Outcome of alternative approach to displaced acetabular fractures


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A R T I C L E   I N F O

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A B S T R A C T

Introduction: Anatomical reduction of displaced acetabular fracture is not without its limitations and complications. This study is conducted to assess clinical and radiological outcomes as well as complications of treating displaced acetabular fractures with emphasis on anatomical reduction in weight-bearing area, mainly the posterior column, and imperfect reduction of the anterior column is acceptable. However, stability of both columns is mandatory.

Methods: It was a retrospective study carried out in a Level 1 orthopaedic trauma centre. 23 patients (17 males, 6 females) with average age of 50.1 years (range, 36–68 years) with displaced acetabular fracture treated with combined incisions and plate-cable systems were included. There were 3 elementary and 18 associated fractures according to Letournel classification. Average follow-up was 23.5 months (range, 12–38.7 months). Mean operation time was 160 min (range: 75–320 min). Functional scores were evaluated using Harris Hip Score (HHS) whilst reduction was assessed by Matta criteria. Any displacement of reduction, osteoarthritis, heterotopic ossification, and other complications was recorded.

Result: 65.2% (15/23) of the patients obtained excellent HHS and 21.7% (5/23) had good HHS. There were 12 anatomical, 6 imperfect, and 5 poor reductions. No displacement was recorded in final follow-up. Complications documented: three lateral femoral cutaneous nerve injuries, two conversions to total hip arthroplasty, three Brooker stage 1 heterotrophic ossification, one pulmonary embolism and one screw irritation. No incidence of wound breakdown, infection and radiological osteoarthritis was reported.

Conclusions: Imperfect reduction of the anterior column provided clinical outcomes that are as good as total anatomical reduction. This approach minimizes soft tissue damage and reduces perioperative morbidities.

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Introduction

In order to restore congruency of the articular surface and minimize perioperative morbidities in both elementary or associated displaced acetabular fractures, open anatomical reduction, stable internal fixation and early ambulation are crucial elements [1–5]. Extensive exposures such as extended iliofemoral approach, triradiate approach and combined two incisions are required to obtain good visualization that enable reduction and fixation [2–4]. There are limitations and complications in all approaches, such as limited visualization and accessibility in complicated fracture, devitalization of muscle such as adductors, skin flap necrosis, symptomatic heterotopic ossification, and significant blood loss [6–10].

The approach used in this study emphasizes stability of both columns and anatomical reduction of weight-bearing area only, mainly the posterior column and finds an imperfect reduction of the anterior column acceptable. The approach aims for clinical outcomes that are as good as total anatomical reduction of acetabulum, particularly in avoiding post-traumatic osteoarthritis. In addition, this approach minimizes unnecessary soft tissue dissection and prevents injuries to the important yet high-risk neurovascular structures around the anterior column.

Since 2009, above-mentioned principles were applied in treatment of displaced acetabular fractures using double incisions, plating and cables with a custom-made cable introducer. To date, there is only one paper reported fixation of transverse acetabular fracture using the same principle [11]. Our report shares the approach of treatment and evaluates the results retrospectively.

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Also, it represents the first ever study that includes all different type of displaced acetabular fractures that are managed with this approach. We obtained the institutional ethical approval before we carried out this study.

Patients and methods

23 patients (23 hips) who had combined incisions and plate-cable system for displaced acetabular fractures between June 2009 and December 2013 were retrospectively reviewed. There were 17 male and 6 female patients with a mean age of 50.1 years old (range, 32–68). The mean body mass index was 21.3 (range, 15.8–27.7).

Preoperative diagnosis was made based on plain radiographs and 3-D CT scans. 22 patients suffered isolated acetabular fracture and one patient had concomitant acetabular fracture with femoral neck fracture. We classified each fracture according to Letournel & Judet classification [1]. The characteristic of the fracture was: three cases of anterior column fracture, seven cases of T-shape fracture, ten cases of both column fracture, one case of anterior column fracture with posterior hemitransverse fracture and two cases of transverse fracture with posterior wall fracture. All of the fractures had displacement more than 3 mm.

Harris hip score (HHS) [12] was used to evaluate the postoperative clinical outcomes at each follow-up visit, namely at sixth week, third month, sixth month, one year and subsequently annually. Outcome was considered to be successful when the clinical score is excellent (>90) or good (80–89). On the other hand, outcome was considered as not successful or fails when score is fair (70–79) or poor (<70). Clinical complications such as wound breakdown, infection, venous thromboembolism, neurological deficit and others were documented as well.

Radiological outcomes were evaluated using plain radiographs (antero-posterior, lateral, both oblique 45° Judet views) during each follow-up. Using Matta suggestion [13], the quality of reduction was classified into 3 groups, namely anatomical reduction group in which perfect reduction without any displacement (<1 mm), imperfect reduction group when displacement is lesser than 3 mm and poor reduction group when displacement >3 mm. Furthermore, presence of radiological signs of osteoarthritis, displacement of reduction and nonunion of the fracture would be assessed. Any occurrence of heterotopic ossification was documented according to Brooker classification [14].

