Marginal impaction as a determinant of functional outcome in acetabular fractures involving the posterior wall

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Background
Several variables have been accused for the poor functional results following posterior wall fractures. The authors conducted this study to identify the relative risk of marginal impaction fractures for developing a poor result.
Patients
Cases of acetabular fractures with posterior wall components associated with marginal impaction were compared with the same pattern of fractures without marginal impaction. Patients with recognized variables that may affect the outcome were excluded, including femoral head injuries, nonanatomic reductions, avascular necrosis, deep infection, heterotopic ossification grade III and IV, obesity, and problematic lower limb injuries. Marginal impaction injuries were openly elevated and autografted from the greater trochanter, followed by rigid internal fixation for early postoperative mobilization. A total of 40 cases were excluded for the aforementioned reasons, leaving 27 cases of marginal impaction and 38 cases of control. The average period of follow-up was 35.7 months.
Results
Based on the Merle D'Aubigné and Postel functional score, the marginal impaction grafting group revealed 11 (40.7%) excellent, 7 (25.9%) very good, 6 (22.2%) good, one (3.8%) fair, and two (7.4%) poor results. However, the control group showed 16 (42.1%) excellent, 10 (26.3%) very good, 8 (21.1%) good, one (2.6%) fair, and three (7.9%) poor results.
Conclusion
Taking marginal impaction as a sole variable, adequate grafting and fixation of the osteochondral fragment did not seem to make a statistically significant difference (P=0.9) regarding the end functional results of these patients.

Keywords:
acetabular fractures, functional outcome, marginal impaction, posterior wall

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Introduction

Restoration of the patient's prefracture level of activity and hip function is the goal of any acetabular surgery [1]. However, this is difficult especially with the increasing severity of trauma and the more complex and comminuted fracture patterns [2,3].

Involvement of the posterior wall accounts for about one a third of acetabular fractures [4]. This increases to about 75% of complex fracture patterns [5]. Despite their apparent innocence, literature reports on the postoperative patients' function have been frustrating, with about 20% of patients having poor results [3,6–13]. Various factors have been accused of this poor outcome, including fracture comminution, nonanatomic reductions, avascular necrosis, associated femoral head injuries, and lastly marginal impaction fractures [5,10,13,14].

Marginal impaction is a pattern of injury that has originally been described by Shenck [15] in 1962 in many intra-articular fractures, namely, fractures of the distal end of the Radius. Letournel and Judet [4] also used the terms 'marginal impaction' or 'depression fracture' to describe a rotated impacted single or multifragmented fracture with depression of the osteochondral fragments into the underlying cancellous bone [6]. They suggested elevation of the impacted fragment(s) and grafting of the resultant defects. Such an attempt for an anatomic reconstruction provides the patients with the best chance for a good long-term function without or with minimal degenerative changes of the affected joints [16].

In this study, we tried to assess the effect of the presence of marginal impaction on the prognosis and postoperative functional outcome of simple and complex acetabular fracture patterns involving the posterior wall.

Patients and methods

To assess this particular variable in the different injury patterns encountered in acetabular fractures, we collected 203 cases of acetabular fractures that were treated surgically, under our care during the period between January 2005 and June 2015. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Cairo University, Cairo, Egypt. According to the Letournel classification system [1], we gathered all cases that were associated with a posterior wall component and have a full follow-up record for a minimum of 2 years. These mounted to 105 acetabular fractures, namely 43 posterior wall fractures, 14 associated posterior wall/posterior column, 11 associated T with posterior wall, and 37 associated transverse with posterior wall fractures. Among these, 39 cases were associated with marginal impactions, leaving 66 cases that could be dealt as control with similar patterns of fractures, namely, associations with posterior wall components. All fractures were operated upon within the first 3 weeks of injury, excluding cases that are classified as neglected or late presenters.

