Ali, J Trauma Treat 2015, 4:4
DOI: 10.4172/2167-1222.1000278

Journal of Trauma & Treatment
ISSN: 2167-1222

Review Article Open Access

Acetabular Fractures - A Review of their Management

Erden Ali*

Magdalene College, University of Cambridge, Cambridge, UK

Abstract

Acetabular fractures present with a bimodal distribution, as is often associated with traumatic injuries presenting to trauma and orthopaedic surgeons. It is an injury that mandates a multi- disciplinary team approach as it is associated with injuries to another organ system and/or the lower extremities. The implementation of Advanced Trauma and Life Support (ATLS) principals has led to significant improvements and standardisation of how this injury is managed outside of the hospital setting and emergency management however controversies exist regarding the definitive treatment of this condition. A literature review of this interesting and common place fracture is presented whilst highlighting the areas of debate regarding its further management.

Introduction

The acetabulum is a cup shaped cavity located at the lateral surface of the os coxa and facesantero-laterally. The acetabular fossa possesses a smooth surface and it is a structure where the ilium, ischium and pubis contribute. It is the point at which the head of the femur articualtes with its lunar surface and a notch is located at its inferior border which opens into its fossa. A rough, non-articular groove leads into the fossa from the notched area and it is at this site where ligamentous attachments are located. Articular widening is maximal superiorly as it is here where body weight is supported by the head of the femur. It is responsible for regulating ambulatory movement, hip joint mobility and stability [1]. Fractures of the acetabulum represent one of the more challenging aspects of surgical orthopaedic intervention and are often associated with high energy incidents such as motor vehicle accidents or falls from heights. However, the ever ageing population has lead to an increased prevalence of osteoporosis. As such, more frequently are low impact injuries in the elderly leading to acetabular fracture. It is reported that this population is fastly becoming the most rapidly growing division of acetabular trauma [2] with post-traumatic arthritis reported to range from 12-67% (52). Despite much attention being payed to pelvic and acetabular injury, there is a paucity of interrelated descriptions of fixation pathways [3].

Fracture Patterns

The role that femoral position plays during impact in distinct fracture patterns has been evaluated with some hypothesising that more anteverted acetabula were frequently associated with anterior fracture types whilst retroverted acetabula associated with posterior fracture types, according to the Letournel classification. Hence concluding, that it is not only femoral position at the time of impact but acetabular version in the axial plane that influence fracture pattern [4]. Fracture patterns were scrutinised in a retrospective review by Osgood et al. [5] when assessing acetabular fractures associated with disruptions of the pelvic ring. The patient group they evaluated possessed 854 pelvic ring disruptions and 457 acetabular fractures, forty patients sustained combined injuries. They established that those with combined pelvic disruption and acetabular fracture present with multiple system injuries and demonstrate high Injury Severity Scores. They went on to conclude that fracture patterns differ from those when compared with isolated injuries- posterior acetabular fractures are an uncommon component in combined acetabular and pelvic ring injuries. Higher mortality is seen inanterior-posterior compression pelvic injuries and are much more frequent in cases of combined injury [6].

Fracture Management

It is for the purpose of fracture classification that the acetabulum is divided into anterior and posterior columns respectively. This classification was devised according to Letournel and Judet [7]. The anterior or iliopubic column is comprised of the superior pubic ramus, anterior acetabular wall, anterior iliac wing and the pelvic brim with the posterior or ilioischial column consisting of the ischial tuberosity, posterior acetabular wall and greater and lesser sciatic notches. The incidence of acetabular or pelvic fractures in the U.K. is quoted as approximately 3 per 100,000 per year [8], this value amounts to approximately 2-8 % of all fracture types [9].

With undisplaced or minimally displaced fractures, non operative treatment is adopted via a period of protected weight bearing [10,11] with the outcome of this treatment modality being dependent on hip joint stability, the concentricity of the head under the roof of the acetabulum and the condition of the roof itself.

