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Original Research

Comparison of Single and Double Plate Fixation in Acetabulum Anterior Column Fractures Treated with Stoppa Approach

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ABSTRACT

Objective: Our aim in this study was to evaluate the effect of double plate fixation method on the results of acetabulum anterior column fractures.

Methods: The data of patients who were operated with the stoppa approach for isolated anterior acetabular colon fracture in our department were analyzed. The patients were divided into two groups according to the fixation method as single plate and double plate patients. The two groups were compared in terms of clinical and functional outcomes. Statistical analysis was performed using the Mann-Whitney U test and Chi-square test, with a significance threshold of $p<0.05$.

Results: Forty eight patients who met the study criteria were included in the study. Twenty four patients with single plate fixation were determined as Group 1 and 24 patients with double plate fixation were determined as Group 2. There was no statistically significant difference between the groups in terms of intraoperative blood loss, surgical time, and Harris hip scores ($P>0.05$).

Conlusions: Clinical and functional outcomes were similar in both groups. Therefore, the methods are not superior to each other.

Keywords: acetabulum, anterior column fracture, double plate, single plate

INTRODUCTION

Acetabular fractures are among the most challenging fractures of orthopedic surgery practice [1]. While several acetabular fracture types exist, isolated anterior column fractures constitute 6.3% of these fractures. Therefore, various surgical methods were defined to fix the acetabular fractures [2-4]. However, the Stoppa method, ilioinguinal and pararectus approach represents the most commonly preferred surgical treatment methods for isolated anterior column fractures. In addition, the percutaneous approach can also be implemented to fix these fractures [5, 6].

In acetabular fractures, the prognosis was found to be closely related to the fracture reduction, irrespective of the surgical approach [7, 8]. The primary aim of surgery is to provide anatomical reduction via a stable reduction and prevent gap formation or displacement at the fracture site [9]. In the

literature, there are reports regarding single plate fixation and screw fixation in patients with anterior column fractures [10, 11]. In addition, some biomechanical studies have reported the advantages of double plate fixation for fracture types in different parts of the body. [12]. Nevertheless, to the best of our knowledge, there are no data in the published literature concerning the outcomes of the double plate fixation method in the setting of isolated anterior column fractures. Although some studies analyzed the outcomes of acetabular fractures, they also included both column fractures and hemi transverse acetabular fractures in their analyses [13, 14]. Therefore, data regarding the outcomes of the treatments of isolated anterior column fractures are limited in the current literature [5, 15].

In this study, we aimed to compare the clinical outcomes of the patients who underwent double plate fixation after open reduction via the Stoppa approach with those who went through the single plate fixation procedure following open reduction by the Stoppa approach in patients with isolated anterior column fractures.

MATERIALS AND METHODS

Adult (age≥18) patients who underwent surgery for an isolated acetabular anterior column fracture in our center the target population of this study. Ethical approval for this study was obtained from the Clinical Research Ethics Committee of Gaziantep University (decision no: 2022/58, dated February 7, 2022). After taking approval from the local ethical review committee the patients' data were retrieved from electronic patient folders. The study was conducted in accordance with the Declaration of Helsinki.

Main Points

- To compare the outcomes of single plate and double plate fixation methods in the treatment of isolated anterior column fractures of the acetabulum using the Stoppa approach.
- A retrospective review of 48 patients, divided into two groups (single plate: 24 patients, double plate: 24 patients), evaluating surgical outcomes based on Harris hip score, operation time, blood loss, and complications.
- No statistically significant difference in clinical and functional outcomes between the two methods. However, two patients in the single plate group experienced loss of reduction, while no such cases occurred in the double plate group.
- Single plate and double plate fixation methods generally provide similar outcomes; however, in cases of reduction loss, double plate fixation may be a more stable alternative.

The collected data were retrospectively reviewed. Patients who had isolated acetabular anterior column fractures as per the Letournel fracture classification and underwent the Stoppa procedure were included. Those who did not have postoperative 2-year follow-up data, those with additional injuries such as an acetabular posterior wall or posterior column fracture or pelvic ring injuries, and patients with head trauma requiring prolonged immobilization were excluded. Sixty patients were evaluated within the scope of the study. Six patients who required intensive care follow-up due to head trauma, 4 patients whose follow-up data could not be accessed, and 2 patients with both colon fractures were excluded from the study. Patients were divided into two groups: Group 1 consisted of patients who underwent single plate fixation, while Group 2 included the patients who underwent double plate fixation. Two groups were compared regarding age, gender distribution, mechanism of injury, time until surgery, intraoperative blood loss, presence of quadrilateral surface fracture, hemoglobin values, blood transfusion amount, surgical time, postoperative complications, and intraoperative reduction quality. In addition, functional and radiological outcomes were assessed by the Harris hip scoring system and Matta's reduction criteria. Postoperative hemoglobin was measured at the 6th hour postoperatively in all patients, and the Harris hip scores represent the values at the 24th postoperative month. All patients were operated on by the same surgical team consisting of two orthopedic surgeons. In the patient group consisting of isolated acetabulum anterior column fracture, no special criteria were used in the selection of treatment with single plate or double plate fixation, and patient selection was performed randomly.

