

Surgical Treatment of Periprosthetic Acetabular Fracture: A 5 Cases Report and Literature Review.

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Abstract

Background: With the increasing number of patients undergoing total hip arthroplasty (THA) in recent years, the incidence of periprosthetic acetabular fractures is increasing, which is one of the most serious complications after THA. Periprosthetic acetabular fracture caused by trauma is rare, and it requires orthopedic surgeons to deal with acetabular fracture and component loosening at the same time. This article summarizes 5 cases of periprosthetic acetabular fracture that have undergone surgical treatment, we propose the reverse press-fit technology to increase the stability of fixation for this clinical rare diseases. And the literature for treatment recommendations is reviewed.

Case presentation: A total of 5 patients (3 female) were included, the average patient age at the time of injury was 66.2 years (range 54–78 years). All patients received surgical treatment, 4 cases were treated with open reduction and internal fixation (ORIF), 1 case was treated with revision surgery. There were no postoperative complications. All patients could walk independently on the latest follow-up.

Conclusions: The surgical treatment option of periprosthetic acetabular fracture is ORIF or revision surgery, and the purpose is to make the component stabilized. The reverse press-fit technology could improve the fixation strength between the component and bone, and it can be performed in appropriate situation.

Background

While total hip arthroplasty (THA) technology developed and the number of hip injury increased as the prolongation of life expectancy in the past ten years, more patients received this kind of surgery. The periprosthetic acetabular fracture, which is the serious complication after hip arthroplasty, is clinically rare, Mayo Clinic registration information shows that it was only 0.07% in 20 years^[1], but the incidence of periprosthetic acetabular fractures continues to increase^[2]. It could affect the stability of the bone structure and cause the component loosening. The treatment of periprosthetic acetabular fractures includes conservative treatment and surgical treatment. At present, there is no guideline for clinical treatment, orthopedic surgeons often deal with this kind of fracture improperly due to lack of experience. Therefore, this paper summarizes the surgical treatment experience of 5 cases of periprosthetic acetabular fractures, and reviews the relevant literature to provide reference for clinical treatment.

Methods

The information of patients with periprosthetic acetabular fractures treated in our center from January 2015 to November 2020 was collected. The inclusion criteria were: 1. periprosthetic acetabular fractures after total hip arthroplasty; 2. the patient underwent surgical treatment; 3. complete imaging data. Exclusion criteria: 1. periprosthetic fracture occurred during operation; 2. the patient could not tolerate the operation. A total of 5 patients were included and the general information of patients was collected, the average patient age at the time of injury was 66.2 years (range 54–78 years). Radiographic assessment

(pelvic antero-posterior view, Judet view) and CT scan were performed preoperatively. Acetabular fractures were classified according to Judet and Letournel classification system, periprosthetic fractures were classified according to Pascarella classification system^[2]. Patient information is shown in Table 1.

Table 1
General information of patients with periprosthetic acetabular fractures

Patients	F/M	Age,y	Cause of injury	Acetabular fractures	Periprosthetic fractures	Postoperative time of THA,m	Surgical approach
1	F	78	Stumble	Transverse	2a	84	K-L
2	M	54	High fall	AC + PT	2a	36	Lateral rectus
3	F	65	Stumble	AC + PT	2a	50	Iliioinguinal
4	F	73	Stumble	T-shaped	2c	180	K-L
5	M	61	Accident	AC	2a	21	Iliioinguinal

K-L: Kocher-Langenbeck approach. AC + PT: anterior column and posterior hemitransverse. AC: anterior column

Surgical technique

Iliioinguinal approach, pararectus approach or Kocher Langenbeck (K-L) approach were used during the operation. The choice of surgical approach was based on the fracture type and the need to check the stability of component. If the anterior approaches were used to check the stability of component, which was found to be unstable, then another posterior approach was required for revision surgery. According to the surgical approach, the patients were placed in supine position through iliioinguinal approach and lateral rectus approach, lateral position through K-L approach, and the floating position when necessary. The stability of the acetabular component was examined under direct vision. When using the anterior approach, the surgeon pushed the acetabular component through the fracture gap with hemostatic forceps, and while using the posterior approach, the surgeon dragged the edge of the acetabular component with hemostatic forceps. If there was relative displacement between acetabular component and acetabular bone, the component was considered to be unstable, and if there was no displacement, the component was considered to be stable.

