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ORIGINAL ARTICLE

Short Term Outcome of Percutaneous Fixation of Transverse Acetabular Fractures

Mohamed Ismail Kotb, Reda Hussien El Kady, Mohamed Emad El-sayed Abd-elhadi*, Islam Sameeh Abdelfattah

Department of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:**
Mohamed Emad El-sayed Abd-elhadi

Email Address:
mido10emad@gmail.com

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ABSTRACT

Background: There is a significant risk of morbidity and mortality associated with acetabular fractures due to significant internal organ injury and hemorrhage. Orthopedic surgeons are faced with significant challenge when treating these fractures. Early surgical fixation of acetabular fractures is the preferred course of treatment because it offers a number of benefits, including early ambulation and decreased morbidity and mortality. This study aimed to evaluate of early clinical and radiological outcome of percutaneous fixation of transverse acetabular fractures.

Methods: This prospective study was conducted on 18 patients with transverse acetabular fractures using fluoroscopic guidance who underwent percutaneous fixation by closed reduction aided by Shanz screw with mean follow up period 2 years. All patients was had an AP, Lateral, inlet, outlet and Judet views X-ray and CT scan. The clinical outcomes was evaluated using Merle D'Aubigne. **Results:** According to the Merle d'Aubigne Score Distribution among studied groups was excellent in 15 patients (83.3%), good in 2 patients (11.1%) and only one case 5.6% had fair score. Most of the studied group (16 cases, 88.9%) didn't have any postoperative complications and two cases had complications which is superficial tract infection (11.1%).

Conclusion: we find that the use of fluoroscopic guidance in percutaneous screw treatment of transverse acetabular fractures is a safe and reasonably simple surgical approach for treating non-comminuted and minimally displaced fractures associated with early rehabilitation and less complications.

Keywords: Percutaneous Fixation, Transverse acetabular fractures, Fluoroscopic.

INTRODUCTION

There is a significant risk of morbidity and mortality associated with acetabular fractures due to significant internal organ injury and hemorrhage **[1]**.

The percentage of acetabular fractures in skeletal injuries is 3%. According to studies, the annual incidence of acetabular fractures is 3 per 100000 people, these fractures can be caused by low energy injuries like falls in elderly people with osteoporosis or by high energy traumatic injuries **[2]**.

Orthopedic surgeons are faced with significant challenge when treating these fractures. Early surgical fixation of acetabular fractures is the preferred course of treatment because it offers a number of benefits, including early ambulation and decreased morbidity and mortality. The ideal fixation technique, particularly for unstable fractures, is still up for debate. **[3]**.

Thanks to recent advancements in imaging technologies, closed reduction with percutaneous fixation of non-displaced or minimally displaced fractures of the acetabulum under fluoroscopic supervision has drawn interest **[4]**.

Many clinical scenarios are appropriate for percutaneous fixation. As intraoperative advances in imaging and navigation become more widely available, indications are changing along with surgical approaches. Before fixating severely displaced acetabular fractures, anatomic reductions are necessary. It is important to use caution while making decisions in order to prevent overstretching the use of percutaneous procedures. If reduction can be accomplished with the use of smaller accessory routes and assisted reduction techniques, certain patterns of displaced acetabular and pelvic fractures might still be suitable for percutaneous fixation **[5]**.

Nevertheless, percutaneous screw insertion is a difficult surgery due to acetabular shape. We must be aware of the precise insertion places, screw direction, and screw angle in order to install the percutaneous screw correctly. Percutaneous screws can be used to repair acetabular fractures under fluoroscopic supervision in the outlet-obturator and inlet-iliac views. The orthopedic surgeon must learn to think in three dimensions and comprehend the radiographic visualization image and any pertinent anatomical landmarks it displays. This treatment has a lengthy learning curve and necessitates extensive radiographic exposure to guide the placing of the screws **[6]**.

METHODS

This prospective study in Orthopedic Surgery department of Zagazig University Hospitals on 18 patients with transverse acetabular fractures who underwent percutaneous fixation by closed reduction aided by Shanz screw, with mean follow up period 2 years. After institutional review board approval of (IRB #11180-4-10-2023), Written informed permission was required of each participant. The World Medical Association's Code of Ethics for Research Involving Humans includes the Declaration of Helsinki, which was followed in the conduct of this study.

