CIBTech Journal of Surgery ISSN: 2319-3875 (Online)
An Online International Journal Available at http://www.cibtech.org/cjs.htm
2013 Vol. 2 (3) September-December, pp.11-22/Mustafa et al.
Research Article

SURGICAL MANAGEMENT OF DISPLACED ACETABULAR FRACTURES: MID-TERM RESULTS

Mustafa Gungor[1], *Mehmet Atıf Erol Aksekili[2], Mahmut Nedim Aytekin[2], Arslan Kagan Arslan[3], Ismail Demirkale[4], Mahmut Ugurlu[2], Durmuş Ali Ocguder[2] and Metin Dogan[2]

[1]Emsey Hospital, İstanbul
[2]Department of Orthopediy and Traumatology, Yldırım Beyazıt Üniversity, Ankara Atatürk Training and Research Hospital, Ankara
[3]Department of Orthopediy and Traumatology, Yenimahalle State Hospital, Ankara
[4]Department of Orthopediy and Traumatology, Keçiören Training and Research Hospital, Ankara
**Author for Correspondence*

ABSTRACT

The purpose of the study was to present midterm results of surgically treated 33 patients with displaced acetabular fracture. 33 patients with displaced acetabular fracture were consecutively operated from January 1, 2005 through December 31, 2010, and 33 were available for review with a minimum of 12-month follow-up. Clinical (Merle D'Aubigné modified by Matta *et al.,*) and radiographic (Matta) outcomes were evaluated. Complications due to the fracture and operation were documented. Anatomical reduction was achieved in 61% of patients. Post operative follow up period was 12- 72 months (mean 38.5 months). Clinical results were satisfactory in 76% of patients. Roentgen graphic results were satisfactory in 69% of patients. Complications included sciatic nerve palsy with a rate of 11%, infection with a rate of 6%, heterotopic ossification (Brooker *et al.,* 1973) with a rate of 15%, posttraumatic osteoarthritis with a rate of 18%, and avascular necrosis of the femoral head with a rate of 12%. Despite surgical intervention is an effective method in treatment of deplaced acetabular fractures; we are facing lots of complications. Standard approaches are sufficient in treatment of complex acetabular fractures in most of the cases, and extended approaches should be avoided to minimize probable complications.

Key Words: *Deplaced Acetabular Fracture, Anatomical Reduction, Complicated*

INTRODUCTİON

Surgical treatment for acetabular fractures has become the standard treatment modality following the studies of Judet and Letournel in 1960 (Judet *et al.,* 1964). The standard treatment for displaced acetabular fractures includes anatomic reduction, stable fixation and early motion (Matta *et al.,* 1986; Matta *et al.,* 1986; Matta and Merritt, 1988; Mears *et al.,* 2003; Ruedi and Murphy, 2000). There are many studies supporting that the clinical and radiological outcomes of the patients are good or excellent with the application of these principles in the long term (Matta *et al.,* 1986; Matta and Merritt, 1988; Giannoudis *et al.,* 2005; Kumar *et al.,* 2005; Deo *et al.,* 2001; Magill *et al.,* 2012; Romness and Lewallen, 1990).

The surgical modalities generally accepted in simple type displaced acetabular fractures are the Kocher-Langenbeck and ilioinguinal approaches (Jimenez and Vrahas, 1997; Matta, 1996; Templeman *et al.,* 1999). It is possible to achieve reduction with these approaches (Ochs *et al.,* 2010). However, the debate is going on about the choice of approach to cause minimal complications while achieving sufficient anatomic reduction in complex fractures. The rates of serious complications including deep infections, heterotypic ossification or nerve injuries are still high, particularly in extended and combined approaches (Ghalambor *et al.,* 1994; Mayr, 1997).

The purpose of this study is to report the clinical and radiological mid-term outcomes of the current treatment modalities for simple and complex acetabular fractures.

MATARİALS AND METHODS

Thirty-six patients were operated because of acetabular fractures between January 2005 and December 2010. Because of the advanced degenerative arthritis developed in 3 of these patients, total hip prosthesis was applied, and these patients were not included in the study.

Following the resuscitation and initial clinical evaluation, Judet's pelvic x-rays were taken in addition to the anteroposterior x-rays when the patients were stable. Computerized tomography including the sacroiliac and both acetabuli was taken in all the patients in order to define the fracture line better. Axial tomography sequences and 3-dimensional images were taken from some selected patients. Fractures were classified according to Judet-Letournel (Judet *et al.*, 1964) (Figure 1).

Traumatic hip dislocation was found in 13 patients in total, with posterior hip location in 12 patients and central dislocation in 1. Closed reduction was carried out in patients with posterior dislocation in the emergency room, and then skeletal traction was applied till the operation with a Steinman screw passing through the supracondylar area of the femur. Reduction was performed under general anesthesia in one patient with central dislocation, and then skeletal traction was applied till the operation.

