ORIGINAL ARTICLE

Anterior approach for acetabular fracture fixation using locally designed plates

Israr Ahmad, Wasim Anwar, Noor Rahman, Sabir Khan, Muhammad Arif

Abstract:
Objectives: The objective of this study was to evaluate the outcome of anterior acetabular fractures fixation with locally designed acetabular plate through anterior approach.
Setting: The study was carried out at the Department of Orthopaedics and Spine Surgery, Hayatabad Medical Complex, Peshawar.
Study design: Descriptive case series
Material and Methods: A consecutive series of patients with acetabular fractures treated using anterior approach and locally designed anatomical plates were included in the study. The fracture pattern, approach used, intra-operative and post-operative complications, quality of reduction and early post-operative outcome (6 months) were recorded. The study period was from January 2017 to July 2022.
Results: There were 22 patients in this study, 17 were male and 5 were female. Average age at the time of injury was 34 years and ranged from 22-72 years. Among these 18-patients got admitted via accident and emergency and only 4-patients presented to our out-patient department. Commonest mechanism of injury was reported to be high energy trauma 19(86.3%). Road traffic accident (RTA) was the commonest mode of injury i.e. 16(72.7%). According to the Letournel classification, two fracture types were most common i.e. associated both column fracture 9(40.9%) and anterior column posterior hemi transverse 7(31.8%). Others were transverse fractures anterior column and anterior wall. Quadrilateral plate involvement was in 85% of patients. 18-patients were fixed via ilioinguinal approach while 3 patients were fixed through modified Stoppa approach. Overall anatomical reduction was seen in 75% of patients radio graphically. Associated both column fractures had lower incidence of anatomical reduction. At 6-months follow up 65% patients were symptom free. 60% patients had excellent radiological outcome.
Conclusions: Acetabular fractures are complex injuries. Anterior column and associated both column fractures are usually fixed via anterior approach. Use of specially designed spring plate is useful in holding the quadrilateral plate in reduced form and results in satisfactory outcome.

Keywords: Fracture acetabulum, anterior column fractures, quadrilateral plate, spring plate

Received
Date: 8th October, 2022
Accepted
Date: 17th December, 2022

Khyber Girls Medical College, Hayatabad Medical Complex, Peshawar
I Ahmad,
W Anwar,
N Rahman,
S Khan,
MA Khan

Correspondence:
Dr. Wasim Anwar
Associate Professor,
Khyber Girls Medical College, Department of Orthopedics and Spine Surgery, Hayatabad Medical Complex, Peshawar
Cell No:+92
email: israr_312@yahoo.com

Introduction:
The acetabulum is a cup shaped depression on the outer surface of the hip bone and it makes a ball and socket joint with the head of the femur. Acetabular fractures occur when the head of femur is pushed in to the pelvis by a lateral blow to the hip or by an anterior blow to the flexed knee with hip in flexion and abduction.[1] About 80% of acetabular fractures result from high energy trauma like in road traffic accidents and around 10.7% result from fall from a significant height.[2,3] Acetabulum fracture present more often in multiple trauma patient and are considered as serious injury.[3] Patients present to emergency department with history of pain or a hip deformity, usually with other associated injuries such as

hip dislocation, femoral neck fracture or sciatic nerve palsy and injury to other bones too. They can also present with trauma to the surrounding structures like peri-pelvic soft tissues, extremity fractures, trauma to major abdominal viscera and chest injuries.[4]

Pelvic insults can vary ranging from minor lacerations to major debilitating complex acetabular fractures.[4] Different factors are associated with mortality and morbidity of patient including mechanism and the energy of initial insult, age, male gender, cardiac diseases, dementia, institutionalization and rehabilitation, that should be carried out after hip trauma and plays a significant role in patient recovery.[5,7-9]

In general, operative treatment of an acetabular fracture should not be performed as an emergency except when it is a part of open fracture management or is performed for a fracture associated with an irreducible dislocation of the hip. In such cases, the top priority would be resuscitation based on Advanced Trauma Life Support (ATLS) protocols.[8]

