Medial surface plating of posterior column through the anterior intrapelvic approach in acetabulum fractures with involvement of both columns

a case series of new techniques

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Aims

Posterior column plating through the single anterior approach reduces the morbidity in acetabular fractures that require stabilization of both the columns. The aim of this study is to assess the effectiveness of posterior column plating through the anterior intrapelvic approach (AIP) in the management of acetabular fractures.

Methods

We retrospectively reviewed the data from R G Kar Medical College, Kolkata, India, from June 2018 to April 2023. Overall, there were 34 acetabulum fractures involving both columns managed by medial buttress plating of posterior column. The posterior column of the acetabular fracture was fixed through the AIP approach with buttress plate on medial surface of posterior column. Mean follow-up was 25 months (13 to 58). Accuracy of reduction and effectiveness of this technique were measured by assessing the Merle d'Aubigné score and Matta's radiological grading at one year and at latest follow-up.

Results

Immediate postoperative radiological Matta's reduction accuracy showed anatomical reduction (0 to 1 mm) in 23 cases (67.6%), satisfactory (2 to 3 mm) in nine (26.4%), and unsatisfactory (> 3 mm) in two (6%). Merle d'Aubigné score at the end of one year was calculated to be excellent in 18 cases (52.9%), good in 11 (32.3%), fair in three (8.8%), and poor in two (5.9%). Matta's radiological grading at the end of one year was calculated to be excellent in 16 cases (47%), good in nine (26.4%), six in fair (17.6%), and three in poor (8.8%). Merle d'Aubigné score at latest follow-up deteriorated by one point in some cases, but the grading remained the same; Matta's radiological grading at latest follow-up also remained unchanged.

Conclusion

Stabilization of posterior column through AIP by medial surface plate along the sciatic notch gives good stability to posterior column, and at the same time can avoid morbidity of the additional lateral window.

Take home message

- Stabilization of posterior column through the anterior intrapelvic approach by medial surface plate, along with the sciatic notch, gives good stability to the posterior column.

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- At the same time, it can avoid morbidity associated with the additional lateral window.

Introduction

Acetabular fractures are becoming an increasingly common orthopaedic injury. Ranging from high velocity motor vehicular crash in younger age groups to low-energy falls in the elderly, these injuries are often part of polytrauma injuries. Although Letournel et al[1] have standardized the various fracture patterns by classifying acetabular fractures, understanding its multidimensional anatomical orientation can be difficult.[1] Modern investigations, such as 3D-printed models and CT scans, have helped to overcome this. Choosing the appropriate surgical approach, achieving anatomical reduction with stable fixation, and early functional rehabilitation have been benchmarks for treating thse fractures.

The majority of complex acetabular fractures with the involvement of both columns were managed previously with two separate approaches to address each one, as anatomical reduction was the key to success. However, with better understanding of surgical anatomy, improved skills, and sophisticated instruments, the requirement of the dual approach has reduced significantly, thereby reducing overall morbidity and mortality.[2]

Fixation of acetabular fractures through an anterior approach (ilioinguinal) was first described by Letournel et al.[1] Later, various authors, including Hirvensalo et al[3] and Cole et al,[4] described an anterior intrapelvic approach (AIP) for such fractures, which offers an advantage as it avoids dissection of the inguinal canal and femoral neurovascular bundle. Bible et al[5] stated that the modified Stoppa approach allows exposure of more than two-thirds of the inner true bony pelvis. This allows enough exposure for direct reduction and fixation with plates and screws anywhere along the medial surface of the posterior column, the quardrilateral surface, and along the pelvic brim up to the sacroiliac joint. Thus, the majority of complex acetabular fractures, such as both column, anterior column with posterior hemitransverse, and T-type, can be managed via this single approach.