The surgical approach was determined according to the fracture type. Iilioinguinal incision was used in 6 patients, iliofemoral incision was used in 1 patient, and Kocher-Langenbeck was used in 26 patients. Ilioinguinal incision was preferred in anterior column, two-column, and posterior hemi transverse + anterior column fractures. The indirect method was used to reduce the posterior column in two-column fractures. The Kocker-Langenbeck incision was used in the posterior wall, posterior wall + posterior column, selected transverse, T-shaped and transverse + posterior column fractures. Triradiate incision was needed for placement in none of the patients. Iliofemoral incision was preferred in 1 transverse fracture. Rigid internal fixation was ensured with plates + screws in 26 patients, and with only screws in 7 patients. The presence of intra-articular free bodies, placement and screws within the joint were evaluated by direct inspection, palpation and intra-operative C-arm fluoroscopy.

Placement and quality of the internal fixation was evaluated using the standard anteroposterior and Judet x-rays taken postoperatively. Separation up to 1 mm was accepted as anatomic, between 1 and 3 mm as successful, and separation exceeding 3 mm was accepted as poor reduction. Skeletal traction was applied in 2 patients during the postoperative 2 weeks. The other patients were instructed by a physiotherapist during the passive range-of-motion exercises. The patients were instructed to walk using double crutches or walkers without giving weight to the related side, and the weight allowed was increased gradually after the week 6. Low molecular-weight heparin was used in the pre- and postoperative periods as a routine prophylaxis against deep venous thrombosis and was continued till the postoperative week 6. No prophylaxis for heterotypic ossification was used.

Clinical and radiologic evaluations were performed at postoperative months 1, 3, 6, 12 and 24. Later, these were continued with 2-year intervals in patients without problems, and with six-month intervals in patients with late complications including osteoarthritis and similar. The mean follow-up period of the patients in the postoperative period was 38.5 months (12-72 months). Functional results were evaluated according to D'Aubigne—Postel scoring system (Merle and Postel, 1984), while the radiologic evaluation was carried out according to Matta's criteria (Matta, 1996). The x-rays taken in the last visits were evaluated for heterotypic ossification with Brooker classification as the classification method (Brooker *et al.*, 1973).

RESULTS AND DISCUSSION

Results

Twenty-eight of the patients included in the study were males and 5 were females. The main age was 42.9 (23-77). The mean follow-up period of the patients was 38.5 months (12 months -72 months). Acetabular fractures were related to passenger car accidents in 26 patients, pedestrian car accidents in 3 patients, falling from a height in 2 patients, and falling of a heavy load onto the patient. Twenty-four of the fractures (73%) were simple, and 9 were complex (27%). One or more multiple additional injury was

found in 16 patients in addition of the acetabular fracture. Additional operations were performed outside the acetabulum in 9 of these patients (Table 1). The mean period between the trauma and operation was 3.9 days (1-14 days).

In the clinical evaluation performed according to the Merle d'Aubigne and Postel criteria, outcomes of 12 patients were excellent, good in 13 patients, and medium in 8 patients. While good and excellent results were obtained in our patients younger than 40 years of age, the same rate was 72% in patients older than 40 years. While the clinical outcomes were good or excellent in 100% of the patients we achieved anatomic reduction, the same rate was 50% in the patients that reduction was successful, and 0% in patients that reduction was poor.

In the radiologic evaluation of the patients according to Matta criteria were found as excellent in 14 patients, good in 9 patients, medium in 8 patients and poor in 2 patients. End-of-operation reduction levels were evaluated also as poor for the patients that were evaluated as poor. Avascular necrosis was found in 4 patients. Three of these patients had posterior hip dislocation. While the postoperative reduction was excellent in 1 patient, it was poor in 3 patients.

In our study, the rate of patients with posterior wall fractures accompanied by posterior dislocation was 33%. While the anatomic and successful reduction rate in these patients was 91%, the rate of good and excellent results was 73% according to Matta.

In the evaluation of the early postoperative x-rays, reduction was evaluated as anatomically excellent in 20 patients, successful in 10, and poor in 3 patients. Merle d'Aubigne and Postel scores of patients with poor reduction was medium level.

Complications are listed in the Table 2. Heterotypic ossification grade III according to Brooker was found in 2 patients, grade II in 2 patients, and grade I was found in 1 patient. Kocher-Langenbeck approach had been used in all the patients that heterotypic ossification had developed. Complex fractures were present in 2 of these patients, and simple fractures were present in 3, with medium D'Aubigne-Postel scores.