Surgical technique

All surgeries were performed by the first author. In this case series, Dall-Miles cable (Stryker, Mahwah, NJ) and a specialized custom-made long curved cable introducer were used for all patients (Fig. 1A). For patients in floppy lateral decubitus position on the radiolucent table, standard AP X-ray, 45° oblique and iliac views were obtained prior to the operation. A standard Kocher-Langenbeck approach was used to expose the acetabulum fracture. Sciatic nerve was identified followed by release of the short external rotators at approximately 1.5 cm from the insertion site, until the upper border of quadratus femoris. The greater sciatic notch would be easily accessible at this stage. Distal peristeal dissection was performed to expose lesser sciatic notch when (i) the fracture line was lower than the greater sciatic notch, (ii) the fracture line extended through the greater sciatic notch, or (iii) cable fixation was necessary to pass through lesser sciatic notch.

Mini iliofemoral approach with total measurement of 6–8 cm length extending up and down from anterior superior iliac spine forms the “second window”. This window was particularly for indirect reduction of anterior column and passing of the cable. The lateral part of the iliacus muscle and tensor fascia lata was dissected subperiosteally. The cable introducer was passed subperiosteally through inner wall of ilium underneath the iliacus

Fig. 1. (A) A custom-made cable introducer was used for passage of cable in all displaced acetabular fractures in this series. (B) Serial pictures showed how the cable was passed through greater sciatic notch and secured beneath the inguinal ligament. (C) Serial pictures showed how the cable was passed through the lesser sciatic notch and secured beneath the inguinal ligament.
to greater sciatic notch or lesser sciatic notch followed by the cable. Thereafter, the cable introducer went subperiosteally on the outer surface of ilium underneath the gluteal muscles to the greater/lesser sciatic notch where the cable would be passed through the introducer. Finally, the cable introducer would be passed under inguinal ligament and sartorius muscle to inner wall of ilium to guide the cable to the lateral wall. In the process of passing the cable introducer, it is mandatory to keep the introducer close to the bone in order to avoid muscle damage and to prevent neurovascular injury (Fig. 1B and C). If the cable failed to remain on the greater sciatic notch or lesser sciatic notch, a screw was fixed onto the bone to hold the cable.

With traction of affected lower limb, the cable was gradually tightened at the same time that traction was applied to affected lower limb. In the event of inadequate reduction, elevation and traction of posterior column with bone hook was used. The adequacy of the reduction is assessed through intensifier imaging and finger palpation of the sciatic notch by the first author. For the anterior column reduction, bone impactor was used to indirectly reduce the elevated anterior column fragment while cable was tightened. It is recommended to add a curved reconstruction plate (Synthes, Paoli, PA) and screws after the cable reduction, for rigid stability.

All patients had the same post-operative rehabilitation protocol, whereby postoperative immobilization or traction was not required. Active range of motion of the affected hip commenced the day after surgery. Patients were allowed to perform non-weight bearing walking with two clutches from postoperative day three, partial weight bearing at six weeks and full weight bearing at 12 weeks after operation. For the prevention of deep vein thrombosis, early mobilization was encouraged and mechanical thigh and calf pump with 2 weeks of low molecular heparin was given. No prophylaxis agent for heterotopic ossification was used.

Statics analysis

All date were expressed as mean and range. Statistical analyses were performed using the SPSS statistical software system version 20.0 (SPSS, Chicago, IL, USA). Fisher’s exact test was used for categorical variables with small expected numbers, whereas student’s t test was used for continuous variables. A significant level of ≤0.05 was used for all statistical tests.

Results

Patients were operated on the average 5.7 days after injury (range, 3–15 days). Mean follow up duration was 23.5 months (range, 12.0–38.7 months). Average operation time was 160 min (range, 75–320 min). All fractures complete healed within 12 weeks with no secondary displacement or loss of reduction (Fig. 2). Clinical results such as HHS and reduction degree through plain radiograph are shown in Table 1. There were no statistical significant differences between fracture type and clinical or radiological results (P=0.705, 0.184, respectively).
There was no occurrence of complications during operation. However, postoperatively, there were 3 cases of lateral femoral cutaneous nerve injury that fully recovered within 6 months. Two patients were converted to total hip arthroplasty (THA) due to non-union of the femoral neck fracture (Fig. 3) and osteoarthritis in a patient with poor reduction in the both column group. One patient

<table>
<thead>
<tr>
<th>Harris Hip Score (HHS)</th>
<th>T-shape</th>
<th>Both column</th>
<th>Anterior column</th>
<th>Anterior column &amp; post hemitransverse</th>
<th>Transverse &amp; posterior wall</th>
<th>Total</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>15 (65.2%)</td>
<td>0.705</td>
</tr>
<tr>
<td>Good</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5 (21.7%)</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (4.3%)</td>
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<tr>
<td>Poor</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2 (8.8%)</td>
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<th>Radiographic Results</th>
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<th></th>
<th></th>
<th></th>
<th>0.184</th>
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<tbody>
<tr>
<td>Anatomical</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>12 (52.2%)</td>
<td></td>
</tr>
<tr>
<td>Imperfect</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>5 (26.1%)</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td></td>
<td>5 (21.7%)</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 3.** (A) A 64-year-old male presented with both columns displaced acetabular fractures and femoral neck fracture. (B) Postoperative radiographs revealed anatomical reduction of posterior column and imperfect reduction of anterior column. Screw fixation was performed for femoral neck fracture. (C) Two years postoperatively, there was presence of femoral neck nonunion and symptomatic painful limping. Harris hip score was 56. D, Conversion to total hip arthroplasty was done and patient’s Harris hip score was 88 at postoperatively two years one month.

