*Acta Orthop. Belg.*, 2019, **85**, 182-191

*ORIGINAL STUDY*

# A combination of the modified Stoppa approach and the iliac fossa approach in treating compound acetabular fractures by using an anterior ilioischial plate

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**Most compound acetabular fractures involving both the anterior and posterior columns are caused by high-energy injuries. Patients with compound acetabular fractures are often in critical or poor condition and cannot tolerate major surgery. This study aims to investigate the effectiveness of an ilioischial plate in treating compound acetabular fractures. A consecutive series of 40 patients with complex acetabular fractures were surgically treated and retrospectively reviewed. A modified Stoppa approach in combination with an iliac fossa approach was used. In all of the cases, the anterior column was stabilized with reconstruction plates for the iliac wing and along the iliopectineal line to the pubis. The posterior column was fixed either with the newly developed ilioischial plate running from the ilium to the ischial ramus or with standard fixation techniques. These included either conventional posterior column screws or quadrilateral plate fixation. Patients were divided into an experimental group (ilioischial plate for posterior column fixation) and a control group (standard fixation techniques).**

**In both groups, we found that 90% of all reductions were good to excellent. According to the modified Merle Aubigne and Postel scoring system, the percentage of good to excellent was 85% in the experimental group as compared to 80% in the control group. Compared with the control group, physical function (PF), role physical (RP) and social function (SF) were significantly better in the experimental group (P<0.05). Fracture healing was achieved in all patients.**

**By using the modified Stoppa approach combined with the iliac fossa approach, the ilioischial plate can be directly fixed to the posterior column and the ilium to stabilize the posterior column in patients with complex acetabular fractures.**

**Keywords** : Acetabular fracture; ilioischial plate; surgical approach.

## INTRODUCTION

Most complex acetabular fractures involving both the anterior and posterior columns are caused by high-energy injuries *(1,10,13)*. Patients with complex acetabular fractures are often too ill to tolerate major surgery necessary to stabilize these fractures. The classic extensile exposures to access combined anterior and posterior column fractures cause significant surgical trauma with long operative time and major intraoperative blood loss, leading to

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*No benefits or funds were received in support of this study.*
*The authors report no conflict of interests.*

a higher risk of postoperative complications such as heterotopic ossification, infection, and sciatic and lateral femoral cutaneous nerve damage. In addition to the anatomical reduction of the hip joint, the surgical approach and associated surgical trauma and complications can affect the postoperative functional rehabilitation and prognosis of the patient. To minimize these problems and improve patient outcomes in complex acetabular fractures requiring access to both columns, anterior intrapelvic approaches such as LeTournel's ilioinguinal approach or modifications of the Stoppa approach have been proposed. These approaches are favored because of their relative simplicity, shorter operative time, reduced intraoperative blood loss, and decreased risk of heterotopic ossification *(3,11)*. Compared to the ilioinguinal approach, the modified Stoppa approach is less difficult to perform with decreased intraoperative bleeding and neurovascular injuries *(9,12)*. In addition, the ilioinguinal approach's limited exposure of the posterior column makes direct plate fixation of the posterior column fracture challenging, as it allows only screw fixation, which does not effectively control posterior column fragment rotation. To improve the fixation of the posterior column, a plate is often attached to the internal aspect of the posterior column's ischial3 component and then stabilized to the ilium. This plate application is only possible through an anterior intrapelvic approach such as the modified Stoppa combined with an iliac wing approach. This type of plate application has not been previously reported and we named it the "ilioischial plate". This report describes our initial experience using the ilioischial plate through a modified Stoppa approach. We hypothesized that the plate would be comparable to the present posterior column stabilization techniques through either extensile approaches or the ilioinguinal approach. We directly fixed the posterior column fracture using our newly developed ilioischial plate along the anteromedial side of the pelvis through the modified Stoppa approach combined with the iliac fossa approach. Compared with the single ilioinguinal approach, this procedure is relatively simple, the operative time is shorter, the fixation is more reliable, and the complications are fewer. Compared with the combined anterior and posterior approaches, our technique also has advantages such as less blood loss, fewer complications, shorter operative time and higher clinical evaluation scores.