If the acetabular component was stable, the acetabular fracture needed to be reduced and fixed. The reduction technique was the same as that of acetabular fractures, because the purpose of operation was to restore the stability of acetabular column rather than anatomic reduction of articular surface, also the reduction quality was lower than that of acetabular fractures. During reduction, cortical screws were inserted on both sides of the fracture, and screw reduction forceps were used to compress the fracture to reduce the gap as much as possible. After reduction, 3.5mm plate was used for fracture fixation. The

author called this technique of compression reduction and rigid fixation as reverse press-fit (Fig. 1). After fixation, the stability of fracture and component was checked before closing the wound to prevent the component from loosening during operation.

In one patient, preoperative CT showed that the acetabular was fracture, and there was a radiolucent line between the acetabular component and bone, and also had bone defect (pelvic discontinuity). The acetabular component was checked unstable through the K-L approach intraoperatively, so the acetabular component was revised. There was serious bone defect in the section of the posterior column and the posterior wall. Allogeneic bone graft was utilized, multiple screws were inserted to fix the allogeneic bone to the acetabular bone. Then the acetabulum was reamed again, titanium mesh was inserted and fixed using multiple angles screws. Cemented cup was installed, the femoral component was stable and without revision. The stability of acetabular component was well after reduction of hip joint (Fig. 2).

Postoperative, the drainage tube was placed and removed 48 hours according to the drainage volume. Low molecular heparin calcium was used to prevent deep venous thrombosis. Weight bearing was prohibited within 8 weeks after operation, and functional exercise of limb was performed in bed. After 8 weeks, weight bearing exercises were gradually carried out. There were no postoperative complications such as wound infection and joint dislocation. All patients could walk independently on the latest follow-up by telephone.

Discussion

Postoperative periprosthetic acetabular fractures can be divided into acute traumatic fractures and pelvic discontinuity, Berry^[3] reported that the incidence of pelvic discontinuity was 0.9%. Pelvic discontinuity indicates the need for complex surgical treatment, and the prognosis is poor in the case of segmental or cavitary bone defect. There are few reports about traumatic periprosthetic acetabular fractures. Peterson^[1] reported that 50% of the periprosthetic fractures of the acetabulum were caused by trauma in the follow-up study of 23850 patients after total hip arthroplasty in 1996. Miller^[4] reported that all periprosthetic fractures of the acetabulum were caused by trauma in 1972. Emily Cha^[5] reported a case of traumatic periprosthetic acetabular fracture, both-column fracture combined with pelvic fracture, GAURAV^[6] reported two cases of periprosthetic fracture caused by slight trauma in the early postoperative period, and underwent revision surgery.

The first step in the treatment of periprosthetic acetabular fractures is to evaluate and classify the fractures. The assessment of acetabular component stability is critical for further treatment. Radiographic evaluation includes antero-posterior view and Judet views. CT scan is usually required for evaluation, which can obtain the information between the bone and the component. Pascarella^[2] considered that the stability of the component and the time of fracture were important factors to determine the treatment strategy and predict the prognosis, and proposed the classification of periprosthetic acetabular fractures (Table 2).