Posterior column fractures of the acetabulum have been broadly divided into two types: high, where the fracture line exits close to the greater sciatic notch; and low, where the fracture line exits close to the ischial spine.[6] Depending on the fracture pattern, different reduction and fixation techniques have been advised. The majority of surgeons fix the posterior column via the anterior approach via a two-step technique, in which direct reduction was achieved through the medial window and followed by antegrade lag screw fixation through the lateral window.[7,8] However, we have used the AIP window to achieve reduction, as well as fixation of the posterior column with short 3.5 reconstruction plates starting just below the pelvic brim along the sciatic notch (Figure 1). In addition to avoiding morbidity of another lateral window along iliac crest, this method also has advantages over posterior column screws in that the plate can be more effective in buttressing posterior column in oblique fractures (Figure 2a) compared to transverse fracture pattern in the posterior column (Figure 2b).

The purpose of this study is to assess efficacy of this technique in achieving reduction and maintaining it until fracture union by analyzing functional and radiological outcomes of complex acetabular fractures treated with vertical quadrilateral surface plate fixation of posterior column via the AIP approach.

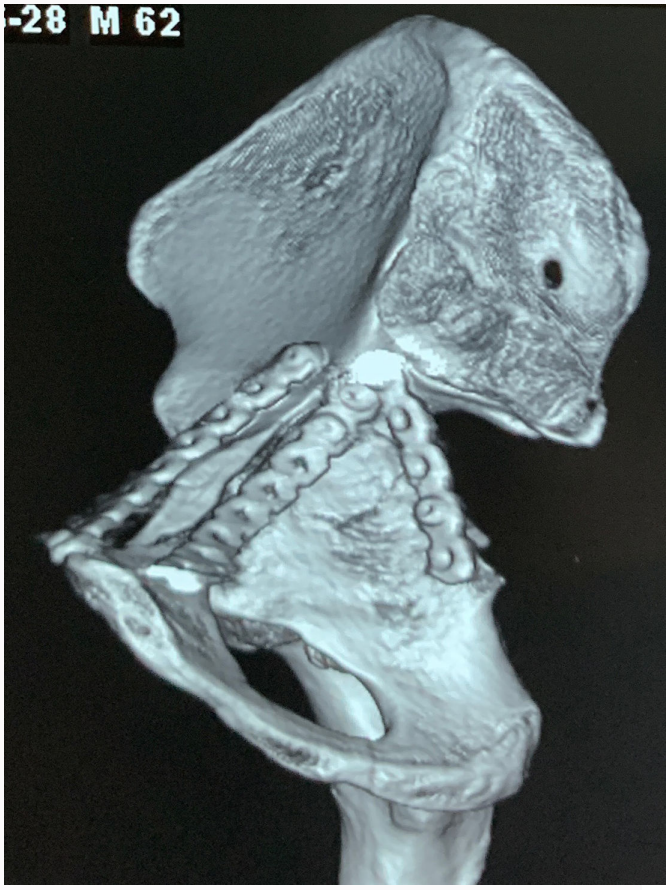

Fig. 1
3D CT scan of right hemipelvis with digital subtraction of opposite hemipelvis and sacrum in a postoperative case of transverse acetabulum fracture showing posterior column plating along the border of sciatic notch on the inner surface of the posterior column. The fracture was also fixed with an infrapectineal and suprepectinial plate.

Methods

We retrospectively reviewed the data from R G Kar Medical College, Kolkata, India, from June 2018 to April 2023, and had a minimum one-year follow-up, as acetabular fractures consolidate by that time. Hence, patients operated on until April 2022 were included in this study. A total of 108 patients with acetabular fractures were operated on during that period, of whom 61 required the AIP approach. Patients with acetabular fractures that were more than three weeks old were excluded from this study, as this delay may affect quality of reduction or require an additional approach to reduce them anatomically. The fracture that had associated posterior wall fractures requiring an additional posterior approach were also not included. Hence, out of these 61 patients, only 35 matched our inclusion criteria (i.e. fractures that had undergone separate posterior column fixation with reconstruction plate along with other fixation procedures through AIP approach only). Approval from the institutional ethical committee was undertaken for this study, and as all data collection was carried out retrospectively, informed consent was waived of by ethical committee.