Included patients were pure transverse acetabular fractures, skeletally mature patients, minimal to moderate displaced transverse acetabular fractures that can reduced by closed reduction aided by Shanz screw or by manual traction. Exclusion criteria were open fractures, unfit or refuse surgery, neglected fractures more than one week of the initial trauma and comminuted and markedly displaced acetabular fractures that can't be reduced by closed reduction.

All patients underwent to complete history-taking, Clinical examination, complete back, hip, and lower limb examination for evaluation of potential and clinically detectable concomitant lesions. Radiological evaluation; all patients was had an AP, Lateral, inlet, outlet and Judet views X ray and CT. Lab investigations included (Complete Blood Picture, Coagulation profile, Liver and kidney function tests, Blood sugar).

Preoperative preparations:

Prophylactic anticoagulant which is stopped 12 hours before surgery. Bowel preparation for all patients in the form of only plain fluids in the day before surgery and evacuation enema 12 and 6 hours before surgery. Fasting 6 hours before surgery.

General anesthesia, patients was in supine position (Figure 1A). Ensure that AP, inlet, outlet and Judet views can be obtained by fluoroscope. Under guidance of fluoroscope, guide wire was inserted through minimal skin incision followed by the screw to fix the fracture. After insertion of screws the wound is closed.

All anterior column screws were put in antegrade technique (Figure 1B). The entry points were situated where a line from the pubic symphysis to the anterior inferior iliac spine and a line drawn along the lateral border of the femur through the greater trochanter met. Next, a 1.8 mm guide wire is introduced, and both the inlet and obturator views are used to verify its placement. The medial superior pubic ramus should be reached by the guide wire's tip. The guide wire's location in the obturator oblique was verified. Determining the guide wire's position above the hip joint and without piercing the top border of the superior pubic ramus is helpful. It aids in locating the guide wire's location inside the ramus so that it doesn't penetrate either the inner or outer surface.

A cannulated drill bit for a 6.5 mm screw is placed over the K-wire inside the superior pubic ramus once the wire has been adjusted to an acceptable position. Next, using C-arm guidance, a 6.5-mm partly threaded cannulated screw of sufficient length is put over the guidewire (Figure 1C). As soon as surgery is completed, the hip joint's mobility is examined to make sure the screw has not pierced it (Figure 1D). Once the hip can move passively without restriction, the pins removed, and the wounds stitched up.

Posterior column:

The posterior column screw was retrogradely fixed while the patient was in the supine position. with a helper flexing the affected limb's hip and knee to a 90-degree angle(**Figure 2**A). Finding the ischial tuberosity when the patient's hip is flexed is the initial step in inserting the screw. The screw entry point was marked 1 cm posterior to the most distal portion of the ischial tuberosity. This guarantees that the screw will follow the proper trajectory and stay extra-articular. Screw guiding is achieved using the iliac oblique and obturator oblique views (**Figure 2**B). The drill sleeve is positioned using the iliac and obturator oblique views as guides. The K wire is then advanced proximally at an angle of 45 degrees from medial to lateral and at an angle of 40 to 45 degrees to the horizontal plane directed upwards to prevent penetration of the iliac bone supraacetabular outer table (**Figure 2**C) .

Once the wire is in a suitable location, the drill bit for the 7,3 mm partly threaded cannulated screw is advanced proximally in the ischium with the assistance of the obturator oblique and iliac oblique views (**Figure 2**D).

In order to prevent intra-articular penetration, the hip must be repositioned prior to fixation. Guide wire removed, wound stitched.

Postoperative follow up:

Patients were followed up at 2 weeks in the first month clinical examination, wound condition and removal of sutures. Then, routine X-rays were taken at each follow-up every month. Duration of follow up for every case is 2 years. All patients in the postoperative period undergone the same rehabilitation protocol: No weight bearing for two weeks, then weight bearing with a walker should be initiated, after six weeks partial weight bearing is allowed, full weight bearing is allowed after twelve weeks.

