Clinical Article

Posterior acetabular wall fracture fixation with a one-third tubular plate

MB Nortje, Registrar in Orthopaedics
GM Siboto, Consultant Orthopaedic Surgeon
J Walters, Professor and Head of Orthopaedics
University of Cape Town, Department of Orthopaedic Surgery, Groote Schuur Hospital, Cape Town, South Africa

Corresponding author:
Marc Nortje
30 Hampstead Rd
Claremont
7708
Email: mbnortje@yahoo.com

Abstract
We reviewed the records of 222 patients treated for posterior wall acetabular fractures from 1994 to 2006 at our institution. In 71 of these patients a 3.5 mm one-third tubular, small fragment plate was used instead of a reconstruction plate. The patients were followed up for an average of 17 months clinically and with radiographs. All fractures united. There were only two cases of hardware failure; in one a screw broke with no loss of reduction, and in the other the plate broke in a case with an associated posterior column fracture. The one-third tubular plate is quick and easy to apply to the posterior wall. It can be secured, providing a strong tension buttress that maintains reduction. We recommend this plate as the implant of choice for internal fixation of isolated posterior wall acetabular fractures that do not involve the posterior column. If the posterior column is involved a reconstruction plate must be added.

Introduction
Traditionally posterior acetabular wall fractures have been fixed with reconstruction plates and screws or screws alone. The plates are rigid and cumbersome and time-consuming to contour to the shape of the posterior wall, while screws alone often do not offer sufficient support to prevent displacement. Something intermediate is needed to address these fractures and in the past we have used 3.5 mm one-third tubular plates instead of reconstruction plates.

The pelvis has always been considered one of the more difficult anatomical areas for orthopaedic surgery and it has been relatively recently that the pelvis and acetabulum have been subjected to less conservative and more operative management. Judet and Letournel were the first to popularise surgery to the pelvis and acetabulum.[1] In their original article they recommend the use of plates and screws, screws alone and staples for fixation of acetabular fractures. Tile and Pennal recommend the use of dynamic compression plates for the internal fixation of pelvic fractures.[2]

The literature has an abundance of information about various aspects of the surgical technique but very little about the type of implants used, except perhaps describing the use of spring plates for comminuted posterior wall fractures.[3] The papers that do mention the implants indicate the use of reconstruction plates for fractures involving the acetabular walls or columns.[4-8] Initially the AO small fragment plate was used for this fixation, but because of restricted length and the necessity to bend this plate in the plane of its flat surface, which proved difficult, the reconstruction plate was introduced, at first just with increased length and later with a choice of pre-contoured plates.

At our institution we have found the pre-contoured pelvic reconstruction plates most applicable with the anterior approach and plating of the pelvic brim, anterior column and the symphysis pubis. Likewise the reconstruction plates work very well for the flat surface of the posterior column, but the complex configuration of the posterior acetabular wall and ischium where purchase is required does not permit easy or accurate contouring of this relatively thick and stiff plate. Despite the recommended use of the aluminium template, the bending process with plate benders and press is time-consuming and often does not achieve a sufficiently accurate 'fit' to ensure that the posterior wall fragment remains reduced after its application.

At our institution we have found the pre-contoured pelvic reconstruction plates most applicable

For this reason the senior author (GS) employed a one-third tubular plate on occasion for those fractures where the reconstruction plate was found to be too cumbersome or difficult to use. The technical ease of use prompted its routine use in place of the reconstruction plate at Groote Schuur Hospital.

The objective of this review was to assess the efficacy of the more user-friendly, one-third tubular plate.

Materials and methods

We operated on 393 acetabular fractures from 1994 to the end of 2006; all of these procedures were performed or supervised by the senior author (GS). The posterior wall of the acetabulum was involved in 222 of these. They were either posterior wall fractures in isolation or as part of associated acetabular fractures as classified by Letournel.[9] We classified the posterior wall fractures according to the method of Thompsen and Epstein[10] *(Table I)* and excluded patients with associated femoral head or neck fractures, i.e. type V (n=13) and those cases where no plate was used (n=13).

