CLINICAL ARTICLE

Surgical Treatment of Acetabulum Top Compression Fracture with Sea Gull Sign

Yan Zhuang, MD, Jin-lai Lei, MD, Xing Wei, MD, Dai-gang Lu, MD, Kun Zhang, MD

Department of Orthopaedic Trauma, Xi'an Red Cross Hospital, Affiliated to School of Medicine, Xi'an Jiaotong University, Xi'an, China

Objective: To investigate surgical procedures and their efficacy for acetabulum top compression fractures with sea gull sign.

Methods: Data of 14 patients (five women, nine men); aged from 28 to 71 years (mean, 49.9 years) who had undergone surgery for acetabulum top compression fractures with sea gull sign and been followed up were retrospectively analyzed. The time from injury to surgery was 4–14 days (mean, 9 days). All patients underwent open reduction and bone graft and internal fixation through an ilioinguinal or ilioinguinal plus Kocher–Langenbeck approach. Quality of fracture reduction was assessed according to Matta reduction criteria and hip function according to Matta acetabular fracture criteria.

Results: Fourteen patients were followed up for 6–60 months (mean, 36 months). All achieved bone healing within 3–4 months (mean, 3.4 months); the excellent and good rate being 78.5% (11/14). The Matta acetabular fracture scores were 10–18 scores (mean, 16.4); the excellent and good rate being 71.4% (10/14). Traumatic arthritis occurred in three patients. Pain was serious in two patients and relieved by total hip joint replacement and mild in one. One patient developed asymptomatic heterotopic ossification postoperatively.

Conclusion: The appropriate delay between injury and surgery with acetabular roof compression fracture with sea gull sign is from 5 to 10 days. Through an ilioinguinal or ilioinguinal plus Kocher–Langenbeck approach, excellent reduction of the articular surface can be achieved and sufficient bone graft material obtained. The clinical efficacy is satisfactory.

Key words: Acetabulum; Bone transplantation; Compression; Fractures; Fracture fixation

Introduction

When acetabular fractures involve the acetabular roof, resulting in acetabular roof compression fractures, X-ray and CT images show two typical double arc shadows on the acetabular roof that are similar to sea gull wings in flight; this is therefore vividly known as the “sea gull sign” (Fig. 1)¹. The mechanism by which this occurs is as follows: when the roof is in external rotation, the femoral head thrusts upward and forward from a posterior inferior position, producing an impact on the internal acetabular roof and fracturing the acetabular anterior column in patients with conditions such as complicated osteoporosis. This leads to compressed collapse of

the acetabular roof, thus forming the double arc shadows. The compression fractures are mostly located in the 1 to 2 o'clock position. When the force is sufficiently great, further posterior column fracture occurs; however, such posterior column fractures are generally relatively simple, mostly being simple transverse fractures. Reduction fixation can be achieved via an ilioinguinal approach.

Anglen *et al.* state that acetabular roof compression fractures are low-energy injuries and therefore common in elderly patients with osteoporosis². Ferguson *et al.* surveyed the data of 1309 patients with displaced acetabular fracture treated from 1980 to 2007, and found that the incidence of acetabular

Address for correspondence Kun Zhang, MD, Department of Orthopaedic Trauma, Xi'an Red Cross Hospital, Affiliated to School of Medicine, Xi'an Jiaotong University, Xi'an, China 710054 Tel: 0086-013572117225; Fax: 0086-29-87894724; Email: zhuangyan2512@163.com

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Fig. 1 When acetabular fractures involve the acetabular roof, X-ray films show two typical double arc shadows on the acetabular roof, which are similar to sea gull wings in flight and therefore vividly described as the “sea gull sign”.

fractures in patients aged more than 60 years increased from 0% in 1980 to 30% in 2007³.