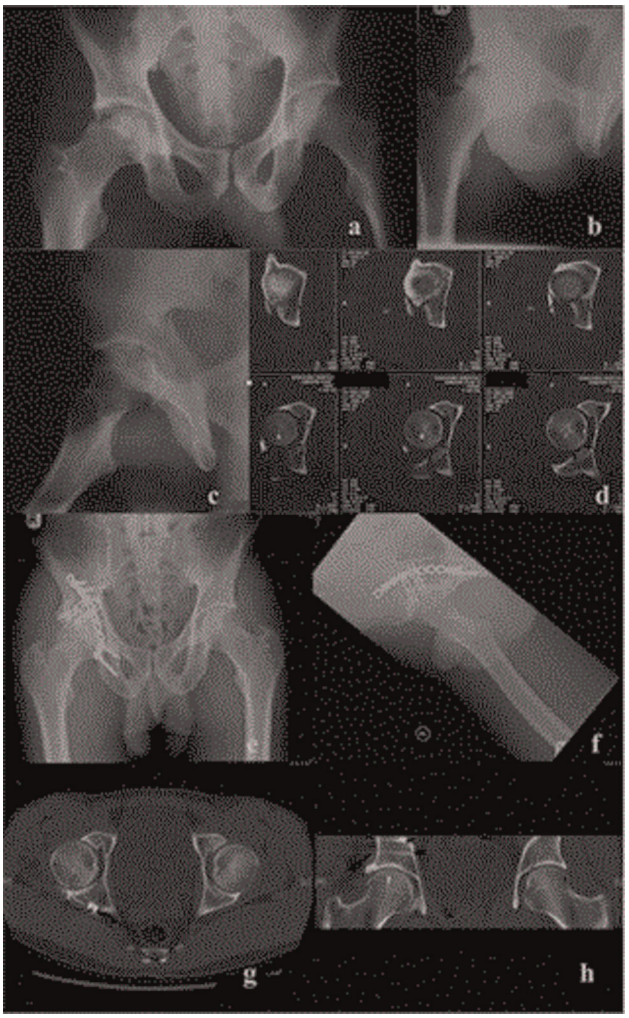
We excluded all other recognized variables that might have an effect on the patients' hip functional results, such as associated femoral head injuries, nonanatomic reductions, that is, 2 mm or more, and cases with resulting complications such as deep infection, avascular necrosis, heterotopic ossification grade III and IV, and associated nerve injuries. Obese patients with BMI greater than 35 or those having associated problematic lower limb skeletal and nonskeletal injuries were equally excluded from both groups. Applying the previous criteria of exclusion left us with 27 cases of marginal impaction and 38 cases of controls.

All the patients were treated in Kasralainy University Hospitals, which function as tertiary referral centers for pelvic and acetabular injuries. Patients' documents were prospectively kept and personally reviewed by the authors, who were also the treating surgeons.

All the patients had an anteroposterior plain radiographic examination of the pelvis and iliac and obturator oblique views at the initial presentation. Computed tomography (CT) scans were done after resuscitation and stabilization of the patient and after one attempt of a closed reduction of any associated posterior dislocation of the hip (Fig. 1). Fractures were reduced openly, and associated marginal impactions were elevated and grafted from the greater trochanter as an integral part of fracture reduction. Fractures were internally fixed with a combination of interfragmentary screws and plates to obtain a rigid fixation that would allow early mobilization with the use of continues passive motion (CPM) from day two after surgery. Postoperative evaluation consisted of an anteroposterior view of the pelvis, and iliac and obturator oblique views of the operated hip. Postoperative CT scans were obtained for a number of selected cases. Postoperative radiological evaluation focused on residual articular displacement in mm for either the posterior wall or other acetabular components.

Patients were brought to regular follow-up visits with radiological evaluation repeated at 6 weeks, 3 months, 6 months, and yearly thereafter. Weight bearing was allowed according to union and in general a

Figure 1



(a–d) Associated posterior wall with posterior column fracture with marginal impaction in an 18-year-old male after a motorcycle accident. Impacted fragments were elevated, and the fracture was fixed using a combination of spring plates and a long reconstruction buttress plate. (e–h) Follow-up radiographies and computed tomography scan taken after 8 years from surgery showing complete union of the fracture and a nearly normal hip. The patient was rated 18/18, with an excellent clinical result.

relatively longer period of restricted weight bearing was chosen in cases of marginal impactions where the articular fragments were elevated and grafted.

The last available radiological investigation was used to assess osteoarthritis, avascular necrosis, and/or heterotopic ossification. Radiological changes of osteoarthritis have been graded according to Kellgren and Lawrence [17] grading system.

The minimum period of follow-up was 2 years. Starting from the 6-month follow-up visit, clinical examination included assessment of hip function and grading by the modified Merle D'Aubigné and Postel [18] scoring system (Table 1). Complications were also noted and investigated.