Surgical Technique

All patients were positioned lying supine, and the fractured extremity was prepped and draped. After manual palpation of the pubic symphysis, a transverse incision was made 1 cm above this landmark. The anterior rectus fascia was dissected, and subsequently, a longitudinal incision was made through the linea alba. The perivesical tissues were freed by blunt finger dissection,

and the urinary bladder was protected by blunt retractors. The periosteum of the superior pubic ramus was freed and dissected alongside the pubic ramus. The corona mortis anastomotic branch was ligated and transected. A blunt retractor was placed toward the iliac ring, the external iliac vessels were protected, and the fracture site was exposed. In single plate fixation cases, after debridement and reduction, the reconstruction plate was bent and adapted to the iliac wing and fixated by placing three nails to the proximal and distal ends of the fracture line. (Figure 1-2) Special attention was given to ensure that, the first nail inserted to the distal end of the fracture line was not placed into the articular space. Therefore, the most proximal hole was used for inserting this nail. On the other hand, in double plate fixation cases, (Figure 3-4) the plates were placed onto the pubic ramus so that they were close to each other and made a 'V' shape on the iliac wing. (Figure 5, 6, 7). The intraoperative reduction quality was assessed by the fluoroscopic anterior-posterior pelvis, iliac oblique, and obturator oblique views. A surgical drain was placed and removed on postoperative day 1 in all cases. After conducting a postoperative bed exercise program, the patients were allowed to ambulate toe touch non-weight bearing for six weeks. Subsequently, weight-bearing was gradually allowed.

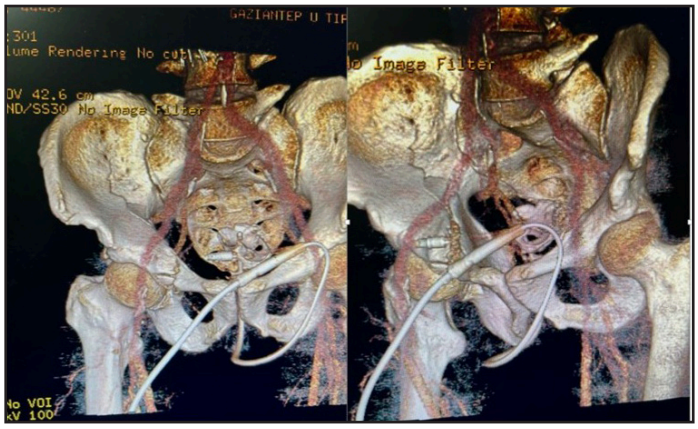

Figure 1. 24 years old male patient, anterior acetabulum column fracture after traffic accident. Preoperative 3D computer tomography sections

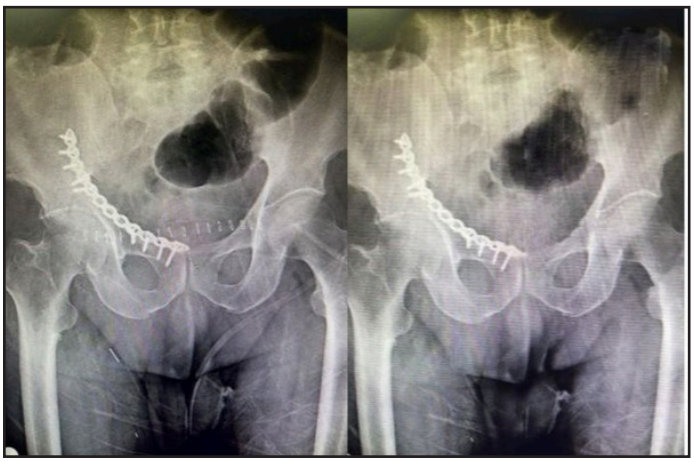

Figure 2. Control xray film of the patient who underwent single plate fixation at the postoperative and 24th month, respectively.