Table 2
Acetabulum periprosthetic fractures classification by Pascarella

Timing	Prosthesis stability
1. Intraoperative fractures	a. Prosthesis stable
2. 2. Postoperative/Traumatic fractures	b. Prosthesis unstable
	a. Prosthesis stable
	b. Prosthesis unstable, mobilized simultaneously trauma
	c. c. Prosthesis unstable, mobilized before trauma (osteolysis/bone loss)

The typical radiographic view of cemented acetabular component loosening is the translucent zone around the component and the position of the component changed^[7]. The performance of cementless component loosening is gradual bone loss, cup migration and cup position change^[8]. If osteolysis occurs around the acetabular component, the component is considered unstable. It is challenge to determine the stability of the component by preoperative radiographic examination, because the typical radiographic findings are not common, sometimes orthopedics doctors can't determine whether the component is stable pre-operation.

Acute traumatic periprosthetic acetabular fracture and pelvic discontinuity are sometimes difficult to differentiate. Even with a history of trauma and pain symptoms, fractures may be caused by migration after progressive osteolysis. In the 5 cases reported in this paper, the history of trauma was clear. One case had typical radiographic findings of periprosthetic translucent line, and the component was considered loosening before trauma. The other 4 cases did not show typical signs of component loosening, and there was no history of hip pain before trauma, so it was impossible to determine whether the component was loosening before surgery. Therefore, the acetabular component was treated by direct vision examination to determine the stability. The preparation for revision was also made.

In addition to the stability of the component, acetabular fractures should also be evaluated pre-operatively. The periprosthetic acetabular fracture is no displacement and can be considered stable. In this situation, it should be noted that the risk of secondary displacement. Displaced fracture is unstable and usually requires surgical treatment. Laflamme^[9]believed that posterior column fracture plays a great role in the stability of component, because the failure rate of posterior column instability was 67%. At the same time, we should also pay attention to the exclusion of vascular injury after trauma. Harvie^[10] reported a case of internal iliac artery injury caused by acetabular fracture in a patient with periprosthetic acetabular fracture.

Periprosthetic acetabular fractures can be divided into two types: component stable or unstable. For unstable acetabular component, revision surgery is needed. If the acetabular component is stable, conservative treatment or surgical treatment is an option. The fracture type, component selection and

patient related risk factors should be considered preoperatively. For conservative treatment, the component stability and fracture displacement should be accurately evaluated, and the risk of fracture displacement or component loosening should be carefully considered. The choice of the final treatment depends on whether the component is loose and the displacement of the fracture. If there is no displacement of fracture and the acetabular component is stable, conservative treatment could be considered. In Petersen report^[1], 8 patients were treated conservatively, 6 patients healed, 2 patients required revision surgery, and of the 6 cases healed, 4 needed revision due to follow-up complications. When conservative therapy is undertaken, surgeons should inform patients of the possibility of fracture displacement and need revision surgery, and recommend that radiographic examination be carried out frequently to evaluate the fracture healing.

When acetabular fracture is serious displacement or the component is unstable, revision surgery is needed. The goal of revision surgery is to firmly fix the fracture, with acetabular bone healing as the prerequisite, and also reconstruct the acetabular bone mass to stabilize the component. The acetabular rotation center and biomechanical condition of the hip joint is restored. There are a variety of options for surgical treatment, such as impaction bone grafting, posterior column plate fixation, antegrade or retrograde anterior column screws, bi-column fixation, acetabular cup augmentation, highly-porous metal cups, anti-protrusion cages, and cup/cage constructs^[11].

Anatomical reduction is not necessary as a reason of traumatic arthritis no longer occurred. Inappropriate reduction can be corrected by acetabular reaming. Evaluate the condition of the fracture bed to decide whether to allogeneic bone graft or using augment. Allogeneic bone graft makes the fracture gap to achieve secondary stability. Finally, the fracture bed needs to be reamed again, and fragment can be fixed by adding multiple angle screws on the acetabular cup. If the stability of the fracture is still uncertain, it can be additionally bridged by protrusion cages. In cases with obvious bone defects, fractures should be augmented with bone grafts and could be stabilized by so-called jumbo cups, which bridge the fracture with screws into the superior and inferior part of the fracture^[12]. For the treatment of pelvic discontinuity, it is recommended to provide support for the component by particle bone graft or structural bone graft, and use anti-protrusion cages to increase the stability^[3].

