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RESEARCH ARTICLE

COMPLICATIONS AFTER POSTERIOR ACETABULAR WALL INTERNAL FIXATION – AVASCULAR NECROSIS AND NONUNION.

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Abstract

Introduction: Serious orthopaedics injuries caused by high impact trauma due to road traffic accidents are more prevalent in Saudi Arabia. Fractures of posterior wall are the most common type of acetabulum fractures. The outcome after surgical management of acetabular fracture is primarily related to the quality of articular reduction. This management is the most challenging task for surgeons.

Methodology: A retrospective cohort study was conducted in a tertiary care hospital, Riyadh, Saudi Arabia. All patients who underwent internal fixation for posterior wall acetabular fracture from October 2013 to September 2015 were included in the study. Post-surgical outpatient evaluation was done clinically by Merle D' Aubigne Y Postel - hip functional evaluation score and radiological assessment using Ficat classification for staging of avascular necrosis of femoral head.

Principal results: With increase in age, the function of hip declined. The step in fixation was found significantly associated with avascular necrosis ($p = 0.020$) and nonunion ($p = 0.020$). The gap was found significantly associated with nonunion only ($p = 0.001$).

Conclusions: Delay in surgery should be avoided if surgical management is decided for posterior acetabular wall fracture. Adequate surgical reduction of fracture of posterior acetabular wall is necessary. Screw seems to be a better choice of implant until further new evidence is received. A randomized controlled trial is needed to evaluate and compare different management options for fracture of posterior acetabular wall and to set standard guidelines for future.

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Introduction:-

The incidence of Acetabular fractures is increasing in developing countries because of rise in road traffic accidents (Robert S. Sterling, 2011). Acetabulum fracture counts about 0.5 to 8% of orthopaedic ward admissions (Grubor P, 2015) and out of this about 24 to 32 % have posterior wall involvement (Vincenzo Giordano et al., 2009). Currently about 1.5 million hip fractures occur every year (Robert S. Sterling, 2011). By the year 2050 the total number of hip fractures is expected to surpass 6 million worldwide (Robert S. Sterling, 2011).

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Fracture of acetabulum is not very common being related to high impact trauma always. The most common cause of such trauma is a road traffic accident, dashboard injury or a fall from height. Fall is the second commonest cause of acetabulum injury occurring in about 10% (Grubor P, 2015).

Sciatic nerve is the thickest and longest nerve of the body which contains both sensory and motor fibres. The location of sciatic nerve is prone to injury when an acetabulum fracture occurs, especially with posterior dislocation of hip. The common involvement is of common peroneal part (Ebraheim NA et al., 2007). The head of femur receives its blood supply from an arterial anastomosis. In this anastomosis, compromise of medial femoral circumflex artery, a branch of profundafemoris artery is most important cause of avascular necrosis of the head of femur due to fracture acetabulum and especially in dislocation of hip. Although a small portion of femoral head has alternate blood supply from a branch of obturator artery that runs in the ligamentum teres (Birhane A et al., 2015).

Rationale:-

In Saudi Arabia, cars are the main mode of transportation with approximately more than 6 million cars on road (Farah A. Mansuri et al., 2015). 20% beds in Ministry of Health hospitals in Saudi Arabia are engaged by Road traffic accident victims (Farah A. Mansuri et al., 2015). In the past 2 decades, 86,000 casualties and 611,000 injuries have been recorded in Saudi Arabia in road accidents (Farah A. Mansuri et al., 2015). Out of these, 7% had ended in disabilities (Farah A. Mansuri et al., 2015). The economic effects of road traffic accidents in Saudi Arabia projected in terms of potential productive years life lost (PPYLL) were examined in a study that has reported a 31.6% increase in deaths due to RTA among males in 1997-2002 compared with a 1.3% increase in deaths due to RTA among females. In Saudi Arabia, road traffic accidents are the major cause of hourly consultation to the health care facilities (Farah A. Mansuri et al., 2015).

When compared to other arab countries, Saudi Arabia has the second highest casualty rate due to road traffic accidents. Globally it is the 23rd country to have high number of casualties due to road accidents. World Health Organization has reported that in Saudi Arabia, a car accident occurs every second; while on average 17 people are killed in crashes daily.