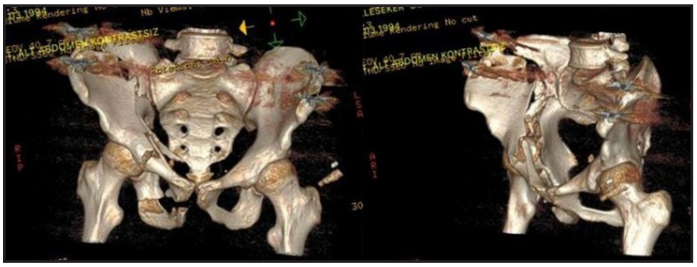

Figure 3. 26 years old male patient, anterior acetabulum column fracture after traffic accident. Preoperative 3D computer tomography sections.

Figure 4. control xray film of the patient who underwent double plate fixation at the postoperative and 24th month, respectively.

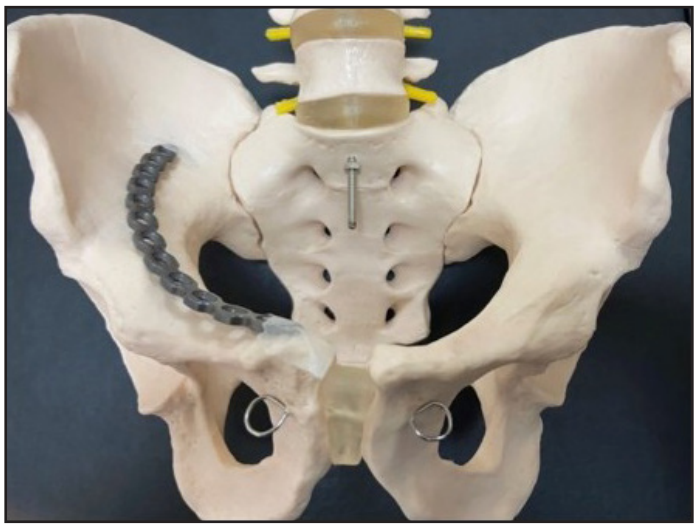

Figure 5. First Plate Position

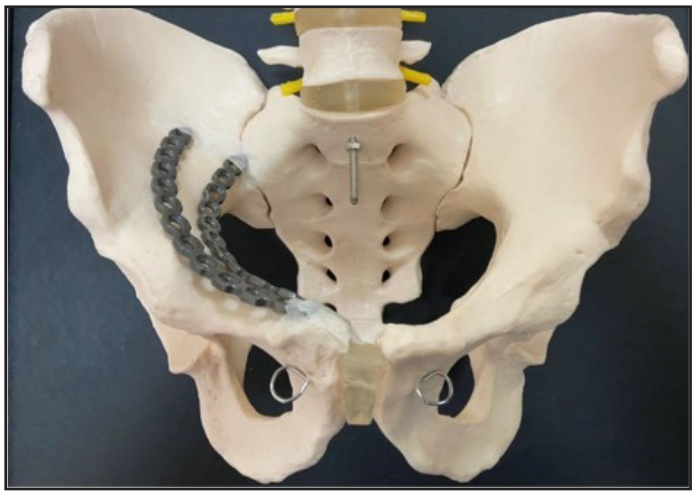

Figure 6. Double Plate Position

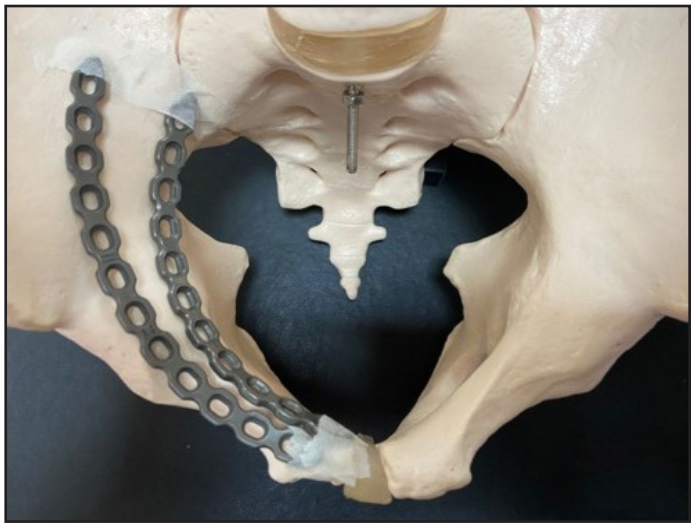

Figure 7. Cephalocaudal view of double plate position

Statistical Analysis

The descriptive data were expressed as means±standard deviations and medians [minimum-maximum], while the nominal variables were given as numbers (n) and percentages (%). The statistical significance of the differences between nominal variables of the two groups was tested using a Chi-square test. In addition, the Mann-Whitney U test was used for analyzing the differences between continuous variables. The p value was considered significant when it was lower than 0.05. The Statistical Package for Social Sciences (SPSS v22.0, IBM Corp., Armonk, NY, US) software was used for all statistical analyses.