Currently, there are few published reports on the treatment of acetabular roof compression fracture. The types of treatment are conservative, open reduction and internal fixation, and total hip arthroplasty; which of these is optimal is controversial. Matta *et al.* report that 33% of patients undergoing conservative treatment have poor outcomes; these authors therefore believe that conservative treatment is appropriate only for patients with minimal displacement or whose physical condition is too poor to tolerate surgery⁴. Laflamme and Hebert-Davies believe that preservation of the joint when treating acetabular roof compression fractures achieves better functional recovery. They treated nine patients with acetabular roof compression fractures by open reduction and bone grafting using a modified Stoppa approach under direct vision. Their postoperative excellent and good rate was 67%⁵. Anglen *et al.* reported that reduction of acetabular roof compression fractures is difficult; even with open reduction and internal fixation, the postoperative failure rate is still as high as 100%. These authors therefore recommend that open reduction and internal fixation be used cautiously². Mears and Velyvis reported a high failure rate for open reduction and internal fixation of acetabular roof compression fractures and found that total hip arthroplasty achieved more satisfactory clinical results, including a lower requirement for second surgeries⁶.

Further investigation is required to determine which method of treating acetabular roof compression fractures achieves the best results, maintains reduction, and minimizes complications such as osteoarthritis. Since June 2008, our department has treated 14 patients with acetabular roof compression fractures (with sea gull sign) via an ilioinguinal or combined ilioinguinal and Kocher–Langenbeck approach and

followed them all up. In this study, data for these patients were retrospectively analyzed with the objectives of: (i) summarizing the characteristic damage in acetabular roof compression fractures; (ii) exploring surgical procedures, approaches and techniques for achieving open reduction and internal fixation and using bone grafts for acetabular roof compression fractures; and (iii) clarifying the postoperative rehabilitation and function exercise.

Materials and Methods

General Information

From June 2008 to June 2013, 14 patients with acetabular roof compression fractures with “sea gull sign” underwent surgical treatment, nine men and five women aged 28–71 years (mean 49.9 years). Eight of the fractures had been caused by traffic accidents, two falls from heights, two being hit by heavy objects, and two falls at ground level (Table 1). According to the Letournel–Judet classification⁷, eight patients had fractures of the anterior column nad post hemisection and six simple anterior column fractures, three of which were complicated by vertebral compression fractures, two by tibial plateau fractures and one by multiple rib fractures.

Preoperative anteroposterior (AP) pelvic, pelvic inlet, pelvic outlet, oblique ilium and oblique obturator view radiographs, CT scans and three-dimensional (3-D) reconstruction imaging showed the two typical arc shadows. Preoperative 3-D printing of the pelvis was performed and surgery simulated for patients with comminuted fractures in both anterior and posterior columns, displacement and apparent fractures. All surgery was performed by the same group of doctors. The time from injury to surgery was 4–14 days (mean, 9 days).

Inclusion Criteria

Inclusion criteria were as follows: normal ability to walk and hip function preinjury and fracture involving the weight-bearing area of the acetabular roof, causing bone compression collapse the “sea gull sign”.

Exclusion Criteria

Exclusion criteria were as follows: inability to walk preinjury, hip disease and dysfunction, fractures not involving the acetabular roof, no collapsed displacement, no “sea gull sign”, acetabular roof fracture complicated by femoral head fracture.

Operative Procedure

Ilioinguinal Approach

The indications for an ilioinguinal approach were simple anterior column fracture or fracture of anterior column plus posterior hemisection. Anterior column fractures are usually complicated whereas posterior column fractures are relatively simple. Reduction is usually performed from front to back and the column fracture fixed. This approach was used in 10 cases in this group, including six with simple anterior column fractures and four with fractures in the anterior column plus posterior hemisection.

TABLE 1 Pre- and post-operative data of 14 patients of acetabular roof compression fractures with "sea gull" sign