The patient after resuscitation undergoes a detailed clinical and radiological study, including CT pelvis with 3D reconstruction. The fractures are classified according to the Letournel and Judet classification. The treatment of acetabular fracture depends on the classification and displacement of fragments, patient's general health, his age and the expertise available at the centre. These are complex injuries and surgery is technically demanding and needs advanced training. There is steep learning curve. More complex injuries need to be referred to specialized centers. Undisplaced or minimally displaced fractures can be treated conservatively with bed rest and traction for 6-8 weeks and gradual mobilization with support. The posterior wall fractures which are more common can be fixed through Kocher Langeback approach. Transverse fractures, anterior, posterior and both column fractures are difficult to treat and need more extensive approach and technical expertise. Anterior column and transverse fractures and both column associated injuries are dealt by ilioinguinal or modified Stoppa approaches which sometimes need general surgeons help especially when the surgeon is beginner.[9,10,19,21,30,31] Multiple surgical approaches and implantations have been invented and modified for the treatment of acetabular fractures.[13,14,16] In 1960s, Letournel described the standardized surgical treatment strategies, approaches and algorithms, which have greatly contributed to the management of acetabular fractures.[1,21] There is increasing trend to use minimally invasive methods to reduce blood loss, shorten hospital stay and reduce other complications.[1,8,11,34]

Superior and medial displacement of fragments occurs due to injury to both anterior and posterior columns. Sometimes it is not possible to classify them easily. The anterior column fragment is displaced superiorly and posterior column medially and the quadrilateral surface is also displaced medially. This two directional displacement makes treatment of these fractures difficult and proximity to the neuro-vascular structure also becomes a challenge.[18,27-30] Therefore, the use of best surgical approach and reduction and fixation methods is very important for achieving satisfactory results. There are various plates which are used to fix the anterior column and the quadrilateral plate which is usually displaced medially by the femoral head. With fixation of plate over the pelvic brim the quadrilateral plate and posterior column remains displaced unless it is also fixed with another plate or a small plate is used as a spring plate under the brim plate. But this construction is not stable.[1,8,9,34-37,39]

Considering the initial difficulty in maintaining reduction we devised our own local plate (pic 1). It's basically a medial extension on the concave side of the curved small fragment reconstruction plate which can be bent at 95° degree, and holds the quadrilateral plate. We are presenting our early results using this plate for associated both column and anterior column and posterior hemi-transverse fractures with displaced quadrilateral surface.

Material and Methods:

This study is a case series for which data was

Figure1: locally designed anterior acetabular plate

Figure 2a: Displaced quadrilateral plate

Figure 2b: Fixation with anterior acetabular plate

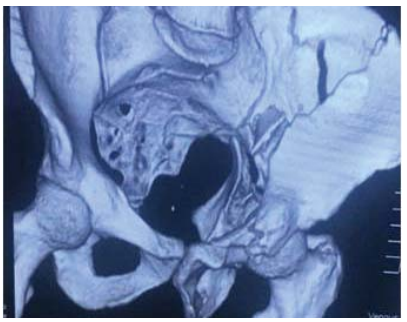

Figure 3a: Associated both column fracture

Figure 3b: Fixation through anterior approach

collected from the Department of Orthopedics and Spine Surgery, Hayatabad Medical Complex, Peshawar. Patients who met the inclusion criteria from January 2017 to July 2022 were selected. The inclusion criteria consisted of adult patients with traumatic acetabular fracture, who underwent acetabular fixation via anterior approach using locally designed acetabular plate. The exclusion criteria included pediatric patient with traumatic acetabular fracture, pathologic acetabulum fracture, peri-prosthetic acetabulum fracture and patients who were previously operated on the same hip joint. The patients were assessed and resuscitated, the demographic features noted, mechanism and severity of injury were recorded, and radiological evaluation including CT-scans were done and fractures classified according to Judet and Letournel classification system. The operative details were recorded including surgical approach and fracture fixation.