Statistical analysis

SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, Illinois, USA) statistical program was used for data analysis. Categorical data were presented as frequencies (%) and relative frequency (percentage). Continuous data were presented as means (SD), and medians (quartiles). Comparison between the study groups was done using χ^2 test, unpaired *t*-test, and Mann–Whitney test as appropriate. *P* value less than 0.05 was considered statistically significant.

Results

Among the group of marginal impaction, there were 25 males and only two females. Their average age was 37 years, with the youngest age of 22 years and the oldest 60 years. Fracture types included 15 posterior wall fractures, five associated posterior wall/posterior column, six associated transverse with posterior wall fractures, and one associated T with posterior wall fracture. All the patients had sustained high-energy trauma, with eight of them having associated skeletal injuries. All cases were operated upon through the posterior Kocker–Langenbeck approach, either in the lateral approach in 17 cases, or in the prone position in nine, and a transtrochanteric extension was added in one case. Additional ilioinguinal approach was added to address the anterior column in the case with T-shaped fracture. The shortest period of follow-up was 24 months and the longest was 96 months, with an average of 33.7 months.

Reviewing the control group, after application of criteria of inclusion, we were left with 38 cases. There were 35 males and three females, with a mean age of 35.7 (range: 21–53) years. There were 14 posterior wall fractures, seven associated posterior wall/posterior column, 12 associated transverse with posterior wall, and five associated T with posterior wall fractures. Similar to the marginal impaction group, all patients had sustained high-energy trauma, with 13 of them having associated skeletal injuries. Cases were operated upon through the Kocker–Langenbeck approach (17 in the lateral and 15 in the prone position). A transtrochanteric extension was added in one case, whereas an ilioinguinal approach was added in three cases. Patients in this group had a mean follow-up of 39.1 months (range: 24–84 months).

The demographics, injury, and treatment characteristics of both groups are summarized in Table 2.

Functional outcome as assessed at the last follow-up using the modified Merle D'Aubigné and Postel [18] scoring system was compared between the two groups. For the marginal impaction group, there were 11 cases rated 18, with an overall excellent result; another four cases also rated 18 but showed some radiological changes of OA and therefore were classified as very good and three cases were rated 17 and were classified as very good, making a total of seven very good cases; six cases were classified as good, with rating between 15 and 16; one fair case; and two poor cases. In summary, there were 11 excellent, seven very good, six good, one fair, and two poor results (Table 3).

Regarding the control group, there were 16 cases rated 18, with an overall excellent result; another five cases also rated 18 but showed some radiological changes of OA and therefore were classified as very good; five cases were rated 17 and were classified as very good, making a total of 10 very good cases; eight cases were classified as good with rating between 15 and 16; one

Table 1 Modified Merle D'Aubigné and Postel [18] scoring system

	Pain	Range of Motion	Ambulation
6	None	Flexion greater than 90°°	Normal
5	Slight or intermittent; normal activity	Flexion 70–90°	No cane; slight limp after long distance
4	Pain after ambulation; easy walk of half an hour or more	Flexion 50–70°	Limp; long distance with cane or crutch
3	Moderately severe; walking no more than 20 min	Flexion 30–50°	Significant limp; cane permanently
2	Severe; ambulation limited to 10 min	Flexion <30°	Very limited; two canes
1	Severe; prevents ambulation	Very restricted	Bedridden

Table 2 Patients' demographics, injury and treatment characteristics of both groups

	Marginal impaction group (*n*=27)	Control group (*n*=38)	*P* value
Age (years)			
Mean±SD	37±12	35.7±10	0.6
Range	22–60	21–53	
Sex			
Male	25	35	0.68
Female	2	3	
Follow-up period (months)			
Mean±SD	33.7±14	39.1±12	0.1
Range	24–96	24–84	
Mode of trauma			
MCA	13	19	0.98
Fall from height	5	7	
Pedestrian accidents	9	12	
Type of acetabular fracture:			
Posterior wall	15	14	0.35
Posterior wall-Posterior column	5	7	
Transverse-Posterior wall	6	12	
T-shaped	1	5	
Surgical approach			
Kocher-Langenbeck alone	25	34	0.77
Combined with ilioinguinal	1	3	
Transtrochanteric	1	1	0.9
Associated injuries	**8**	**13**	
Chest	1	1	
Abdominal	1	1	
Urologic	0	1	
Skeletal	**6**	**10**	
Spine	1	1	
Lower limb	4	8	
Upper limb	2	3	

MCA, motor car accident.