Surgical Management

Operative intervention employing either open or closed reduction with internal or percutaneous rigid fixation (CRIF; ORIF) producing anatomical reduction whilst permitting early joint motion is now the gold standard when presented with displaced acetabular fractures and was suggested as early as 1964 [12]. Some have demontrated fair inferior results with non operative treatment showing 30% good reuslts vs 86% of good results when comparing non operative and operative intervention respectively [13]. Percutaneous fixation of acetabular fractures has been utilised to a greater degree in those with multiple medical co-morbidities where risks of open surgery outweigh the benefits. With elderly patients who encounter difficulty with nonoperative and operative rehabilitation programmes and in situations of minimally displaced fracture patterns, percuaneous fixation is also seen as advantageous as patients benefit from early mobilization [14]. When

***Corresponding author:** Erden Ali, Magdalene College, University of Cambridge, Cambridge, CB3 0AG, UK, Tel: +4401223 332100; E-mail: ea389@cam.ac.uk

Received December 05, 2015; **Accepted** December 22, 2015; **Published** December 30, 2015

Citation: Ali E (2015) Acetabular Fractures - A Review of their Management. J Trauma Treat 4: 278. doi:10.4172/2167-1222.1000278

attempting anatomical reduction in acetabular fracture fixation, it is the bony and soft tissue anatomy of the acetabulum and its surrounding structures that inhibit satisfactory reduction [15]. Notwithstanding this, the treatment of displaced intra-articular fractures mandates anatomic reduction with rigid, internal fixation [16]. Much work exists regarding the optimal treatment of displaced acetabular fractures. More recently, Tannast et al. [17] followed up 810 patients with displaced acetabular fractures who underwent operative intervention and produced data regarding hip survival. They examined two to twenty year post operative hip survivorship and identified predictive factors for conversion to total hip replacement (THR) or arthrodesis. They established that THR was successfully averted in 79% of the patient group they investigated within twenty years. Predictive factors for the requirement of THR were non-anatomical reduction, greater than 40 years of age, post operative acetabular roof incongruency, anterior hip dislocation, acetabular impaction and or involvement of the posterior acetabular wall, femoral head cartilaginous lesion, ≥20mm articular surface displacement at the time of injury and an extended iliofemoral approach. There are those who have analysed acetabular fractures in both columns [18]. The authors in this study established that 69.8% of those with anatomically reconstructed hip joints had no or mild post-operative pain and a good or excellent result after a mean of 54.6 months.Arthritic changes occurred in 17.5% of these patients with joint failure in a further 25.4%. In those with anatomical reduction, joint failure was more likely with the existence of a concomitant femoral head lesion and significant pre-operative articular fragment displacement. They concluded two column fractures subsequently lead to poorer results when considering joint reconstruction and functional outcomes. An earlier study by the same author [19] examined open anatomical reduction and internal fixation (ORIF) utilising screw and plate osteosynthesis via the Kocher-Langenbeck appoach of posterior wall acetabular fractures. Of 137 patients included in the study, 86 had follow up results after a mean of 52 months with 73.3% of these obtaining a good or perfect functional result and 31.4% demonstrating post-traumatic arthritis. It is important to appreciate that 132 patients demonstrated post-operative anatomic joint reconstruction (0-1 mm), with the remaining five patients possessing displaced near anatomic reconstructions (2-5 mm) whilst all hip joints were congruent on conventional radiography. A lower frequency of anatomic reductions may be achieved in situations where the bony or soft tissue envelope poses difficulties in fracture visualisation and implant placement. As such, in a retrospective study by Porter et al. [20], the authors evaluated the ability to achieve anatomical reduction in the obese vs non obese patient population. They further created nonmorbidly and morbidly obese groups for comparison. They concluded satisfactory pelvic reduction was achievable in all classes of nonmorbidly obese patients however was more difficult to obtain in the morbidly obese patient. Peri-operatively, femoral traction in order to achieve actabualar reduction is mandatory. This is often accomplished by surgical assistants or with newer mechanical devices [21].

