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U. Stöckle · R. Hoffmann · M. Nittinger
N.P. Südkamp · N.P. Haas

Screw fixation of acetabular fractures

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Abstract Between 1992 and 1995, 50 patients with 51 acetabular fractures underwent internal fixation using 3.5 mm cortical screws. There were 21 simple and 30 associated fracture types, as described by Letournel. Most of the patients had sustained multiple injuries with an average injury severity score (ISS) of 20 points. The modified extended iliofemoral approach was used in 32 cases, the Kocher Langenbeck approach in 9 cases, the ilioinguinal approach in 7 cases, the extended iliofemoral in 2 cases and the Kocher-Langenbeck approach combined with an ilioinguinal approach in a second stage procedure in 1. Anatomical reduction could be achieved with persistent displacement of no more than 1 mm in 40 fractures. Implant failure with loss of reduction occurred in 3 patients who underwent a revision procedure. At 2 year follow-up, 38 out of 44 of the patients had excellent or good clinical and radiological results. In acetabular fractures with sufficiently large fragments, screw fixation with 3.5 mm cortical screws proved satisfactory. In very comminuted fractures or where there is poor patient compliance an additional buttress plate should be used.

Résumé La fixation avec des vis corticales de taille 3,5 mm a été réalisée pour 51 fractures du cotyle (50 patients) à fragments suffisamment grands de 1992 à 1995. Il y avait 21 fractures simples et 30 fractures associées d'après la classification de Letournel. La plupart des patients souffraient de multiples lésions et un ISS moyen de 20 points a été enregistré. La voie d'abord de Kocher Langenbeck a été utilisée chez 9 patients et la voie ilio-inguinale chez 9 patients. La voie d'abord ilio-fémorale prolongée modifiée a été utilisée dans 31 des cas, et la voie iliocrurale élargie classique à deux reprises. Dans 40 fractures, une réduction anatomique a pu être atteinte avec un déplacement restant mesuré de moins de 1 mm. Un échec d'implant avec perte de réduction a été observé chez trois patients entraînant ainsi une re-opération. Lors des examens de suivi après 2 ans, 38/44 des patients avaient un excellent ou un bon résultat clinique et radiologique. Pour les fractures du cotyle à fragments suffisamment larges, la fixation avec des vis corticales de taille 3,5 mm a prouvé être une méthode adéquate pour obtenir une réduction anatomique et une rétention. Pour les fractures comminutives ou chez les patients à compliance réduite, une plaque d'appui supplémentaire est recommandée.

U. Stöckle · R. Hoffmann · M. Nittinger · N.P. Südkamp
N.P. Haas
Medical Faculty Charité, Campus Virchow,
Department of Trauma
and Reconstructive Surgery Humboldt University Berlin,
Berlin, Germany

U. Stöckle (✉)
Unfall- und Wiederherstellungschirurgie,
Charité, Campus Virchow,
Augustenburgerplatz 1, 13353 Berlin, Germany
e-mail: ulrich.stoeckle@charite.de
Tel.: +49-30-45052012, Fax: +49-30-45052905

Introduction

Displaced acetabular fractures should be treated surgically [8, 9, 13–16, 19, 21–23, 24]. Letournel showed that anatomical reconstruction of the hip joint is essential in order to achieve good functional results and reported that 82% of patients with anatomical reduction obtained excellent or very good long-term results [13]. However, there are still differences in the treatment of acetabular fractures and articular fractures in general concerning the type of osteosynthesis. In most of the displaced joint fractures, reconstruction of the joint surface is better achieved with screw fixation using the lag screw technique. With good interfragmentary compression the various fragments can be reduced anatomically. This is widely accepted and recommended. Additional plates are only inserted for buttressing. In acetabular fracture treatment, plate osteosynthesis is the preferred method of stabilization. However, primary plate osteosynthesis can lead to slight incongruencies of the joint surface by fragment displacement due to eccentric loading while tightening the screws. There are few authors who discuss only screw fixation in acetabular fracture treatment. It is

used in less than 30% of cases [14]. The purpose of this prospective study was to evaluate a treatment protocol with screw fixation alone whenever the fracture fragments were large enough. Our aim was to establish how often a stable anatomical reduction was obtainable with this technique.