Aim:-

The aim of this study was to assess the outcome of acetabular fracture in Saudi population after the surgical fixation procedure. The main objective was to note the complications of acetabular fixation with special focus on avascular necrosis and nonunion.

Materials and Methods:-

The study design was a retrospective cohort study. All male patients, Saudi nationals, who underwent surgical fixation for fracture of posterior acetabulum wall due to any cause at King Saud Medical City, Riyadh, Saudi Arabia were included. The period of surgical intervention was from 1st October 2013 to 30th September 2015. This study was approved by the Institutional Review Board and informed consent was taken from all study participants.

The data collected from medical records included patient's age, nationality, sex, cause and duration of fracture prior to admission, date of admission and surgery, any delay in surgery, percentage joint involvement, side of fracture, presence of dislocation, type of implant used, any associated fractures and co morbidities. Radiological investigations including x-rays and CT scan of pelvis were reviewed in hospital-based PACs system. Patients are routinely followed six weeks after surgery in the outpatient department. At follow up in the orthopaedic research clinic, clinical assessment was done using Merle D-Aubigne Y Postel (hip functional) score (David J. Biau et al., 2009). Sciatic nerve function was assessed clinically. Conventional x-rays of pelvis and hip joint were reviewed for any presence of step and gap at the site of surgical fixation. CT scan of pelvis was requested if there was suspicion of nonunion or avascular necrosis on plain x-rays and Ficat classification (Jawad et al., 2012) was used to stage the avascular necrosis of femoral head.

Totally 36 patients underwent surgery for posterior acetabular wall fracture during the study period. Approximate duration of outpatient follow-up for all patients was between nine months to two and half years. 1 non-Saudi national patient and 2 females were excluded from the study according to pre-decided exclusion criteria. 2 patients were noted to have avascular necrosis & total hip replacement before the start of study and were therefore excluded. 6 patients had lost their follow up earlier and were not accessible. 3 patients had provided incorrect contact information and 10 patients refused to participate in the study. Finally evaluation was done for 12 patients.

Statistical Analysis:-

The software used for data analysis was SPSS 21 and the results are presented as descriptive Statistics: frequency, percentage, range, means, median, 95% confidence interval and the inferential statistics: student-t-test for independent samples. Pearson's coefficient of Correlation, one way anova and χ^2 were used for testing the statistical significance at 5% level with 5% type I error and 20% power of the study. (Betty R.K and Jonathan A.C.S, 2009)

Results:-

The baseline characteristics of the patients are given in **Table 1**. Age of patients ranged from 18 to 65 years with mean \pm SE (mean) of 37.0 ± 4.4 years. The fracture for eleven patients (91.7 %) was due to road traffic accident and one (8.3%) had a history of fall. The fracture of posterior wall of acetabulum was divided in three grades according to the percentage of damage. One patient (8.3%) had < 25percent, 5 patients (41.7%) had 25-50 percent and 6 patients (50%) had >50 percent joint involvement. Six (50%) patients had an additional fracture (Upper limb(1), Lower limb(1), Both limbs(2), Pelvis(1), Ribs(1)). 4 patients (33.3%) had co-morbid illness (Lymphoma(1), Wegner's disease (1),Diabetes Mellitus& Hypertension (1), Diabetes, Hypertension and Ischemic heart disease (1)).

The Merle D - Aubigne Y Postel score was ranging from 6 to 12 with a mean \pm SE of 10.17 ± 0.57 and Pearson's Coefficient of Correlation of this score with Age in years showed a statistically significant negative high magnitude with $r = - 0.849$ ($P=0.000$) as observed in **Figure 1** with 95% confidence interval, but delay in surgery (days) did not show much correlation with the hip function score.

Based on Ficat classification, one patient (8.3%) was classified in category IIB, one patient (8.3%) in category IV and ten patients (83.3%) in category zero. Two patients (16.7%) had nonunion and two patients (16.7%) had developed avascular necrosis.

For the patient who had step, Sciatic Nerve was not involved after surgery and the radiological Ficat classification was observed to be IV with $\chi^2=12.0$ ($P=0.002$), experienced avascular necrosis, $\chi^2=5.45$ ($P=0.02$) and had nonunion $\chi^2=5.45$ ($P=0.02$).