## METHODS

Between January 2012 and December 2013, 40 patients with complex acetabular fractures were treated with either the modified stoppa approach or the iliac fossa approach or a combination of these two approaches. The inclusion criteria were 1- fractures that were fixed within 3 weeks of injury; 2- easy reduction of the posterior fracture dislocation; 3- T-shaped or transverse fractures; 4- anterior column posterior hemitransverse fractures with operable posterior columns. Exclusion criteria included any fractures with a posterior wall component or intraarticular fragment involvement of the posterior column. Our study had 20 patients in the experimental group that consisted of 12 males and 8 females with a mean age of 46.8 years (range, 26 to 66 years). The left side was involved in 9 cases and the right side was involved in 11 cases. The following types of fractures were treated: 6 anterior column posterior hemitransverse fractures, 10 T-shaped fractures, and 2 transverse fractures. The control group included 10 males and 10 females with a mean age of 45.6 years (range, 24 to 65 years). The left side was involved in 8 cases and the right side was involved in 12 cases, 9 anterior column posterior hemitransverse fractures, 7 T-shaped fractures, and 1 transverse fracture. Each patient had an antero-posterior pelvis X-ray, obturator and iliac oblique X-rays, and a pelvic CT scan with three-dimensional reconstruction to precisely evaluate the fracture type and status of displacement so as to identify whether a single approach was appropriate or not.

### Surgical procedure

In the experimental group, the patient was placed in a supine position. The affected lower limb was sterilized and draped to the middle of the thigh. The lower limb was draped free to allow the hip and knee joints of the affected limb to be flexed to relax the iliopsoas and the neurovascular bundle. A longitudinal incision was made from a point 2 cm

inferior to the umbilicus to the pubic symphysis. The skin, subcutaneous tissue and linea alba were opened and the retropubic space was entered. A blunt extraperitoneal dissection was performed by retracting the peritoneum posteriorly and medially with a broad blunt retractor. The abdominal wall together with the external iliac artery and vein were pulled laterally to expose the region from the pubic symphysis along the pelvic brim to the sacroiliac joint and the superior aspect of the quadrilateral plate. Because the external iliac blood vessels are located in the superior aspect of the operative field, the retraction was performed with caution to avoid unnecessary injuries. If the exposure was limited, the lateral aspect of the rectus abdominis was lifted subperiosteally off the pubic body to increase the surgical exposure. The mid portion of the superior pubic ramus was carefully explored to identify the presence of the corona mortis, namely the communicating vessels between the obturator and the external iliac vessels, which were either covered or wrapped by hematoma. If present, it was cut and ligated. At this stage, the periosteum along the arcuate line (iliopectineal) was incised and dissected inferiorly to expose the quadrilateral plate and fracture lines. The obturator artery, vein and nerve were retracted medially and dissected to the medial side of the ischial spine at which point the posterior column fracture line was exposed. The inferior aspect of the iliac wing was exposed where it met the arcuate line. This required elevating the iliopectineal fascia as it is attached to the pubic rami and is along the arcuate iliopectineal line. Since, the external iliac artery and vein and ilipsoas are located anteriorly and superiorly, it was imperative that the dissection stayed subperiosteally on the bone. These structures were retracted anteriorly and superiorly to expose the ipsilateral iliac fossa approach and reach the iliac wing. Depending on the location and extent of the iliac wing fracture, an incision was made along the iliac crest to facilitate fracture reduction. Fracture reduction was performed according to the status of the fracture displacement. The anterior column and iliac wing components were reduced first and provisionally stabilized with K-wire(s). If the anterior column was initially fixed rigidly, reduction of the posterior column can be difficult. The medially displaced bone fragments of the posterior column were reduced with a pusher or a bone retractor and K-wires and/or clamps were applied to provisionally control the reduction. Radiographic confirmation of the reduction was then performed. If acceptable, the anterior column and iliac wing were stabilized with reconstruction plates and/or lag screws based on fracture configuration. The plate from the ilium to the anteromedial side of the ischial spine was then placed to fix the posterior column. This allowed the posterior column to be fixed directly by plate-screw fixation (Figure 1). The closure was performed in anatomical layers that left a drain in the deep portion of the exposure.