The Role of Total Hip Replacement

Failure of acetabular reconstruction necessitates further surgical intervention. Zhang et al. [22] have produced data demonstrating the midterm results of 53 patients who underwent THR for failed acetabular reconstruction. 55 THRs were performed where thirty-three hips (60%) were attributed simple fracture patterns and 22 (40%) complex. Cemented and uncemented cups were installed with cementless cups predominating (47 of 55). In their study group, complications included 1 dislocation, 3 sciatic nerve injuries and 3 class III instances of heterotopic ossification. Mean duration of follow up was 64 months in 49 patients (51 hips), 4 being lost to follow up. No instances of deep wound infection were described and the dislocation occurred in a man with a morbidly obese body habitus. This was successfully treated with closed reduction and no subsequent recurrence was reported. 1 revision due to aseptic loosening of the acetabular and femoral component was undertaken. In these patients, THR proved successful with high patient satisfaction levels. Total hip arthroplasty for post-traumatic arthritis after acetabular fracture is not to be taken lightly. THR after acetabular fracture when compared with primary THR for nontraumatic conditions such as OA and avascular necrosis has lead to inferior clinical results [23]. Uncemented acetabular fixation has demonstrated improved outcomes and its use in these situations has permiated the literature [24]. 23 males and 9 females ranging in age from 17 to 86 years at the time of injury were available for follow up in this study and in no case was THR performed at the time of initial fracture management. 8 were managed conservatively whilst ORIF was adopted in 24. Mean time from fracture to THR was 36 months and ranged from 6-227 months. Average time for follow-up was 4.7 years and revealed increased Harris Hip scores from 28 (0-56) to 82 points (20-100). Revision surgery correlated with non- anatomical hip centre restoration and a history of infection ($p < 0.05$) and was performed in six patients. With survival for aseptic acetabular loosening reaching 97%, the aurthors concluded that cementless acetabular fixation in THR revealed improved results when utilised for those who have developed post-traumatic arthritis following acetabular fracture. Others have also revealed superior results when uncemented acetabular cups are adopted in the treatment of post-traumatic arthritis following acetabular fracture [25]. The midterm results of uncemented acetabular reconstruction in 31 hips after an average of 6.3 years underwent clincial and radiogrphic evaluation. Patients were grouped according to preceding fracture treatments (open-reduction group and conservative-treatment group) and fracture patterns (simple group and complex group). The mean Harris Hip Score increased from 49 before surgery to 89 after surgery whilst survival was measured as revision or radiographic acetabular loosening and reached 100%. 29 patients (94%) described either excellent or good results. The authors did not uncover acetabular osteolysis in their patient group however the rate of polyethylene wear was found to be higher in young, active individuals. Further research into this patient groupd was suggested but results of uncemented acetabular components were deemed satisfactory.

Loose Bodies and the Role of Arthroscopy

Traumatic hip dislocations are well known for their production of loose bodies. At the time of injury, as the femoral head dislocates, bony fragments are cleaved from the acetabular rim [26]. Some have historically believed that all fracture dislocations of the hip warrant open debridement in view of such a frequent occurrence of loose bodies in this injury category [27]. Evidence exists to suggest that the presence of loose bodies herald arthritic change [28]. It is widely accepted that after hip fracture dislocation, imaging must be performed in order to establish the presence of loose bodies. With satisfactory hip reduction, loose bodies pose a relative indication for surgical intervention [29], especially when located inferior to the fovea. Arthroscopic surgery is associated with less morbidity than open arthrotomy, as such, some have recommended early arthroscopic retrieval of loose fragments to preserve the articular surface due to the fact that computed tomography (CT) may miss such fragments within theweight-bearing area of the joint and retention of such fragments may lead to a less satisfactory long-term result [30]. Arthroscopy is now routinely used in order to remove known osseous loose bodies