Among 10 patients who had no gap, one patient (10.0%) had sciatic nerve involvement after surgery. One out of ten patients (10.0%) who had no gap, the Ficat classification was observed to be IIB, 1 patient (10.0%) had avascular necrosis. One patient (100.0%) who had step and 1 out of 11patients (9.1%) without step had avascular necrosis. 2 out of 10 patients with gap had non-union. One patient (8.3%) had poor hip function score (<7), 2 patients (16.7%) had fair score (8), 1 patient (8.3%) with medium (9) and good score (10) in each group, and 7 patients (58.3%) had very good score (11-12).

Merle score was compared to all variables shown in the **Table 2**. It was seen significantly related to AVN ($p = 0.017$) and percentage of fractured wall ($p = 0.05$) only. Among the 11 patients who had road traffic accident as the cause of fracture, one patient (9.1%) had a poor score, 2 patients (18.2%) had fair score, 1 patient (9.1%) had good score and 7 patients (63.6%) had very good score and a significant $\chi^2 = 12.0$ ($P=0.017$).

Among 8 patients with dislocation, 1 patient (12.5%) had POOR Merle score, 2 patients (25.0%) had FAIR score and 5 patients (62.5%) had VERY GOOD score. Of 2 patients whose sciatic nerve was found injured, 1 patient (50.0%) had a POOR score and 1 patient (50.0%) had VERY GOOD score. There were 8 patients without systemic illness and their average Merle score was 9.87 ± 0.81 . One patient was diabetic & hypertensive with a score of 11 ± 0.0 . One patient with diabetes, hypertension and ischemic heart disease had a score of 9.0 ± 0.0 . One patient with lymphoma had a score of 12 ± 0.0 and one patient with Wegner's disease had a score of 11.0 ± 0.0 . There was an insignificant difference in the mean Merle scores $F=0.322(0.855)$.

Two patients had avascular necrosis and both had POOR Merle score. Of two patients with nonunion, 1 patient (50.0%) had a FAIR score and the other patient had GOOD score. Seven patients were implanted with plate. Of them 1 patient (14.3%) had a FAIR score, 1 patient (14.3%) had MEDIUM score, 1 patient (14.3%) had GOOD score and 4 patients (57.1%) had VERY GOOD score. Out of 3 patients who were implanted with both plate and screws, 1 patient (33.3%) had POOR score, 1 patient (33.3%) had FAIR score and 1 patient (33.3%) had VERY GOOD score. 2 patients who were implanted with screws, both (100.0) had VERY GOOD score with $\chi^2 = 6.204$ ($P=0.624$) and is given in **Figure 2**. There was no significant difference in the category of delay in surgery.

Table 1:- Descriptive Statistics of study participants.

Baseline Characteristics	n=12	(%)	Baseline Characteristics	n=12	(%)
Age in Years - 18-25	2	16.7	Fractured Wall - <25%	1	8.3
26-45	7	58.3	25-50%	5	41.7
46-65	3	25.0	>50%	6	50.0
Cause of Fracture - RTA	11	91.7	Sciatic Nerve Injury - Pre Op	2	16.7
Fall	1	8.3	Post Op	1	8.3
Fracture Side - Right	8	66.7	Normal	9	75.0
Left	4	33.3	Delay in Surgery - <7 Days	2	16.7
Dislocation - Yes	8	66.7	>7 Days	10	83.3
No	4	33.3	Fixation - Plate	7	58.3
Poly trauma - Yes	6	50.0	Screws	2	16.7
No	6	50.0	Plates + Screws	3	25.0
Co-morbid - Yes	4	33.3	Gap - Yes	2	16.7
No	8	66.7	No	10	83.3
			Step - Yes	1	8.3
			No	11	91.7

Table 2:- Inferential Statistics of Merle Score for patients under study.