The case records and the radiographs of the remaining 196 cases that had the posterior wall internally fixed with one or more plates and screws were reviewed. These patients were then divided into two groups. Group A consisted of patients where the posterior wall was fixed with a reconstruction plate and group B were fixed with a one-third tubular plate. The age, gender, mechanism of injury, fracture classification, time to surgery, implants used, duration of operation, date of last follow-up and any complications were recorded.

Table I: Classification of posterior dislocations of the hip according to Thompsen and Epstein

Type I	With or without minor fracture
Type II	With a large single fracture of the posterior acetabular rim
Type III	Comminution of the rim of the acetabulum ± a major fragment
Type IV	With fracture of the acetabular floor
Type V	With fracture of the femoral head

Plain film X-rays of the pelvis, AP and Judet views were taken to diagnose and classify the fracture. In selected cases a CT scan and 3D reconstruction was performed. Pre-operatively all patients were given mechanical and chemoprophylaxis against DVT and Doppler ultrasound of the femoral veins was performed the day before surgery looking for thrombi. If patients had a DVT then a vena cava filter was inserted prior to surgery.

All posterior wall fractures were plated through a Kocher-Langenbeck approach with the patient in a lateral position. Care was taken dividing the external rotators to avoid damage to the posterior ascending branch of the medial femoral circumflex artery, supplying the femoral head. Associated anterior column fractures were managed by a separate anterior ilioinguinal approach. The posterior wall fractures were plated with either a 3.5 mm reconstruction plate (Group A: n=125) or a 3.5 mm one-third tubular plate (Group B: n=71). *See Figure 1.*

The selection of the one-third tubular plate over the recon plate was made intra-operatively. Initially this was used in cases where the reduction was difficult to maintain while the heavier plate was being contoured or while it was being applied. The malleability of the thinner plate allowed for 'dynamic reduction' of the fracture. Later this plate was used in preference to the recon plate without specific indication.

Posterior column fractures when present were stabilised with a separated recon plate.

Care was taken not to place any screws into the joint and passive flexion, extension and rotation of the hip post fixation was done to ensure a smooth range of movement. No intra-operative imaging was used. Routine closure of the wound was performed and a closed system drain was used for 24 to 48 hours as required.

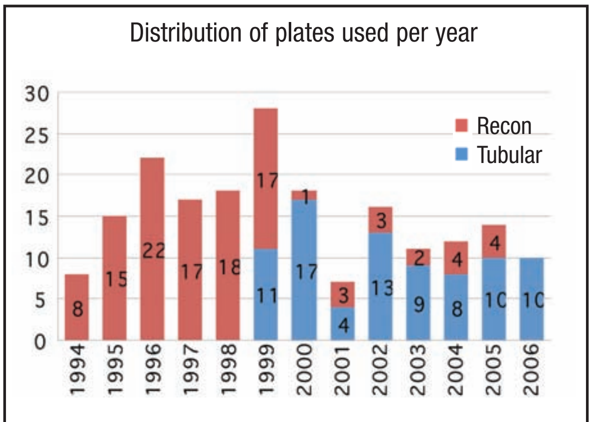

Figure 1: The reconstruction plate was used exclusively from 1994 until the one-third tubular plate was introduced in 1999

Table II: The age distribution and fracture types demonstrate an equitable spread within each group

	Overall	Group A (Recon)	Group B (Tubular)
No. of patients	196 (M137:F36)	125 (M88:F37)	71 (M49:F22)
Average age	37.3y (M36:F39)	36.8y	37.2y
Fracture type	TE I = 6 TE II = 135 TE III = 55	TE I = 3 (2.4%) TE II = 89 (71%) TE III = 33 (26%)	TE I = 3 (4.2%) TE II = 46 (65%) TE III = 22 (30%)

The patients were kept in bed for one to three weeks depending on the extent of fracture and fixation and then mobilised non-weight-bearing on the affected side for a total of three months. Indomethacin was used for the prophylaxis against heterotrophic ossification for three weeks post surgery. Three view radiographs of the pelvis were obtained post op, at two months, five months and one year, and then yearly until discharge.