All patients were admitted under the care of consultant Orthopedic Surgeon and were operated on a dedicated list. Data was analyzed using SPSS version 22. Cross tabulations were made and recorded where required. The patients were followed at 2-weeks, 6-weeks and then every 3-months. Any per operative complication and post-operative events were recorded in a data base. The quality of reduction were assessed with Judet views and graded according to Matta scoring system. The patients were followed at 2-weeks, 6-weeks, 3-months and 6-months for functional outcome.

Results:

There were 22-patients in this study, 17 were male and 5 were female. Average age at the time of injury was 34-years and ranged from 22-72 years. Among these 18-patients got admitted via Accident and Emergency and only 4-patients presented to our out-patient department. Average Injury Severity Score at the time of injury was calculated to be 12.8. Commonest mechanism of injury was reported to be high energy trauma 19(86.3%). Road traffic accident was the commonest mode of injury i.e. 16(72.7%). According to the Letournel classification, two fracture types were most common i.e. associated both column fractures 9(40.9%) and anterior column posterior hemi transverse fractures 7(31.8%). Quadrilateral plate involvement was in 85% of

Table 1: Demographic data of patients N=22

Characteristics	Number of patients %
Age	Average 34 (range 21-72)
Sex	
Male	17 (77.2%)
Female	5 (22.7%)
Follow up	6-months
Surgical approach	
Ilio inguinal	19 (86.3%)
Modified Stoppa	3 (13.6%)
Mechanism of injury	
Motor vehicle accidents	16 (72.7%)
Fall from height	3 (13.6%)
Others	3 (13.6%)
With other multiple fractures	10 (45.4%)

Table 2: Classification of fractures and quality of reduction

Type of fracture	Number of patients	Anatomical reduction	P value
Associated both column	9	5 (55.5%)	0.00
Anterior column and posterior Hemitranverse	7	*6 (85.7%)*	0.00
Transverse	3	*2 (66.6%)*	0.057
Anterior column and wall	3	*3 (100%)*	NA
Overall	22	*16 (72.7%)*	0.00

If p-value is less than 0.05 than it is statistically significant.

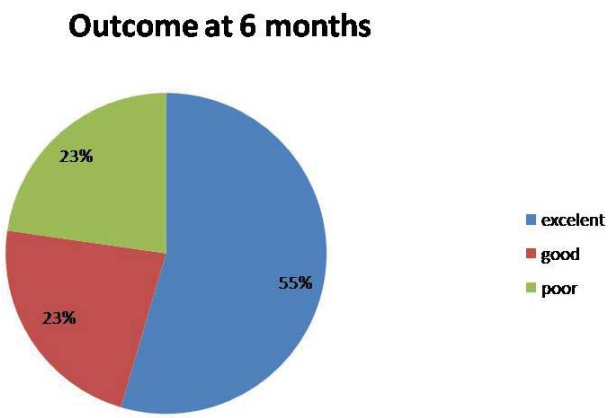

Figure 4: Outcome at 6 months

patients. 19-patients were fixed via ilioinguinal approach while 3-patients were fixed through modified Stoppa approach. Overall anatomical reduction was seen in 16(72.7%) of patients on plain radiograph. Associated both column fractures had lower incidence of anatomical reduction. There were no major intra operative complications. At 6-months follow up 15(68.1%) patients were symptom free. 17(78%) patients had good excellent radiological outcome at 6 months. 2-patients among those with poor reduction have symptoms of pain and limitation of movements and radiological joint space narrowing.