One patient (3%) had sciatica symptoms preoperatively, and this condition was recovered fully in the postoperative follow-ups. Postoperative iatrogenic nerve injury developed in 3 patients (11%) with Kocher-Langenbeck approach. Involvement was in the perineal component of the sciatic nerve in all the 3 patients. It was observed that the sciatic nerve symptoms continued in the follow-ups of patients. Upon the complaint of sciatica in 1 patient (3%) revision was carried out to shorten the length of the plate in the postoperative month 1. The patient recovered completely after this operation.

Superficial infection developed in 1 patient (3%) and the incision site. Infection receded with debridement + antibiotic therapy. Deep infection developed in 1 patient (3%). Acinetobacter grew in the wound specimens collected. Infection was cured completely with piperacilin and tazobactam therapy. Clinical and radiologic scores of the patient were medium.

Discussion

The rate of good and excellent clinical results in the mid-term in this study of ours was 76% (% 36+40). This result is similar of the clinical results reported in the literature (Letournel and Judet, 1993; Matta, 1996; Siebenrock *et al.*, 1998; Helfet and Schmeling, 1994; Erdoğan *et al.*, 1998; Nabil *et al.*,). One of the most important factors affecting the clinical outcomes is the achievement of the anatomic reduction (Matta, 1996; Letournel and Judet, 1993).

Our study supports this opinion, although the patient number is limited (Table 3). While the necessity of achieving anatomic reduction is accepted, patient's age, complexity of the fracture and timing of the operation will be determinative for the issue of which approach will be used in which fracture type to achieve anatomic reduction (Matta, 1996). There is a generally-accepted opinion for the approach to fractures of the basic type. Extended approaches aiming at seeing both columns and joint have been defined for complex fractures. While such approaches provide vision of the two columns and joint, their complication rates are high.

To reduce the complex fractures without extended approaches, indirect reduction methods can be used with the help of special acetabular reduction clamps. Ilioinguinal approach is preferred gradually more

particularly in two-column fractures. We preferred the ilioinguinal approach in two-column fractures in our study, and we obtained anatomic reduction.

Table 1: Co-injuries

Injury	Number
Head	3
Thorax	2
Vertebra	-
İntraabdominal	-
Genitourinary	-
Post. Pelvic Ring	4
Major Vascular	-
Extremity	12
Neurological	1

Table 2: Complication amount and percentage

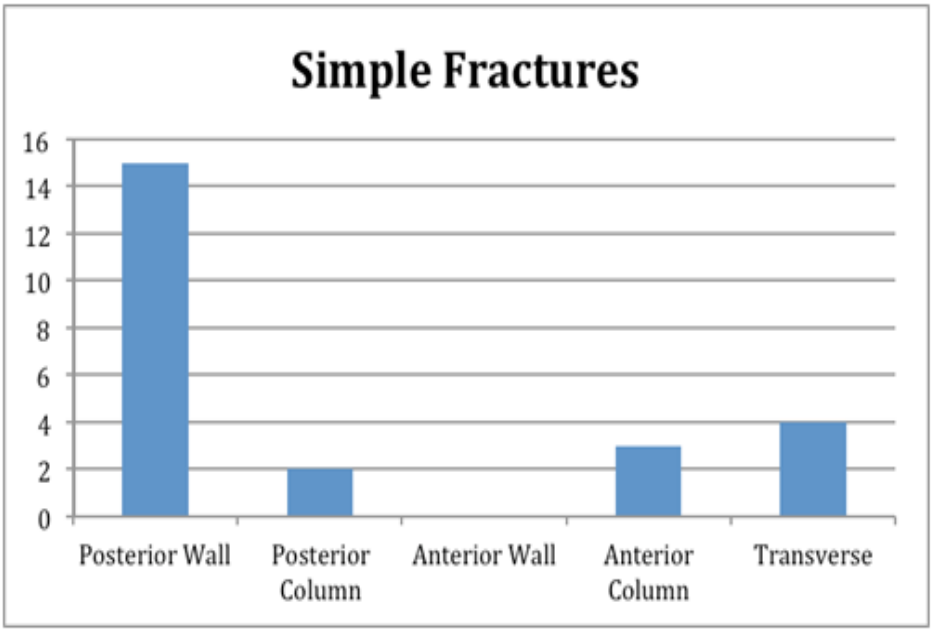
Complications	Amount/%
Heterotopik ossification	5/ %15
Avascular necrosis	4/ %12
Post-traumatic arthrosis	6 / %18
L.femoral cutaneous nerve paresthesia	1 / %3
Superficial Infection	1 / %3
Deep infection	1 / %3
Sciatic nerve damage	3 /%11

Table 3: Relationship between quality of reduction and clinical outcome

Reduction	Excellent	Good	Moderate	Poor
Anatomic Reduction	11	9	-	-
Adequate Reduction	1	4	5	-
Poor Reduction	-	-	3	-