No.	Sex	Age (years)	Cause of injury	Fracture type	Approach	Interval (days)*	Operation time (h)	Blood loss (mL)	Healing time (months)	Reduction quality†	Scoring points‡
1	Female	42	Traffic accident	Anterior column + Posterior hemisection	Ilioinguinal	7	3.0	1200	3.0	Excellent	18
2	Male	62	Bruise	Anterior column + Posterior hemisection	Ilioinguinal plus Kocher–Langenbeck	6	3.0	1600	3.4	Good	16
3	Male	28	Traffic accident	Anterior column + Posterior hemisection	Ilioinguinal plus Kocher–Langenbeck	7	3.1	1500	3.5	Excellent	18
4	Female	64	Fall	Simple anterior column	Ilioinguinal	10	3.0	1200	3.0	Good	17
5	Male	40	Traffic accident	Simple anterior column	Ilioinguinal	8	3.0	900	3.5	Excellent	18
6	Male	38	Traffic accident	Anterior column + Posterior hemisection	Ilioinguinal	10	3.0	1100	3.1	Good	15
7	Female	48	Bruise	Anterior column + Posterior hemisection	Ilioinguinal	12	3.0	950	4.0	Fair	13
8	Female	71	Fall	Simple anterior column	Ilioinguinal	14	3.0	900	4.0	Poor	10
9	Male	58	Traffic accident	Simple anterior column	Ilioinguinal	4	3.0	1100	3.5	Excellent	18
10	Male	43	Fall	Anterior column + Posterior hemisection	Ilioinguinal plus Kocher–Langenbeck	8	5.0	1800	3.0	Excellent	18
11	Male	51	Traffic accident	Simple anterior column	Ilioinguinal	9	3.0	950	3.8	Good	16
12	Female	55	Traffic accident	Anterior column + Posterior hemisection	Ilioinguinal	10	3.1	1100	3.0	Fair	14
13	Male	45	Fall	Simple anterior column	Ilioinguinal	11	3.0	1000	3.6	Excellent	13
14	Male	54	Traffic accident	Anterior column + Posterior hemisection	Ilioinguinal plus Kocher–Langenbeck	10	3.0	1500	3.0	Good	16

*, interval between injury and surgery; †, Matta reduction criteria; ‡, Matta acetabular fracture score.

Fig. 2 Schematic diagram of open reduction and internal fixation of acetabular roof compression fractures via an ilioinguinal approach, fracture line, reduction, and internal fixation position are displayed from the inner pelvis view. (A) The incision for the ilioinguinal approach starts from the 1/3 junction of the iliac crest, extends anteriorly to 2 cm above the inguinal ligament, then curves medially and inferiorly to end 2 cm above the pubic symphysis. (B) The anterior column, anterior wall and posterior column fracture line are exposed. (C) After reduction of the posterior column, a plate is inserted along the lower margin of the true pelvis to fix the fracture across the joints. (D) The fracture fragments in the anterior wall are uncovered, revealing the acetabular roof compression fractures and femoral head fragments. (E) The femoral head is used as a template to achieve reduction; a periosteum screwdriver or pry bar is used to pry downward and push the collapsed articular surface so that the articular surface lies flat or slightly higher than the surrounding articular surface. (F) The anterior column and anterior wall fracture are set and a reconstruction plate is placed along the anterior margin of the true pelvis for cross articular fracture fixation.

After induction of general anesthesia, the patient was placed in the floating posture. An approximately 25 cm long incision was started from the 1/3 junction of iliac crest, extended anteriorly to 2 cm above the inguinal ligament, then extended medially and inferiorly to end 2 cm above the pubic symphysis (Fig. 2A), thus successively exposing the external side window (the first window, located on the outside of the psoas iliac to reveal the internal side of ilium), the middle window (the second window, located anterior to the iliopsoas muscle and between the femoral artery and vein to reveal a square region), and the internal side window (the third window, located medial to the femoral artery and vein to reveal the superior pubic ramus and pubic symphysis), revealing the fracture line through the anterior column, anterior wall and posterior column (Fig. 2B). The second window exposed the

acetabular anterior column, anterior wall fracture fragments and the square region. In patients with posterior column fractures, setting was performed from front to back. After fracture reduction, one to two lag screws were used to fix the fracture in the ischial spine direction, whereas fixation was achieved along the joint of the lower margin of the true pelvis with a plate (Fig. 2C). After fixation of the posterior column, the fracture fragments of the anterior wall were uncovered and the lower limbs flexed and traction applied, revealing the fragments of the acetabular roof compression fracture and the femoral head (Fig. 2D).