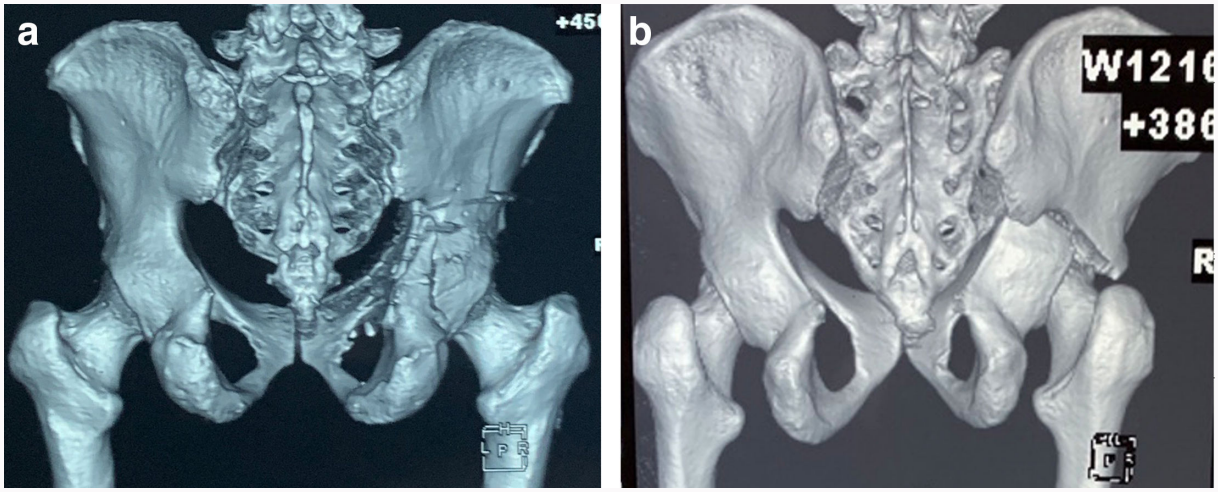

Fig. 2
a) 3D CT scan of a pelvis in a postoperative case of anterior column posterior hemitransverse acetabulum fracture showing oblique orientation of posterior column fracture line which was buttressed with reconstruction plate along the border of sciatic notch on the inner surface of posterior column, neutralizing medial force of head of femur, as well as preventing proximal migration of apex of distal fragment. b) 3D CT scan of pelvis in a case of transverse acetabulum fracture showing horizontal orientation of posterior column fracture line, which can be fixed with reconstruction plate along the border of sciatic notch on the inner surface of posterior column; although this neutralizes the medial force of head of femur, interfragmentary compression should be applied with clamps before fixation, since compression is not possible with this technique as it would be possible with antegrade posterior column screw fixation.

Technique

The patient was placed in supine position after spinal anaesthesia. A Foley catheter was placed preoperatively to empty the bladder and keep it collapsed. The ability to obtain anteroposterior (AP) and Judet views was verified before draping. The injured limb was then draped free and the hip kept in flexion. The operating surgeon stood on the contralateral side, with the fluoroscope kept on ipsilateral side. With a stab incision on the lateral aspect of greater trochanter, a Schanz's pin (5 mm) was placed in the femoral head for the purpose of traction of the limb. After proper draping, a Pfannenstiel incision was made approximately 2 cm superior to pubic symphysis. The rectus sheath was divided into midline, and rectus muscles were split longitudinally. Some part of the rectus must be released from anterior part of the pubic body and tubercle. The urinary bladder must then be mobilized carefully away from the fracture site, corona mortis, if present, was then identified and secured, and the obturator nerve was mobilized medially to avoid any injury. The surgeon then started to work from the pubis, along the pelvic brim stripping the periosteum, and iliopectineal fascia so that the fracture site could be exposed and hohman's retractors could be placed safely, as described by Sagi et al.[9] The whole of the quardrilateral plate and medial surface of the posterior column up to the ischial spine was visible at this point.