In the control group, the patient was first placed in a supine position to fix the anterior column via the modified Stoppa approach or the anterior ilioinguinal approach. The method was the same as above. The patient was then placed in a lateral recumbent position and the posterior column fracture was exposed via the conventional Kocher-Langenbeck approach. The posterior column fracture was fixed with two pre-bent reconstruction plates (Figure 2).

**Postoperative treatment**

After surgery, the affected limb was elevated slightly and the hip and knee joints were flexed appropriately. The wound drain was removed 24-72 hours after surgery and antibiotics were used for 24-72 hours. Oral administration of celecoxib was administered for pain control and prevention of heterotopic ossification. Venous thromboprophylaxis consisted of low-molecular-weight heparin. Functional exercises of the low extremity muscles to enhance the blood circulation of the lower limb were initiated. Three days after surgery, the patient started ambulation with crutches and non-weight-bearing on the affected limb. At 6 weeks, the patient started partial weight-bearing and by 12 weeks the patient started full weight-bearing without aids.

**Outcome evaluation**

The acetabular fracture reduction on the AP and Judet views were evaluated using the modified

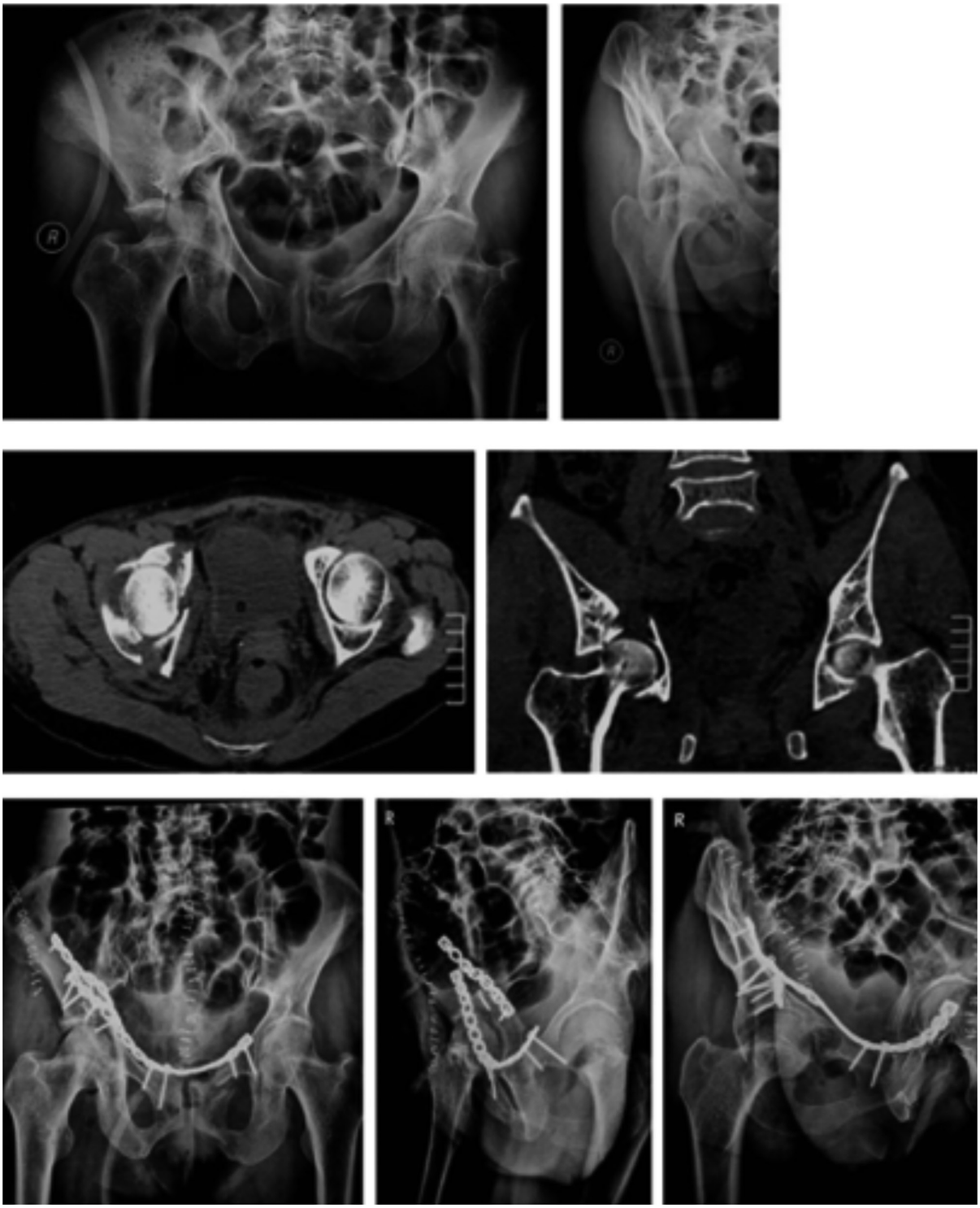

***Fig. 1.*** — A 63-year-old female had a T-shaped right acetabular fracture caused by a fall-related injury and underwent open reduction and internal fixation. The posterior column was fixed with a plate extending from the medial side of the ilium to the ischial tuberosity. Postoperative X-ray shows anatomical reduction of the acetabulum

