

GLUTEUS MINIMUS MUSCLE: LESS INVASIVE POSTERIOR APPROACH FOR THE SURGICAL MANAGEMENT OF POSTERIOR WALL ACETABULUM FRACTURE

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ABSTRACT

The Posterior wall acetabulum fractures are the most common acetabulum fracture. Most of this fracture requires surgical intervention. Less invasion treatment planning, choice of suitable surgical approach, minimal injury to the soft tissue, muscles, nerves and blood vessels, anatomical reduction maneuvers and surgical fixations are most important for best surgical reconstruction. The aim of our study is less invasive posterior approach, small incision, minimal bluntly splitting of gluteus minimus muscle, less soft tissue and muscle injury, less blood vessels injury; to give the patient rigid fixation and functional hip minimizing the complication and fixation in short periods. So that, the postoperative mobilization of the patient could be faster than other traditional posterior approach. According to our study, the outcome of less invasive path of surgical approach is better for early mobilization of the patient, less chances of infection, due to early post operative mobilization there will be less chances of early complication like DVT, bed sores, pulmonary embolism, and pneumonia and late complications like post traumatic osteoarthritis, avascular necrosis and heterotopic ossification. The aim of our approach is to give the patient rigid fixation and functional hip, minimizing the complication.

Keywords: Posterior wall acetabular fracture, Gluteus minimus muscles, Less invasive posterior approach, Cadaveric data study.

INTRODUCTION

The most common type of acetabulum fractures are the posterior wall which counts approximately 25 to 30 % [1]. This type of fracture usually occurs when axial load applied to the femur with hip flexed, drives the femoral head against the posterior articular surface of acetabulum [1]. Force exerted on the femur, passes through the femoral head and is transferred to the acetabulum [2]. The direction and magnitude of the force as well as the position of the femoral head determine the pattern of acetabular injury. Usually occurs in motor vehicle accident. Posterior wall acetabular fracture usually needed open reduction and internal fixation, which was first reported by Judet et al, this has become the standard treatment and has led to a reduction in the incidence of post traumatic arthritis and an improvement

in the overall outcome [3]. Meanwhile, it is of paramount importance to preserve as much as

possible of the periosteal and capsular structures attached to a posterior wall fragment to protect the residual blood supply as well as obtain anatomical reduction during open surgery [1]. Early fixation of acetabulum fracture is important to reduce further blood loss, decreasing pain, and facilitating early mobilization to improve patient outcome.

We herein describe a less invasive approach for the surgical management of posterior wall acetabulum fractures. The minimal invasive surgery means that the surgeon can do the similar operation through a small incision. In this approach the tissue sparing procedure which aims is to get patients back on their daily life instead of weeks. The less invasive surgery doesn't only

refer to the incision but also means fewer traumas to the muscles, tendons and soft tissue. In Our less invasive surgical path or approach fractures are fixed, gluteus minimus muscle splits about 3-4cm bluntly, the incision is small, easy way to expose, less invasive, less injury to the blood vessels, nerves and soft tissue, less bleeding, easy to visualize the fracture site and fix fracture, duration of perioperative time is short, post operative complications are less.

METHODOLOGY

The acetabulum is an inverted cup (cup that inclined at 45° to the horizontal in the coronal and 20 degrees anteverted in the sagittal plane) that sits on the infero-lateral aspect of the pelvis [4]. It is at the center of the inverted Y-shaped innominate bone, which is formed by the fusion of the ilium, ischium and pubis at the triradiate cartilage [4]. The posterior column of acetabulum is composed of quadrilateral plate, posterior wall and dome, ischial tuberosity and greater and lesser sciatic notches. The surgical approach is depending upon surgeon's choice. There are most commonly used approaches such as anterior intra pelvic, ilio-inguinal and Kocher-Langenbeck.

The traditional approach is Kocher-Langenbeck approach which is also called posterior approach [5]. Posterior wall fracture acetabulum is indication for this approach. The skin incision is centered over the greater trochanter with proximal branch directed toward the posterior superior iliac spine ending approximately 6 cm short of this bony landmark [6]. Distally the incision extends approximately 12 cm along the midlateral aspect of the thigh [6]. In this approach fascia lata and gluteus maximus muscles were split and the hip is internally rotated and piriformis and short external rotators muscles were divided. Capsulotomy and trochanteric osteotomy can be done if needed. Debridement of avascular gluteus medius and gemelli muscles is desirable to prevent heterotopic ossification [4]. The chances of sciatic nerve palsy, injury to superior and inferior gluteal vessels, profundus femoris or medial femoral circumflex artery (excessive retraction on quadratus femoris) is high [4].