Characteristics	Mean ± SE	Test (P-value)	Characteristics	Mean ± SE	Test (P-value)
Cause - RTA	10.2 ± 0.61	t = 0.59	Sciatic N. Damage		
Fall	9.0 ± 0.00	(0.56)	Pre Op - Yes	9.0 ± 3.00	t = 0.89
Affected Side			No	10.4 ± 0.49	(0.39)
Right	10.6 ± 0.53	t = 1.14	Post Op - Yes	11.0 ± 0.00	t = 0.42
Left	9.2 ± 1.37	(0.28)	No	10.0 ± 0.62	(0.68)
Dislocation			Fixation - Plate	10.4 ± 0.57	
Yes	10.0±0.82	t = 0.39	Screws	11.5 ± 0.50	F = 1.47
No	10.5±0.64	(0.70)	Plate + Screws	8.6 ± 1.76	(0.27)
PolyTrauma			Step - Yes	8.0±0.0	t = 1.15
Yes	9.5 ± 0.95	t = 1.18	No	10.3±0.59	(0.27)
No	10.8 ± 0.60	(0.26)	Gap - Yes	9.0±1.00	t = 0.89
Wall Fracture (%)			No	10.4±0.65	(0.39)
<25	6.0 ± 0.00				
25 - 50	11.0 ± 0.77	F = 4.10			
>50	10.1 ± 0.60	(0.05)*			

*Statistically significant at 5% level

Figure 1:- Scatter Diagram for Merle Score.

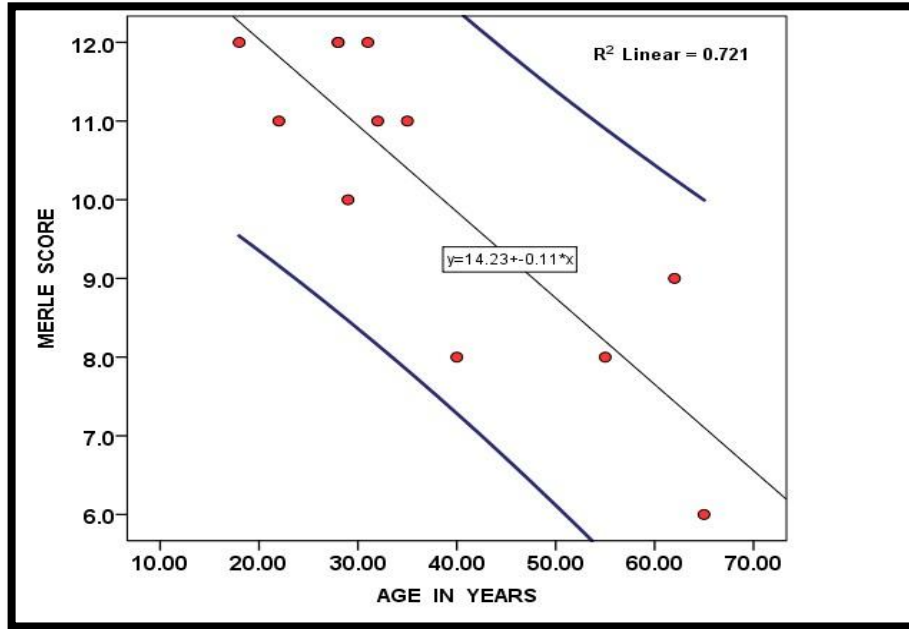
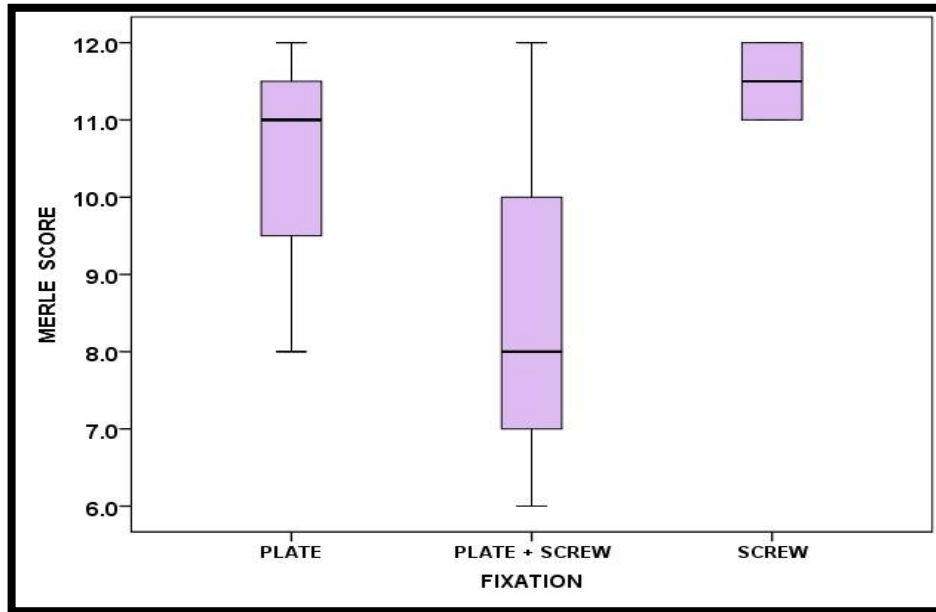