The three views of the pelvis on plain films recorded before to hospital discharge were used to measure the residual displacement at the joint level in order to assess the reduction of the fracture. Anatomical reductions with displacements between 0 and 1 mm, satisfactory reductions with displacements between 1 and 3 mm, and unsatisfactory reductions with displacements greater than 3 mm were classified into three categories based on the largest displacement measured in millimeters at any of the acetabulum's normal radiographic lines. At the final follow-up, the clinical results were assessed utilizing **Merle D'Aubigne [7].**

Statistical analysis

SPSS version 23 was used for data processing, checking, entering, and analyzing the data. Numbers and percentages were used to express the data for qualitative factors, while mean plus standard deviation (SD) was used for quantitative variables. Quantitative variables before and after surgery were compared using the paired t-test. The threshold of significance was fixed at 5% level P-value of < 0.05 indicates significant results.

RESULTS

Table 1; showed that the average age of the studied group was (29.8±9.4) ranging from 20 to 60 years. Regarding sex, (77.8%) were males, and (22.2%) were females. That most of the studied group (88.8%) didn't have comorbidities, one case (5.6%) had HTN and one case (5.6%) had D.M. This table showed that Motor vehicle accidents were the commonest cause of injury (72.2%) followed by Falling from height (16.6%) then motorcycle and pedestrian (5.6%) for each. This table showed that (58.3%) of the studied group had associated injury and fracture BB forearm& leg was the commonest one (12.5%).

Table 2; showed that most of the studied group 14 patient (77.7%) had anatomical radiological outcome, 3 patient (16.6%) had satisfactory outcome and only 1 patient (5.6%) had unsatisfactory outcome.

Table 3; showed that Merle'd Aubigne Score Distribution among studied groups where 15 patients (83.3%) had excellent score, 2 patients (11.1%) had good and only one case (5.6%) had fair score.

Relation between radiological outcome & clinical outcome:

To insure if there is a relationship between the quality of reduction and the clinical outcome we divided our cases into 2 groups; ***First group*** including the patients with anatomical reduction of acetabular fractures which include 14 cases. ***Second group*** including the patients with non-anatomical reduction of acetabular fractures or either (satisfactory and non-satisfactory for acetabular fractures which include 4 cases. As shown in **table 4**.**Relation between preoperative delay and radiological outcome:**

According to our thesis, there was a range of time from the trauma date to the operation, from one day to thirteen days. In order to ensure that the preoperative delay and the quality of reduction are correlated, we separated our cases into two groups: ***First group*** including the patients underwent operative management in the first week from the date of trauma which includes 14 cases**. *Second group*** we will look for any association between the preoperative delay and the patients who underwent operational management after the first week, which covers 4 cases. As shown in **table 5**.

Complications

Table 6; showed that the majority of the studied group 16 cases (88.9%) had clean wounds and two cases (11.1%) had Superficial tract. Superficial tract infection in one patient, that patient was suffering from general surgery pilonidal sinus. After management of this problem the patient improved. The other patient was diabetic and hypertensive. It was managed by controlling blood glucose level and improvement of the general condition. In this study, no cases developed deep venous thrombosis (DVT).

Case Presentation:

Case 1: 35 years old patient, A teacher. motor vehicle accident. Patient admitted to hospital on the day of trauma. Primary survey at polytrauma unit. Diagnosed Lt transverse acetabular fracture. Merele D'Aubigné score 18 (excellent) after 6 months from the trauma.

Table 1: patient characteristics, Mallampati classification, time for intubation and duration of surgery among three studied groups.