We started by applying lateral femoral traction with Schanz's pin to avoid medial forces on the quardrilateral plate and posterior column by the femoral head. If there any impacted dome fragments were present, it was then reduced through the fracture site, and a void created due to disimpaction of dome fragment, which was filled with autologous bone graft or artificial bone substitute. A ball-spiked pusher with disc plate was then used to push the quardrilateral plate laterally, and the posterior column was reduced and temporarily fixed with Kirschner wires. Depending on the pattern of fracture of the posterior column (high or low), one tine of the reduction forceps were placed either in the greater sciatic notch (high variety) or ischial spine (low variety) and the other tine over the pelvic brim. A 3.5 mm pelvic reconstruction plate was contoured and placed along the sciatic notch starting from the sciatic buttress just below pelvic brim towards the ischial spine (Figure 3). We completed the procedure after fixing the anterior column with contoured suprapectineal or infrapectineal plates, or both as and when required. Final fixation was checked under fluoroscopy and the wound was closed in layers. Postoperatively, rehabilitation was started

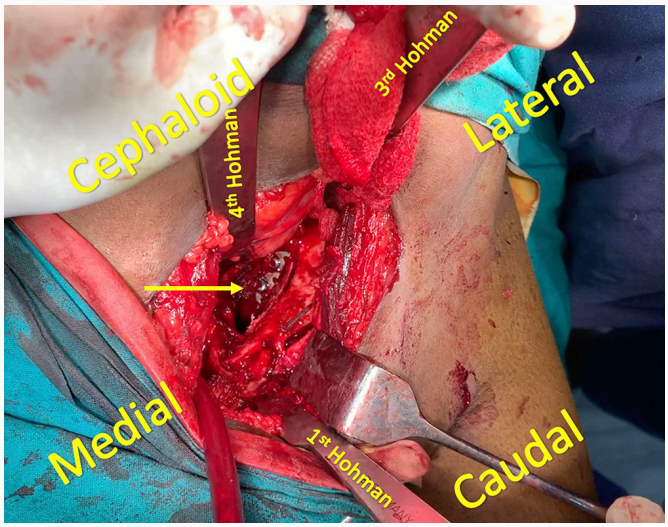

Fig. 3
Anterior intrapelvic approach with position of Hohman's position, as described by Sagi et al.[9] Hohman positioned at pubic tubercle third at iliac fossa just lateral to sacroiliac joint, and fourth Hohman at ischial spine. The second Hohman, described by Sagi et al,[9] was not placed here. The position of the plate along the medial side of posterior column along the border of sciatic notch is shown (see arrow).

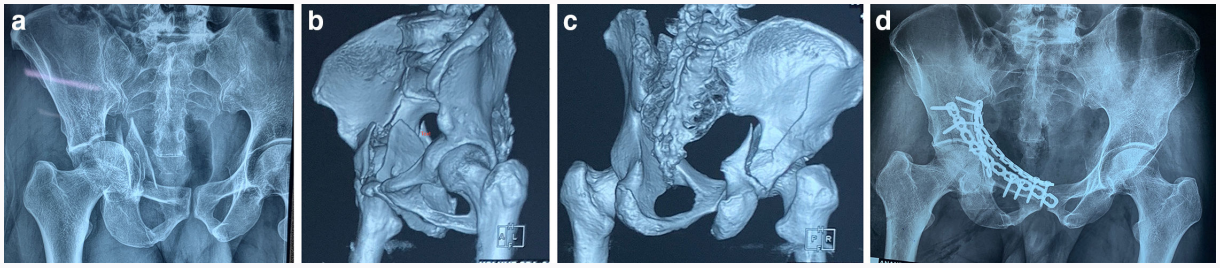

Fig. 4

a) Anteroposterior Radiographic view of 55 year-old male showing anterior column posterior hemitransverse (ACPHT) acetabulum fracture with seagull sign and medial subluxation of femoral head. b) 3D CT scan of the same patient with an ACPHT acetabulum fracture showing oblique orientation of posterior column fracture. c) 3D CT scan of the ACPHT acetabulum fracture showing displaced anterior column and medially displaced quadrilateral plate. d) Immediate postoperative radiograph showing anatomical reduction of fracture with vertical posterior column plate, infrapectineal, and suprapectineal plate.

with no weightbearing for four weeks, followed by partial weightbearing ambulation for the next four to eight weeks, and later, as union progressed, full weightbearing gradually.