When the component is stable, the acetabular fracture can be fixed. From the biomechanics, achieve both column fixation, which could be done through both column plates or anterior column screw and posterior column plate, is the most stable way of fixing^[13]. Posterior column fixation is very important because the posterior column can provide the stability of bone-component interface. Plate is usually used for posterior column fracture fixation to obtain the stability of component^[9].

The reverse press fit technology proposed in this paper, is to compress the gap on acetabular fracture while the acetabular component is not loose. This technology could obtain the maximum range of contact between the acetabular bone and the component. The plate is used to firmly fix the fracture, so as to wrap the acetabular component and achieve the press fit effect from the opposite direction, and provide a stable biomechanical environment for secondary bone ingrowth between component and bone.

This technique also has some limitations. In the case of severe osteoporosis, it may not be able to provide enough pressure when using screw reduction forceps to compress the fracture, and the fixation strength of pelvic plate can't be guaranteed. If the fracture around acetabular component is comminuted, the fracture could not be compressed. The long-term prognosis of reverse press fit technology need further follow up.

The literature reported a variety of surgical methods for the treatment of periprosthetic acetabular fractures. Emily Cha^[5] reported a case of pelvic fracture combined with periprosthetic acetabular fracture after total hip arthroplasty. The ilioinguinal approach was used to determine the stability of the component and posterior column was fixed with plates during the operation. The patient could walk on 18 months follow up. Falzarano^[14] reported 24 cases of periprosthetic acetabular fractures treated with tantalum component. The average HHS score was 89.3 on 24 months post-operation. Gras^[15] reported a case of periprosthetic fractures of the acetabulum treated with navigation assisted screw placement.

Summary

Periprosthetic acetabular fracture is a severe challenge to surgeons, which is required to have not only surgical techniques to deal with acetabular fractures, but also rich experience in hip revision surgery. The treatment of periprosthetic acetabular fractures mainly depends on the stability of the component, which can be evaluated both pre-operatively and intra-operatively. More research on periprosthetic acetabular fractures is needed to provide the best treatment strategy for patients to achieve better prognosis.

Abbreviations

THA

total hip arthroplasty .

K-L

Kocher-Langenbeck approach.

AC + PT

anterior column and posterior hemitransverse.

AC

anterior column.

ORIF

open reduction and internal fixation.

Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: All the patients gave consent for their clinical details along with any identifying images to be published in this study. All patients gave written consent for their personal or clinical details

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Authors' contributions:

YXC performed the case collection and surgery, and was a major contributor in writing the manuscript

HLD performed the case collection.

BFZ performed literature review.

DLZ performed literature review.

CK performed telephone follow-up.

SH performed telephone follow-up.

CF performed the surgery

YZ performed the surgery.

HH performed the surgery.

