นิพนธ์ต้นฉบับ Original Article

การศึกษาเปรียบเทียบย้อนหลังระหว่างการรักษาด้วยวิธีเปิดแผลเพื่อจัดกระดูกและยึดด้วยโลหะดามกระดูกกับการรักษาด้วยวิธีเปิดแผลเพื่อจัดกระดูกเพียงอย่างเดียว ในผู้ป่วยกระดูกโหนกแก้ม–ขากรรไกรบนแตก ณ โรงพยาบาลสกลนคร

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บทคัดย่อ

การวิจัยครั้งนี้เป็นการศึกษาย้อนหลัง โดยมีวัตถุประสงค์เพื่อประเมินผลการรักษาทางคลินิก ภาวะแทรกซ้อน และความคุ้มค่าทางเศรษฐกิจของการผ่าตัดเปิดและยึดแน่น (ORIF) เมื่อเปรียบเทียบกับการรักษาแบบเปิดในการจัดการกระดูกโหนกแก้ม–ขากรรไกรบนเชื่อมกัน (ZMC) โดยทบทวนรายงานทางการแพทย์และภาพถ่าย CT 3 มิติของผู้ป่วยจำนวน 210 ราย ที่มีกระดูกโหนกแก้ม–ขากรรไกรบนเชื่อมกันทางด้านเดียวที่ได้รับการรักษาที่โรงพยาบาลสกลนคร ตั้งแต่เดือนมิถุนายน 2561 ถึงมิถุนายน 2566 แบ่งผู้ป่วยเป็น 3 กลุ่ม ดังนี้ กลุ่มที่ 1 รักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดเพียงอย่างเดียว กลุ่มที่ 2 รักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดร่วมกับ ORIF สองจุด และกลุ่มที่ 3 รักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดร่วมกับ ORIF สามจุด ผลลัพธ์ที่ประเมินได้แก่ ความสูงของกระดูกแก้ม (malar height) ความเบี่ยงเบนในแนวดิ่ง (vertical dystopia) ความมั่นคงของกระดูก และภาวะแทรกซ้อนหลังการผ่าตัด

ผลการศึกษาพบว่า ความสูงของกระดูกแก้มสูงกว่าอย่างมีนัยสำคัญในกลุ่มที่ได้รับ ORIF สองจุดและสามจุด เมื่อเปรียบเทียบกับกลุ่มที่รักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดเพียงอย่างเดียว ที่ติดตามผลในสัปดาห์ที่ 6 ($p < 0.04$) ความเบี่ยงเบนในแนวดิ่งต่ำกว่าอย่างมีนัยสำคัญในกลุ่ม ORIF เมื่อเทียบกับกลุ่มที่รักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดเพียงอย่างเดียว ที่ติดตามผลในสัปดาห์ที่ 6 ($p < 0.001$) สัดส่วนของความมั่นคงของกระดูกสูงกว่าในกลุ่ม ORIF สองจุดและสามจุด เมื่อเปรียบเทียบกับกลุ่มที่รักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดเพียงอย่างเดียว ระยะเวลาในการผ่าตัดยาวนานขึ้นสำหรับเทคนิค ORIF สามจุด เทคนิค ORIF โดยเฉพาะการยึดแน่นสามจุดแสดงผลลัพธ์ที่ดีกว่าในการคืนสภาพความสูงของกระดูกแก้ม ลดความเบี่ยงเบนในแนวดิ่ง และบรรลุความมั่นคงของกระดูกที่ดีกว่าการรักษาด้วยการผ่าตัดจัดกระดูกแบบเปิดเพียงอย่างเดียว อย่างไรก็ตาม ระยะเวลาในการผ่าตัดที่ยาวนานขึ้นของเทคนิค ORIF สามจุดควรได้รับการพิจารณา ผลการศึกษานี้สามารถช่วยแพทย์ในการเลือกวิธีการรักษาที่เหมาะสมสำหรับกระดูกโหนกแก้ม–ขากรรไกรบนเชื่อมกัน (ZMC) โดยพิจารณาจากลักษณะของกระดูกหักและความต้องการของผู้ป่วย

คำสำคัญ: กระดูกโหนกแก้ม–ขากรรไกรหัก การยึดตรึงกระดูกแบบสามจุดตามแนวทางดั้งเดิม ระดับความสูงของกระดูกโหนกแก้ม ภาวะตาเอียงในแนวดิ่ง

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A Retrospective Comparative Study of Open Reduction and Internal Fixation (ORIF) versus Open Reduction in Zygomaticomaxillary Complex (ZMC) Fractures at Sakon Nakhon Hospital

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Abstract

This retrospective comparative study was conducted to evaluate clinical outcomes, postoperative complications, and cost–effectiveness of open reduction and internal fixation (ORIF) versus open reduction alone in the management of zygomaticomaxillary complex (ZMC) fractures. The comprehensive review of medical records and three–dimensional computed tomography imaging of 210 patients with unilateral ZMC fractures who underwent surgical treatment at Sakon Nakhon Hospital from June 2018 to June 2023 were performed. The patients were stratified into three distinct therapeutic groups: Group 1 underwent open reduction alone, Group 2 received open reduction with two–point ORIF, and Group 3 was treated with open reduction combined with three–point ORIF. Primary outcome measures included malar height restoration, vertical dystopia correction, osseous stability, and postoperative complications.