The radiographs were examined for any sign of plate or screw breakage or pull out, or any loss of reduction of fracture fragments.

Results

The average age at surgery was 37 years, with the males being slightly younger than the females. There were 137 males and 59 females. The mechanism of injury was high energy motor vehicle accident in the majority of cases.

The distribution of fractures is shown in *Table II*. The demographics and type of fracture were similar between the two groups.

The surgery was performed an average of 12 days post injury with a median time to surgery of 9 days.

The average duration of the surgical procedure was 143 minutes. The average duration of surgery where reconstruction plates were used to fix the posterior wall was 146 minutes compared to 141 minutes where a one-third tubular plate was used.

Additional ilioinguinal approaches were required in 42 of the 196 (21%) patients to address the associated anterior column fractures.

A total of 196 posterior walls were plated. In 125 (64%) of these a reconstruction plate was used and in 71 (36%) a one-third tubular plate was used. None of the reconstruction plates experienced any hardware failure. Two (3%) of the one-third tubular plates failed. In the first *(Figure 2)*, the most distal ischial screw broke but the plate remained intact. This was seen on the five month X-ray and did not result in any displacement of the plate or fracture fragment. In the second case *(Figures 3 and 4)*, the plate broke and there was loss of reduction at the two-month follow-up. This patient went on to a malunion that was symptomatic and is awaiting further surgery.

Discussion

As expected there were more than twice as many males injured than females, reflecting their higher risk-taking behaviour. The vast majority of these patients were injured in motor vehicle accidents, highlighting the dangers of our roads and the high energy that is needed to cause these fractures.

Figure 2: Case 1 demonstrating the broken screw seen at 5 months

Figure 3: Case 2 showing the inadequate reduction of the posterior column fracture

Figure 4: Case 2 at 12 months. The fracture has united satisfactorily despite the plate breaking through the proximal screw hole

The similarity of the demographics between the two groups is indicative of the arbitrary manner in which patients were chosen to receive a one-third tubular plate as opposed to a reconstruction plate. A one-third tubular plate was often chosen intra-operatively if the posterior wall reduction was difficult to maintain while bending the reconstruction plate. In this case the fracture fragments were placed in a best fit position and then the one-third tubular plate screwed down over the fragments to reduce them.

The reconstruction plates were used less since the introduction of the one third tubular plate in 1999 and in 2006 no reconstruction plates were used on the posterior wall fractures, as shown in *Figure 1*.

The main concern regarding the use of this thinner plate is its strength and ability to maintain the reduction in an area of high demand. We looked for any breakage of the plate or screws or loss of reduction of the fracture fragments.

In contouring the plate we believe that it has sufficient flexibility to provide a 'tension buttress' effect when secured to the posterior wall

In the first failure, we did not feel that the broken screw was as a result of the plate selection. The fracture remained well reduced and the plate maintained its integrity.

In the second failure there are two factors that contributed. Firstly the fracture was not adequately reduced as can been seen in the post-operative radiograph *(Figure 2)*. This may have resulted in increased forces through the plate. The fractured plate can be clearly seen in *Figure 3*. It is unclear from the operative notes as to the reason for the use of the unusual plate configuration in this case but the small plate may have caused a stress riser in the longer plate, contributing to its breakage. Secondly, and most importantly, the fracture involves the posterior column in addition to the wall imparting far greater instability to the fracture configuration.

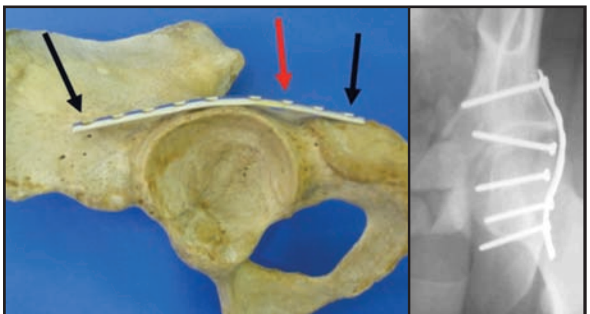

Figure 5: Black arrows showing screw fixation points and red arrow showing the position of the sub-cotyloid fossa screw that will tension the plate with the end result shown on the X-ray on the right

These fractures further compound the amount of force and movement transmitted to the plate and an additional reconstruction plate should be used for fixation of the column fracture. The senior author retrospectively admitted to being seduced by the effectiveness of the tubular plate fixation that he in this case neglected to apply a separate plate for the posterior column.