Discussion:

Acetabular fractures are serious Orthopedic injuries and they can prove to be a complex surgical issue. In our study the most common cause for acetabular fracture was the road traffic accident (RTA). 72.7% cases were accounted due to RTA. The rest were injured due to history of fall from height and other causes. This trend is similar to other previous studies on acetabular fractures[1,6,17,23]. Complex fracture like associated both column, transverse and anterior column and posterior hemi-transverse fractures are difficult to treat. These fractures were treated with anterior approach through ilioinguinal route or modified Stoppa approach.[1,2,12] Use of various reduction methods and use of screws and plates has evolved over the years. The most common method was to reduce the fracture directly and apply plate over the pelvic brim. 3.5 reconstruction plate contoured per operatively was use to fix these fractures. Minimally invasive per coetaneous techniques and use of pre contoured anatomical plates are gaining popularity due to less surgical trauma and less complications.[8,9,15]

Superomedially displaced acetabular fractures are generally caused by the medial impact of the femoral head into the quadrilateral plate and superior dome, which displaces the anterior column superiorly and the posterior column including the quadrilateral plate medially. The appropriate approach and reduction method is of paramount importance for achieving satisfactory results in these two-directionally displaced fractures. In the past, these fractures were fixed mainly with reconstruction plates through the ilioinguinal or combined. Intra operative reshaping of the conventional plates may be required to improve the buttress effect.[20,24,25,33]

We have used same 3.5 reconstruction plate with some structural modification by adding extension on medial concave side which can be contoured to hold the quadrilateral surface after reduction while the plate over the brim hold the reduction of anterior column.

In the literature, modified Stoppa approach has been reported to reduce the operation time and blood loss in the treatment of superomedially displaced acetabular fractures compared to ilioinguinal approach. In contrast, some authors reported that there were no differences in the amount of bleeding or operation time between both approaches. However, these studies were based on the fixation of the acetabular fractures using a conventional reconstruction plate.[11,17,32,39]

The complications were few as reported by others in literature. The duration of surgery was also comparable with other similar studies and blood loss was also acceptable. The quality of reduction was anatomical in 72% of patients. The non-anatomical reductions were mostly in associated both column fractures and transverse fracture.

In two local studies the radiological anatomical reduction was achieved in 78% cases but both studies also included simpler fractures like posterior wall and column.[5,6] In another recent study by U Nadeem et al, using modified Stoppa approach the authors were able to achieve anatomical reduction in 75% cases.[39] The clinical outcome is graded from good to excellent in 70 to 80% cases in most local and international studies. Our results also show similar picture.[3,5,6,22,39]

Conclusions:
Acetabular fractures are complex injuries. Anterior column and associated both column fractures are usually fixed via anterior approach. Use of specially designed spring plate is useful in holding the quadrilateral plate in reduced form and results in satisfactory outcome.

Conflict of interest: None

Funding source: None

Role and contribution of authors:
Israr Ahmad, helped in collection of data, references and article writing, critically review the article, and did the final changes.

Wasim Anwar, collected the data, references and helped in intoduction and discussion writing.

Noor Rahman, collected the references and helped in introduction writing.

Sabir Khan, collected the data, references and did the initial writeup.

Muhammad Arif, critically review the article and did the useful changes.