The results showed significantly superior malar height restoration in patients treated with two–point and three–point ORIF compared to those managed with open reduction alone at the 6–week follow–up assessment ($p < 0.04$). Vertical dystopia was significantly lower in both ORIF cohorts relative to the open reduction monotherapy group at the 6–week postoperative evaluation ($p < 0.001$). Osseous stability proportions were markedly higher in the two–point and three–point ORIF groups compared to the open reduction alone cohort. Operative duration was prolonged for the three–point ORIF technique. The three–point ORIF technique demonstrated superior therapeutic efficacy in achieving anatomical malar height restoration, minimizing vertical dystopia, and establishing robust osseous stability compared to open reduction monotherapy. However, the extended operative time associated with three–point ORIF warrants careful consideration in surgical planning and patient selection. These findings provide evidence–based guidance for clinicians in optimizing treatment algorithms for ZMC fractures, enabling individualized therapeutic decision–making based on fracture morphology, patient comorbidities, and functional requirements.

Keywords: ZMC fracture, Traditional three–point fixation, Malar height, Vertical dystopia

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Introduction

The incidence of orbitozygomatic complex (OZC) fractures in Southeast Asia varies considerably by country, often correlating with road traffic accidents, particularly those involving motorcycles and unsafe driving practices. OZC fractures account for 5–15% of facial injuries, with prevalence influenced by access to specialized care, resource limitations, and treatment variations throughout the region. Orbitozygomatic complex fractures represent common maxillofacial injuries affecting both function and aesthetics.

Treatment focuses on functional rehabilitation, employing two primary methodologies: Open Reduction and Internal Fixation (ORIF) and Open Reduction alone (The Gillies Temporal Approach). Open Reduction and Internal Fixation (ORIF) involves surgical exposure of the fracture site, anatomical reduction, and stabilization using metallic implants. A comprehensive study by Chen et al.[1,2] demonstrated that ORIF resulted in superior anatomical reduction and functional outcomes in complex orbitozygomatic fractures. Conversely, Open Reduction alone (The Gillies Temporal Approach) involves external manipulation of the fracture without surgical exposure. Research conducted by Kumar et al[3] demonstrated that Open Reduction alone can be efficacious in selected cases, offering reduced operative time and diminished risk of surgical complications.

Ongoing debate persists regarding the comparative effectiveness of Open Reduction with Internal Fixation (ORIF) versus Open Reduction alone in the treatment of orbitozygomatic fractures. The treatment selection is influenced by various factors, including fracture complexity, patient age, and surgeon expertise.

This study aims to compare the outcomes, complications, and cost–effectiveness of both approaches to provide evidence–based data for treatment decisions, ultimately enhancing management strategies and long–term patient outcomes. Hypothesis: ORIF will result in superior bone alignment, improved facial function recovery, and enhanced aesthetic outcomes, leading to increased patient satisfaction and reduced complications compared with Open Reduction alone. A retrospective analysis of OZC fracture treatments comparing ORIF and Open Reduction alone reveals that ORIF may provide superior bone alignment, improved facial function, and enhanced aesthetics, leading to accelerated recovery and increased patient satisfaction[4]. However, ORIF carries inherent surgical risks. In contrast, Open Reduction alone poses fewer surgical risks but may result in delayed healing, incomplete alignment, and potential aesthetic challenges.

Impact on the Healthcare System: ORIF incurs higher costs due to the requirement for surgical intervention, specialized medical teams, and extensive postoperative care. Conversely, Open Reduction alone is less expensive but may necessitate additional treatments or follow–up procedures to address complications. ORIF demands long–term follow–up and specialized resources, increasing the overall burden on the healthcare system, whereas Open Reduction alone requires fewer resources but necessitates careful monitoring to ensure proper healing.

Comparative studies can facilitate evidence–based treatment decisions based on injury severity, patient–specific requirements, and resource availability. The zygomatic, frontal, maxillary, sphenoid, and temporal bones collectively contribute to facial symmetry and orbital stability. Fractures in these anatomical regions affect

alignment, function, and aesthetics. Understanding these anatomical components is essential for evaluating the effectiveness of ORIF versus Open Reduction alone in restoring alignment, facilitating recovery, and preserving aesthetics in OZC fractures.

OZC fractures, caused by high–impact trauma, affect multiple facial bones and can result in deformities, ocular complications, and neurovascular sequelae. Diagnosis encompasses clinical examinations and imaging studies, with CT scans providing detailed bone visualization and MRI for soft tissue assessment. Comparing ORIF and Open Reduction alone facilitates evaluation of their effectiveness in restoring anatomical alignment, functional recovery, and aesthetic outcomes.

OZC injuries affect both function and aesthetics, with two primary treatment approaches: Open Reduction with Internal Fixation (ORIF) and Open Reduction alone. Studies indicate that ORIF achieves a higher success rate (95% versus 80%) but requires an extended recovery period. Additionally, ORIF is associated with reduced complication rates, particularly in complex fractures, and enhanced aesthetic satisfaction. However, no significant differences have been observed in mandibular or ocular function between the two methods. ORIF is approximately 30% more costly and necessitates prolonged hospitalization, though it results in fewer readmissions. It is generally recommended for complex fractures, while Open Reduction alone may be more suitable for elderly or high–risk patients.