We have explained the ease of use of one-third tubular plates in the introduction. Intuitively one can see how they would save time during surgery, as they can be bent without the use of plate benders. This is borne out when comparing the average duration of surgery with reconstruction plates (146 minutes) compared to one-third tubular plates (141 minutes); however, we accept that there are numerous other variables that have a more direct bearing on the duration of the procedure, not least of which is the fact that most of the reconstruction plates were used in the first half of the series where the surgeon was not as skilled as in the latter half of the series.

In contouring the plate we believe that it has sufficient flexibility to provide a 'tension buttress' effect when secured to the posterior wall. The plate is bent to approximate the shape, and then secured to the ischial tuberosity and to the ilium superior to the acetabulum; it then lies against the posterior wall with a gap under the plate at the sub-cotyloid fossa. A screw placed through the plate in to this fossa will pull the plate down, forcing it to conform to the posterior wall providing an even pressure fit or 'tension buttress' effect, locking the fracture wall fragments into place *(Figure 5)*.

A criticism of this paper is its structure, namely a retrospective review which has no randomisation. Also, the posterior column fractures within this series were not extracted so that the duration of the operation could be separately interrogated. It is perhaps reasonable for the authors to assume that an equitable number of cases were treated by both plating protocols because all posterior column fractures were plated using a separate recon plate, with the exception of the case of the plate breakage which was incorrectly left unplated. This review of our cases does not address all issues, not least of which is that it does not relate the type of plate used to functional outcome or patient satisfaction. However, it is relevant that in this consecutive series no cases were excluded and all procedures were conducted by a single surgeon, using the same technique in all cases.

However in the continual quest for the ideal implant, it was merely our intention to assess whether the one-third tubular plate had sufficient integrity for isolated posterior acetabular wall fixation, and we have shown that it does.

Conclusion

A one-third tubular AO SFS plate which offers ease of application can be successfully used for the fixation of posterior wall fractures. In cases involving the posterior column it is recommended that a separate reconstruction plate be used for the posterior column.

This research has been approved the Health Sciences Faculty Research Ethics Committee (REC REF 072/2008).

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

This paper is the sole, original work of all the authors and is not published elsewhere.

References

1. Judet R, Judet J, Letournel E. Fractures of the acetabulum: Classification and surgical approaches for open reduction: preliminary report. *J Bone Joint Surg Am.* 1964;**46**:1615-75.
2. Tile M, Pennal G. Pelvic disruption: Principles of management. *Clin Orth and Related Research* 1980 Sept;**151**: 56-64.
3. Richter H, *et al.* The use of spring plates in the internal fixation of acetabular fractures. *J Orthop Trauma* 2004;**18**:179-181.
4. Letournel E. The treatment of acetabular fractures through the ilioinguinal approach. *Clin Orth Related Research* 1993 July;**292**:62-76.
5. McMaster J, Powell J. Acetabular fractures. *Current Orthopaedics* 2005;**19**:140-54.
6. Keela M, Trentz O. Acute management of pelvic ring fractures. *Current Orthopaedics* 2005;**19**:334-44.
7. Petsatodis G, *et al.* Surgically treated acetabular fractures via a single posterior approach with a follow-up of 2-10 years. *Injury, Int. J. Care Injured* 2006.
8. Schopfer A, DiAngelo D, Hearn T, *et al.* Biomechanical comparison of methods of fixation of isolated osteotomies of the posterior acetabular column. *Int Orthop* 1994;**18**:96-101.
9. Letournel E. Acetabulum fractures: classification and management. *Clin Orthop* 1980;**151**:81-106.
10. Thompsen VP, Epstein HC. Traumatic dislocation of the hip. *JBJS* 1951(**33A**)746-78.

• SAOJ