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Figures

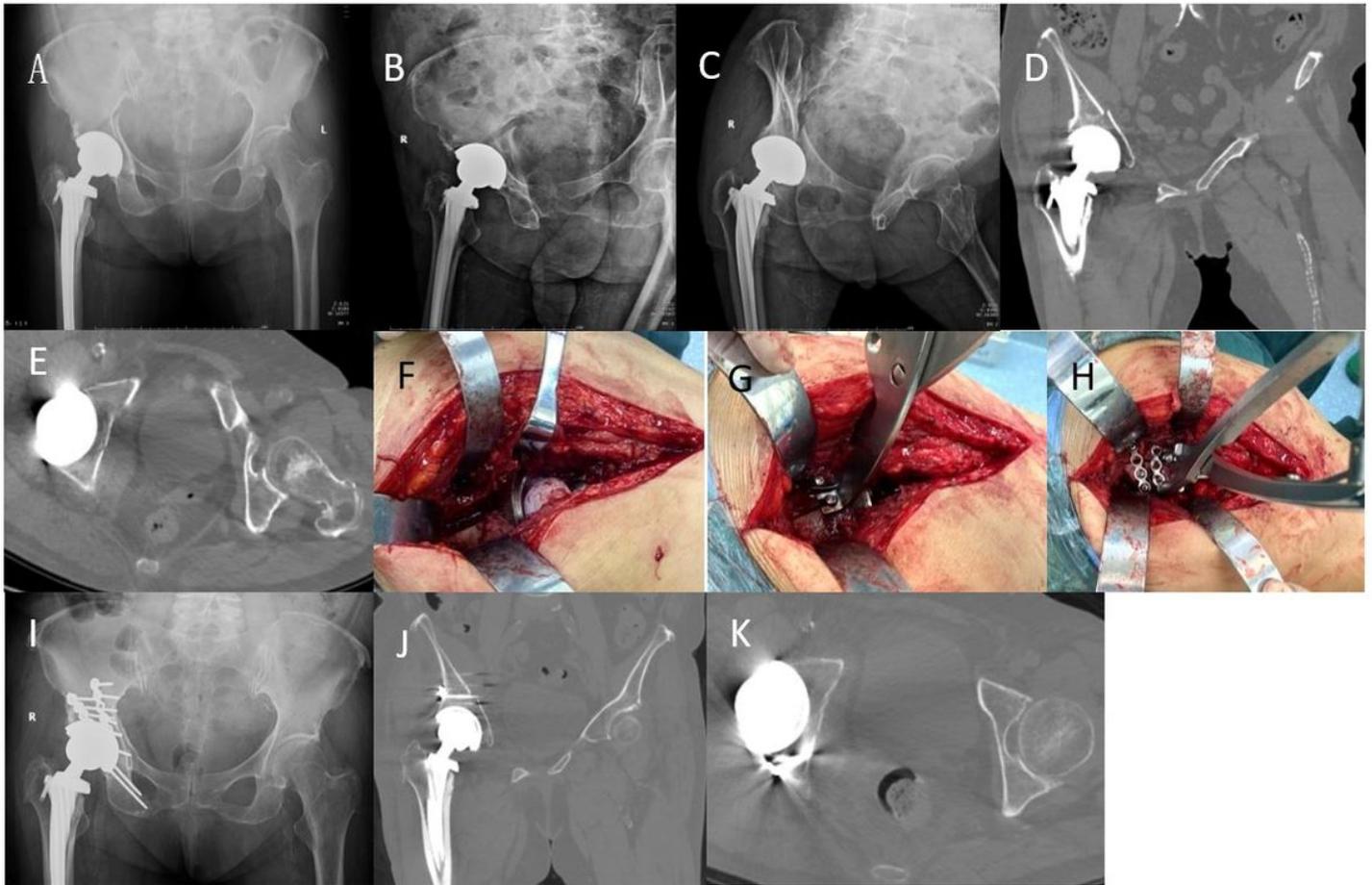


Figure 1

78 year old female 84 months after THA, was injured by stumble. Preoperative x-ray (A, B, C) showed periprosthetic acetabular fractures, and the acetabular fracture was T-type. CT scan showed that there was no radiolucent line (C, D). The stability of the acetabular component was examined under direct vision intraoperatively (F), the fracture was reduced by compression with screw reduction forceps (G), and then was fixed rigid (H). The reduction was well by postoperative x-ray (I), and the component was closely combined with the acetabular bone by CT scan (J, K).