Limitations: This study is constrained by limited sample sizes and insufficient long–term follow–up, which may affect the generalizability of the findings.

Ethical Considerations

This study received approval to conduct research from the Sakon Nakhon Hospital Ethics Committee (SKNH REC NO.007/2568, April 25, 2025).

Methods

This retrospective comparative study was conducted at a single tertiary care center to evaluate the outcomes of different surgical approaches in ZMC fractures. The study was conducted at Sakon Nakhon Hospital, Thailand, from June 2018 to June 2023. The study included 210 patients with unilateral zygomaticomaxillary complex (ZMC) tetrapod fractures. Inclusion criteria comprised of patients aged 15 years and above who underwent treatment within two weeks following trauma with complete CT scan documentation. Exclusion criteria included bilateral fractures, comminuted fractures, active infection, diabetes mellitus, uncontrolled hypertension, or incomplete medical records.

The patients were stratified into three distinct therapeutic groups: Group 1 underwent open reduction alone. Group 2 underwent two–point ORIF at the zygomaticomaxillary buttress and infraorbital rim. Group 3 underwent three–point ORIF including the zygomaticofrontal suture. Various surgical approaches (buccogingival, subciliary, eyebrow incisions) and fixation devices (miniplates/microplates) were utilized.

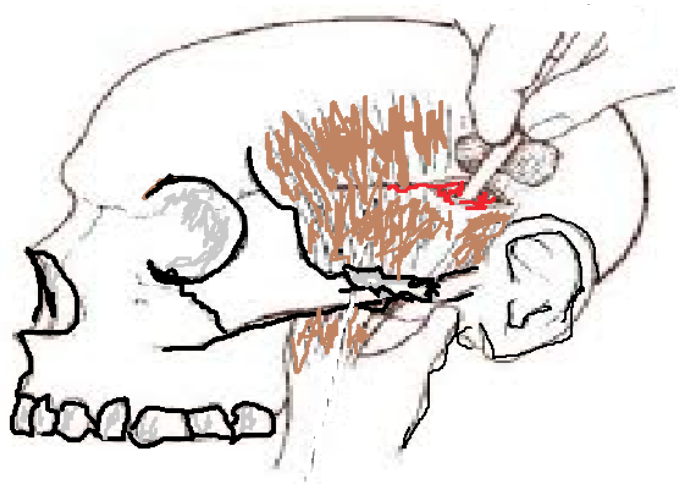
Methods of Reduction

1. The Gillies Temporal Approach

The Gillies Temporal Approach involves creating a 2.5 cm incision in the temporal region of the hair–bearing scalp, oriented at a 45° angle to the zygomatic arch. Fracture manipulation is accomplished by inserting the Rowe zygomatic elevator between the temporalis fascia and the

temporalis muscle, thereby minimizing the risk of further fracture. The Keen's technique involves creating a small 1 cm incision in the mucobuccal fold, immediately inferior to the zygomaticomaxillary buttress of the maxilla. To prevent inadvertent penetration of the temporal fat pad, the elevator is advanced superiorly, maintaining continuous contact with the bone surface posterior to the fracture site. Reduction is achieved by applying lateral and superior forces to the displaced bone fragments; successful reduction may be accompanied by an audible "pop" as anatomical alignment is restored (Figure 1).

Figure 1 The Gillies Temporal Approach



2. Lateral Eyebrow Approach – Dingman Approach

The Dingman approach provides superior exposure for complex zygomatic fractures but requires meticulous technique to prevent complications such as ectropion. This surgical technique serves as an alternative method for treating zygomaticomaxillary complex fractures.

Purpose: To access and repair fractures of the zygomaticomaxillary complex, providing wider surgical exposure compared to the standard lateral eyebrow approach.

Incision: The incision is created along the upper eyelid crease, extending from the medial canthus to beyond the lateral canthus.

Dissection: The surgical dissection proceeds sequentially through the skin, orbicularis oculi muscle, and orbital septum.