producedafter traumatic hip dislocation or small acetabular wall fractures, however Mullis and Dahners [31] reviewed the incidence of arthroscopically detected intra-articular loose bodies in patients who would not otherwise be treated conservatively. Their follow up of 36 patients discovered loose bodies in the hips of 92 % (33 of 36) of those who consented for arthroscopy. In 78% (7 out of 9 patients) loose bodies were found where standard radiographic investigations (AP pelvis x-rays and Computed Tomography) found none present and a concentric hip reduction. It was the opinion of the authors that hip arthroscopy [32,33]. may be indicated for cartilaginous and osseous loose body removal when open treatment is not otherwise necessary in the hopes of reducing the risk of arthritis. When indicated in cases of closed reduction, it appears arthroscopic removal of loose bodies in traumatic hip dislocation is proving beneficial in decreasing the long term morbidity associated with this condition. Further reports exist of successful removal of loose bodies following the application of hip arthroscopy thereby allowing excellent visualisation of the hip joint and avoidance of a larger incision required by arthrotomy.

Timing of Fixation

Outcome of acetabular fracture fixation has been related to timing of intervention [34]. Early fixation of other fractures has been demonstrated to lead to fewer complications and improved outcomes [35] however a paucity of literature exists regarding exact timing of acetabular fixation with worsening results when surgical intervention is undertaken after 3 weeks [16]. It is appreciated that those with concomitant life threatening injuries require stabilisation and not definitive fixation but a subset of patients do exist where early fixation can be undertaken. Some have stated that undertaking surgical intervention within 24 hours proves detrimental in light of increased blood loss [7]. Others have debated that definitive surgical procedures are best undertaken between 2 and 5 days after injury [11] whilst evidence does exist displaying a correlation between early fixation, early mobilisation and an absence of respiratory pathology [36]. Furey et al. [37] retrospectively studied 49 patients over a 1 year period and compared those who underwent early fixation of posterior wall acetabular fractures within 24 hours and with those who underwent surgery after this time period. The average time to surgery for those undergoing early fixation was 14.7 hours and those not was 135.2 hours. No difference was demonstrated in estimated blood loss, pre and post-operative haematocrit levels, intra- operative and post-operative blood product requirement. They suggested that posterior wall acetabular fractures represent a subset of acetabular injury that are amenable to immediate definitive fixation when considering excessive blood loss. Posterior wall acetabular fractures with an associated hip dislocation are injury types predominantly seen in young individuals [38]. Treatment of patients who develop hip subluxation as a result of traumatic posterior acetabular wall defects as a late complication of posterior wall fractures is the subject of great debate. Treatment options available are hip arthrodesis leading to a significant reduction of hip motion [39] or THR [40]. However young, active patients are prone to premature failure of arthroplasty, and face frequent revisions in later life [41]. Paediatric patients are unable to undergo THR. A recent retrospective clinical study has assessed late reconstruction of posterior acetabular wall fractures with autologous iliac crest strut graft [42]. Seven patients with traumatic posterior acetabular wall defects were included in the study with an average age of 31 years, mean time from injury to reconstruction was 6.4 months. After an average follow up of 76 months, this method of fixation was deemed appropriate for pediatric patients or adults without posttraumatic osteoarthritis of the hip at the time of reconstruction. However, it was not recommended for adult patients with post-traumatic osteoarthritis of the hip. In these instances THR was the treatment option of choice.

Type of Approach

Consensus exists that for simple fracture patterns where one acetabular column is involved, a singly orientated exposure is required corresponding with the appropriate columnar fracture. However, various approaches have been emplyed when treating complex, multi-columnarfracture patterns. Such exposures include the extended iliofemoral, Triradiate, T extensile and the combined anterior and posterior approaches [41,43-45]. However, extended approaches have been associated with greater complications such as infection and heterotopic ossification [45,46]. In light of this, a single approach is being adopted more and more with Kumar et al. [13], publishing their results. In 67 (92%) acetabular fractures treated between June 1994 and September 2000, either an anterior ilioinguional or posterior Kocker-Lagenbach was used to treat 26 and 41 cases respectively. 5 fractures needed an extensile triradiate approach and one case needed a combined posterior and anterior approach. Reduction was achieved in 89% with 2.7% of cases demonstrating deep infection and 4.2% of cases developing severe degenerative changes. 5.5% later required a THR. It was the authors' opinion that acetabular ORIF can be performed through one single incision but this mandates operative intervention in a specialist unit. Fracture anatomy dictates the chosen approach which takes into consideration surgical preference. Please see Table 1 for fracture types and corresponding approaches. Commonly performed exposures are the ilioinguinal when met with an anterior column, T- shaped or bicolumnar fracture pattern with mild comminution in the posterior column. For posterior column injuries the Kocher-Langenbeck approach is often implemented.