Acetabular roof compression fractures are generally in the 1 to 2 o'clock position. The femoral head was used as a template for reduction by prying it downward with a periosteum screwdriver or pry bar and pushing the collapsed

articular surface until the articular surface lay flat or slightly higher than the surrounding articular surface (Fig. 2E). The bone defects beneath the articular surface could then be seen, the joint cavity was cleaned and the appropriate amount of iliac bone obtained to be implanted in the bone defect region. A "C"-arm X-ray machine was used to check the fracture reduction and ascertain whether the double arc lines had disappeared. After satisfactory fracture reduction had been achieved, the anterior wall or anterior column fracture fragments were reset and a pelvic reconstruction trans-articular plate placed in the anterior edge of the true pelvis to fix the fracture in the anterior wall or anterior column (Fig. 2F).

Combined Ilioinguinal and Kocher–Langenbeck Approach

The indication for a combined ilioinguinal and Kocher–Langenbeck approach was complicated fractures in the anterior and posterior columns. Because posterior column fractures are not adequately exposed by an anterior approach, reduction and fixation are difficult to achieve with this approach alone. Therefore, it is necessary to use a posterior approach and perform posterior fixation. The four patients in this group with fractures of the anterior column plus posterior hemisection underwent this combined approach.

After induction of general anesthesia, the patient was placed in a floating posture. Via a Kocher–Langenbeck approach, the fractures were revealed and the posterior column fracture set first. Steel plate or screws were then used to fix and stabilize the reduction of the posterior column. The patient was then placed in a supine posture and the anterior column fracture treated via an ilioinguinal approach as described above.

For patients with severe comminuted fractures in the square region, additional home-made elastic plates (made by bending a "T" shaped plate) can be fixed in the square region. For young patients with good bone condition, two lag screws can be used to directly fix the acetabular roof compression fracture fragments.

Closing of Incision

After fracture reduction, oblique obturator, oblique ilium and pelvic inlet radiographs of the fractures were taken to confirm satisfactory fracture reduction and disappearance of the double arc shadows. Before placing a screw in the joint cavity, drainage tubes were placed in the retropubic space and iliac fossa. In patients in whom the combined approach had been used, a drainage tube was placed in the rear side of the joint before the incision was sutured.

Postoperative Treatment

Antibiotics were administered for 48 h postoperatively. From the second day, 0.4 mL low molecular heparin calcium was administered daily to prevent deep venous thrombosis. The drainage tubes were removed within 48 h. After the surgery, the patients were instructed to perform quadriceps femoris and moderate passive flexion and extension exercises of the hip joint. Bed rest time was extended and calcitonin, 50 IU/day was

administered as anti-osteoporosis treatment for 3 months to prevent collapse of the fracture. Four and 12 weeks after surgery, the patients were reviewed, including taking oblique obturator, oblique ilium and front view radiographs of both hip joints, CT scan and 3-D imaging to evaluate fracture healing and reduction. When imaging showed complete fracture healing, the patients were allowed to walk with partial or full weight-bearing. Degree of activity and hip joint pain was assessed by regular clinic visits or telephone follow-ups.

Evaluation of Efficacy

Hip joint function was assessed according to the Matta acetabular fracture assessment scoring system⁸, in which a maximum of six points each is assigned for pain, walking, and range of motion; a total of 18 points is excellent, 15–17 good, 13–14 fair and <13 poor.

Postoperative acetabular fracture reduction quality was assessed according to the Matta criteria⁹. No fracture displacement was classified as excellent, fracture displacement of 0–1 mm as good, 1–3 mm as fair and >3 mm as poor.

Results

General Results

Operative time was 3–5 h (mean, 3.1 h) and intraoperative blood loss 900–1800 mL (mean, 1200 mL). One patient was reinfused with 400 mL of autologous blood. All 14 patients were followed up by another group of the same level of doctors for from 6–60 months (mean, 36 months); bone union was achieved in all patients, the healing time being 3–4 months (mean 3.4 months).