Data collection

One patient was not available for follow-up as they could not be contacted; therefore, data for only 34 patients were available. Preoperative radiographs and CT scans with 3D reconstruction images were obtained for all patients, and the fractures were classified according to the Judet and Letournnel Classification.[1] All patients were followed up at regular interval with minimum follow-up of one year and maximum follow-up of 58 months, and data collected at each follow-up were compiled for assessment. Immediate postoperative radiograph of pelvis with both hip AP and Judet views were reviewed, and accuracy of reduction was noted by independent assessor as per graded Matta's criteria.[10] All patients were evaluated functionally by the Merle d'Aubigné score[11] after union of fracture at three months, one year, and then at a yearly interval, and radiologically with Matta's radiological scoring at immediately after operation, at six weeks, three months, one year, and then at a yearly interval. The clinal scores were obtained from follow-up data, which were assessed by members of the surgical team (NS, MC). However, the follow-up radiological scores were re-evaluated by independent assessor. The one-year scores of clinical and radiological data were chosen for evaluation, as fracture consolidation is complete by that time and further loss of reduction is unlikely. Hence, this will give good a idea about quality of reduction of fracture and adequacy of fixation, which were our main objectives for assessment. The latest follow-up scores were also evaluated to assess long-term outcomes of our method. A case example with follow-up radiographs is shown in Figure 4.

Results

Posterior column fixation with reconstruction plates via the AIP approach was carried out in 34 patients (21 males and 13 females). The mean age of the patients was 43 years (23 to 67). In all, seven patients had other concomitant bony injuries and one had abdominal/urethral injuries, which did not alter our line of management. The mean time from injury to surgery was 11 days (3 to 20). Mean operating time was 135 minutes (55 to 210). The fracture patterns managed with this technique were anterior column posterior hemitransverse (ACPHT), associated both column fracture (ABC), transverse fracture, and T-type. The mean follow-up period was 25 months (13 to 58). Immediate postoperative radiological Matta's reduction accuracy showed anatomical reduction (0 to 1 mm) in 23 cases (67.6%), satisfactory (2 to 3 mm) in nine (26.4%), and unsatisfactory (> 3 mm) in two (6%) (Table I). All patients achieved radiological union between 11 and 17 weeks. Obturator nerve palsy was noted in four patients, which recovered spontaneously in 11 weeks. There were no patients with sciatic nerve palsy. Superficial wound infection was seen in three cases, which were managed with antibiotics, and there were no deep infections. There were no incidences of osteonecrosis until latest follow-up, most likely due to not touching vascular supply of head of femur, as all the work was carried out intrapelvically. There were no cases of heterotropic ossification, which could be due to the lack of any bulky muscles in the true pelvis. One patient developed post-traumatic arthritis at 19 months, which was managed by total hip arthroplasty. Merle d'Aubigné score at the end of one year was calculated to be excellent in 18 cases (52.9%), good in 11 (32.3%), fair in three (8.8%), and poor in two (5.9%) (Table I). Matta's radiological grading at the end of one year was calculated to be excellent in 16 cases (47%), good in nine (26.4%), fair in six (17.6%), and poor in three (8.8%) (Table I). Merle d'Aubigné score at latest follow-up deteriorated by 1 or 2 points in some cases, but the grading remained the same (i.e. excellent in 18 cases (52.9%), good in 11 (32.3%), fair in three (8.8%), and poor in two (5.9%)). Matta's radiological grading at latest follow-up also remain unchanged with excellent in 16 cases (47%) and good in nine (26.4%), except in one patient of ACPHT, whose radiological grading deteriorated from fair to poor (i.e fair in five cases (14.7%) and poor in four cases (11.9%)). The radiological outcomes of individual fracture patterns at one year and at latest follow-up were also calculated (Table I).

Discussion

Achieving and maintaining anatomical reduction in a high posterior column fracture until consolidation is key to long-term success, as the weightbearing dome of the acetabulum lies there. Plate fixation along the medial surface of posterior column parallel to posterior border of sciatic notch achieves adequate, if not better, stability than posterior

Table I.