RESULTS

After applying the inclusion and exclusion criteria, 48 patients were included in this study. Both Group 1 (Single Plate Fixation group) and Group 2 (Double Plate Fixation Group) consisted of 24 patients. Demographic data of the patients in two groups are displayed in Table 1. There were 28 male and 20 female patients in the entire cohort. The mean patient age was 40.41 [19-68]. While 32 patients presented after a traffic accident, 16 patients presented due to a fall from height. The mean follow-up duration was 25.87 [24-30] months. The mean time interval until surgery and estimated intraoperative blood loss were 2.41 [1-4] days and 397.91 [100-900] milliliters, respectively. While the mean preoperative hemoglobin level was 13,4 [11.2-15.7] gr/dl, mean postoperative hemoglobin level was 12,16 [9.2-15.2] gr/dl. Mean surgical time, and blood transfusion volumes were 81.83 [55-100] minutes and 1.95 [0-8] units. As per Matta's criteria for reduction quality, the reduction quality was poor in 2, good in 14 and excellent in 32 patients. Mean Harris hip score was 87.08 [70-94]. While 12 patients did not have a quadrilateral surface fracture, 36 patients had this fracture type. Analysis of postoperative complications revealed that 2 patients had reduction loss, and 1 developed hip arthrosis.

There was no statistically significant difference between the two groups regarding Harris hip scores, intraoperative estimated blood loss, and surgical time (p=0.31, p=0.85, p=0.45; respectively). There was a significant association between intraoperative reduction quality and the postoperative Harris hip scores and between patient age and postoperative Harris hip scores (p=0.01, p=0.01). However, there was no significant relationship between the mechanism of injury and the postoperative Harris hip score (p=0.83). The relationship between the presence of a quadrilateral surface fracture and the

Table 1. Demographic data of the patients in both groups

Variables		Group 1 (Single plate Group)	Group 2 (Double plate Group)	p value
Gender	Male	14	14	-
	Female	10	10	
	Total	24	24	
	Age	43.91 ±16.71 [20-68]	36.91 ±13.55 [19-56]	0.090
Mechanism of injury	Traffic accident	16	16	0.370
	Fall from height	8	8	
	Mean follow-up duration (month)	26 ±1.66 [24-29]	25.75 ±2.17 [24-30]	0.420
	Time until surgery (day)	2.08 ±0.65 [1-3]	2.75 ±0.6 [2-4]	0.520
	Intraoperative blood loss (mililiter)	391.66 [150-900]	404.16 [100-850]	0.850
	Preoperative hemoglobin	13.97 [11.8-15.3]	12.82 [11.2-15.7]	0.280
	Postoperative hemoglobin	12.78 [9.7-14.9]	11.55 [9.2-15.2]	0.260
	Surgical time (minute)	80.58 ±12.76 [55-95]	83.08 ±7.87 [85-100]	0.450
Reduction quality as per Matta	Excellent	16	16	0.350
	Good	6	8	
	Poor	2	0	
Quadrilateral surface fracture	Present	16	20	0.180
	Absent	8	4	
Complications	Postoperative reduction loss	2	0	0.150
	Arthrosis	0	1	0.310
	Harris hip score	86.08 ±7.87 [70-94]	88.08 ±5.41 [76-94]	0.310

postoperative Harris hip score was also insignificant (p=0.88).

DISCUSSION

This study aimed to compare the clinical outcomes of the single plate and double plate fixation procedures in patients with isolated acetabular anterior column fractures. Our findings showed that the double plate fixation method was not superior to the single plate fixation method.

Acetabular fracture is a complex clinical entity caused by high-energy traumas and in the patient group in our study, the reason was traffic accident in 32 patients and falling from a height in 12 patients. [16]. It is associated with fractures of other extremities, head, thorax, and abdominal organ injuries in most patients. Our study did not include the patients with associated injuries to focus on isolated acetabular anterior column fractures. It is known that there is a continuous change and improvement in the surgical management of patients with acetabular fractures [17, 18]. The primary aim of all surgical methods is providing pain relief, early mobilization, and stable fixation for allowing anatomical joint reconstruction [19]. On the other hand, the fact that the patient group is in the young active population, as in our study, is another factor affecting fracture treatment. In addition, it is widely accepted that the Stoppa approach has several technical advantages: It provides adequate exposure to the anterior column of the acetabulum and the quadrilateral surface, and the neurovascular structures are spared [20, 21]. Due to these advantages, we preferred the Stoppa approach in our study.