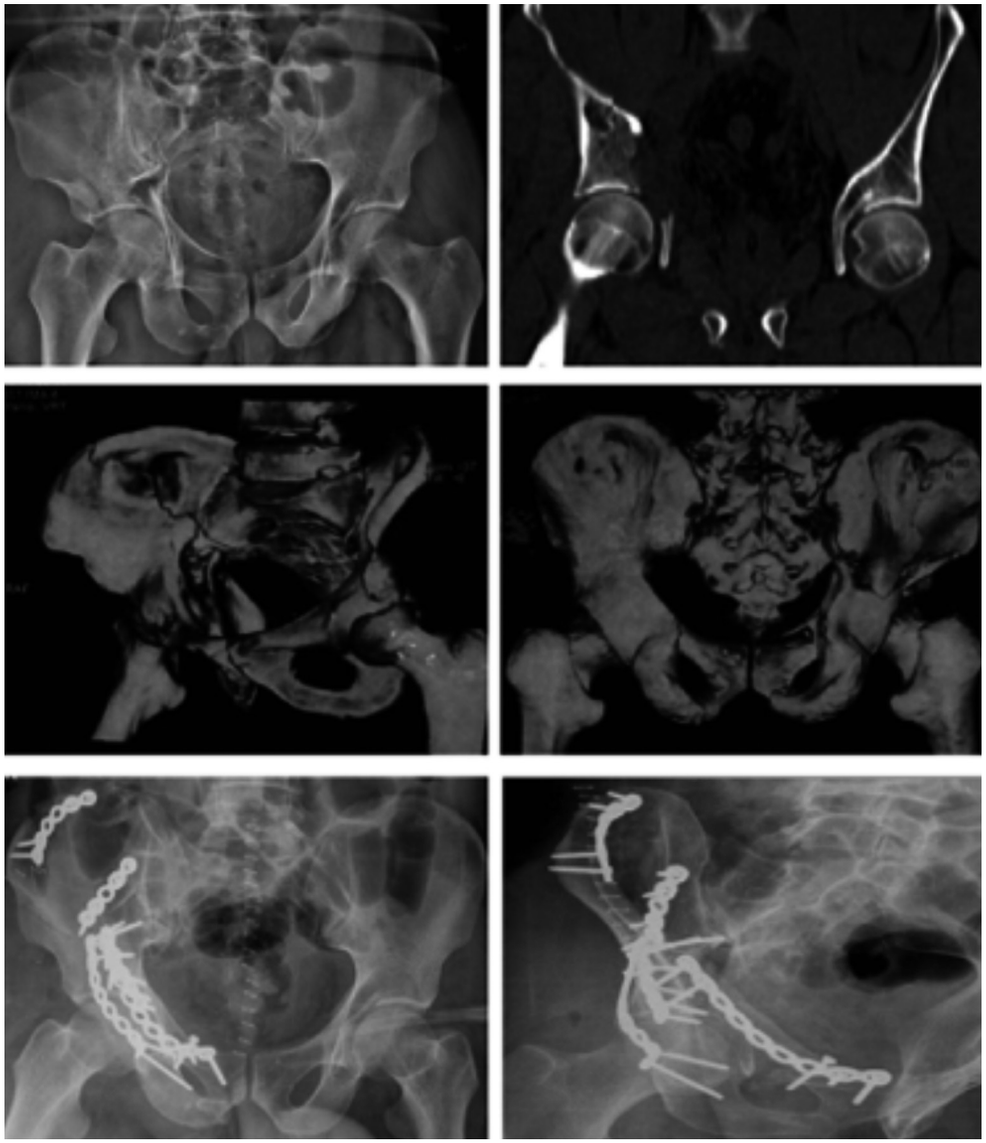

***Fig. 2.*** — A 32-year-old female had a right acetabular fracture involving the anterior and posterior columns and underwent open reduction and internal fixation via anterior and posterior approaches. Postoperative X-ray shows anatomical reduction of the acetabulum

Matta's criteria. Anatomical reduction was considered as excellent, 0-1 mm residual fracture displacement was good, 2-3 mm residual fracture displacement was fair, and > 3 mm residual fracture displacement was poor. The postoperative function of the affected hip joint was evaluated using the modified Merle d'Aubigne *(4)* and Postel scoring system; excellent: no pain, normal gait, the range of joint motion is more than 75%, X-ray shows no sign of arthritis changes or mild joint space narrowing or sclerosis; good: mild pain, normal gait, the range of joint motion is more than 50%, X-ray shows joint surface sclerosis or joint space narrowing or osteophyte formation; fair: moderate pain, mild lameness, the range of joint motion is less than 50%, X-ray shows significant joint space narrowing, joint surface sclerosis and osteophyte formation; poor: severe pain, obvious lameness, joint stiffness

with deformity, X-ray shows significant arthritis changes or obvious dislocation of the femoral head. Clinical function was evaluated using the SF-36 scoring system. The physical functioning (PF), role limitations due to physical health problems (RP), social functioning (SF), bodily pain (BP), general health perceptions (GH), vitality (VIT), role limitations due to personal or emotional problems (RE) and general mental health (MH) were compared between the two groups.

## RESULTS

In the experimental group, the mean time interval between injury and surgery was 8 days (range, 3 to 13 days), the mean operative time was 2.1 hours (range, 1.4 to 3.2 hours), and the mean intraoperative blood loss was 320 ml (range, 220 to 450 ml). The mean postoperative follow-up was 18 months (range, 3 to 28 months). Based on Matta's criteria *(5)*, the postoperative reduction was excellent in 15 cases, good in 3 cases, fair in 1 case and poor in 1 case. According to the modified Merle d'Aubigne and Postel scoring system, the

***Fig. 3.*** — A 43-year-old male was injured during a traffic accident. Six weeks after surgery, the patient started partial weight-bearing ambulation. There was no internal fixation failure

function of the affected hip joint was excellent in 14 cases, good in 3 cases, fair in 2 cases and poor in 1 case. Bone healing was achieved in all 20 cases and no complications such as internal fixation failure, postoperative infection and heterotopic ossification were observed. Two patients had an obturator nerve injury caused by traction (thigh adduction weakness), but the patients recovered 3 months later without any treatment. One patient had traumatic arthritis 2 years after surgery, which was controlled by medication (Figure 3).