Different fracture patterns included in this study and their accuracy of reduction, along with fracture-specific clinical Merle d'Aubigné score and Matta's radiological scoring at one year.

Variable	Matta's accuracy of reduction immediately postoperative (n)	Merle d'Aubigné score at 1 yr (n)	Matta's accuracy of reduction at 1 yr (n)
ACPHT (n = 11)	Anatomical (5)	Excellent (5)	Excellent (4)
	Satisfactory (5)	Good (4)	Good (3)
	Unsatisfactory (1)	Fair (1)	Fair (2)
		Poor (2)	Poor (2)
Associated both column (n = 11)	Anatomical (7)	Excellent (6)	Excellent (5)
	Satisfactory (3)	Good (3)	Good (3)
	Unsatisfactory (1)	Fair (1)	Fair (2)
		Poor (1)	Poor (1)
T-type (n = 7)	Anatomic (5)	Excellent (5)	Excellent (4)
	Satisfactory (2)	Good (2)	Good (2)
	Unsatisfactory (0)	Fair (0)	Fair (1)
		Poor (0)	Poor (0)
Transverse (n = 5)	Anatomical (4)	Excellent (3)	Excellent (3)
	Satisfactory (1)	Good (2)	Good (1)
	Unsatisfactory (0)	Fair (0)	Fair (1)
		Poor (0)	Poor (0)

ACPHT, anterior column posterior hemitransverse.

column screw, along with reduced radiation and morbidity of another lateral window.

Treating complex acetabular fractures is still a major challenge. Choosing the correct surgical approach and fracture fixation technique requires great experience and expertise. For fixation of fracture patterns, such as both column, anterior column with posterior hemitransverse, and T-type, Letournel et al[1] had first mentioned tackling posterior column through ilioinguinal approach with the help of long cancellous screws along the posterior column. This approach has a long learning curve as it requires dissection along vital neurovascular structures. Later, several authors started using modified Rives Stoppa approach (now known as AIP),[2,4,9] which was relatively straightforward as it required less extensive dissection, and also helped in direct visualization of the pelvic brim and quadrilateral plate. However, for placing posterior column screws, another lateral window (iliofemoral) needs to be created, which has its own added morbidity. Bible et al[5] quantified that the Stoppa approach allows for around 79% exposure of the inner true bony pelvis, including the entire pelvic brim and 80% of the quadrilateral surface, which gives sufficient exposure of medial surface of posterior column for plate application.

Zhuang et al[12] achieved anatomical reduction through the AIP approach in 61% of cases and satisfactory reduction in 24% of cases. Their modified Merle d'Aubigné score at one year was excellent to good in 75% of cases, which was similar to this study. Cavalié et al[7] also achieved comparable results to ours, both in terms of achieving quality of reduction and Merle d'Aubigné score, but they mentioned that radiation exposure was significantly higher with antegrade posterior column screw fixation.

Though biomechanical studies have shown good stability with the use of long cancellous screws in the posterior column, these have their own drawbacks.[13] According to the concept of lag screws, the screw should be perpendicular to the plane of the fracture to get proper compression across fracture site, otherwise in oblique fractures, shear stress within the fracture fragments can lead to loss of reduction.

In posterior column fractures, apart from true transverse fractures, it is not always possible to put the lag screw perpendicular to the fracture plane. Busuttil et al[13] in their biomechanical study mentioned that posterior column screw gives adequate stability compared to the buttress plate, but they created a pure transverse fracture in the posterior column, which helped in putting posterior column screws perpendicular to the fracture line. This technique is also highly dependent on the use of a fluoroscope and an expert technician, and requires good orientation of the surgeon to get proper views for putting the screw in a safe corridor.[14] Hence, using only the AIP approach for both the column fixation, we are not only able to decrease morbidity, but also reduce radiation exposure. Furthermore, the incidence of geriatric fractures has increased in last two decades[15] . Fixing acetabular fractures in the geriatric age group can be a challenge due to presence of osteoporosis. The purchase strength of long cancellous screws can also be compromised. In such cases, reconstruction plates with a locking hole along

the posterior column provides a more rigid support to the posterior column fracture.