Table 4: Correlation of radiological outcome with clinical outcome

	Matta radiological score			
Merle D'Aubigne score	**Excellent**	**Good**	**Moderate**	**Poor**
Excellent	10	1	1	-
Good	4	7	2	-
Moderate	-	1	5	2
Poor	-	-	-	-



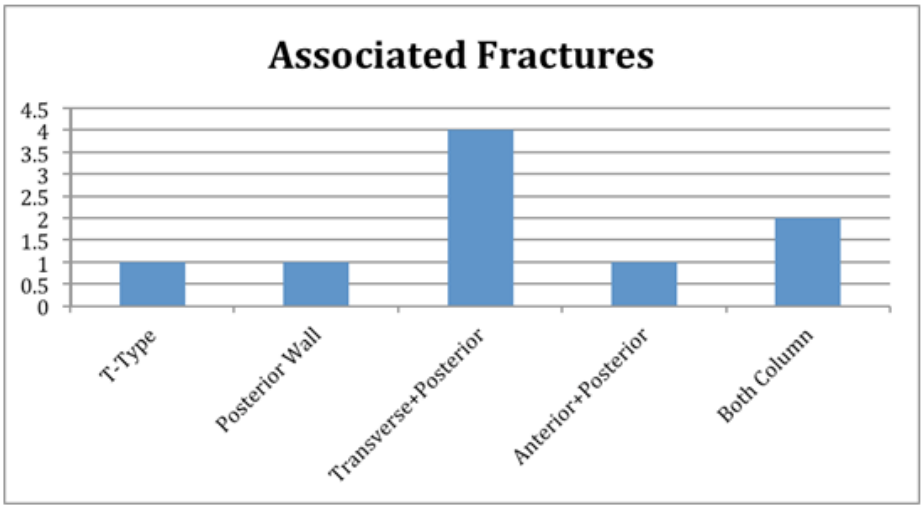
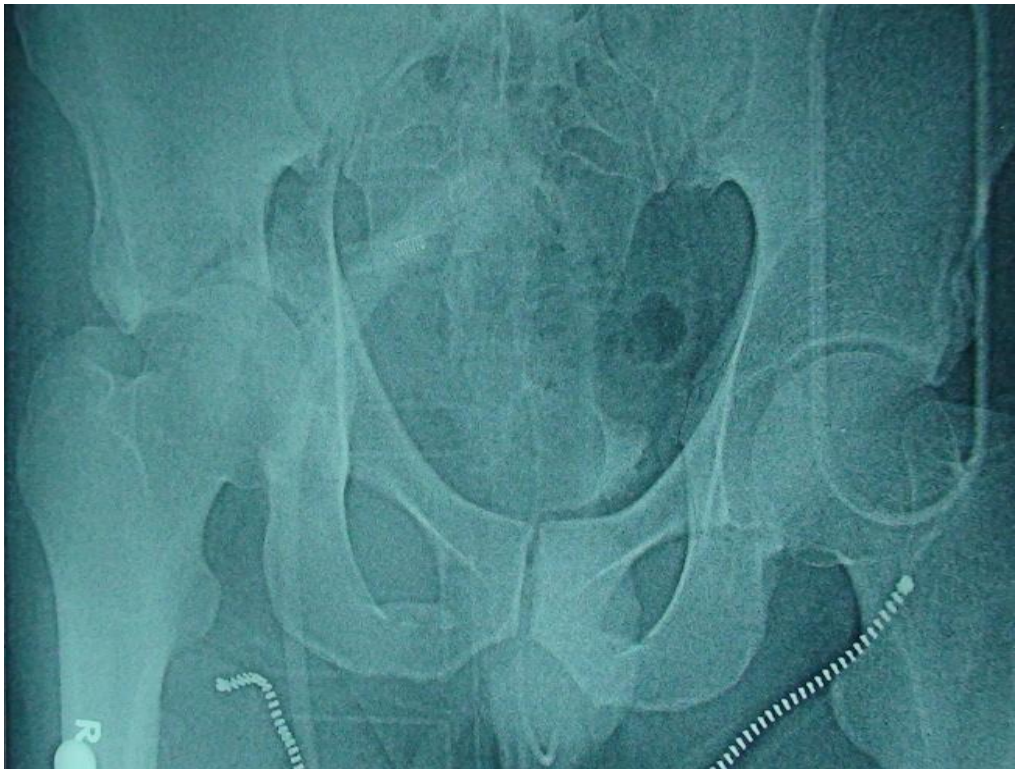
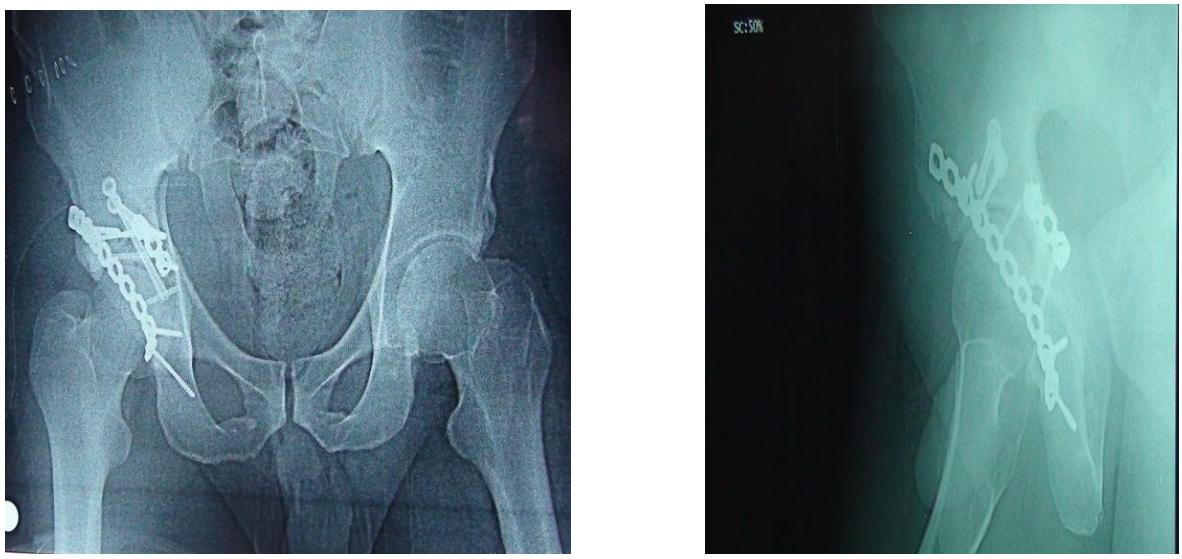