In the control group, the mean time interval between injury and surgery was 7 days (range, 2 to 13 days), the mean operative time was 2.8 hours (range, 2.2 to 3.6 hours), and the mean intraoperative blood loss was 620 ml (range, 500 to 740 ml). The mean postoperative follow-up was 16 months (range, 12 to 28 months). Based on Matta's criteria *(5)*, the postoperative reduction was excellent in 17 cases, good in 1 case, fair in 1 case and poor in 1 case. According to the modified Merle d'Aubigne and Postel scoring system, the function of the affected hip joint was excellent in 12 cases, good in 4 cases, fair in 3 cases and poor in 1 case. Bone healing was achieved in all 20 cases and no complications such as internal fixation failure, postoperative infection and heterotopic ossification were observed. Three patients had sciatic nerve injury caused by traction, and these patients recovered 3 months later. One patient had traumatic arthritis 2 years after surgery, which was controlled by medication (Figure 3). One patient had stage II avascular femoral head necrosis 18 months after surgery. Two patients had heterotopic ossification.

The SF-36 showed that the physical function (PF), role limitation due to physical health (RP) and social function (SF) increased significantly in the experimental group compared with the control group ($P < 0.05$). However, we did not observe any significant differences between the two groups in bodily pain (BP), general health (GH), vitality (VT), role emotional (RE) and mental health (MH) ($P > 0.05$) (Table 1, 2, 3).

## DISCUSSION

Most orthopedic surgeons consider surgery as the preferred method of treatment for displaced acetabular fractures. Complex acetabular fractures in many situations require access to both anterior and posterior columns for reduction and fixation. Combined anterior and posterior approaches are routinely used in patients with complex acetabular fractures. However, repeated intraoperative position changes require extremely strict aseptic technique and vigilant anesthesia as well as a potential risk for significant blood loss and prolonged hospital

Table I. — Comparison of general conditions between the two groups

| Indicators | | Experimental group | Control group | T or $X^2$ | P |
|---|---|---|---|---|---|
| Sex | Male | 12 | 10 | 2.15 | >0.01 |
| | Female | 8 | 10 | | |
| Age | | 46.8±10.32 | 45.61±11.71 | 1.35 | >0.01 |
| Affected side | Left | 9 | 8 | 0.68 | >0.01 |
| | Right | 11 | 12 | | |
| Fracture type | Two-column fx. | 2 | 3 | 4.77 | >0.01 |
| | Anterior column with transverse posterior column fx. | 6 | 9 | | |
| | T-shaped fx | 10 | 7 | | |
| | Transverse fx | 2 | 1 | | |
| Interval between injury and surgery | | 8±5.12 | 7±6.37 | 2.12 | >0.01 |

Table II. — Analysis of perioperative data

| Groups | Merled'Aubigne and Postel score | Operative time (h) | Intraoperative blood loss (ml) | Complications | |
|---|---|---|---|---|---|
| | | | | Presence | Absence |
| Control group | 10.03±2.51 | 2.87±0.62 | 621±118.69 | 7 | 13 |
| Experimental group | 18.41±3.01 | 2.1±0.72 | 320±100.37 | 3 | 17 |
| T or $X^2$ | -3.37 | -4.55 | -2.21 | 0.31 | |
| P | <0.01 | <0.01 | <0.01 | <0.01 | |

Table III. — Comparison of SF-36 scores between the control and experimental groups (mean ± standard deviation)

| Groups | PE | RP | BP | GH | VT | SF | RE | MH |
|---|---|---|---|---|---|---|---|---|
| Experimental group | 79.32± 21.33 | 67.21± 36.22 | 75.7± 22.18 | 66.32± 22.45 | 65.18± 24.33 | 72.31± 21.63 | 68.33± 28.10 | 63.30± 17.20 |
| Control group | 68.11± 18.91 | 54.51± 28.89 | 68.45± 16.28 | 64.27± 19.33 | 61.32± 20.45 | 61.88± 31 | 62.89± 34.71 | 65.71± 21.08 |
| T value | 3.204 | 3.624 | 2.910 | 0.348 | 0.489 | 3.018 | 1.672 | 1.326 |
| P value | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