References:
1. Judet R, Judet J, Letournel E. Fractures of the acetabular classification and surgical approaches for open reduction. J Bone Joint Surg Am 1964;46-A(8):1615–47.
2. Cole JD, Bolhofner BR. Acetabular fracture fixation via a modified Stoppa limited intrapelvic approach. Description of operative technique and preliminary treatment results. Clin Orthop Relat Res. 1994;305:112–23.
3. Aigner R, Hellige R, Knippel S, Oberkircher L, Ruchholtz S, Buecking B. Internal fixation of acetabular fractures in an older population using the TIMI approach - midterm results of a prospective study. Injury. 2017;48(4):890–6.
4. Chen K, Ji Y, Huang Z, Navinduth R, Yang F, Sun T, et al. Single modified Ilioinguinal approach for the treatment of Acetabular fractures involving both columns. J Orthop Trauma. 2018;32(11):e428–e34.
5. Iqbal F, Taufiq I, Zia BO. Functional and radiological outcome of surgical management of acetabular fractures in tertiary care hospital.Hip Pelvis 2016;28(4):217-24.
6. Malik AL, Iqbal M, Mehboob I. Functional outcome of surgical fixation of acetabular fractures. Postgraduate Med Journal.2016;27 (1):29-32.
7. Verbeek DO, Ponsen KJ, van Heijl M, Goslings JC. Modified Stoppa approach for operative treatment of acetabular fractures: 10-year experience and mid-term follow-up. Injury. 2018;49(6):1137–40.
8. Farouk O, Kamal A, Badran M, El-Adly W, El-Gafary K. Minimal invasive Para-rectus approach for limited open reduction and percutaneous fixation of displaced acetabular fractures. Injury. 2014;45(6):995–9.
9. Zhuang Y, Cao S, Lin Y, Li R, Wang G, Wang Y. Minimally invasive plate osteosynthesis of acetabular anterior column fractures using the two-incision minimally invasive approach and a preshaped three dimension plate. Int Orthop. 2016;40(10):2157–62.
10. Peter, R. E. Open reduction and internal fixation of osteoporotic acetabular fractures through the ilio-inguinal approach: Use of buttress plates to control medial displacement of the quadrilateral surface. Injury.2015 46, S2–S7.
11. Wu XB, Wang JQ, Sun X, Zhao CP. Guidance for treatment of pelvic Acetabular injuries with precise minimally invasive internal fixation based on the Orthopaedic surgery robot positioning system. Orthop Surg. 2019;11(3):341–7.
12. Mardian S, Schaser KD, Hinz P, Wittenberg S, Haas NP,