Materials and methods

The inclusion criteria of the subjects for the study were: displaced acetabular fracture with an articular step or gap of more than 3 mm; fragment size greater than 1 cm; and age between 16 and 65 years. Fifty patients with 51 acetabular fractures of sufficient fragment size for fixation with 3.5 mm cortical screws were included in the study between August 1992 and August 1995. A total of 72 acetabular fractures were treated surgically during this time. The mean age of the 34 men and 16 women was 36.9 years (16–63). In 26 of the patients the fracture was on the left side, 23 were on the right and 1 patient had bilateral acetabular fractures. Most patients had been injured in road traffic accidents. Forty-four patients sustained additional injuries; the average injury severity score (ISS) [2] was 20, and 13 patients had an ISS of more than 25 points. Routine neurological examination revealed 9 patients with associated nerve lesions; in 8 the sciatic nerve was involved and in 1 the femoral nerve.

The standard preoperative X-rays included a plain AP view of the pelvis with the oblique iliac and obturator views. A computed tomography (CT) scan was performed with 2 mm slices or by using the spiral CT technique. The fractures were classified according to Letournel [13] and the AO classification [18]. There were 21 simple and 30 associated fractures. In 9 patients there was an associated posterior dislocation and 3 patients suffered an additional Pipkin fracture. According to the AO classification there were 12 A-fractures, 27 B-fractures and 12 C-fractures.

The surgical approach was determined by the fracture pattern. The Kocher-Langenbeck approach was used in the 5 posterior wall fractures and in 4 cases with a transverse fracture combined with a posterior wall fragment. The ilioinguinal approach was performed for the 5 anterior column fractures, 1 transverse fracture and 1 anterior column/posterior hemi-transverse fracture. Most of the associated fractures were treated through an extended approach. The modified extensile iliofemoral approach (the Maryland approach) [20] was used in 31 cases; the classic extended iliofemoral approach was used in 2 cases; and the Kocher Langenbeck combined with the ilioinguinal approach was used once in a second stage procedure.

All patients underwent surgical treatment within 3 weeks of injury. The mean time from injury to surgery was 7 days (0–20). Schanz screws were inserted into the ischial tuberosity and the greater trochanter to facilitate reduction. AO pelvis reduction forceps and K-wires were used to maintain reduction while definitive ostosynthesis was performed with the 3.5 mm cortical screws by using the lag screw technique. The stabilizing screws for the posterior column were inserted from the inner aspect of the ilium towards the ischium. The anterior column screw was directed from the outer surface of the ilium towards the pubis (Fig. 1). The screws were inserted under visual and X-ray control (Fig. 2).

Following a standardized protocol indomethacin (50 mg/day) was given for 6 weeks as prophylaxis against heterotopic ossification for the Kocher-Langenbeck approach, and in patients treated with extended approaches single dose irradiation with 7 Gy was given during the first 24 h postoperatively. Routine antibiotic prophylaxis with Amoxicillin was used for 3 days. Thromboembolic prophylaxis was maintained with continuous heparin administration (adjusted to a PTT of 40–60 s) for 10 days postoperatively, and thereafter low-molecular-weight heparin was used. Physiotherapy was started on the first postoperative day with continuous passive motion. Mobilization was started when possible on the third postoperative day with partial weight bearing for 12 weeks.

The quality of reduction was evaluated by measuring persistent displacement on the postoperative X-rays, the oblique views and the CT scans. No distinction was made between a gap and a step at the fracture site. The congruence of the femoral head with the roof of the acetabulum was also assessed. Displacement of 1 mm or less was considered an anatomical reduction, 2–3 mm was satisfactory and more than 3 mm was unsatisfactory, as described by Matta et al.. [15]. The hip joint was evaluated radiologically and compared with the contralateral side as described by Heeg et al. [8]. Grade 1 is a normal hip joint; grade 2 is a joint with minimal osteophytes, zones of sclerosis or joint space narrowing; grade 3 is a joint with moderate degenerative changes; and grade 4 is a joint with severe deformity of the femoral head associated with subchondral cysts or subluxation of the femoral head. Heterotopic ossification was classified according to Brooker et al. [5]. The extent of ossification was correlated with the postoperative range of movement. Brooker stage III or IV ossification with more than 20% decrease in range of movement was considered significant.