Figure 1: Fracture classification according to Judet-Leutournel



(a) Preoperative pelvic X-Ray



(b) Early postoparative X-Rays

(c) Postoperative 2 years

Figure 2: T-type acetabular fracture reduced and fixed with Kocher-Langenback approach

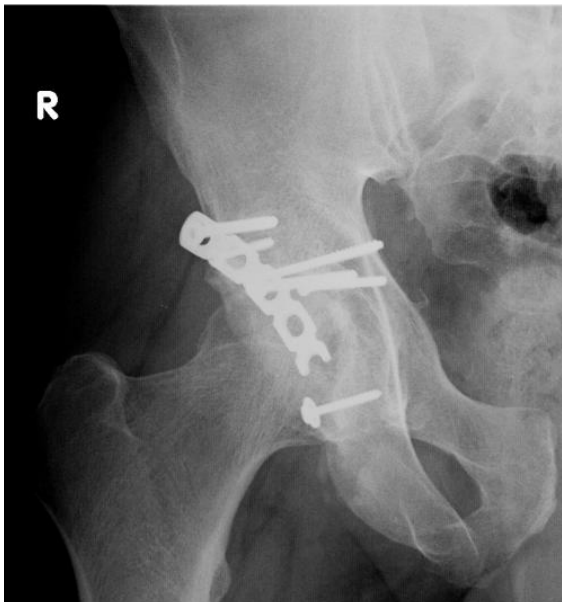
It is possible to treat many T-shaped fractures with Kocher-Langenbeck approach (Zhu *et al.,* 2011) (Figure 2). The cases that excellence in the reduction of the joint does not correlate with clinical outcome are the posterior was fractures together with posterior dislocation. First Letournel, and then Matta had reported mostly poor outcomes in posterior wall fractures together with posterior dislocations despite high anatomic reduction (Matta *et al.,* 1986; Letournel and Judet, 1993; Mayo, 1994).

Letournel has reported that reduction will be more difficult and outcomes in the follow-ups will be poorer in cases operated after periods exceeding three weeks (Letournel and Judet, 1993). All our patients with acetabular fractures operated in our clinic were operated within two weeks following the trauma. The period from the trauma to the operation was 3.9 days in the average. Madhu R and colleagues have stated that basic type fractures must be operated within 15 days and complex fractures must be operated within 10 days for good and excellent results (Madhu *et al.,* 2006).

One of the most important complications of the acetabular fracture surgery is the heterotypic ossification. The most important risk factor for heterotypic ossification is the scraping of gluteal muscles from the

external face of ileum (Matta, 1996; Letournel and Judet, 1993; Bosse *et al.*, 1988; Mears and Velyvis, 2002; Moed and Maxey, 1993). Since the extended iliofemoral and triradiate approaches require the scraping of gluteal muscles from the ileum widely, their heterotypic ossification rates are high. Alonso and colleagues have reported 53% heterotypic ossification for triradiate approach and 86% for extended iliofemoral approach (Alonso and Davila, 1994). Kocher-Langenbeck approach had been used in all our patients that heterotypic ossification had developed. Our heterotypic ossification rate in cases that we had preferred the Kocher-Langenbeck approach is 19%. The same rate is 8% according to Letournel, and 47% according to Griffin (Letournel and Judet, 1993; Griffin *et al.*, 2013).