Table 3 Functional outcome score at last follow-up for both patient groups

Grade	Marginal impaction group	Control group	*P* value
Excellent (18/18)	11	16	0.9
Very good (18/18)[?]	4	5	
Very good (17/18)	3	5	
Good (15–16/18)	6	8	
Fair (13–14/18)	1	1	
Poor (12 or less)	2	3	
Total	27	38	

*Cases that were rated 18/18 but showed heterotopic ossification, slight malunion of the acetabulum, some osteoarthritic changes or secondary surgical congruence.

fair case; and three poor cases. In summary, there were 18 excellent, 10 very good, eight good, one fair, and three poor results (Table 3).

At the final follow-up, variable radiological changes of osteoarthritis has been graded according to Kellgren and Lawrence [17] grading system. Three patients in each group having grade 3 and 4 changes were considered to have a poor radiological outcome. Moreover, reviewing the patient records for re-operations, two patients in the marginal impaction group and four patients in the control group were found to have had total hip arthroplasty. The main indication was pain associated with post-traumatic arthrosis. The timing of the arthroplasty surgery ranged from 6 months to 3 years postoperatively.

Discussion

Despite an anatomical reduction, the clinical outcome of posterior wall fractures may be surprisingly poor. This has been explained in the literature with different variables incriminated as the factors contributing to this apparent paradox [5,10,13,14,19,20].

Marginal impaction, though remained ignored for a significant period of time in the literature, the recent specialized publications [3,5,14,16,20,21] observed its importance and questioned its contribution as an independent factor adversely affecting the functional outcome of this subset of fracture types.

Kreder *et al.* [14], considered marginal impaction to be independently associated with the development of arthritis, whereas comminution of the posterior wall was associated with a higher likelihood of residual displacement, which in turn was associated with arthritis. Moreover, they observed marginal impaction, along with older age and arthritis, to be directly and indirectly associated with the need for total hip replacement (THR) during their period of study. Those findings were consistent with those of Wolinsky *et al.* [22] who found that the presence of marginal impaction, intra-articular fragments, a fracture of the posterior wall, and an older age correlated highly with the need for THR after operative fixation of fractures of the acetabulum.

However, Moed *et al.* [3] declared marginal impaction to be of borderline independent statistical significance with respect to the clinical outcome in contrast to the more common poor clinical outcome in patients over 55 years of age and in those with intra-articular comminution, delay in reduction of the hip of more than 12 h, and avascular necrosis. Conversely, as well, Matta [5] considered the presence of a lesion of the femoral head to result in a worse clinical outcome but not marginal impaction, intra-articular fragments, initial displacement of the fragment, and associated injuries.

Furthermore, the study by Giannoudis *et al.* [16] also emphasized that elevation of the articular impaction and supporting them with bone graft leads to joint preservation with satisfactory overall medium-term functional results. However, univariate linear regression analysis of their functional outcome data showed that factors associated with worse pain were increasing age and an inferior location of the impaction.

In this work, we studied the functional outcome of acetabular fractures involving the posterior wall taking marginal impaction as a sole variable, with exclusion of cases with any other variable that would affect the outcome. We similarly concluded that on a short- to a medium-term follow-up, careful identification of the lesion with adequate grafting and fixation of the osteochondral fragment did not seem to make a statistically significant difference (P=0.9) regarding the end functional results of these patients. A significant correlation between the functional and radiological outcomes was also noted. In addition, we found the need for total hip replacement to be closely associated with the presence of a poor radiological grade.

Strengths of this study include the presence of study and control groups with patients that were age and injury matched. Despite the retrospective nature of the study, patient data were prospectively collected. Downside to this study is the rather limited number of cases, which did not allow us to compare the results for each of the different types of acetabular fractures. Moreover, a postoperative CT scan as well as a last follow-up CT to exclude a delayed secondary collapse may have also been useful in providing further evidence of stability of the construct over time. Lastly, a longer time follow-up over more than 10 years may be more significant in our recommendation for scrutinizing the presence of such easily missed and frequently ignored lesions.

Conclusion

Marginal impaction does not affect the midterm functional results of acetabular fractures; however, ? further work is needed to be done to study its effect on the variable fracture patterns.?

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Conflicts of interest

There are no conflicts of interest.

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