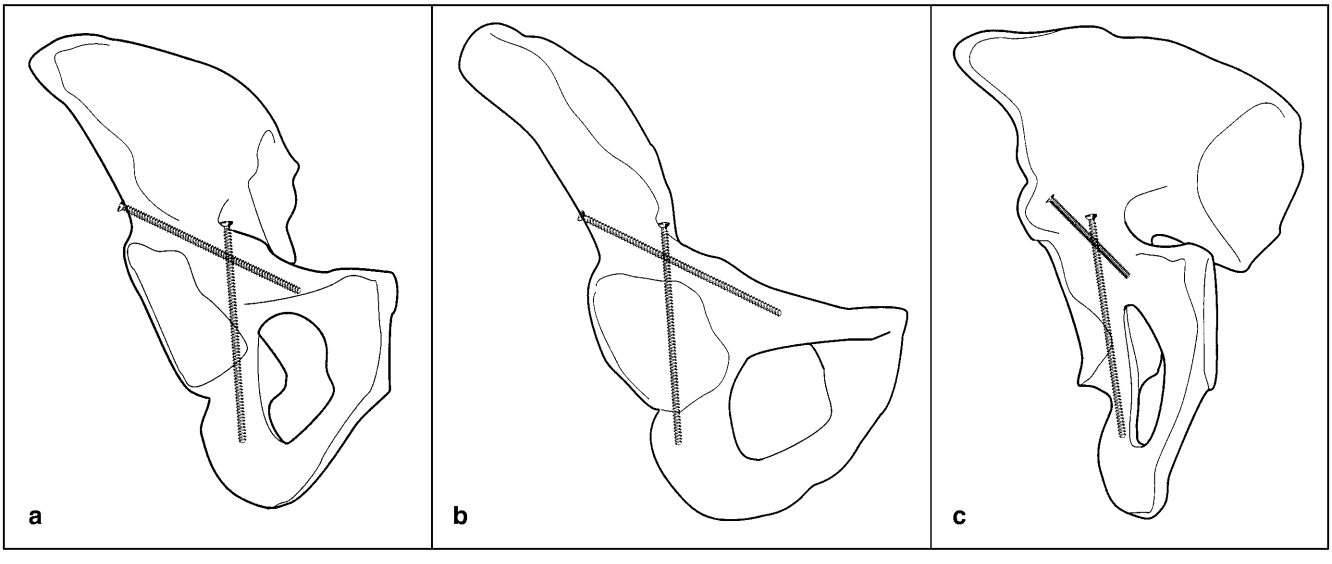

Fig. 1a-c Positioning of the screws into the anterior and posterior column. From the inner surface of the ilium a 3.5 mm screw is passed into the posterior column. Another cortical screw is placed from the outer surface of the ilium into the anterior column. **a** AP, **b** (ala) and **c** obturator views