(a) Postoperative X-Ray



(b) Postoperative 3 years with partial implant removel

Figure 3: (a) shows that distal tip of the plate doesn't fit ischium. This resulted with sciatica. After removal of distal tip of the plate patient's symptoms disappeared

Osteonecrosis of the femoral head has been reported between 5 and 23% in various publications (Matta, 1996; Mayo, 1994; Aşık and Eralp, 2000; Wright *et al.*, 1994; Kaempffe *et al.*, 1991). Possibility of osteonecrosis increases in patients having acetabular fracture with hip dislocation. The outcome is generally arthrosis (Matta, 1996; Letournel and Judet, 1993). In our study, we found osteonecrosis in 4 of our patients (%12). Of these patients, 3 had posterior dislocations. Arthrosis developed in all these patients. These patients will probably need total hip prostheses or arthrodesis within their follow-up times.

The sciatic nerve injury related to acetabular fractures can occur during the trauma or operation, as a result of the long-term complications and as sensory and/or motor symptoms (Issack and Helfet, 2009). Perioperative sciatic nerve injury is reported between 5 and 15% (Helfet and Schmeling, 1994; Schmeling *et al.*, 2003; Letournel E and Judet, 1993). We encountered complications related to the sciatic nerve in 5 patients. Our patient with sciatica symptoms, whom we saw after a trauma, had transverse fracture. During the operation of this patient, we did not encounter any problems related to the anatomic localization of the sciatic nerve, and thought that the said symptoms were related to the problems related to the stretching and compression related to the trauma, and likewise, we observed in the follow-ups that the condition recovered fully. Peroneal component of the sciatic nerve was symptomatic in 3 patients (11%) postoperatively. We had used the Kocher-Langen back approach in all of these patients. Causes of iatrogenic injuries include the retractors and reduction clamps placed on the sciatic notch, failing to keep the hip in extension and knee in flexion and direct injury during the placement of the screws or plates (Schmeling *et al.*, 2003; Haidukewych *et al.*, 2002; Letournel and Judet, 1993). Keeping the hip joint in extension and knee is flexion is recommended to prevent this problem. In addition, specially-designed Hohman type retractors placed in the lesser sciatic notch during posterior approach can prevent injury of the nerve (Letournel and Judet, 1993). Together with this, Matta and colleagues had carried out studies showing that the risk of iatrogenic nerve injuries reduces with the increase of surgical experience (Matta *et al.*, 1986; Matta, 1996). The distal end of the plate disturbed the sciatic nerve in one patient. After complete healing was achieved, we solved this problem by cutting the distal end of the plate off. It is seen that the plate does not fit the bone fully (Şekil3). With the purpose of preventing problems like this, a template can be used in the procedure and the plate can be formed according to this template to ensure the full fitting of the plate to the bone.

The risk factors specific for acetabular fractures can be listed as the Morel-Lavallee lesion, fractures of the pelvic ring in addition to the former, urinary trauma, antegrade femoral nailing, and embolism from the pelvic arterial injury (Letournel and Judet, 1993; Hak *et al.*, 1997; Kregor and Templeman, 2002; Manson *et al.*, 2008; Suzuki *et al.*, 2010). The surgery-related risk factors include massive bleeding, long operational time and long periods of hospital stay (Suzuki *et al.*, 2010; Wimmer *et al.*, 1998). Moreover, there are studies reporting that the infection risk in the basic approaches is higher as compared to the extended approaches (Alonso and Davila, 1994; Kaempffe *et al.*, 1991). The infection rate in our study is comparable to the infection rate (5%) reported in the literature with 6%. In one of our patients that ilioinguinal approach was used, superficial infection developed and then recovered completely with debridement and irrigation. The deep infection developing in the other patient was healed with antibiotic therapy specific for the microorganism that grew in the wound culture. In these patients that we wished to preserve the implants till healing is achieved, removal of the implants were not required since we did not find any sings related to infection.

Conclusion

In conclusion, we see that the mid-term results of the surgical treatment are satisfactory. Together with this, the surgery-related complication rates are still high. It must be kept in mind that the basic approaches will suffice to reduce complications particularly for complex acetabular approaches. The extended approaches may be required to see the joint perfectly; however, complication rates of such approaches are much higher.

REFERENCES

Alonso JE and Davila R (1994). Extended iliofemoral versus triradiate approaches in management of associated acetabular fractures. *Clinical Orthopaedics and Related Research* **305** 81–87.