As per the current literature, double plate fixation methods are commonly used in orthopedic surgery. Katthagen et al. [22] reported the advantages of the double plate fixation method in upper extremity fractures. Gandapur et al. [23] applied double plate fixation in patients with tibia plateau fractures. As such, Kilinc et al. [24] preferred double plate fixation in the acetabular

posterior wall or column fractures, and they noted that this approach provided biomechanical advantages due to stable fixation. Zhang et al. reported the technical benefits of double plate fixation in patients with acetabular posterior wall fractures [25]. In these studies, the double plate method was evaluated as more advantageous in terms of reduction stabilization and biomechanics.

Our study showed that there was no statistically significant difference between the two techniques in terms of intraoperative blood loss and surgical times. ($p>0.05$) Also, the clinical outcomes, including Harris hip scores, were similar. Our complication analysis revealed that two patients who underwent single plate fixation had reduction loss prior to mobilization by loading the ipsilateral extremity during postoperative follow-up. Subsequently, an early revision with a double plate was performed in these cases. Of note, these two patients did not have poor reduction quality as per Matta's criteria after first single plate fixation surgery. None of the patients who underwent double plate fixation experienced reduction loss. The rate of reduction loss seen in the single plate group did not make a statistically significant difference. In this respect, superiority could not be established between the two treatment modalities . However, double plate method can be considered when revision surgery is required due to loss of reduction after single plate fixation. We also chose double plate fixation in 2 patients in the study group who experienced reduction loss.

Since acetabular fractures bear high risk for thromboembolic events, stable fixation and early mobilization should be the main target of all surgical modalities [26-28]. Although we did not encounter any thromboembolic complications in our study, we suggest that the double plate fixation method is relatively more encouraging in terms of early mobilization.

One patient who underwent double plate fixation was later diagnosed with coxarthrosis in our cohort. It is known that there is an increased risk of chondral defect formation and arthrosis in patients with acetabular fractures [29]. Therefore, we did not relate this complication with the double plate fixation technique. Our analysis showed that there was no statistically significant relationship between the presence of quadrilateral surface fracture and functional outcomes. In their report, Panella et al. [30] stated that the presence of quadrilateral surface fracture did not impact the functional outcomes in patients with excellent or good intraoperative reduction quality as per Matta's criteria. As per our results, there is a significant relationship between the intraoperative reduction quality and functional outcomes. In line with this finding, Letournel and Matta denoted that the intraoperative reduction quality was one of the essential determiners of the surgical outcomes in patients with acetabular fractures [31].

Anatomical reduction and stable fixation are crucial for preventing post-surgical complications in orthopedic surgery practice [32]. Therefore, we suggest that double plate fixation can play a vital role in protecting the reduction.

Our study has some limitations which need to be considered while evaluating its findings. First, it is a retrospective study that could be affected by all inherent weaknesses stemming from its retrospective design. Second, it has a relatively small sample size. Third, no special criteria were used in the selection of the treatment method in the patient groups. This may affect homogeneity in treatment groups. However, to the best of our knowledge, it is the first study analyzing the outcomes of double-plate fixation in patients with isolated acetabular anterior column fractures. Although it can be stated that double plate fixation can be associated with prolonged surgical time and increased risk of intraoperative bleeding, our findings are encouraging in this regard.

CONCLUSION

The double plate fixation technique's clinical outcomes are similar to those in fixed with a single plate patients with acetabular anterior column fractures. In this respect, treatment methods are not superior to each other. However, in the presence of fracture reduction loss after single plate fixation, double plate fixation may be an alternative option.

Funding: None

Conflict of Interest: None

Informed Consent: No consent is required due to the retrospective study.

Data Availability Statement: We value transparency and reproducibility in research; however, to protect the privacy of the participants, the raw data from this study cannot be publicly shared. Detailed descriptions of the methodology and statistical analyses are provided within the manuscript to allow other

researchers to replicate our procedures and compare their results with ours.

Ethics Committee Statement: This study was approved by the Clinical Research Ethics Committee of Gaziantep University eith desicion number 2022/58 on February 7, 2022.

Author Contributions: Conception: B,B; Ç,K - Design: S,B,T;S,G - Supervision: B,B; Ç,K - Fundings: S,B,T;S,G -Materials: B,B; Ç,K - Data Collection and/or Processing: S,B,T;S,G - Analysis and/or Interpretation: B,B; Ç,K - Literature: S,B,T;S,G - Review: B,B; Ç,K - Writing: S,B,T;S,G - Critical Review: S,B,T;S,G

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