Andersen et al[8] discussed fixation of posterior column through the modified Stoppa approach, but they primarily fixed with a lag screw in the posterior column. However, they were able to achieve excellent to satisfactory reduction in all 17 of their cases. The authors concluded that the contraindication of fixing the posterior column through the modified Stoppa technique are segmental posterior column fracture or presence of posterior wall fracture. However, in our technique, a segmental fragment can also be fixed through this approach, but a posterior wall fracture requires the separate posterior approach.

Even though the studies are sparse in posterior column plating through the anterior approach, there have been few studies mentioning posterior column plating through the anterior approach. Guy et al[14] published literature about a safe zone for putting a screw in the acetabulum to avoid the hip joint. They mentioned that for inner side of posterior column, the safe distance for avoiding joint is between 23 and 28 mm from the ischial spine. However, the authors reported on a small infrapectineal plate parallel to the pelvic brim, and concentrated on the number of screws that can be safely given posterior to hip joint along the sciatic buttress area. We used this knowledge of the safe zone in the posterior column to put the posterior column plate along the sciatic notch, and tried to make the screw hole about 10 to 20 mm from the ischial spine, to remain just within the safe zone.

Sagi et al[9] recommended the AIP approach as a potential alternative to the classic ilioinguinal approach. The authors also mentioned the use of short reconstruction plates along the posterior column area parallel to the pelvic brim for stabilizing the quadrilateral plate, and supplementing it with long cancellous screws in the posterior column through the lateral window.

Kistler et al[16] compared biomechanical strength of fixation by an anatomical contoured quadrilateral plate (Stryker, USA), a posterior column plate, and screw construct, and concluded the anatomical contoured plate with quadrilateral surface overhang alone gives equal stiffness compared to plate and column screws.[16] Hence, a posterior column plate on the quadrilateral surface should be adequate in holding reduction of posterior column. A new design of anatomical quadrilateral surface buttress plate was also discussed by Sen et al.[17] They highlighted that these plates are best optimized for the management of comminuted acetabulum fractures, especially in poor-quality bones. The biggest limitations of these precontoured anatomical plates are that they do not allow placement of the plate in the posterior column as per choice of surgeon and requirement of fracture pattern, but it is pre-determined by the size of the plate, and it is often not possible to put screws through the quadrilateral surface overhang area of plate to achieve adequate stabilization in posterior column. Hence, an independent plate is superior in this respect, as it gives freedom to put the plate as posterior and as low down as possible according to the requirement of fracture pattern.

Recently, Chen et al[18] also mentioned plating of the posterior column through the AIP approach, but they applied the plate from ilium to the ischial spine, thereby making it difficult to include any additional infrapectineal plate, which is often required in addition to the posterior column plating to buttress the quadrilateral plate effectively. We applied our posterior column plate starting below the pectineal line, as this allows us to place an additional infrapectineal plate. Furthermore, the sciatic buttress has strong bones; hence, extending the plate to the ilium is not essential, as two screws in proximal fragment give adequate stability in that area.

The posterior column bears most of the weight transmission and, to the authors' knowledge, that is why it is bulkier of the two columns. One separate plate gives better stability than other methods of posterior column stabilization, like column screw or horizontally placed infrapectineal plate.

Limitations were that a comparison with posterior column screw fixation would have increased the strength of the study. There were also a small number of cases, and possible bias due to non-blinded assessors (NS, MC) for clinical scores. A comparison with posterior column screw fixation would have also increased the strength of this study.

In conclusion, stabilization of posterior column through the AIP by medial surface plate, along with the sciatic notch, gives good stability to posterior column; at the same time, the lateral window (iliofemoral)can also be avoided, along with the associated morbidity.

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ICMJE COI statement

The authors have no conflict of interests to declare.

Data sharing

The data that support the findings for this study are available to other researchers from the corresponding author upon reasonable request.

Ethical review statement

Approval from the Instituitional Ethical Committee (IEC) was sought; as all data collection was carried out retrospectively, informed consent was waived by the IEC.

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