Aşık M and Eralp L (2000). Long term results of surgical therapy in acetabular fractures. *Acta Orthopaedica et Traumatologica Turcica* **34** 245-253

Bosse MJ, Poka A, Reinert CM, Ellwanger F, Slawson R and McDevitt ER (1988). Heterotopic ossification as a complication of acetabular fracture. Prophylaxis with low-dose irradiation, *Journal of Bone and Joint Surgery - American Volume* **70**(8) 1231-7.

Brooker AF, Bowerman JW, Robinson RA and Riley LH (1973). Ectopic ossification following total hip replacement. Incidence and a method of classification, *Journal of Bone and Joint Surgery* **55-A** 1629—32.

Deo SD, Tavares SP, Pandey RK, El-Saied G, Willett KM and Worlock PH (2001). Operative management of acetabular fractures in Oxford. *Injury* **32**(7) 581-6.

Erdoğan F, Poursani RS, Öğüt T and Tenekecioğlu Y (1998). Results of the conservative and surgical treatment of displaced acetabular fractures. *Acta Orthopaedica et Traumatologica Turcica* **32** 111-5.

Ghalambor N, Matta JM and Bernstein L (1994). Heterotopic ossification following operative treatment of acetabular fracture. An analysis of risk factors, *Clinical Orthopaedics and Related Research* **305** 96–105.

Giannoudis PV, Grotz MR, Papakostidis C and Dinopoulos H (2005). Operative treatment of displaced fractures of the acetabulum. A meta-analysis, *Journal of Bone and Joint Surgery - British Volume* **87** 2-9.

Griffin SM, Sims SH, Karunakar MA, Seymour R and Haines N (2013). Heterotopic Ossification Rates After Acetabular Fracture Surgery Are Unchanged Without Indomethacin Prophylaxis. *Clinical Orthopaedics and Related Research*.

Haidukewych GJ, Scaduto J and Herscovici D Jr *et al.*, (2002). Iatrogenic nerve injury in acetabular fracture surgery: a comparison of monitored and unmonitored procedures. *Journal of Orthopaedic Trauma* **16** 297–301.

Hak DJ, Olson SA and Matta JM (1997). Diagnosis and management of closed internal degloving injuries associated with pelvic and acetabular fractures: the Morel-Lavalle´e lesion. *Journal of Orthopaedic Trauma* **42** 1046–51.

Helfet DL and Schmeling GJ (1994). Somatosensory evoked potential monitoring in the surgical treatment of acute, displaced acetabular fractures. Results of a prospective study, *Clinical Orthopaedics and Related Research* (301) 213-220.

Issack PS and Helfet DL (2009). Sciatic nerve injury associated with acetabular fractures. *HSS Journal* **5**(1) 12-8.

Jimenez ML and Vrahas MS (1997). Surgical approaches to the acetabulum. *The Orthopedic Clinics of North America* **28** 419–34.

Judet R, Judet J and Letournel E (1964). Fractures of the acetabulum: classification and surgical approaches for open reduction, Preliminary report. *Journal of Bone and Joint Surgery. American Volume* **46** 1615–46.

Judet R, Judet J and Letournel E (1964). Fractures of the acetabulum. Classification and surgical approaches for open reduction. *Journal of Bone and Joint Surgery* **46-A** 1615—75.

Kaempffe FA, Bone LB and Border JR (1991). Open reduction and internal fixation of acetabular fractures: heterotopic ossification and other complications of treatment. *Journal of Orthopaedic Trauma* **5**(4) 439-45.

Kregor PJ and Templeman D (2002). Associated injuries complicating the management of acetabular fractures: review and case studies. *Orthopedic Clinics of North America* **33** 73–95 viii.

Kumar A, Shah NA, Kershaw SA and Clayson AD (2005). Operative management of acetabular fractures: A review of 73 fractures. *Injury* **36**(5) 605-612.