The physical function (PF), role physical (RP) and social function (SF) increased significantly in the experimental group compared with the control group (P<0.05). We did not observe any significant differences between the two groups in terms of bodily pain (BP), general health (GH), vitality (VT), role emotional (RE) and mental health (MH) (P > 0.05)

stays if performed at separate operative encounters. Another proposed solution is the use of extensile approaches. The extensile iliofemoral approach is a classic extensile approach but has resulted in significant surgical morbidity. The anterior ilioinguinal approach is also considered as an extensile approach since both columns are accessible from one incision. However, both incisions have significant associated risks. The iliofemoral is dependent on the superior gluteal artery pedicle and if injured or surgically damaged, gluteal muscle necrosis ensues with a high risk of infection and poor functional outcome. The ilioinguinal approach requires dissection of important structures such as the lateral femoral cutaneous nerve, iliopsoas, femoral nerve, external iliac vascular and lymphatic bundles, spermatic cord or uterine round ligament *(7)*. In addition, repeated traction of the external iliac vascular bundle and lateral femoral cutaneous nerve can result in traction injuries and subsequent external iliac artery spasm and embolism, and paralysis of the lateral femoral cutaneous nerve. Moreover, in cases with corona mortis, the stump can retract into the obturator foramen and effective ligation and bleeding control can become difficult due to the unfit operating angle. In addition, direct access to the posterior column is difficult through the ilioinguinal approach because the operating angle and space are limited. It is not possible to effectively use plate fixation for the posterior column fracture via this approach and hence indirect placement of lag screws to fix the posterior column from the anterior column, is required. In order to obtain rigid fixation, direct plate-screw fixation is better than single screw fixation in controlling the fracture fragment rotation. Cole et al. *(8)* performed a biomechanical experiment and proved that the single column screw or plate fixation of the posterior column fracture through the anterior column was not as rigid as the direct plate fixation of the posterior column.

To avoid many of the problems of the dual or extensile approaches, the modified Stoppa approach allows for direct visualization of the posterior

column fracture, while a simple iliac fossa exposure allows access to the anterior column component of these complex fractures. Consequently, this results in better control of vascular structures especially the corona mortis, direct reduction of the posterior column and the ability to apply a plate for posterior column stabilization, making this extensile approach appealing. Because rigid fixation is critical for managing the intraarticular fracture, direct fixation using the ilioischial plate is more suitable for the intraarticular fracture compared with lag screw fixation. We have used this approach to apply a plate along the internal aspect of the posterior column just ventral or superior to the posterior border of the posterior column. This plate is contoured to allow it to go over the pelvic brim and be fixed to the iliac wing anterior to the sacroiliac joint where there is good bone stock. The position of the anterior ilioischial plate fixation is similar to the posterior plate fixation, and thereby provides similar stability for the posterior column fracture (Figure 4).

Results of the present study showed that the modified Stoppa approach combined with the iliac fossa approach was suitable for direct fixation of the posterior column fracture with the ilioischial plate along the medial side of the pelvis. Compared to the single ilioinguinal approach, the intraoperative bleeding is less with 320 ml (range, 220 to 450 ml), as compared to 620 ml in our study and 925 ml to 760 ml from the literature. The operative time is shorter, and the incidence of complications is lower. The mean operative time is 2.1 hours (range, 1.4 to 3.2 hours), compared to 2.8 hours (range, 2.2 to 3.6 hours) in our study and a range between 3.3 hours and 2.6 hours reported in the literature. No heterotopic ossification occurred after surgery and only one case had obturator nerve injury, which recovered within 3 months after surgery. The combined approach used in the present study significantly reduced the incidence of heterotopic ossification compared with the single posterior K-L approach *(2,6)*. Although the reductions were comparable, the use of the ilioischial plate had better functional outcome results. Although this is a small series, the improvement in functional results is most likely related to the enhanced stability provided with plate fixation.