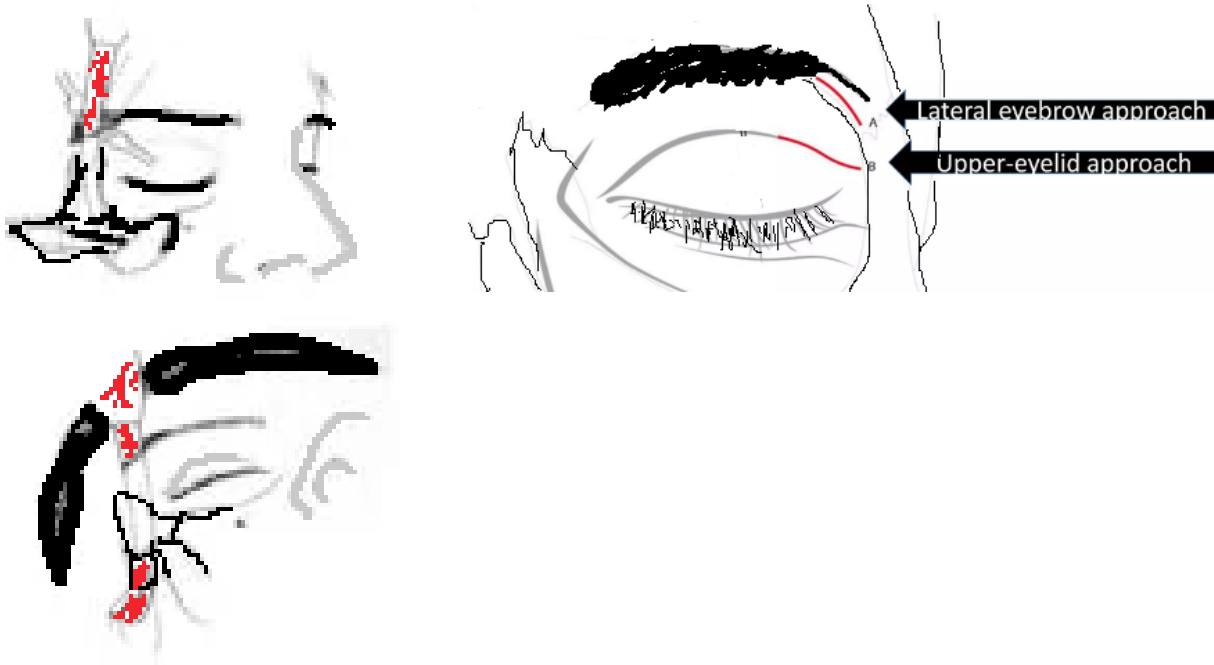
Exposure: This approach provides comprehensive access to the infraorbital rim, lateral orbital rim, and zygomatic arch (Figure 2).

Fracture Reduction: The technique allows for direct visualization and precise manipulation of the zygoma and its anatomical articulations.

Fixation: Titanium plates and screws can be applied at multiple fixation points to achieve stable internal fixation.

Closure: The incision is meticulously closed in anatomical layers, typically resulting in a well–concealed scar within the natural eyelid crease.

Figure 2 Exposure: Provides access to the infraorbital rim, lateral orbital rim, and zygomatic arch.



Methods of Fixation

Various conventional incisions were employed to expose the fracture sites. A lateral eyebrow incision or upper lid blepharoplasty incision was utilized to access the frontozygomatic suture in patients who underwent two–point fixation procedures. The zygomaticomaxillary buttress (ZMB) was exposed through an intraoral buccal sulcus incision. Subciliary incision or transconjunctival approach was employed to achieve optimal exposure of the infraorbital rim in patients who underwent three–point fixations. The frontozygomatic suture (FZS) and the ZMB region were stabilized using 1.5–mm miniplates, while the infraorbital rim was secured using 0.9–mm microplates. Patients who underwent two–point fixation received fixation at the FZS and ZMB regions, whereas patients who underwent three–point fixation received fixation at the ZMB region, infraorbital rim, and FZS (Figure 3).

Figure 3–a

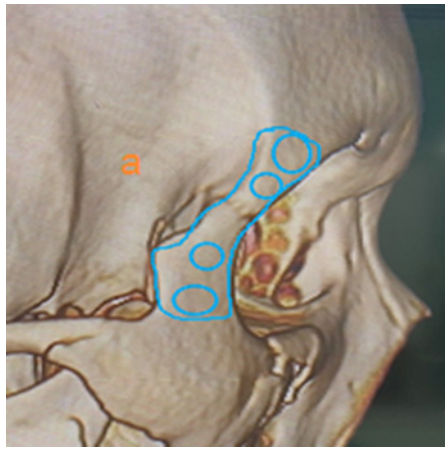
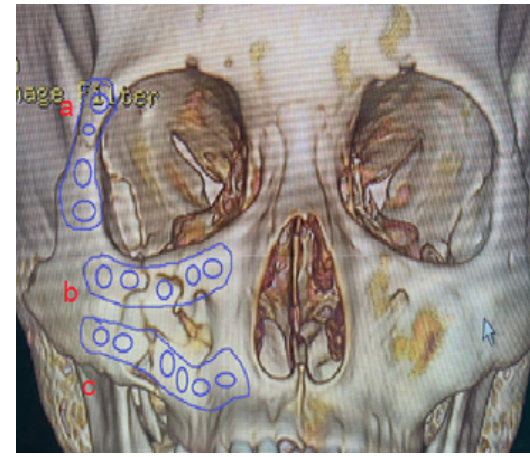


Figure 3–b



Anatomical alignment and fixation

a) Anatomical alignment and fixation with titanium miniplates at the frontozygomatic suture (FZS).

b) Anatomical alignment and fixation with titanium miniplates at the infraorbital rim.

c) Anatomical alignment and fixation with titanium miniplates at the zygomaticomaxillary buttress (ZMB).