Clinical and Radiological Outcomes

At the last follow-up, 10/14 patients had no significant limp or hip pain; three patients had slight limps with mild hip pain; and one had a severe limp and walked with crutches with obvious hip joint pain. Pain was alleviated by analgesics. Imaging studies showed significant improvement in acetabular roof collapse compared with preoperative findings in all patients. Eleven cases showed satisfactory reduction (Fig. 3). Another collapse of fracture and displacement of 1–3 mm occurred within the first postoperative month with severe hip pain in two patients. These two patients had obvious limps; their pain responded to non-steroidal anti-inflammatory drugs and no further surgeries were performed. At the final follow-up, the fractures of all 14 patients had healed and all the acetabular roof collapses showed no further significant changes.

Evaluation of Efficacy

At the last follow-up, according to Matta ratings of the quality of acetabular fracture reduction six cases were excellent, five good, two fair and one poor. The rate of excellent and good was 78.5% (11/14). Matta acetabular fracture scores ranged from 10 to 18 points (mean, 16.4), including five excellent cases, five good, three fair and one poor. The excellent and good rate was

Fig. 3 Man, 41 years old, left anterior column plus posterior hemisection acetabular fracture caused by traffic accident. (A–C) Preoperative frontal X-ray, CT and 3-D reconstruction, respectively, of an inner top compression collapse of the acetabular roof with double arc shadow, “sea gull sign”. (D, E) Three days after surgery, front view X-ray and 3-D CT reconstruction, respectively, of acetabular roof fracture reduction showing satisfactory fixation and a smooth articular surface; the “sea gull sign” has disappeared. (F, G) Four months after surgery, frontal and lateral X-ray films showing fracture healing, loss of fracture line and flat articular surface. (H) Four months after surgery, hip joint function is good.

71.4% (10/14). The one patient with a poor rating was a 71-year-old woman with a low-energy injury that was classified as anterior column plus posterior hemi-section fracture according to the Letournel–Judet classification. She had severe preoperative osteoporosis and femoral head injury and cartilage exfoliation were identified intraoperatively. Two months after the primary surgery, she was found to have developed

collapse and displacement of the fracture, joint pain, limited hip joint mobility, and unsteady walk and therefore underwent total hip arthroplasty.

Complications

Two patients developed deep vein thrombosis with affected limb swelling within 1 week of surgery; one of them was

implanted with an artificial filter, and the other underwent anticoagulant therapy with low molecular heparin calcium. The swelling of both patients resolved within three weeks. One week after surgery, one patient had urinary tract infection that resolved with bladder irrigation and antibiotics. By 6 months after surgery, three patients had developed traumatic arthritis that was relieved by non-steroidal anti-inflammatory drugs. One patient developed heterotopic ossification, Grade II according to Brooker grading¹⁰; however, this did not require treatment. No study subjects had other infections or avascular necrosis.

Discussion

Indications for the Ilioinguinal Approach

Letournel and Judet believe that double arc shadows above the acetabular roof can occur in certain regions of the posterior column¹. Posterior fixation can be achieved when the posterior bone fragments have rotated inwardly and posteriorly. Although this group of patients has similar imaging findings, the mechanisms of injury are different. Most patients in the present study had anterior column or anterior column plus posterior hemisection types of fracture; all involved compression of the cartilage of the superior aspect of the acetabular floor, which is difficult to expose and fix via a posterior approach.

In the present study, the main injury was anterior column fracture; thus, a simple ilioinguinal approach met the requirements for exposure and setting of most patients' fractures. Therefore, we propose the following indications for an ilioinguinal approach: (i) able to walk before injury; (ii) the roof arc angle (the angle between a vertical line through the center of the femoral head on a front or Judet oblique view of the pelvis and a line to the fracture region Fig. 4) $<45^\circ$; and (iii) articular surface displacement >2 mm.

