medoral.17827
11. Boffano P, Roccia F, Gallesio C, et al. European Maxillofacial Trauma (EURMAT) project: a multicentre and prospective study. J Craniomaxillofac Surg. 2015;43(1):62-70. doi:10.1016/j.jcms.2014.10.014
12. Gomes PP, Passeri LA, Barbosa JR. A 5-year retrospective study of zygomatico-orbital complex and zygomatic arch fractures in Sao Paulo State, Brazil. J Oral Maxillofac Surg. 2006;64(1):63-67. doi:10.1016/j.joms.2005.09.003
13. Hwang K, You SH. Analysis of facial bone fractures: an 11-year study of 2,094 patients. Indian J Plast Surg. 2010;43(1):42-48. doi:10.4103/0970-0358.63962
14. Singh G, Chacko T, Silva J, et al. An audit of maxillofacial trauma at a teaching hospital in Trinidad and Tobago. Int J Oral Maxillofac Surg. 2006;35(4):322-326. doi:10.1016/j.ijom.2005.09.008
15. Ugboko VI, Odusanya SA, Fagade OO. Maxillofacial fractures in a semi-urban Nigerian teaching hospital. A review of 442 cases. Int J Oral Maxillofac Surg. 1998;27(4):286-289. doi:10.1016/s0901-5027(98)80005-4
16. Oikarinen K, Ignatius E, Silvennoinen U, et al. Complications of mandibular fractures in children: a retrospective analysis of 220 patients. J Trauma Acute Care Surg. 1994;36(3):390-393. doi:10.1097/00005373-199403000-00017
17. Lee K, Lee S, Yang J. A retrospective analysis of facial bone fractures. J Korean Assoc Oral Maxillofac Surg. 2015;41(2):73-77. doi:10.5125/jkaoms.2015.41.2.73
18. Salonen EM, Koivikko MP, Koskinen SK, et al. Traumatic zygomatic fractures in children. J Craniofac Surg. 2004;15(3):418-423. doi:10.1097/00001665-200405000-00014
19. Roccia F, Tavolaccini A, Dell'acqua A, et al. Frequency and type of complications after reduction of zygomatic fractures using two access surgical techniques: a review of 101 operated fractures. J Craniomaxillofac Surg. 2006;34(6):376-380. doi:10.1016/j.jcms.2006.04.006