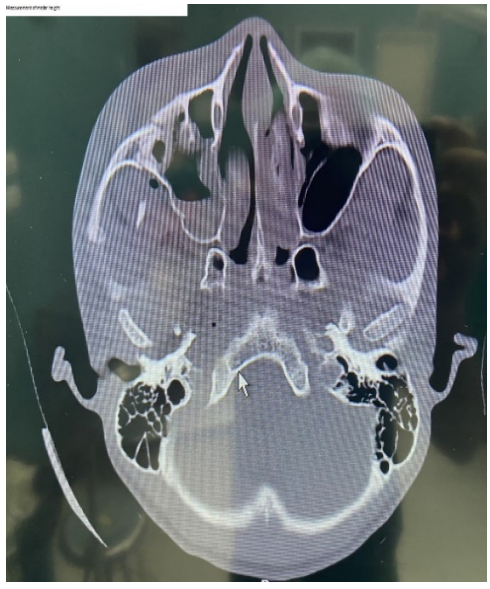
Assessment of Outcomes

All patients underwent comprehensive preoperative examination and radiological investigation utilizing Caldwell's posterior–anterior projection, Waters' lateral projection, and computed tomography (CT) imaging (Figure 4). Prior to surgical intervention, vertex view radiography was employed to measure and compare the malar region of the fractured site with the contralateral unaffected side (Figure 5). Two anatomical reference points were established: the primary point at the intersection of the midsagittal line with the intercanthal line, and a secondary point at the peak height of the malar prominence as visualized on the vertex view projection. The linear distance between these two reference points was measured both preoperatively and postoperatively.

Preoperative and postoperative measurements of the vertical infraorbital rim dimensions were obtained using Waters' projection, along with assessment of any discrepancies in orbital rim levels through palpation and comparative analysis with the contralateral normal side (Figure 6).

Evaluation of malar height and vertical dystopia was conducted for all study participants at the first week and sixth week post–operative follow–up intervals. A comprehensive final assessment was performed at the 3–month follow–up to determine the stability or instability of the reduced and stabilized fractures.

Figure 4 Three–dimensional CT scan



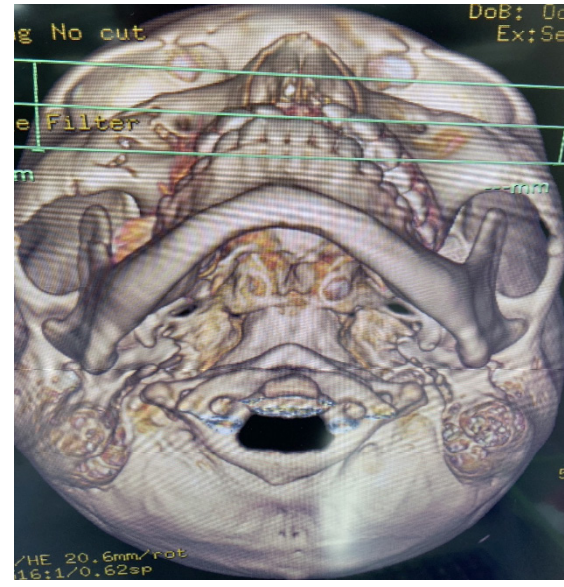
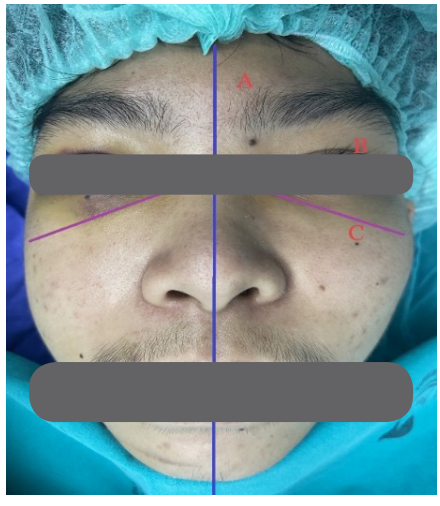
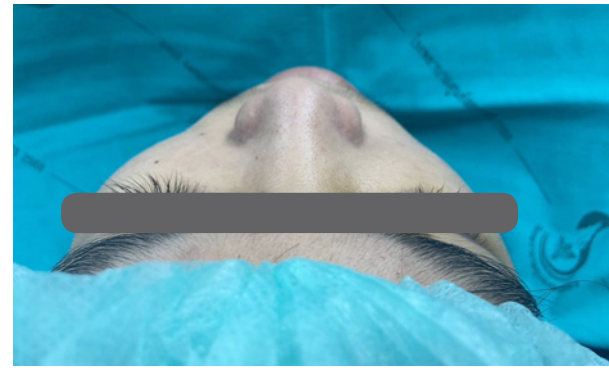


Figure 5 Measurement of malar height



A. Midsagittal line B. Intercanthal line
C. Maximum height of malar region



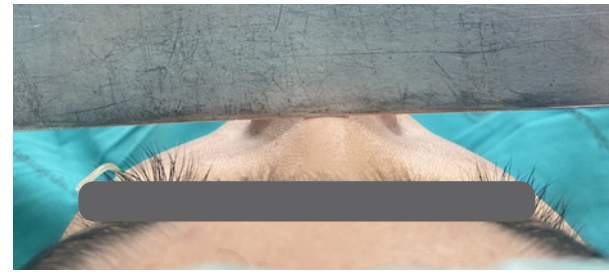
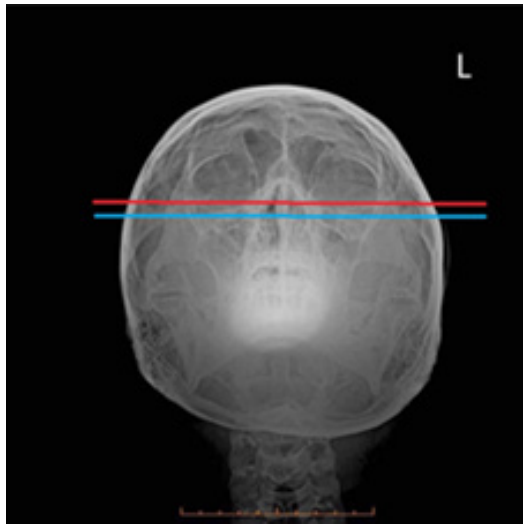