Letournel E and Judet R (1993). Early complications of operative treatment within three weeks of injury. In: *Fractures of the acetabulum, 2nd edition,* edited by Elso RA (Springer, Berlin) 535–540.
Letournel E and Judet R (1993). Fractures of the acetabulum, 2nd edition Berlin: Springer-Verlag, 1993.
Letournel E and Judet R (1993). Late complications of operative treatment within three weeks of injury. In: *Fractures of the acetabulum, 2nd edition,* edited by Elso RA (Springer, Berlin) 541–564.
Madhu R, Kotnis R, Al-Mousawi A, Barlow N, Deo S, Worlock P and Willett K (2006). Outcome of surgery for reconstruction of fractures of the acetabulum. The time dependent effect of delay, *Journal of Bone and Joint Surgery - British Volume* **88**(9) 1197-203.
Magill P, McGarry J, Queally JM, Morris SF and McElwain JP (2012). Minimum ten-year follow-up of acetabular fracture fixation from the Irish tertiary referral centre. *Injury* **43**(4) 500-4.
Manson T, Perdue P, Pollak A and O'Toole R (2008). Embolization of pelvic arterial injury is a risk factor for deep infection after acetabular fracture surgery. In: Orthopaedic Trauma Association 24th annual meeting 164.
Matta JM (1996). Fractures of the acetabulum: accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. *The Journal of Bone and Joint Surgery* **78** 1632–45.
Matta JM (1996). Fractures of the acetabulum: accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. *Journal of Bone and Joint Surgery: American Volume* **78**(11) 1632-1645.
Matta JM and Merritt PO (1988). Displaced acetabular fractures. *Clinical Orthopaedics and Related Research* **230** 83–97.
Matta JM, Anderson LM, Epstein HC and Hendricks P (1986). Fractures of the acetabulum. A retrospective analysis. *Clinical Orthopaedics and Related Research* **205** 230–40.
Matta JM, Mehne DK and Roffi R (1986). Fractures of the acetabulum. Early results of a prospective study. *Clinical Orthopaedics and Related Research* **205** 241–50.
Mayo KA (1994). Open reduction and internal fixation of fractures of the acetabulum. Results in 163 fractures, *Clinical Orthopaedics and Related Research* (305) 31-37.
Mayr E, Braun W, Kogl F and Ruter A (1997). Approach-related results following acetabular fractures. *Der Orthopade* **26** 384–93.
Mears DC and Velyvis JH (2002). Acute total hip arthoplasty for selected displaced acetabular fractures: two to twelve-year results. *Journal of Bone and Joint Surgery - American Volume* **84-A**(1) 1-9.
Mears DC, Velyvis JH and Chang CP (2003). Displaced acetabular fractures managed operatively: indicators of outcome. *Orthopaedics and Related Research* 173-86.
Merle D'Aubigne RM and Postel M (1984). Functional results of hip arthoplasty with acrylic prosthesis. *Journal of Bone and Joint Surgery: American Volume* **36A** 451—75.
Moed BR and Maxey JW (1993). The effect of indomethacin on heterotopic ossification following acetabular fracture surgery. *Journal of Orthopaedic Trauma* **7**(1) 33-8.
Nabil A Ebraheim, Vishwas Patil, Jiayong Liu, Chris G Sanford Jr. and Steven P (2007). Hama Reconstruction of comminuted posterior wall fractures using the buttress technique, *International Orthopaedics Journal (SICOT)* **31** 671–675.
Ochs BG, Marintschev I, Hoyer H, Rolauffs B, Culemann U, Pohlemann T and Stuby FM (2010). Changes in the treatment of acetabular fractures over 15 years: Analysis of 1266 cases treated by the German Pelvic Multicentre Study Group (DAO/DGU). *Injury* **41**(8) 839-51.
Romness DW and Lewallen DG (1990). Total hip arthoplasty after fracture of the acetabulum. Long-term results. *Journal of Bone and Joint Surgery - British Volume* **72**(5) 761-764.
Ruedi T and Murphy WM (2000). AO Principles of Fracture Management. Stuttgart-New York: Thieme **1**.

Schmeling GJ, Perlewitz TJ and Helfet DL (2003). Early complications of acetabular fractures. In: *Fractures of the pelvis and acetabulum, 3rd edition,* edited by Tile M, Helfet DL, Kellam JF (Lippincott Williams and Wilkins, Philadelphia) 729–740.

Siebenrock KA, Gautier E and Ziran BH *et al.*, (1998). Trochanteric flip osteotomy for cranial extension and muscle protection in acetabular fracture fîxation using a Kocher-Langenbeck approach. *Journal of Orthopaedic Trauma* **12**(6) 387-391.

Suzuki T, Morgan SJ, Smith WR, Stahel PF, Gillani SA and Hak DJ (2010). Postoperative surgical site infection following acetabular fracture fixation. *Injury* **41**(4) 396-9.

Templeman DC, Olson S, Moed BR, Duwelius P and Matta JM (1999). Surgical treatment of acetabular fractures. *Instructional Course Lectures* **48** 481-96.

Wimmer C, Gluch H, Franzreb M and Ogon M (1998). Predisposing factors for infection in spine surgery: a survey of 850 spinal procedures. *Journal of Spinal Disorders* **11** 124–8.

Wright R, Barre K and Christie MJ *et al.*, (1994). Acetabular fractures: long-term follow-up of open reduction and internal fixation. *Journal of Orthopaedic Trauma* **8**(5) 397-403.

Zhu SW, Wang MY, Wu XB, Yang MH and Sun X (2011). Operative treatment of associated acetabular fractures via a single Kocher-Langenbeck approach. *Zhonghua Yi Xue Za Zhi* **91**(5) 327-30.