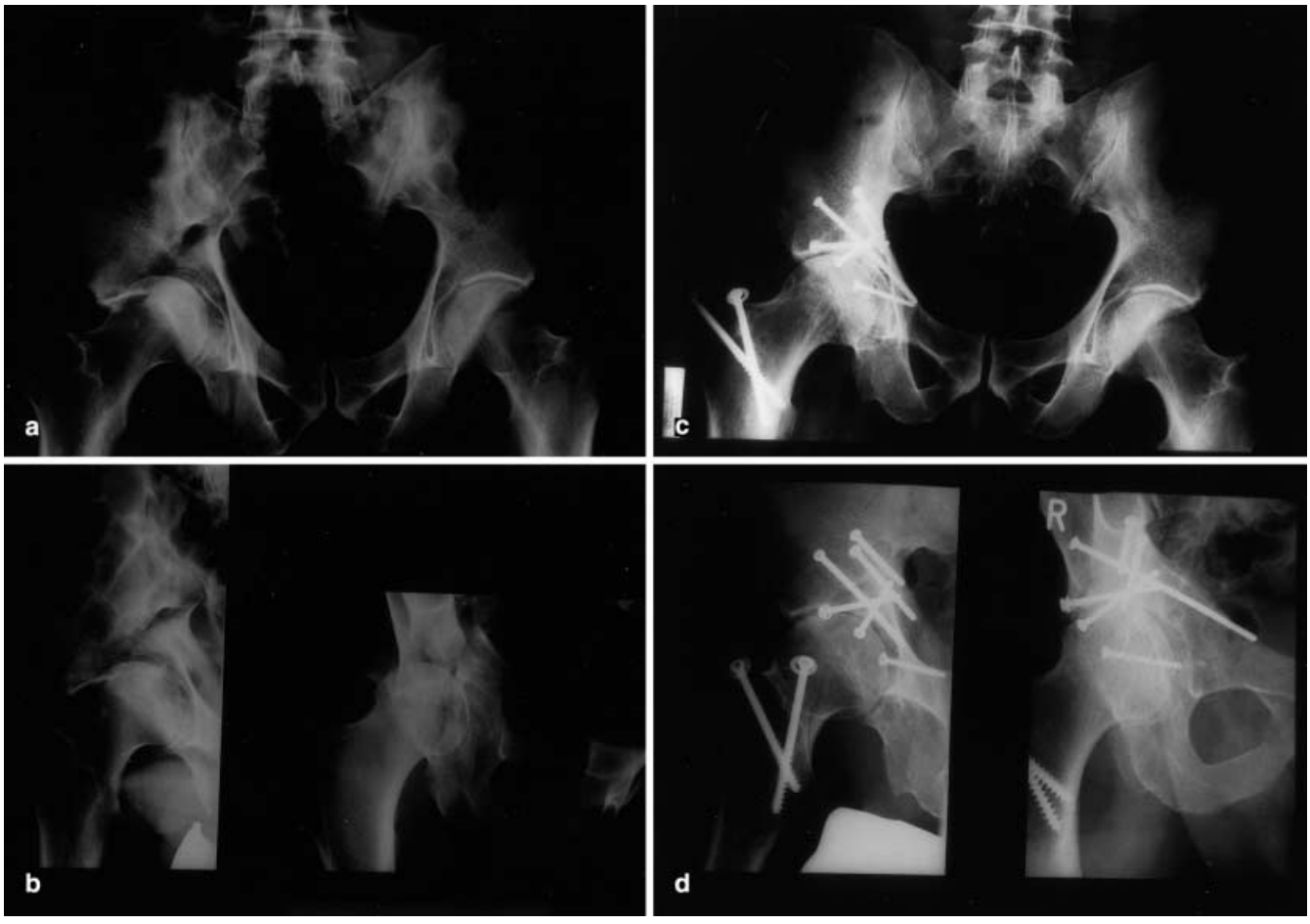

Fig. 2a–d Fifty-five-year-old patient who sustained a T-type acetabular fracture on the right side in a motor vehicle accident. **a** AP pelvis radiograph and **b** the oblique ala and obturator views show the extent of the fracture. **c, d** Thirty months after ORIF through the modified extended iliofemoral approach with 6 cortical screws the follow-up X-rays show anatomic reduction with only minimal arthritic changes

The hip function at follow-up was evaluated according to the Harris hip score [7] and the Merle d'Aubigne score [6].

Results

The mean operating time was 3.6 h (1.5–6); between 2 and 7 screws were used (average 4.4). Anatomical reduction (Table 1) was achieved in 40 of 51 fractures, satisfactory reduction in 9 and unsatisfactory reduction in 2. One unsatisfactory reduction was performed in a patient with a transverse fracture approached through an ilioinguinal incision. Anatomical reduction of the posterior column could not be achieved and a second stage procedure was performed using the Kocher-Langenbeck approach. The second unsatisfactory reduction occurred in a patient with a posterior wall fracture – dislocation in which a separate fragment was missed at the time of reduction.

Seven patients in the group treated with the Maryland approach developed a subcutaneous haematoma requiring repeated aspiration, and in 3 cases the haematoma was evacuated operatively. There were no cases of infection, nor was there clinical evidence of deep venous thrombosis or pulmonary embolism. Implant failure with loss of reduction occurred in 3 patients. All patients underwent a revision procedure using plate and screw fixation.

The incidence of avascular necrosis of the femoral head was 4% (2 of 51). Both patients had sustained posterior fracture – dislocation with a posterior wall fragment.

Forty-four patients with 45 fractures of the acetabulum were available for follow-up at a mean of 24 months (18–44). The radiographic state of the joint was classified according to Heeg et al. [8] and was excellent in 24 cases, good in 15, fair in 2, and poor in 4. Thirty-three of the 36 patients with anatomical reduction had an excellent or good radiological result. Three patients with THR were classified with a poor result.

Three patients developed significant heterotopic ossification (Brooker III, IV) with a limited range of movement of less than full extension and less than 90° of flexion (Table 2). These were all polytrauma patients (ISS>25) with complex pelvic trauma and a closed head injury. Two were treated with the Maryland approach and one with the ilioinguinal approach. Twelve of the 31 patients treated with the Maryland approach developed heterotopic ossification. Five of these were classified as Brooker type III.