Variables	Group C (n=21)	Group K (n=21)	Group M (n=21)	P value
Age (years) Mean ± SD	35.2 ± 9.68	35.2 ± 4.92	33.1 ± 7.59	0.592
Sex (N. %) – Male – Female	 8 (38.1%) 13 (61.9%)	 13 (61.9%) 8 (38.1%)	 13 (61.9%) 8 (38.1%)	0.2
BMI (Kg/m^2) Mean ± SD	26.6 ± 2.93	25.9 ± 2.62	26.8 ± 2.22	0.685
Physical state (N. %) – ASA – ASA	 17 (81%) 4 (19%)	 16 (76.2%) 5 (23.81%)	 13 (61.9%) 8 (38.1%)	0.35
Mallampati class (N. %) – 1 – 2	 9 (42.9%) 12 (57.1%)	 11 (52.3%) 10 (47.6%)	 8 (38.1%) 13 (61.9%)	0.73
Time for intubation (sec) Mean ± SD	17.11±3.09	17.77±3.79	17.04±3.90	0.771
Duration of surgery (min) Mean ± SD	75.89±4.58	78.59±5.54	76.51±4.28	0.188

Non-significant: P >0.05, data was expressed as Mean ± SD or number (percentage) using one way ANOVA & Chi square test- Group C= control group - N= number - Group k = ketamine group - BMI= body mass index - group M= magnesium sulphate group - ASA = American Society of anesthesia

Table 2: Blood cortisol level changes among the three studied groups

	Group C (n=21)	Group K (n=21)	Group M (n=21)	*P Value	Post Hoc test
Blood cortisol level 45 minutes before operation (mcg/dl)	13.06±0.65	13.21±1.14	12.97±0.84	0.693	-------
Blood cortisol level 10 minutes after intubation (mcg/dl)	15.04±0.51	14.56±0.48	12.24±0.99	0.000	**P1, P2, P3=0.000**
Difference in Blood cortisol level	2.88±0.82	1.36±1.30	-0.72±1.13	0.000	**P1, P2, P3=0.000,**
P 4	0.000	0.000	0.008		

Data were expressed as mean±SD; using one way ANOVA followed by Post Hoc test, Non-significant: P >0.05, Significant: P ≤0.05P1=Comparison between group C and group K; P2=Comparison between group C and group M; P3=Comparison between group K and group M, P4= comparison within the same group between blood cortisol level 45 minutes before intubation and blood cortisol level 10 minutes after intubation (mcg/dl)

Table 3: Blood glucose level change among the studied groups.

Blood glucose level mg/dl	Group C (n=21)	Group K (n=21)	Group M (n=21)	*P Value	Post Hoc test
45 minutes before operation	92.2 ± 4.62	93.4 ± 5.28	92.64 ± 8.61	0.828	
1 minute after intubation	95.2 ± 9.62	94.4 ± 7.28	95.64 ± 8.61	0.956	
5 minutes after intubation	112.1 ± 3.37	107.5 ± 3.64	98.2 ± 3.13	**0.000**	P1= **0.0002** P2 **=0.000** P3= **0.000**
10 minutes after intubation	115.3 ± 4.48	109.9 ± 2.83	98.8 ± 2.1	**0.000**	P1=**0.000** P2 **=0.000** P3 **=0.000**
**P value	**<0.001**	**<0.001**	**<0.001**		

Data were expressed as mean and SD using one way ANOVA followed by Post Hoc test when significant*P=Comparison between the three groups, -P1=Comparison between group C and group K, -P2=Comparison between group C and group M, -P3=Comparison between group K and group M **P=Comparison within the same group

Table 4: Number of patients need intraoperative fentanyl and total amount of fentanyl among the studied groups

Variables	Group C (n=21)	Group K (n=21)	Group M (n=21)	P value	
Number of patients needed fentanyl (N. %) – No – Yes	3 (14.3%) 18 (85.7%)	13 (61.9%) 8 (38.1%)	20 (95.2%) 1 (4.8%)	**<0.001**[1]	**P1= 0.004,** **P2= 0.000** **P3= 0.02**
Amount of fentanyl (µg) Median (IQR) Range	75 (5) (60 – 90)	75 (30) (60 – 90)	75	1.00[2]	

Data were expressed as number (percentage) or median (Interquartile range) using [1]Fisher exact test, [2]Mann-Whitney U test, Non-significant: P >0.05, Significant: P ≤0.05; P1=Comparison between group C and group K, -P2=Comparison between group C and group M, -P3=Comparison between group K and group M