Key Points of this Surgical Procedure

The key points of this surgical procedure are exposure, reduction and fixation of the compressed fracture fragments of the inner acetabular roof. Alonso *et al.*¹¹, Cole and Bolhofner¹² have reported that it is difficult to set and fix these fracture fragments, especially in patients with osteoporosis. Tile reported using wire rope and autologous iliac bone graft to fix the collapsed bone fragments of the acetabular roof and a plate and screw to fix the fracture(s) in the anterior wall, anterior column and square area¹³. Though this approach can prevent early shift of fracture fragments, its long-term results are poor. Anglen *et al.* pointed out that exposure of acetabular floor fractures is difficult because the fracture fragments are located within the acetabulum². The upper fragments are therefore compressed into cancellous bone. Although the fracture line can occasionally be reached via an ilioinguinal approach, the fracture fragments of the articular surface lack the support of cancellous bone and are therefore liable to be displaced further. Additionally, fixation here is very difficult because bone graft or steel support cannot be used to fix fracture fragments. These

Fig. 4 Schematic diagram of arc angle (α), that is, the angle between a vertical line drawn through the center of the femoral head on a front view or Judet oblique view of the pelvis and a line through the center of the femoral head and the fracture site.

authors therefore believe that it is possible to achieve only temporary anatomical reduction, never reliable fixation, by any approach, meaning that the failure rate is 100%.

Most of the patients in the current study group had associated comminuted fractures in the anterior wall of the acetabulum, which made exposure of the collapsed fracture fragments easy. Surgically uncovering the fracture fragments in the anterior wall clearly revealed the collapsed fracture in the acetabular roof. Traction on the flexed lower limbs allowed exposure of the articular surface of the acetabulum, clearly showing the femoral head. In four of our patients, there was stripping damage of the femoral head cartilage, femoral compression, and small fracture fragments, making fixation difficult; these were therefore removed. Because most posterior column fractures were simple fractures, they could initially be set via an anterior approach, after which either a reconstruction plate was placed along the pelvic inner edge and fixed across the joints, or from front to back, two lag screws were screwed toward the ischial spine for fixation. Because placing a plate at the inner edge of the pelvis is difficult in obese patients, for them special tools such as spring drills and screwdrivers were needed. A plate of slightly larger radius was used to press the posterior column outward. Before setting the anterior column, all small intra-articular bone fragments were completely cleaned up and the collapsed fracture fragments were

pressed and set using the femoral head as a template to achieve as close to anatomical reduction as possible and the articular surface level to <2 mm. After achieving reduction of the articular surface, appropriate amounts of autologous bone were used to fill in the collapse and support the articular surface. It is important to ensure that sufficient bone is used to fill as closely as possible; in patients with severe osteoporosis, the reduced collapsed articular surface can be slightly higher than the surrounding articular surface to help prevent collapse and retraction of bone after ambulation. A “C”-arm X-ray machine was used to check that the articular surface was flat and even and the double arc shadows had disappeared, indicating adequate setting of the fracture fragments of the anterior wall. Once satisfactory reduction had been achieved along the anterior edge of the pelvis, a reconstruction plate was inserted to fix across the joints. In young patients with good bone condition, screws were used to directly fix the fracture fragments in the acetabular roof and anterior wall. In patients with severe comminuted fractures in the square area, a “T” shaped plate was used to fix across the square area. In addition, the operator took care to avoid damaging nerves and blood vessels and to minimize the extent of dissection. An intraoperative autologous blood transfusion device may be used to reduce the need for allogeneic blood transfusion. Because the fracture involves the square region and because the risk of screw fixation into a joint is usually great, two reconstruction plates were used to fix along the inner and anterior edges of the pelvis to support the anterior column fracture fragments and prevent their displacement. During the procedure, a “C”-arm X-ray machine was required to provide anteroposterior, front, pelvic inlet, pelvic outlet, oblique ilium and oblique obturator views to confirm the adequacy of reduction and ensure no screws had entered the joint space.

Surgical Efficacy

According to Matta's criteria for setting⁸, the excellent and good rate in this group of patients was 78.5%, which is very different from the 100% failure rate reported by Anglen *et al.*². This may be attributable to the following factors: (i) our patients were relatively young, with an average age of 49.9 years compared with the average age of 71.6 years in Anglen *et al.*'s study; (ii) the fracture type was relatively simple, mostly simple anterior column or anterior column plus posterior hemisection fractures; (iii) postoperatively our patients strictly followed the doctors' medical orders, performed functional exercises, extended the time to weight-bearing ambulation and received anti-osteoporosis drug therapy to prevent bone collapse with load; (iv) sufficient bone was taken from the ilium to permit full and dense grafting, thus providing strong support for the articular surface; additionally, the anterior and posterior columns and the square region were supported with double plates; and (v) all surgeries were performed by experienced, highly skilled doctors: the resultant shorter operative time minimized complications.