Table 1 Quality of reduction by fracture pattern

Fracture pattern	Number of fractures	Screws	Anatomic (≤1 mm)	Satisfactory (2–3 mm)	Unsatisfactory (>3 mm)
Posterior wall	5	3	3	1	1
Anterior column	4	4	3	1	
Transverse	10	3.3	8	1	1
Posterior column, posterior wall	3	4	3		
Transverse, posterior wall	13	4.5	10	3	
T-shaped	2	5.5	2		
Anterior column, posterior hemi-transverse	2	5	2		
Both columns	12	5.3	9	3	
Total	51	4.4	40	9	2

Screws, average number of screws used for osteosynthesis; Anatomic, remaining dislocation ≤1 mm; satisfactory, remaining dislocation 2–3 mm; Unsatisfactory, remaining dislocation >3 mm

Table 2 Heterotopic ossifications at follow-up in respect to approach

Approach	Brooker 0	Brooker I	Brooker II	Brooker III	Brooker III, IV ROM <90/0/0
Maryland (*n*=32)	21	2	5	3	2
Kocher-Langenbeck (*n*=5)	4			1	
Ilioinguinal (*n*=4)	3				1
Ilio + K.-L. (*n*=1)	1				
Total (*n*=42)	28	2	5	4	3

Brooker 0-IV: Classification of heterotopic ossification according to Brooker. Brooker III, IV, ROM <90/0/0: significant heterotopic ossifications with reduced range of motion

At the time of follow-up, 26 patients with 27 fractures had regained a full range of movement of the hip. Fifteen patients were pain free, while 12 had minor and occasional pain. Seven patients complained of slight pain under weight-bearing. Moderate abductor muscle weakness was observed in 2 patients.

There were 26 excellent and 12 good results according to the d'Aubigne [6] and Harris hip scores [7]. Two patients had a fair functional outcome and 5 a poor outcome.

Discussion

In this study the use of screw fixation alone in the treatment of displaced acetabular fractures was evaluated, with particular reference to the quality of reduction and the stability of fixation. Anatomical reduction was achieved in 40 fractures. Two unsatisfactory results were caused by technical failures. In one case, an inappropriate approach was used and anatomical reduction could only be obtained in a second procedure. In the other case a fracture fragment was missed at the time of surgery. Nevertheless, a 4% incidence (2/51) of unsatisfactory reductions is low compared to other studies [8, 9, 11–13, 21–23], and anatomical reduction with screw fixation alone proved to be a satisfactory method of treatment. In this study it is important to consider the high number of extended approaches used. More extensive surgery has been advised in recent years for the treatment of complex acetabular fractures in order to attempt to achieve an anatomical reduction [1, 20]. The extended Maryland approach offers control of the anterior and posterior columns, facilitating reduction and allowing intra-articular comminution to be addressed. The incidence of morbidity which was specifically related to the surgical approach was low, with a 6% incidence of significant heterotopic ossification, 1% postoperative nerve lesions and 1% moderate abductor weakness; this justifies treating complex acetabular fractures through this extended approach [3, 4, 10, 17].

The stability of small fragment screw fixation was also evaluated. Loss of reduction occurred in 3 fractures; 2 of the screw breakages occurred less than 3 months postoperatively and were caused by premature weight-bearing. We recommend at least 3 months' partial weight-bearing for patients whose acetabular fractures are treated with screws alone. In patients with decreased compliance or osteopenic bone an additional buttress plate is recommended.

This group of patients is characterized by a high incidence of multiple injuries. Forty-four patients sustained additional injuries with an average ISS of 20 points. This incidence is higher than in comparable studies [9, 13, 21–23]. In these patients the clinical results of the acetabular fracture are sometimes hard to separate from the overall result. As an example, a radiological and, objectively, clinically excellent result can be impaired by symptoms due to nerve injury as a result of a sacral fracture. On the other hand, a fair radiological result with ectopic ossification (Brooker type III) and a decreased range of movement could give a reasonable result in a

patient with polytrauma. It is difficult to compare the results of an acetabular fracture as an isolated injury and as part of polytrauma. In our series 77% of the patients with anatomical reduction had an excellent result. This is comparable to the results of Letournel (77%); however, in his series only 45% of the patients had additional injuries [13].

With the excellent or good clinical and radiological results achieved in this study at 2 year follow-up, the therapy regimen with screw fixation using 3.5 mm cortical screws in a lag screw technique proved to be an adequate method of achieving anatomical reduction in acetabular fractures with sufficiently large fragments. In complex fractures an extended approach such as the Maryland approach is preferred due to the access achieved to both the anterior and posterior columns. A differentiated rehabilitation program is required with a minimum of 12 weeks' partial weight-bearing. In patients with decreased compliance, osteopenic bone or comminuted fractures an additional reconstruction plate is recommended.

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