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developed symptomatic pulmonary embolism and it was treated with anti-coagulation. 1 case screw irritation had revision surgery for screw removal. There was presence of three asymptomatic heterotopic ossifications Brooker stage 1.

Discussion

Following Judet and Letournel classification, there were 3 patients with elementary and 20 patients with associated acetabular fractures. 3 elementary fractures (anterior column) were included in this case series as they displaced more than 3 mm. All three of them were managed by cable only whereas the remaining 20 associated acetabular fractures were managed by plate-cable system.

This study has several limitations. Being a retrograde study and subjected to recall bias, it is limited in its ability to generate details about the complications post acetabular fixation. Patient demography is heterogeneous with relatively short duration of follow-up without control group. As the sample size of each subgroup is small, it is difficult to conclude whether the fixation is the most effective way to manage specific fracture. Furthermore, there were no CT scans performed for post-operation evaluation. The main reason for the limitations is that displaced acetabular fractures are relatively rare and this was a single surgeon’s series. It is believed that this report supports the findings reported by Giodano et al. [11], but differs as it includes all different patterns of displaced acetabular fractures.

Standard Kocher-Langenbeck and mini iliofemoral approach were used in all the cases. This study’s approach differs from others in that perfect reduction in all dimensions was not the aim. The focus is on stability of both columns and congruency of the weight bearing area, which is mainly the posterior column and wall through Kocher-Langenbeck approach. The mini iliofemoral approach was merely used for indirect reduction of the anterior column and wire passing. Nevertheless, there was care taken to reduce the anterior column with cable as best as possible and not liberally accept displacement more than 3 mm. This approach enables us to have shorter operation time, zero iatrogenic injuries to neurovascular structures around anterior column, reasonable good to excellent reduction, and stable fixation with any later displacement.

It is generally accepted that accurate fracture reduction decreases the incidence of osteoarthritis and improves the overall clinical outcome [12,15]. However, a critical literature review reveals that some acetabular cases fare poorly in the presence of joint instability despite the congruously repaired intra-articular injuries [16,17]. Therefore, in our case series, we prioritized stability than the congruency of the joint surface. For displaced acetabular fracture, particularly both column fractures, screw and plate fixation are recommended. However, it must be noted that to maintain the reduction of displaced fragment while advancing of screw fixation is not easy and there is a risk of malreduction, later displacement, and joint penetration. In some studies, cable fixation has proven to produce strong fixation [18–23]. Further, the cable is able to maintain the reduction during plate fixation of either neutralization plate or compression plate modes. The introduction of custom-made cable introducer in this case series also limits the muscle damage and accordingly prevents unnecessary postoperative complications.

78.3% satisfactory reduction (52.2% anatomical reduction and 26.1% imperfect reduction) was achieved without any soft tissue complications. Anatomical reduction was relatively low, but it is in line with other studies [13,22,23]. Park et al. [22] reported approximately 48% of anatomical reduction in 31 patients with associated acetabular fracture treated with double incisions and plate-cable system. Mears et al. [24] showed in his retrospective analysis of 305 associated acetabular fractures treated by operation, that anatomical reduction could be achieved in only 59%. Whereas Matta et al. [13] achieved anatomical reduction in 64% (133/208) patients with associated fractures. Both studies proposed that both column and T-type fractures obtained the least accuracy of reduction [13,24]. The low anatomical reduction rate in our series was particularly affected by imperfect reduction of the anterior column and majority of the cases were associated fractures, particularly both column and T type fractures. We have 5 patients (4 patients with both columns fractures and 1 patient with anterior column and posterior hemitransverse fracture) failed to achieve reasonable reduction due to complexity of the fractures and presence of some comminution. One patient with the poor reduction in fracture of both-column underwent THA. Another patient who underwent THA was not related to quality of reduction but was due to nonunion of the femoral neck fracture.

Complication rate in this case series was notably acceptable. We only had one patient (4.3%) with symptomatic pulmonary embolism and 3 patients (13.0%) with asymptomatic heterotopic ossification. One revision surgery was done in one patient due to screw irritation. No infection occurred.

In conclusion, by adopting this alternative aim to manage both elementary and associated type of displaced acetabular fractures, not the clinical results are not compromised, but also the benefit of soft tissue preservation and reducing perioperative morbidities can be obtained. However, long-term result of this series of patients particularly the occurrence of osteoarthritis will be further evaluated.

Conflict of interest

There is no any funding or financial support and potential sources of conflict of interest.

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