Mears and Velyvis believe that the major factors affecting treatment outcomes are unsatisfactory setting of the articular

surface, loss of reduction and heterotopic ossification⁶. One of our patients who had undergone combined anterior and posterior approaches developed heterotopic ossification (Level II by Brooker grading). Letournel and Judet reported an incidence of heterotopic ossification with the anterior approach of 1%, whereas its incidence with the posterior approach is as high as 66%¹. An ilioinguinal approach was used in 10 of our patients, which would have significantly reduced the incidence of heterotopic ossification. Acetabular roof compression fractures with “sea gull sign” are a type of intra-articular fracture: the treatment principles for intra-articular fractures are anatomical reduction and strong fixation. According to Matta's criteria, setting the articular surface to <1 mm is excellent; we therefore aimed for an articular surface height difference of <2 mm in order to reduce the incidence of traumatic arthritis. In addition, prolonging of time in bed, and the treatment of osteoporosis may have reduce the incidence of loss of reduction.

Choice between Open Reduction and Internal Fixation and One-stage Total Hip Arthroplasty

Whether acetabular roof compression fractures should be treated by open reduction and internal fixation or one-stage total hip arthroplasty is still controversial. Unsatisfactory reduction of such fractures or postoperative loss of reduction are prone to result in hip osteoarthritis that can be severe enough to eventually require total hip arthroplasty. Herscovici *et al.*¹⁴ and Mears and Velyvis⁶ have recommended that older patients with osteoporosis and acetabular fractures should undergo primary total hip arthroplasty, especially those with comminuted or compression fractures or cartilage loss. Mears and Velyvis reported 57 patients with an average age of 69 years and acetabular fractures who underwent total hip arthroplasty. The average follow-up time was 8 years and the excellent and good rate 79%. These authors state that the indications for arthroplasty are cartilage loss, femoral head compression and fractures involving more than 40% of the acetabulum⁶. However, we believe that total hip replacement should be reserved for advanced osteoarthritis and not used routinely in patients with acetabular roof compression fractures. Total hip arthroplasty in patients with one-stage acetabular fractures would substantially increase surgical trauma and incidence of complications, especially in elderly patients, because they have poor tolerance to surgery. In addition, one-stage total hip arthroplasty for acetabular fractures is associated with a much higher acetabular loosening rate than second-stage replacement¹⁵. Therefore, for acetabular roof fractures, we do not advocate first-stage total hip arthroplasty; rather, we recommend open reduction and internal fixation to restore joint stability, and pave the way for secondary surgery. Of note, because the average age of our patients was younger than in many reported studies, most of our patients did not meet the surgical indications of the total hip arthroplasty. Therefore, we performed open reduction and internal fixation to treat their acetabular roof fractures, retaining their hip joints as much as possible and striving for

anatomical reduction and effective postoperative rehabilitation exercises. At the last follow-up, according to Matta evaluation of acetabular fractures, the outcomes in six cases were excellent, in five good, in two fair and in one poor. The excellent and good rate was 78.5% (11/14). Matta acetabular fracture scores ranged from 10–18 points (mean, 16.4 points). Five cases were scored as excellent, five good, three fair and one poor, the excellent and good rate being 71.4% (10/14).

In conclusion, acetabular roof compression fractures are a relatively rare type of acetabular fracture. The optimal treatment is open reduction and internal fixation. The key to successful treatment is correct diagnosis, skilled surgical technique, satisfactory reduction, secure fixation and postoperative rehabilitation exercises. The “sea gull sign” confirms the diagnosis and predicts the surgical treatment outcomes, that is, a “sea gull sign” above an acetabular roof fracture means a possible adverse prognosis.

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