MATERIAL AND METHODS (AUTOPSY)

Cadaveric Dissection

Twenty formalin processed hip from ten fresh cadavers out of these six male and four female were selected for the anatomical studies which were obtained from department of anatomy, the basic medicine faculty of Wuhan University. Ethical approval about the experiment was given by the medical ethics committee of Wuhan University. To correct interobserver variability, each specimen was examined by five members of the team independently.

The instruments and anatomical measurement tools used for the cadaveric study: scalpel, artery forceps,

retractors, tweezers, surgical needles silk suture, measurement scales (1mm accuracy). Measurements were made using a digital caliper accurate to 0.01 mm. (Vernier LCD Digital caliper Measuring tool 4" 100 mm USA).

Dissections

The cadavers were placed in prone position and dissection began with a longitudinal incision on the posterior region of hip between iliac crest and greater trochanter about 8-10cm. The skin and superficial fascia were carefully dissected and reflected bilaterally. The gluteus maximus muscles were identified and bluntly dissected. The gluteus medius and minimus muscle were identified and bluntly dissected about 3-4 cm as shown figure 1. Then we approached at the posterior wall of acetabulum. Then the gluteus maximus muscles were reflected as in figure 2.

The gluteus minimus muscles is exposed from its origin to insertion and the vessels and nerves supplying it were identified and bluntly dissected. The distance between incision site and superior gluteal vessels, piriformis, sciatic nerve, gemelli, inferior gluteal vessels, ischial tuberosity were measured and data were recorded as well.

A muscle belly of gluteus minimus were cut at its origin and reflected downwards or splits longitudinally to show the deep branch of superior gluteal artery and nerve supply. Superficial and deep branch of superior gluteal artery and nerve were identified as in figure 3.

The posterior wall of acetabulum was identified as a distinct structure in all specimens. The data was collected and processed into personal computer. Statistical analysis was used to determine the mean, standard deviation (SD) and minimum and maximum values done using IBM statistical Package for Social Sciences (SPSS/version 23 software). The level of significance was 0.05. The measurement of distance of incision site and other important structure are measured in all 20 hips. To determine the possible injury of major structures, we have measured the distance as follows.

Case report 1. And Gluteus minimus muscle less: invasive posterior approach technique

A 54 years old male weighing 85kg, presented to emergency room with pain left hip over a motor vehicle accident. Patient C/O tenderness, pain, swelling, and decrease range of motion. At the time of admission, patient had severe bruise over left thigh and difficulty in moving left leg, vitals are T: 37.5 degree C, pulse 90b/m, R 20b/m, BP: 130/80mmHg. Initial plain radiographs of his pelvis showed a comminuted posterior wall fracture of left acetabulum. He went to have CT scan of his pelvis which confirmed the plain film findings and also demonstrated marginal impaction of his articular surface figure 4.

Case Report 2

A 21 years old male weighing 60kg, presented to emergency room with pain left hip by a Road traffic accident. Patient C/O tenderness, pain, swelling, decrease range of motion left leg. At the time of admission, patient was complaining of pain and difficulty in moving left thigh and leg, vitals are: T: 38 degree C, pulse 95b/m, R 22b/m, BP: 110/80mmHg. CT scan of his pelvis showed a comminuted posterior wall fracture of left acetabulum.

Finally surgery was performed through a gluteus minimus muscle less invasive posterior approach [fig 5]. Patient was kept in right lateral position on the table and knee flexed at least 60 degree to protect the sciatic nerve palsy. A longitudinal incision was given on the greater trochanter which then extending approx 8-10 cm from iliac crest to the tip of greater trochanter. Subcutaneous tissue was sharply incised along the gluteus maximus and fascia lata. Gluteus maximus origin was not detached from the iliac crest but it was bluntly splitted in a line with its fiber. Gluteus medius and minimus were bluntly separated [fig 6] and retracted gently to protect the sciatic nerve (for the protection of sciatic nerve we used hohmann retractor in greater and lesser sciatic notch). The articular surface was fixed and supported by two parallel reconstruction buttress plates with screws [fig 7].

The wound was irrigated and muscles were reattached by using absorbable sutures, the skin and soft tissue were sutured. The screw fixation and plate placement was confirmed by image intensifier. Post operative radiographs revealed anatomical reduction of

the posterior wall fragment and stable fixation [fig 8]. Passive range of motion exercise of hip was applied to the patient after the operation.