However, this approach is not suitable for all complex acetabular fractures. Complex fractures with easily reduced posterior columns, T-shaped or transverse fractures without posterior wall fractures, anterior column fractures associated with transverse fractures of the posterior column that lack significant intraarticular fragmentation of the weight-bearing area are suitable for this technique. The presence of a posterior wall fracture especially if the displacement is displaced is a

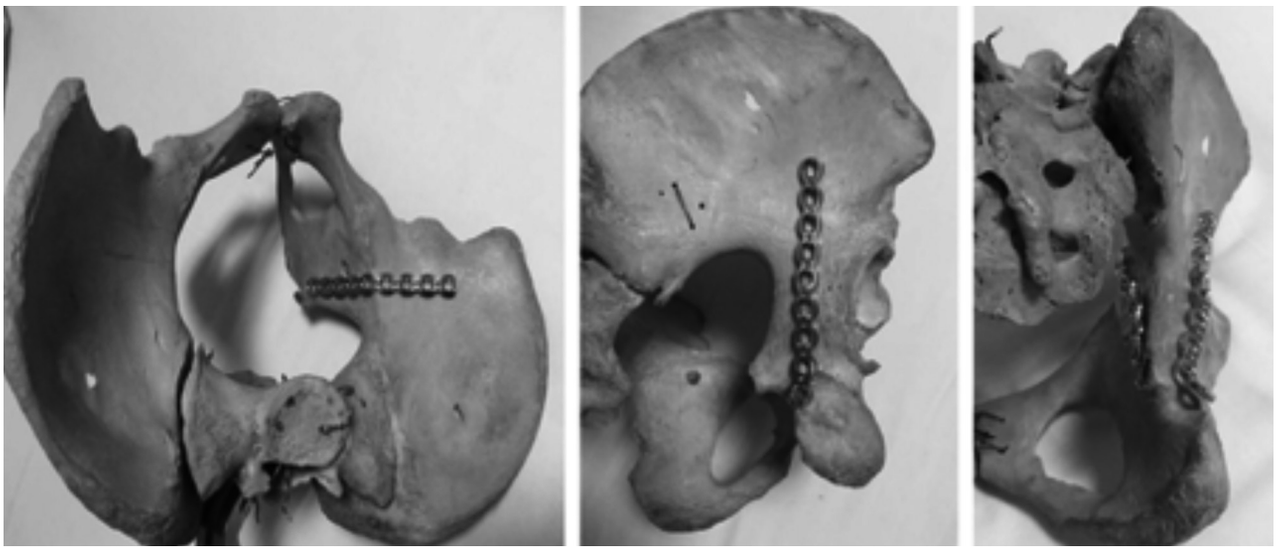

***Fig. 4.*** — The picture shows that the projection of anterior plate fixation is similar to the posterior plate fixation

contraindication for this approach. Previous lower abdominal surgery can make the surgical exposure difficult due to local adhesion. Obesity can make the manipulation and fixation of the fracture difficult. Alternate approaches have to be chosen in such cases. We also recommend that the Stoppa approach be applied after the ilioinguinal approach is sufficiently studied.

The small sample size and short follow-up periods of less than 2 years are limitations of this paper. In addition, no mechanical data exists other than the Coles report on the stability of the plate. Despite these drawbacks, our study reports a novel and effective method to stabilize complex acetabular fractures that is beneficial to acteabular surgeons.

## CONCLUSION

The results of the present study showed that the modified Stoppa approach combined with the iliac fossa approach and application of posterior column plate fixation along the internal aspect of the pelvis can effectively treat some complex acetabular fractures involving the anterior and posterior columns. This approach has the added advantage of being able to fix the posterior column with a plate that also provides enhanced stability to the posterior column fracture reduction. This technique is just one of many that acetabular fracture surgeons need to be familiar with in order to treat the spectrum of injuries that are observed.

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