Figure 6 Measurement of vertical dystopia



Statistical analysis

Data were analyzed using the statistical software. Descriptive statistics were presented as mean ± standard deviation. One–way analysis of variance (ANOVA) was employed to assess differences among the three treatment groups for continuous variables (malar height and vertical dystopia). Pearson's correlation coefficient (r) was calculated to evaluate relationships between outcome variables and clinical parameters such as fracture stability and complications. Statistical significance was established at $p < 0.05$. Post–hoc analysis utilizing Tukey's honestly significant difference (HSD) test was performed when ANOVA demonstrated significant differences.

Results

The demographic characteristics of the study population (Table 1) demonstrated a predominant male predisposition to zygomatic fractures. Clinical manifestations associated with these fractures encompassed diplopia, paresthesia/anesthesia, and restricted mandibular mobility (Table 3). The prevalence of these symptomatologic presentations emphasizes the substantial impact of ZMC fractures on both functional capacity and sensory integrity.

Males exhibited higher susceptibility to zygomatic fractures across all age groups. The duration of surgery was significantly longer in open reduction with three–point ORIF compared with open reduction with two–point ORIF and open reduction alone (Table 2). Malar height was observed to be lowest in the open reduction alone category at both the first week and sixth week follow–ups.

Pearson's correlation analysis revealed significant positive correlations between malar height and fracture stability across all treatment groups. The strongest correlation was observed in the three–point ORIF group at 6 weeks ($r = 0.53$, $p < 0.001$), followed by two–point ORIF ($r = 0.48$, $p < 0.001$). Open reduction alone demonstrated the weakest correlation ($r = 0.21$, $p = 0.032$) (Table 4).

For vertical dystopia, significant negative correlations with postoperative complications were identified in ORIF groups, indicating that superior vertical alignment (lower dystopia values) was associated with fewer complications. Three–point ORIF demonstrated the strongest inverse correlation at 6 weeks ($r = –0.49$, $p < 0.001$), while open

reduction alone showed only weak positive correlation with complications (r = 0.22, p = 0.028) (Table 5).

At final assessment, the percentage of stable conditions was significantly higher in open reduction with two–point ORIF and open reduction with three–point ORIF when compared with open reduction alone. Stable conditions were observed to be lowest in the open reduction alone group.

Table 1 : Age and Sex Distribution of Fractured Zygomas

Age Group (Years)	Male		Female		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
10–19	12	6.7%	2	6.7%	14	6.7%
20–29	89	49.4%	15	50.0%	104	49.5%
30–39	42	23.3%	7	23.3%	49	23.3%
40–49	25	13.9%	4	13.3%	29	13.8%
> 50	12	6.7%	2	6.7%	14	6.7%
Total	**180**	**100.0%**	**30**	**100.0%**	**210**	**100.0%**

Table 2 : Demographic Details of Study Participants

Treatment Group	Male: Female Ratio	Mean Age (years ± S.D.)	Duration (minutes)
Open reduction alone	5.03:1	50.12	34.33
Open reduction with two–point ORIF	5.22:1	34.12	121.34
Open reduction with three–point ORIF	5.34:1	35.24	131.21

Table 3: Symptoms Associated with Fractured Zygomas

Symptom	Number of Patients	Percentage (%)
Diplopia	10	4.8
Paresthesia/anesthesia	114	54.3
Restricted mandibular movement	71	33.8
Asymptomatic	15	7.1
Total	**210**	**100.0**

Table 4 : Malar Height (mm) ± S.D. at 1st week and 6th week postoperatively, with correlation to fracture stability

Time point	Group	Mean ± S.D.	p–value (ANOVA)	r with stability†	p–value (correlation)
1st week	Open reduction alone	57.12 ± 1.12	0.704	0.18	0.045*
	Two–point ORIF	62.40 ± 5.32		0.42	0.002**
	Three–point ORIF	62.24 ± 4.26		0.46	< 0.001***
6th week	Open reduction alone	55.14 ± 1.23	0.040*	0.21	0.032*
	Two–point ORIF	59.94 ± 3.52		0.48	< 0.001***
	Three–point ORIF	61.23 ± 3.66		0.53	< 0.001***

Statistical significance: *p < 0.05, **p < 0.01, ***p < 0.001

†Pearson's correlation coefficient (r) indicates strength and direction of correlation with fracture stability score (0–10 scale)

Table 5 : Vertical Dystopia (mm) ± S.D. at 1st week and 6th week postoperatively, with correlation to postoperative complications