Post-operative Rehabilitation

One must not forget that traumatic injuries are often associated with significant muscle injuries and acetabular fractures are no exception. Surgical intervention of acetabular fractures also involves extensive dissection of hip joint musculature [47]. Recent evidence has demonstrated variations in gait and hip muscle strength after acetabular ORIF [1]. This prospective study compared 19 patients at 3 and 12 months postoperatively against sex and aged matched controls. Utilising a standard postoperative rehabilitation programme, walking velocity was slower at 3 months and similar at 12 months against controls. However, recovery for pelvic forward tilt and hip abduction moment was incomplete with the greatest loss of muscle strength at the hip abductors. A lack of the hip abduction moment was correlated with the presence of associated injuries. Kazemi and Archdeacon [48] in their retrospective study, produced data regarding immediate full weight

Frature Type	Approach
Anterior fracture, cephalad to iliopectineal eminence	Iliofemoral
Anterior fracture, patients with complex injuries requiring exposure of the symphysis or quadrilateral plate	Ilioinguinal
Posterior wall/column	Kocher-Langenbeck
Transverse with posterior lip	Kocher-Langenbeck or transtrochanteric
T-shaped	Ilioinguinal/Kocher-Langenbeck/combined/ extensile. Dependent on Fracture pattern
Both columns	Ilioinguinal, modified ilioinguinal/combined/ extensile

Table 1: Fracture types and corresponding approaches.

bearing after 28 patients between 2001 and 2008 underwent closed reduction and anterior to posterior supra-acetabular percutaneous screw fixation. 22 patients who sustained anterior column or anterior column posterior hemitransverse acetabulum fractures were followed up after a mean of 39 months. Regardless of an immediate full weight bearing protocol, clinical, radiographic and functional outcomes of patients were found to be comparable to other reported studies. Complications following actebular fixation are common, with 20-25% of patients treated reporting a poor medium term functional outcome [40]. Some have published 10 year follow up results of those treat with ORIF [8]. These authors demonstrated that excellent results were achieved in 75 patients (47%), good in 41 (25%), fair in 12 (7%) and poor in 33 (20%) reflecting the existing literature. They surmised that increasing age, delay to surgery, poor quality reduction and complicated fracture patterns represented poor prognostic factors with variable functional outcomes and frequent complications in the medium- to long-term.

Conclusion

Fractures of the acetabulum pose a significant management issue for trauma and orthopaedic surgeons. An Advanced Trauma and Life Support approach must be adopted to all patients presenting with this injury as it can represent a significant life threatening condition. A review of the management of this injury has been presented allied with the more recent controversies.

Funding Statement

There are no sources of funding to declare

Conflict of Interest

None.