Figure 2:- Whiskers Box Plot for Merle Score.



Main findings of this study were:-

1. Step in fixation was significantly associated with avascular necrosis (p = 0.020) and nonunion (p = 0.020).
2. The gap was significantly associated with nonunion only (p = 0.001).

Discussion:-

Being rare, fracture of posterior acetabular wall has not been studied extensively in past. There are no randomized controlled trials available comparing the management options. In literature we mostly have case reports or case series which have not comprehensively reviewed the complications of different management modalities. In an older

study the percentage of avascular necrosis was reported to range from 18 to 32% (Michael R. Baumgaertner, 1999). Another recent study showed 11.53% incidence of avascular necrosis (Magu NK et al., 2014) while in our study it was 17%. We, therefore, present new and recent data related to the complications of posterior acetabular wall fracture and their relation to surgical intervention.

Avascular necrosis and nonunion of posterior acetabular wall fracture are related to poor surgical reduction. As noted in our study that absence of step and gap after surgical fixation is related to higher hip function scores. Similarly post-fixation step and gap will provide poor hip function and possibility of nonunion. There is no recommended protocol for radiological evaluation other than conventional x-rays after surgical fixation but some surgeons recommend an immediate postoperative CT scan of hip before discharge, to observe the quality of reduction (P.V. Giannoudis and V.S. Nikolaou, 2008). It is already recommended to consider total hip replacement as primary procedure in patients who have comminute fracture of posterior acetabular wall (James L. Guyton and Edward A Perez, 2012). Until we have more data comparing post OP radiological assessment to no assessment; we suggest performing a confirmatory CT scan of hip soon after procedure. It will aid in earlier detection of potential complications.

The choice of implant used in surgery is based on fracture anatomy and surgeon's choice. In one review some benefits of different implants over each other i.e. plate, screws or both together have been postulated (Zhang Y et al., 2013). There are no RCT's comparing the two options and no recommendation of using one method over other. Nevertheless at times surgeon has to use screws to hold the broken bone pieces in addition to plate fixation, to achieve complete reduction. Also at times two plates should be used to achieve reduction (Ebraheim NA et al., 2007). In our study, the clinical outcome was compared to the type of implant used at the time of surgical fixation. As we can see that the screw is a better option when compared to plate or plate plus screw (Rosario Spagnolo et al., 2009). However the availability of implant and the learning curve of surgeon also play a role in choosing the type of implant.

The presence of dislocation has an impact on sciatic nerve function and avascular necrosis (Iselin LD et al., 2013) observed an average delay of seven days from trauma to surgery Most of our patients were operated later than 7 days. We recommend early intervention for patients who are candidates for surgery as it will help in reduction of late complications.

Most of our patients were young drivers below age of 40 years. The accident rate cannot be controlled except efforts to be done at national level but appropriate and timely surgical intervention for such patients soon after fracture can prevent future complications. If they have to undergo hip arthroplasty after few years, it is associated with related complications. Careful selection of choice of intervention and proper complete follow up will markedly reduce permanent disability in our patients.

There is essential need of a randomized control trial to compare and evaluate different management options for fracture of posterior acetabular wall, types of implants used, best time for surgery and post-operative clinical and radiological assessment. The trial should follow the patients for longer duration to compare the long term complications among different groups - mainly avascular necrosis and nonunion.

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