Table 5: Post-operative sore throat among the studied groups

Variables	Group C (n=21)	Group K (n=21)	Group K (n=21)	P value	
Post operative sore throat (N. %) – No – Yes	4 (19%) 17 (81%)	8 (38.1%) 13 (61.9%)	17 (81%) 4 (19%)	**<0.001**[1]	**P1= 0.306** **P2= 0.000** **P3= 0.011**

Data were expressed as number (percentage) using *1Fisher exact test, Non-significant: P >0.05, Significant: P ≤0.05; P1=Comparison between group C and group K, -P2=Comparison between group C and group M, -

P3=Comparison between group K and group M

DISCUSSION

Large surgical exposures of the deep pelvic structures were necessary for formal open reduction with internal fixation of acetabular fractures using a variety of techniques. These procedures have been linked to serious complications, significant blood loss, infection, extended operating times, major blood vessel or nerve damage, and issues with wound healing**[8]**.

Therefore, it was preferable to think of less intrusive options to traditional therapy using open approaches. Picture-guided surgical navigation has made it easier to do percutaneous reduction and fixation of a specific acetabular fracture pattern **[8]**.

The aim of treating transverse acetabular fractures is to restore articular architecture with stable internal fixation so that the patient can be mobilized as soon as possible **[8]**.

Percutaneous methods should ideally be employed where fractures are receptive and/or individuals are contraindicated to larger treatments. Using percutaneous methods to treat transverse acetabular fractures was reported to result in a shorter hospital stay and lower morbidity in early results of numerous trials **[8]**.

The objective of this study was to evaluate the functional outcome after management of transverse acetabular fractures by percutaneous technique.

According to our results, the number of patients included was 18 patients. That was close to **Elsaka et al.** who include 20 patients in their study**[9]**. In the line with our study, **Einhorn et al.** reported 23 patients included in their study**[10]**. However, **Alsheikh et al.** reported that 36 patients included in their study**[11]**. **Dinesh et al.** also included 30 patients in their study**[12]**.

As regard Average Age in Years, the average age of our patient was 29.8 ranging from (20 – 60). That was close to **Elsaka et al.** who demonstrated the average age of their studied group was 36 ranging from (18-70) **[9]**. However, **Alsheikh et al.** reported the average age of their studied group was 38 ranging from (18–72) **[11]**. Additionally, **Dinesh et al**. reported the average age of their studied group was 40 ranging from (18 – 80) **[12]**. **Einhorn et al.** reported the average age of their studied group was 70 ranging from (47–85) **[10]**.

According to sex distribution in our study, there was 14 male (78%) and 4 females (22%). However, **Elsaka et al.** reported 17 male (85%) and 3 females (15%)**[9]**. Additionally, **Alsheikh et al.** reported 29 male (85%) and 7 females (15%)**[11]**. **Dinesh et al.** reported 17 male (85%) and 3 females (15%)**[12]**. **Einhorn et al.** reported 25 male (85%) and 5 females (15%)**[10]**.

Regarding mechanism of injury, in this study, Motor vehicle accidents were the commonest cause of injury (72.2%) followed by Falling from height (16.6%) then motorcycle and pedestrian (5.6%) for each. That was in agreement with **Alsheikh et al.** who reported that motor vehicle accident (75%) was the commonest cause of injury, followed by harm from a fall, an automobile accident, or being hit by a falling object (25%)**[11]**. Elsaka et al., however, found that falls from height accounted for 40% of the injuries sustained by the remaining 12 patients, with road traffic accidents (RTAs) accounting for the majority of injuries (60%) **[9]**. **Dinesh et al [12]** revealed that car accidents were the most frequent cause of injuries. Additionally, **Einhorn et al.** indicated that car accidents were the most common cause of injuries **[10]**.

As regard time of surgery, the study found that the average duration was 5.96±5.6 days, with a range of 1 to 13 days. That was comparable to the findings of **Elsaka et al.** who found that the average time between an accident and surgery was eight days **[9]**. According to Einhorn et al., the average preoperative delay was 14, which is consistent with our findings **[10]**. Nonetheless, according to **Alsheikh et al.** the average length of time a patient spent in the hospital was 26.7± 24.4 days **[11]**.