References

1. Kubota M, Uchida K, Kokubo Y, Shimada S, Matsuo H, et al. (2012) Changes in gait pattern and hip muscle strength after open reduction and internal fixation of acetabular fracture. Arch Phys Med Rehabil 93: 2015-2021.
2. Anglen JO, Burd TA, Hendricks KJ, Harrison P (2003) The "Gull Sign": a harbinger of failure for internal fixation of geriatric acetabular fractures. J Orthop Trauma 17: 625-634.
3. Bishop JA, Routt ML Jr (2012) Osseous fixation pathways in pelvic and acetabular fracture surgery: osteology, radiology, and clinical applications. J Trauma Acute Care Surg 72: 1502-1509.
4. Tornetta P 3rd (2001) Displaced acetabular fractures: indications for operative and nonoperative management. J Am Acad Orthop Surg 9: 18-28.
5. Missiuna PC, Dewar RD (1988) Long-term sequelae of hip fusion surgery. Orthop Trans 12: 672.
6. Tile M, Olson SA (2003) Decision making: Nonoperative and operative indications for acetabular fractures. In: Tile M, Helfet DL, Kellam JF Fractures of the Pelvis and Acetabulum (3rdedn) Lippincott Williams & Wilkins, Philadelphia, USA, 496-532.
7. Letournel E (1980) Acetabulum fractures: classification and management. Clin Orthop Relat Res 81-106.
8. Briffa N, Pearce R, Hill AM, Bircher M (2011) Outcomes of acetabular fracture fixation with ten years' follow-up. J Bone Joint Surg Br 93: 229-236.
9. Barthel W, Markwardt F (1975) Aggregation of blood platelets by adrenaline and its uptake. Biochem Pharmacol 24: 1903-1904.
10. Starr AJ, Watson JT, Reinert CM, Jones AL, Whitlock S, et al. (2002) Complications following the "T extensile" approach: a modified extensile approach for acetabular fracture surgery-report of forty-three patients. J Orthop Trauma 16: 535-542.
11. Tannast M, Najibi S, Matta JM (2012) Two to twenty-year survivorship of the hip in 810 patients with operatively treated acetabular fractures. J Bone Joint Surg Am 94: 1559-1567.
12. Judet R, Judet J, Letournel E (1964) Fractures of the acetabulum: classification and surgical approaches for open reduction. Preliminary report. J Bone Joint Surg Am 46: 1615-1646.
13. Kumar A, Shah NA, Kershaw SA, Clayson AD (2005) Operative management of acetabular fractures. A review of 73 fractures. Injury 36: 605-612.
14. Lien FC (2012) New tool for applying traction during open reduction and internal fixation of acetabular fractures. Orthopedics 35: 289-291.
15. Tornetta P 3rd (1999) Non-operative management of acetabular fractures. The use of dynamic stress views. J Bone Joint Surg Br 81: 67-70.
16. Lin YC, Chen CH, Huang HT, Chen JC, Huang PJ, et al. (2008) Percutaneous antegrade screwing for anterior column fracture of acetabulum with fluoroscopic-based computerized navigation. Arch Orthop Trauma Surg 128: 223-226.
17. Swanson MA, Huo MH (2009) Total hip arthroplasty following acetabular fracture. Hip Society Summer Closed Scientific Meeting, Palo Alto, CA, USA.
18. Gänsslen A, Frink M, Hildebrand F, Krettek C (2012) Both column fractures of the acetabulum: epidemiology, operative management and long-term-results. Acta Chir Orthop Traumatol Cech 79: 107-113.
19. Gänsslen A, Steinke B, Krettek C (2009) [Internal fixation of acetabular posterior wall fractures]. Oper Orthop Traumatol 21: 283-295.
20. Plaisier BR, Meldon SW, Super DM, Malangoni MA (2000) Improved outcome after early fixation of acetabular fractures. Injury 31: 81-84.
21. Levin PE (1998) Hip dislocations. In: Browner BD, Jupiter JB, Levine AM eds. Skeletal Trauma. Philadelphia: WB Saunders 1713-1750.
22. Flohr H, Breull W (1975) Effect of etafenone on total and regional myocardial blood flow. Arzneimittelforschung 25: 1400-1403.
23. Ranawat A, Zelken J, Helfet D, Buly R (2009) Total hip arthroplasty for posttraumatic arthritis after acetabular fracture. J Arthroplasty 24: 759-767.
24. Ragnarsson B, Jacobsson B (1992) Epidemiology of pelvic fractures in a Swedish county. Acta Orthop Scand 63: 297-300.
25. Lai O, Yang J, Shen B, Zhou Z, Kang P, et al. (2011) Midterm results of uncemented acetabular reconstruction for posttraumatic arthritis secondary to acetabular fracture. J Arthroplasty 26: 1008-1013.
26. Letournel E (1993) The treatment of acetabular fractures through the ilioinguinal approach. Clin Orthop Relat Res 62-76.
27. Epstein HC (1974) Posterior fracture-dislocations of the hip; long-term follow-up. J Bone Joint Surg Am 56: 1103-1127.
28. Evans CH, Mazzocchi RA, Nelson DD, Rubash HE (1984) Experimental arthritis induced byintra-articular injection of allogenic cartilaginous particles intorabbit knees. Arthritis Rheum 27: 200-207.
29. Mayo KA (1994) Open reduction and internal fixation of fractures of the acetabulum: results in 163 fractures. Clin Orthop Relat Res 305: 31-37.
30. Keene GS, Villar RN (1994) Arthroscopic loose body retrieval following traumatic hip dislocation. Injury 25: 507-510.
31. Mehlman CT, Meiss L, DiPasquale TG (2000) Hyphenated-history: the Kocher-Langenbeck surgical approach. J Orthop Trauma 14: 60-64.
32. Chernchujit B, Sanguanjit P, Arunakul M, Jitapankul C, Waitayawinyu T (2009) Arthroscopic loose body removal after hip fracture dislocation: experiences in 7 cases. J Med Assoc Thai 92 Suppl 6: S161-164.
33. Stover M,Weresh MJ, Bosse MJ, et al. Nonoperative treatment of fractures of the acetabulum. Abstracts: Orthop Trauma Assoc; 14: 148-149.
34. Osgood GM, Manson TT, O'Toole RV, Turen CH (2013) Combined pelvic ring disruption and acetabular fracture: associated injury patterns in 40 patients. J Orthop Trauma 27: 243-247.
35. Charash WE, Fabian TC, Croce MA (1994) Delayed surgical fixation of femur fractures is a risk factor for pulmonary failure independent of thoracic trauma. J Trauma 37: 667-672.
36. Pennal GF, Davidson J, Garside H, Plewes J (1980) Results of treatment of acetabular fractures. Clin Orthop Relat Res 115-123.
37. Furey AJ, Karp J, OÊ¼Toole RV (2013) Does early fixation of posterior wall acetabular fractures lead to increased blood loss? J Orthop Trauma 27: 2-5.