After surgery, alternate 2 day dressing was done, non weight bearing on operated side with crutch walking was maintained for about 4 weeks, and then after, tolerable weight bearing with crutch walking was allowed. The patient was evaluated clinically and radiographically at postoperative period of 2 weeks, 4 weeks, and 6 weeks. Full weight bearing was permitted after 12 weeks of surgery. In postoperative periods, isometric quadriceps contraction exercise with leg extension was encouraged. After 6 months follow up this patient was completely asymptomatic and returned to full activity without any complication. The clinical grading was evaluated by Merle d Aubigne and postel scoring which has been modified by Matta [7]. Heterotopic ossification was graded according to the criteria established by Brooker *et al.* [8].

The score is summing of points for pain, walking and range of movement [3]. In our study the score is 18. According to above data, with comparison to traditional posterior approach, in less invasive approach the operative time is comparatively short. Intraoperative blood loss and post operative complication is less. After recovery, there is no pain at operative site. Walking is normal and the range of movement is 95-100 percent. There is no iatrogenic injury to the sciatic nerve and blood vessels. The outcome is satisfactory.

Table 1. Anatomical Results

Parameters	Range	Statistical Mean($\bar{x} \pm s$)	Std. error Mean (SE \bar{x})
Distance of incision and piriformis	2-3.5	2.75 \pm 0.645	0.233
Distance of incision and sciatic nerve	3-4.5	3.75 \pm 0.645	0.322
Distance of incision and Superior Gluteal artery	1.5-2.5	2.00 \pm 0.500	0.288
Distance of incision and inferior gluteal artery	2.5-5	3.75 \pm 0.935	0.381
Distance of incision site and gemelli	2.5-4	3.25 \pm 0.645	0.322
Distance of incision and ischial tuberosity	7.5-10	8.75 \pm 0.935	0.381

Table 2. Clinical Results

Operative technique	Traditional Posterior Approach(K-L)	Modified Posterior Approach	Gluteus minimus muscle less Invasive Posterior Approach From case 1 and 2.
Operative Time	1 hr 45min - 3 hrs [3] 125-190min [2]	1.5 hr - 4 hr [9]	60-90min
Intraoperative blood loss	150 - 450ml [3] 600 -1500ml [2]	400-1250 ml [9]	90-250ml
Postoperative complication	Infection [2], Avascular necrosis of the femoral head(AVN FH) 14%, Heterotopic ossification ,incomplete palsy of the sciatic nerve [3]	heterotopic ossification [9] posterior hip dislocation [9]	Not seen
The mean hospital stay	5-12 days [2]	-	5-7 days
Numbness	Not seen	Not seen	Not seen

Fig 1. Gluteus maximus



Fig 2. Gluteus minimus and external rotator muscles

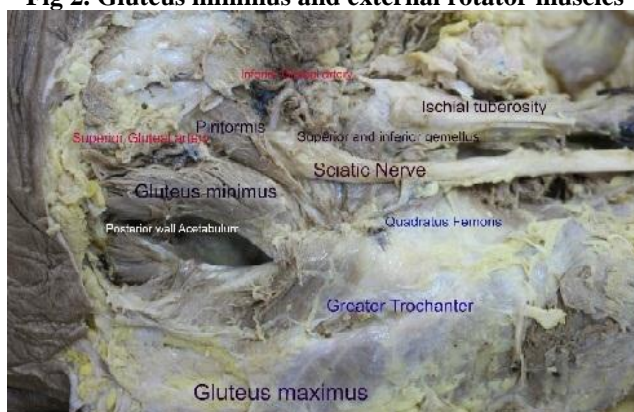


Fig 3. The posterior wall of acetabulum



Fig 4. Pre op CT scan showing a posterior wall fractures of the left acetabulum

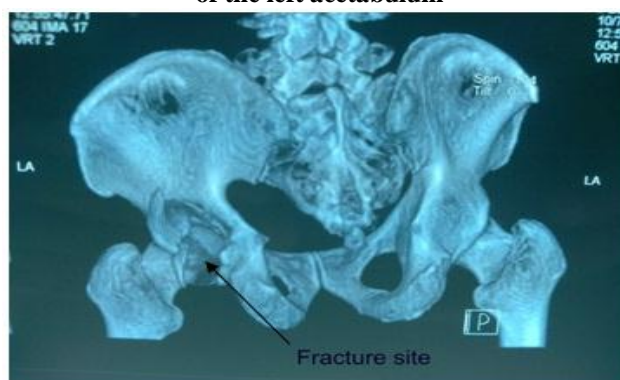


Fig 5. Intraoperative photographs showing a less invasive approach



Fig 6. Exposed tensor fascia lata and gluteus maximus muscle



Fig 7. Parallel buttress reconstruction plate for the anatomical fixation of fracture.