As regard operative time Elsaka et al. the average fluoroscopic time was 90 seconds and the screw took an average of forty-five minutes to operate. The screw took an average of 10 minutes to operate during our investigation **[9]**.

As regard Matta Radiological results, in this study, 14 patient (77.7%) had anatomical outcome, 3 patient (16.6%) had satisfactory outcome and only 1 patient (5.6%) had unsatisfactory outcome. No data reported in other studies.

As regard functional outcome according to Merele D Aubigne scoring system, In the current study, three patients (11.1%) had good clinical outcomes, fifteen patients (83.3%) had excellent clinical results, and only one patient (5.6%) got a fair grade. That was comparable to the final outcomes reported by **Elsaka et al. [9]** following a 6-month follow-up, which revealed that 13 patients had excellent scores and 7 patients had good scores **[9]**. Furthermore, out of the thirty cases, **Einhorn et al.** reported that 21 cases were excellent, 3 cases were very good, 5 cases were good, and 1 case was fair **[10]**.

As regard Clinical outcome in relation to the reduction achieved:

Being the most important determining factor of the closed reduction and internal fixation clinical outcomes of an acetabular fracture, the adequacy of surgical reduction was compared to the incidence of various clinical results. **Elsaka et al. [9]** not reported, **Alsheikh et al. [11]** not reported, **Einhorn et al. [10]** not reported, **Dinesh et al. [12]** not reported.

In our study, among the group under study, Merle d'Aubigne and the radiologic result were significantly correlated ($p<0.05$).

As regard relation between preoperative delay and radiological outcome:

Elsaka et al. [9] not reported, **Alsheikh et al. [11]** not reported, **Einhorn et al. [10]** not reported, **Dinesh et al. [12]** not reported.

In our study, preoperative delay and the Matta rating system for the acetabular and pelvic components were significantly correlated ($p<0.05$).

As regard complications, the majority of the 16 cases in this study (88.9%) had no surgical complications, but two cases (two individuals) experienced difficulties in the form of superficial tract infections. No post-traumatic arthritis, ischemic necrosis of the femoral head, iatrogenic vascular or nerve injury, or heterotopic ossification **Elsaka et al.[9]** two patients with medial cortical penetration and two with minor limb deformities. **Alsheikh et al. [11]** stated Only a tiny portion of the study's subjects had post-operative problems: four patients had sexual dysfunction and three individuals had distal limb anomalies in terms of neurovascular functioning **[11]**. **Einhorn et al.** reported screw loosening in one patient, tendinopathy in one and two cases required revision**[10]**.

The findings of this study prove that percutaneous fixation of transverse acetabular fractures has good to excellent results in patients, with significant improvements in the patient rehabilitation as well as in the radiographs taken after 6 months up to 2 years.

The advantage of percutaneous fixation is the immediate stability obtained which leads to early weight bearing mobilization. Other important advantages over formal open procedures are the decreased operative morbidity, blood loss, time to perform the procedure, wound healing, infection and blood loss are all complications that are more attributable to the open procedure than to the actual fractures themselves **[8]**.

This study's limitations include a small sample size, stringent inclusion criteria and scarce resources. A further limitation of the study is its design, which did not include a control group and made it impossible to evaluate whether the new procedure was more valuable than the traditional one.

Conclusion

In conclusion, we find that employing fluoroscopic guidance to perform percutaneous screw fixation of transverse acetabular fractures is a safe and relatively simple surgical technique for treating non-comminuted and minimally displaced fractures. It has the benefits of early weight bearing, early rehabilitation, pain management, and, in some cases, the avoidance of a second procedure. One benefit of percutaneous acetabular fixation is that technique causes less disruption to soft tissues and is related with fewer problems, shorter surgical times, and less blood loss. Early fixation is linked to improved clinical and radiological results. To minimize significant soft tissue injury, adjuvant percutaneous transverse acetabular screw fixation is a viable and smart alternative to open reduction and internal fixation.

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