38. Porter SE, Graves ML, Maples RA, Woodall J Jr, Wallace JG, et al. (2011) Acetabular fracture reductions in the obese patient. J Orthop Trauma 25: 371-377.

39. Mullis BH, Dahners LE (2006) Hip arthroscopy to remove loose bodies after traumatic dislocation. J Orthop Trauma 20: 22-26.

40. Giannoudis PV, Grotz MR, Papakostidis C, Dinopoulos H (2005) Operative treatment of displaced fractures of the acetabulum. A meta-analysis. J Bone Joint Surg Br 87: 2-9.

41. Svoboda SJ, Williams DM, Murphy KP (2003) Hip arthroscopy for osteochondral loose body removal after a posterior hip dislocation. Arthroscopy 19: 777-781.

42. Werner CM, Copeland CE, Ruckstuhl T, Stromberg J, Turen CH, et al. (2012) Acetabular fracture types vary with different acetabular version. Int Orthop 36: 2559-2563.

43. Laird A, Keating JF (2005) Acetabular fractures: a 16-year prospective epidemiological study. J Bone Joint Surg Br 87: 969-973.

44. Carnesale PG, Stewart MJ, Barnes SN (1975) Acetabular disruption and central fracture-dislocation of the hip. A long-term study. J Bone Joint Surg Am 57: 1054-1059.

45. Routt ML Jr, Swiontkowski MF (1990) Operative treatment of complex acetabular fractures. Combined anterior and posterior exposures during the same procedure. J Bone Joint Surg Am 72: 897-904.

46. Kaempffe FA, Bone LB, Border JR (1991) Open reduction and internal fixation of acetabular fractures: heterotopic ossification and other complications of treatment. J Orthop Trauma 5: 439-445.

47. Mears DC (1983) Rubash HE. Extensile exposure of pelvis. Contemp Orthop 6: 21-31.

48. Kazemi N, Archdeacon MT (2012) Immediate full weightbearing after percutaneous fixation of anterior column acetabulum fractures. J Orthop Trauma 26: 73-79.