Schwabe P. Fixation of acetabular fractures via the ilioinguinal versus pararectus approach: a direct comparison. Bone Joint J. 2015;97-B(9):1271–8.
13. PV Giannoudis, MRW Grotz, C Papakostidis, H Dinopoulos (2005) Operative treatment of displaced fractures of the acetabulum: a metaanalysis. J Bone Joint Surg Br 87(1): 2-9.
14. Sagi HC, Afsari A, Dziadosz D. The anterior intra-pelvic (modified rives-stoppa) approach for fixation of acetabular fractures. J Orthop Trauma. 2010;24(5):263–70.
15. Chen K, Yang F, Yao S, Xiong Z, Sun T, Guo X. Biomechanical comparison of different fixation techniques for typical Acetabular fractures in the elderly: the role of special quadrilateral surface buttress plates. J Bone Joint Surg. 2020;102(14):e81.
16. Verbeek DO, van der List JP, Moloney GB, Wellman DS, Helfet DL. Assessing postoperative reduction after Acetabular fracture surgery: a standardized digital computed tomography-based method. J Orthop Trauma. 2018;32(7):e284–e8.
17. KSA Hussain, NR Kancherla, SK Kanugula, C Patnala Analysis of displaced acetabular fractures in adults treated with open reduction and internal fixation. Int J Res Orthop 2016; 2(3): 99-103.
18. Huang H, Chen L, Mao G, Bach J, Xue Q, Han F, et al. The 2019 yearbook of Neurorestoratology. J Neuro-Oncol. 2020;08(01):1–11.
19. Liu Y, Yang H, Li X, Yang SH, Lin JH. Newly modified Stoppa approach for acetabular fractures. Int Orthop. 2013;37(7):1347–53.
20. Kwak DK, Lee SH, Lee KU, Huang JH, Yoo JH.Simultaneous reduction and fixation using an anatomical suprapectineal quadrilateral surface plate through modified Stoppa approach in superomedially displaced acetabular fractures.Sci Rep 12,15221.(2022)
21. Khalefa, M A,El Nahal, W A, Abdel K M, Abdel-Kader, Khaled F. M, Chesser, Timothy J S, Ward A,Acharya M. Anterior Approach for Fixation of Acetabular Fractures Using Anatomically Designed Plates: Accuracy of Reduction and Early Functional Outcomes With a Minimum of 1-Year Follow-Up.J Orthop Trauma. 2022;36(9):439-444
22. Hammad AS, El-Khadrawe TA. Accuracy of reduction and early clinical outcome in acetabular fractures treated by the standard Ilio-inguinal versus the Stoppa/iliac approaches. Injury. 2015;46(2):320–6.
23. A Kumar, NA Shah, SA Kershaw, AD Clayson Operative management of acetabular fractures: a review of 73 fractures. Injury 2005; 36(5): 605-612.
24. Kistler BJ, Smithson IR, Cooper SA, Cox JL, Nayak AN, Santoni BG, et al. Are quadrilateral surface buttress plates comparable to traditional forms of transverse acetabular fracture fixation? Clin Orthop Relat Res. 2014;472(11):3353–61.
25. White, G. et al. Quadrilateral plate fractures of the acetabulum: An update. Injury.2013; 44, 159–167.
26. Letournel, E. Fractures of the acetabulum: A study of a series of 75 cases. Clin. Orthop. Relat. Res. 1994; 305, 5–9.
27. Weber, T. G. & Mast, J. W. The extended ilioinguinal approach for specific both column fractures. Clin. Orthop. Relat. Res. 1994; 305, 106–111.
28. Amr, S. Transverse subgluteal-ilioinguinal approach to the acetabulum. Microsurgery. 1998;18, 432–441. https://doi.org/10.1002/(sici) 1098-2752(1998)18:7%3c432::aid-micr9%3e3.0.co;2-g
29. Matta, J. M. Fractures of the acetabulum: Accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. J. Bone Joint Surg. 1996; 78, 1632–1645
30. Merle D'Aubigné, R. Numerical classification of the function of the hip. 1970. Rev. Chir. Orthop. 1990; Reparatrice Appar. Mot. 76, 371–374
31. Isaacson, M. J., Taylor, B. C., French, B. G. & Poka, A. Treatment of acetabulum fractures through the modified Stoppa approach: Strategies and outcomes. Clin. Orthop. Relat. Res.2014; 472, 3345–3352. https://doi.org/10.1007/s11999-014-3460-x
32. Shazar, N. et al. Comparison of acetabular fracture reduction quality by the ilioinguinal or the anterior intrapelvic (modified Rives-Stoppa) surgical approaches. J. Orthop. Trauma.2014; 28, 313–319. https://doi.org/10.1097/01.bot.0000435627.56658.53
33. Sagi, H. C., Afsari, A. & Dziadosz, D. Te anterior intra-pelvic (modified rives-stoppa) approach for fixation of acetabular fractures. J. Orthop. Trauma .2010;24, 263–270.
34. Yang, Y. et al. Modified ilioinguinal approach to treat pelvic or acetabular fractures: A retrospective study. Medicine 2015;94, e1491. https://doi.org/10.1097/md.0000000000001491.
35. Shazar, N., Brumback, R. J., Novak, V. P. & Belkof, S. M. Biomechanical evaluation of transverse acetabular fracture fixation. Clin. Orthop. Relat. Res.1998; 352, 215–222.
36. Qureshi, A. A. et al. Infrapectineal plating for acetabular fractures: A technical adjunct to internal fixation. J. Orthop. Trauma.2004; 18, 175–178. https://doi.org/10.1097/00005131-200403000-00009.
37. Srivastava, A., Rajnish, R. K., Kumar, P., Haq, R. U. & Dhammi, I. K. Ilioinguinal versus modified Stoppa approach for open reduction and internal fixation of displaced acetabular fractures: A systematic review and meta-analysis of 717 patients across ten studies. Arch. Orthop. Trauma Surg.2022; https://doi.org/10.1007/s00402-022-04369-6 .
38. Elmadağ, M., Güzel, Y., Acar, M. A., Uzer, G. & Arazi, M. Stoppa approach versus the ilioinguinal approach for anterior acetabular fractures: A case control study assessing blood loss complications and function outcomes.Orthop.Traumatol. Surg. Res.2014; 100: 675–680. https://doi.org/10.1016/j.otsr.2014.05.020 (2014).
39. Nadeem U,Khalid Z,Ali A, Abdullah T, Zaman AU, Shahzad S. Outcome of modified Stoppa approach for fixation of acetabular fractures. J Pak Orthop Assoc 2021;33(2):57-60.