Fig 8. Post-operative plain x ray showing anatomical reduction of the posterior wall fragment and safe fixation.



Fig 9. Posterior wall acetabulum fracture.



Fig 10. Less invasive posterior approach



Fig 11. Exposed tensor fascia lata and gluteus maximus muscle

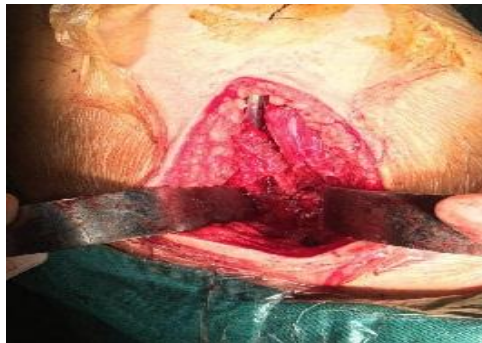
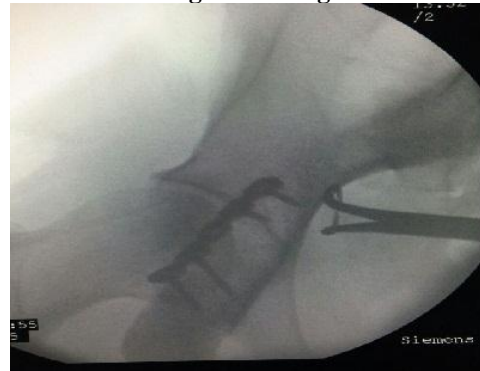


Fig 12. Plating



DISCUSSION

The treatment of acetabular fracture is necessary to achieve a functional, painless, and mobile hip joint that continues to function for the rest of patient's life. This fracture has poor outcome regardless of the treatment method [2]. The factors may include no proper anatomical reduction, osteochondral defect, OA, AVN of the femoral head, heterotopic ossification, sciatic nerve injury and infection [10].

Small incision: In less invasive approach, the incision is approximately 8-10cm from the iliac crest longitudinally to the tip of greater trochanter. But in traditional Kocher-Langenbeck approach the incision is 5 cm lateral to the posterior superior iliac spine and extends anteriorly and distally to the greater trochanter and then distally along the thigh approximately the mid portion of thigh.

Less muscle injury: Both Magu and Josten reported a lower heterotopic ossification rate with less vigorous retraction and less iatrogenic soft tissue damage [7, 11]. The tensor fascia lata and gluteus maximus muscles were bluntly dissected and gluteus medius and minimus were dissected bluntly and retracted bilaterally. But in traditional approach trochanteric bursa are incised. The gluteus maximus muscle is transected at its insertion on the posterior femur. The piriformis, obturator internus, gemelli superior and inferior muscles are transected. Due to excessive transection of soft tissue and muscle there is

postoperative complication like bleeding, infection, heterotopic ossification, delay healing of soft tissue and bone, decrease range of movement, difficulty in walking.

Short operative periods (60-90min): In less invasive technique there is small incision and comparatively less muscles and soft tissue transected so that it will be faster than traditional approach to reach in to the fracture site. The reduction time of fracture is fast. As in our result the operative time is shorter than in traditional approach.

No iatrogenic injury to the blood vessels and nerve: In this approach we gently placed retractor to protect the sciatic nerve. We do not expose too much so that there is less chances of vessels injury. Because of this there is no post operative complication of numbness in our case. In spite of less invasive surgical approach the exposure to the fracture site is enough.

CONCLUSION

The gluteus minimus muscle less invasive posterior approach decreases the perioperative time (approx 60-90min), less iatrogenic trauma to the neurovascular supply, less iatrogenic soft tissue damage with less invasive technique, results in good anatomical reduction of fracture without complication. The major structures are safe distance from incision site. The sciatic nerve is an important structure which should be kept in mind during the perioperative time. The mean total

distance of incision site and sciatic nerve is 3.75 ± 0.645 cm and has close relation with superior gluteal artery and nerve which is at mean distance of 2.00 ± 0.500 cm. Vascular injuries should be avoided by carefully and bluntly dissection of surrounding structure. The result of our study revealed that it is safe site of incision for our less invasive approach without getting injuries to major vessels, nerve, external rotators muscles and less soft tissue injuries. Thus seems to be a best surgical approach invasive posterior approach is the best procedure for the surgical management of posterior wall acetabular fractures. We have even done cadavers study and a clinically study on our Patients.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

STATEMENT OF HUMAN AND ANIMAL RIGHTS

All procedures performed in human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.