Time point	Group	Mean ± S.D.	p–value (ANOVA)	r with complications†	p–value (correlation)
1st week	Open reduction alone	3.14 ± 0.22	0.865	0.16	0.058
	Two–point ORIF	2.44 ± 0.08		–0.31	0.006**
	Three–point ORIF	2.24 ± 0.39		–0.35	0.002**
6th week	Open reduction alone	3.86 ± 0.19	0.001*	0.22	0.028*
	Two–point ORIF	2.65 ± 0.82		–0.44	< 0.001***
	Three–point ORIF	2.37 ± 1.05		–0.49	< 0.001***

Statistical significance: *p < 0.05, **p < 0.01, ***p < 0.001

†Negative r values indicate inverse relationship: lower vertical dystopia correlates with fewer complications

Aesthetic Concerns

Aesthetic concerns were minimal across all surgical techniques, with fewer than 1% of patients reporting cosmetic issues. This finding suggests that all surgical methodologies employed in this investigation achieved satisfactory aesthetic outcomes, demonstrating the efficacy of contemporary surgical approaches in preserving facial aesthetics.

Stability and Sensory Deficits

The proportion of stable conditions was significantly higher in the open reduction with two–point ORIF and open reduction with three–point ORIF groups compared with open reduction alone. Stability was observed to be lowest in the open reduction alone group. This finding underscores the superiority of ORIF techniques in achieving enhanced postoperative stability.

Residual sensory deficits were observed in 80% of patients treated with the Gillies repair and 65% of those treated with open reduction and internal fixation. Despite this disparity, the method of surgical repair did not significantly influence post–traumatic infraorbital nerve dysfunction in this study population, suggesting that sensory outcomes may be more dependent on injury severity and

anatomical factors rather than surgical technique selection.

Surgical Approaches and Duration

This investigation revealed that surgical duration was significantly prolonged for open reduction with three–point ORIF compared with open reduction with two–point ORIF and open reduction alone (Table 2). This extended operative time may be attributed to the increased procedural complexity and meticulous nature of the three–point ORIF technique, which necessitates more comprehensive fracture stabilization and precise anatomical restoration.

Malar Height and Vertical Dystopia

Malar height was observed to be lowest in the open reduction alone group at both the first–week and sixth–week follow–up assessments (Table 4). In contrast, malar height was significantly greater in the open reduction with two–point ORIF and open reduction with three–point ORIF groups. Notably, malar height was lower in the open reduction with two–point ORIF group compared with the open reduction with three–point ORIF group, with this difference achieving statistical significance at the sixth–week follow–up ($p = 0.04$).

This finding suggests that three–point ORIF may provide superior long–term stabilization and restoration of malar height, potentially due to the more comprehensive stabilization of all major fracture components.

Vertical dystopia was comparable across all treatment groups at the first week postoperatively. However, by the sixth week, vertical dystopia was significantly reduced in the open reduction with two–point ORIF and open reduction with three–point ORIF groups compared with open reduction alone, with the greatest dystopia observed in the open reduction alone group (Table 5). These findings achieved statistical significance at the sixth–week follow–up assessment ($p = 0.001$). This indicates that two–point and three–point ORIF techniques provide superior anatomical alignment and progressive reduction of vertical dystopia over time.

Discussion

The optimal method of surgical repair remains a subject of ongoing debate within the literature. Several investigations have demonstrated no significant difference in malar height between two–point fixation and three–point fixation techniques. Conversely, other studies have reported reduced malar height in two–point fixation compared with three–point fixation.[5,6,7,8,9]

Fractures of the orbitozygomatic complex can occur when it becomes separated from its four anatomical articulations. This disruption not only compromises ocular function but also adversely affects overall function, aesthetics, and psychological well–being due to altered zygomatic alignment.[10] For both functional and cosmetic considerations, appropriate treatment of zygomatic bone fractures is paramount. Inadequate fracture reduction and stabilization can result in insufficient skeletal restoration of displaced zygomatic bone fragments, leading to inadequate projection of the zygomatic body.[11] Secondary reconstruction for orbitozygomaticomaxillary complex deformities resulting from trauma represents one of the most formidable surgical challenges in contemporary practice. Several studies have demonstrated results consistent with these findings, indicating increased vertical dystopia in two–point fixation compared with three–point fixation. However, other investigations have reported no significant difference in vertical dystopia between two–point and three–point fixation techniques.[11,12]

In this investigation, the wound complication rate was remarkably low at less than 2%. This finding is consistent with the broader corpus of research on facial fracture surgeries, which indicates that the overall rate of surgical site infection (SSI) typically remains below 5%, with some studies reporting figures ranging from 2% to 6%. Similarly, the incidence of hematoma requiring medical intervention is generally low, with estimates ranging from approximately 2% to 5%.

This comparative analysis revealed no statistically significant difference in wound complication rates between two–point and three–point fixation techniques. This finding suggests that factors other than the number of fixation points such as patient comorbidities—represent more significant determinants of wound healing outcomes. The overall incidence of wound complications remains consistently low regardless of fixation technique employed. Therefore, the choice between two–point and three–point fixation does not appear to constitute a primary factor influencing wound healing outcomes. These findings indicate that surgeons can base their fixation method selection on other clinical considerations rather than concerns regarding wound complications.