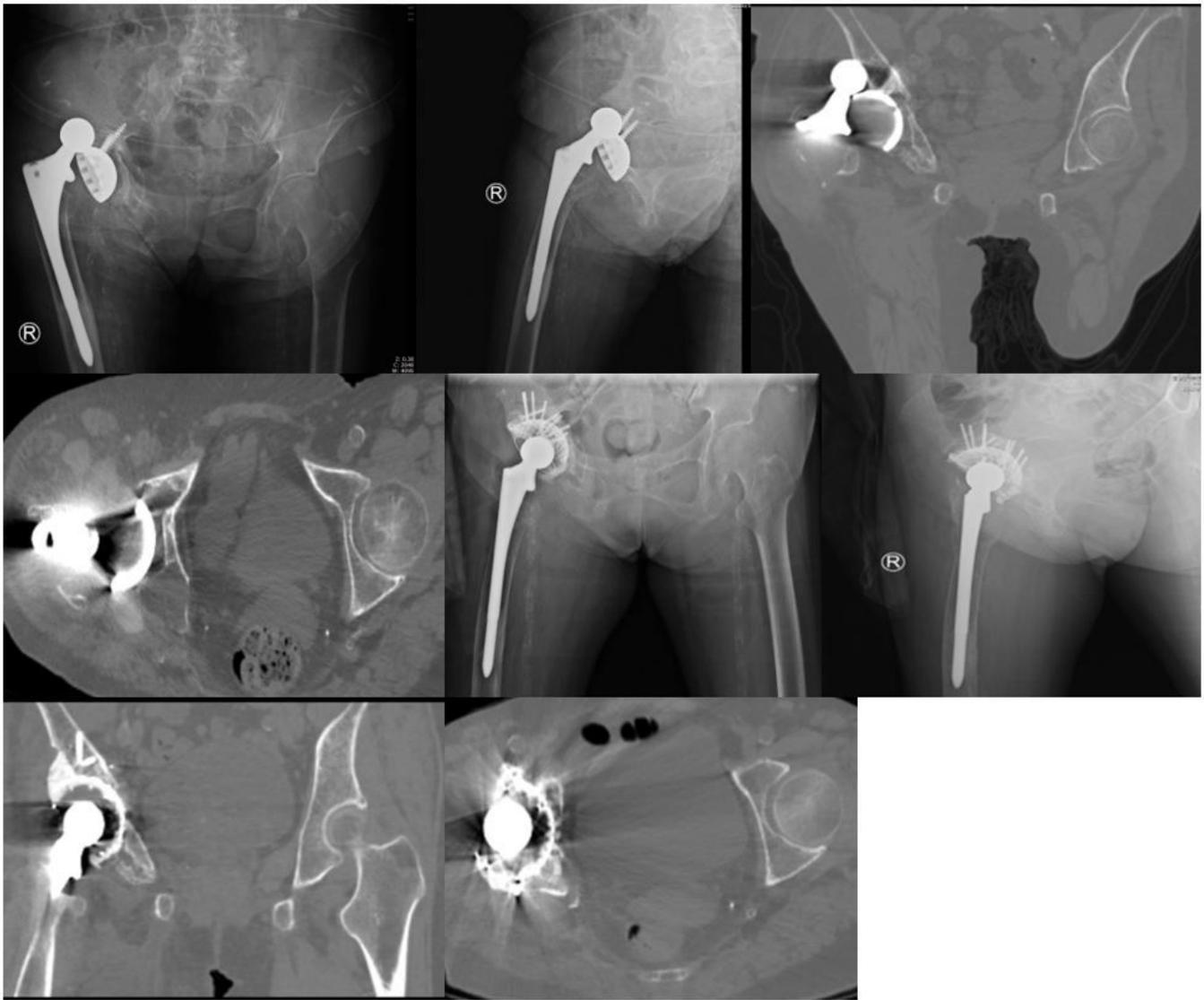


Figure 2

73 year-old female, 15 years after THA, was injured by stumble. Preoperative X-ray (A,B) showed dislocation of the hip joint and a change in the position of the acetabular component. CT scan (C, D) showed that there was a radiolucent line between the acetabular component and the bone, and bone defect of the posterior wall and posterior column. The patient was underwent revision surgery. Postoperative X-ray(E, F) showed that the limb length and offset were appropriate, postoperative CT scan showed that the component was closely combined with acetabular bone.