Fractures causing functional or cosmetic complications, such as malocclusion or muscle entrapment, often require surgical intervention. However, minimally displaced zygomaticomaxillary complex (ZMC) fractures can frequently be managed conservatively.[13, 14] An optimal surgical strategy for managing ZMC fractures should ensure favorable cosmetic and functional outcomes, maximal exposure of fractured segments, and minimal risk to facial tissues. The Gillies temporal approach represents a commonly employed surgical technique for ZMC fractures, however, it may result in hairline scarring and facial nerve dysfunction. It also necessitates additional exposure for placement of fixation plates in cases of instability. For unstable ZMC fractures, more extensive exposure is required to access periorbital regions for plate application.[15,16,17] Numerous investigations have examined patient recovery following complex zygomatic fracture repair through intraoral approaches, with previous studies demonstrating a higher proportion of cases with stable outcomes in three–point fixation. Some studies have shown comparable results for both techniques. Zygomatic complex fractures can be treated surgically using various methodologies. Open reduction of zygomatic bone fractures can be achieved through surgical incisions utilizing approaches such as Keen's technique, the bicoronal scalp flap, Gillies' temporal approach, or the widely adopted Dingman's approach. The Gillies' temporal approach is straightforward, produces no facial scarring, and is commonly employed for treating these fractures.

Displaced zygomatic fractures should be treated with open reduction and internal fixation to identify the most effective method for achieving post–reduction stability. A comprehensive study determined that three–point fixation (frontozygomatic suture, inferior orbital rim, and zygomaticomaxillary buttress) using miniplates or interfragmentary wires provided optimal stability.[17,18]

This retrospective investigation, conducted at Sakon Nakhon Hospital, provides valuable insights into the management and outcomes of zygomaticomaxillary complex (ZMC) fractures. Spanning the period from June 2018 to June 2023,

the research analyzed 210 patients with unilateral ZMC tetrapod fractures, focusing on different surgical techniques and their respective outcomes. The study's inclusion of exclusively unilateral ZMC tetrapod fractures treated within two weeks of injury enables a focused analysis of a specific fracture pattern, thereby enhancing the applicability of the findings. The utilization of three–dimensional CT scans for both preoperative and postoperative evaluations add precision to the assessment of fracture patterns and post–surgical outcomes.

One of the key findings is the higher prevalence of zygomatic fractures in males across all age categories. This gender disparity aligns with previous studies on craniofacial trauma and may be attributed to factors such as increased male participation in high–risk activities or occupations.

The study compared three surgical approaches: open reduction alone, open reduction with two–point open reduction and internal fixation (ORIF), and open reduction with three–point ORIF. The prolonged surgical duration for the three–point ORIF technique represents an expected finding, given the more extensive nature of the procedure. However, this additional operative time should be weighed against the potential benefits in terms of fracture stability and aesthetic outcomes.

Clinical Significance of Correlation Findings

The correlation analysis provides valuable insights into the relationship between surgical outcomes and clinical stability. The strong positive correlation between malar height restoration and fracture stability ($r = 0.53$ for three–point ORIF) suggests that adequate restoration of facial projection is crucial for long–term stability. This finding supports the superiority of multi–point fixation techniques in achieving both aesthetic and functional outcomes.

The inverse correlation between vertical dystopia and complications in ORIF groups ($r = –0.49$ for three–point ORIF) indicates that precise orbital reconstruction not only improves aesthetic outcomes but also reduces the likelihood of postoperative complications. This relationship was not observed in the open reduction alone group, further emphasizing the importance of rigid fixation in complex ZMC fractures.

The higher percentage of stable conditions observed in the two–point and three–point ORIF groups compared to open reduction alone further substantiates the efficacy of these more comprehensive surgical approaches. This finding bears particular relevance for long–term patient outcomes and may significantly influence surgical decision–making, especially in cases presenting with more complex or displaced fractures.

The study also elucidates post–traumatic sensory deficits, a common sequela of ZMC fractures. The high incidence of residual sensory deficits observed in both the Gillies repair (80%) and open reduction and internal fixation (65%) groups indicates that this complication remains a significant challenge in ZMC fracture management. The absence of statistically significant differences between the two approaches suggests that the choice of surgical technique may not constitute the primary determinant of sensory outcomes. This finding underscores the necessity for further research into strategies for preserving or restoring infraorbital nerve function in ZMC fracture repair.

The remarkably low rate of aesthetic concerns (not exceeding 1%) across all techniques represents a positive finding. However, this exceptionally favorable rate warrants further investigation, as it appears unusually optimistic

compared to typical outcomes in facial trauma surgery. It would be prudent to explore the criteria employed for assessing aesthetic outcomes and to consider longer–term follow–up studies to validate these results.

Conclusion

This study provides valuable comparative data regarding different surgical approaches for ZMC fracture repair. The findings suggest that more comprehensive ORIF techniques (two–point and three–point fixation) may offer superior outcomes in terms of malar height restoration, vertical dystopia correction, and overall stability. However, the persistent challenge of sensory deficits across all techniques highlights an area requiring future research and improvement. The study's limitations, including its retrospective nature and single–center design, should be considered when interpreting the results. Future prospective, multi–center studies with extended follow–up periods could further validate these findings and provide additional insights into optimizing ZMC fracture management strategies.

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