

# Comparison of stable and unstable pertrochanteric femur fractures managed with 2- and 4-hole side plates

Robert Peter Baird, BSc (Hons),  
BMBS\*

Peter O'Brien, MD†

David Cruickshank, MD, BSc†

From the \*Royal Adelaide Hospital Department of Orthopaedics and Trauma, Adelaide, Australia, and the †University of British Columbia Department of Orthopaedics, Vancouver, BC

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**Correspondence to:**  
P. O'Brien  
3114-910 West 10th Ave.  
Vancouver BC V5Z 1M9  
Peter.O'Brien@vch.ca

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**Background:** Sliding hip screw (SHS) fixation traditionally involves the use of 4-hole side plates; however, 4-hole plates have disadvantages, including longer surgery and greater postoperative pain, and there is little evidence that they provide increased stability. We compared 2- and 4-hole side plates in stable and unstable pertrochanteric fractures.

**Methods:** We prospectively enrolled consecutive patients with pertrochanteric femoral fractures treated between Jan. 1, 2004, and Apr. 30, 2009, with a 135° SHS using either a 2- or 4-hole side plate, based on surgeon preference.

**Results:** A total of 327 patients were managed with an SHS device (252 women, 75 men). There were 208 stable fracture patterns (AO/OTA 31 A1, A2.1) and 119 unstable (AO/OTA 31 A2.2, A2.3, A3). We managed 172 patients with 2-hole plates and 155 with 4-hole plates. The average duration of surgery (30.44 v. 51.45 min), blood loss (26.0 v. 31.3 g/L) and transfusion requirements (43% v. 31.60% transfusion) were significantly lower with the 2-hole than the 4-hole plate. There was no significant difference in length of stay (19 v. 16 d). With stable fractures there was no significant difference in failure rate (6.3% v. 4.9%). In unstable fractures there was a significantly higher rate of failure using 2-hole side plates (24.4% v. 10.8%).

**Conclusion:** In stable fractures, use of an SHS with a 2-hole side plate results in shorter surgery and less blood loss/transfusion than a 4-hole side plate, with equivalent survival. In unstable fractures, there is a greater than 2-fold rate of failure when a 2-hole side plate is used.

**Contexte :** La vis coulissante pour hanche (SHS) implique habituellement la pose de plaques latérales à 4 perforations; toutefois, ce type de plaque comporte des inconvénients, notamment une durée de chirurgie plus longue et des douleurs postopératoires plus persistantes, et il n'a pas été démontré qu'elle confère plus de stabilité. Nous avons comparé les plaques à 2 et à 4 perforations dans des fractures pertrochantériennes stables et instables.

**Méthodes :** Nous avons inscrit de manière prospective des patients consécutifs ayant de fractures pertrochantériennes du fémur et traités entre le 1er janvier 2004 et le 30 avril 2009 au moyen d'une SHS de 135° et d'une plaque latérale à 2 ou à 4 perforations, selon la préférence du chirurgien.

**Résultats :** En tout, 327 patients ont été traités de la sorte (252 femmes, 75 hommes). Nous comptons 208 fractures stables (AO/OTA 31 A1, A2.1) et 119 fractures instables (AO/OTA 31 A2.2, A2.3, A3). Nous avons traité 172 patients au moyen de plaques à 2 perforations, et 155 au moyen de plaques à 4 perforations. La durée moyenne de la chirurgie (30,44 c. 51,45 min), les pertes sanguines (26,0 c. 31,3 g/L) et les besoins transfusionnels (43 % c. 31,60 % transfusés) ont été significativement moindres avec les plaques à 2 perforations qu'avec les plaques à 4 perforations. On n'a noté aucune différence significative pour ce qui est de la durée du séjour hospitalier (19 c. 16 jours). En ce qui concerne les fractures stables, il n'y a pas eu de différence significative au plan du taux d'échec thérapeutique (6,3 % c. 4,9 %). En ce qui concerne les fractures instables, on a noté un taux significativement plus élevé d'échecs avec les plaques à 2 perforations (24,4 % c. 10,8 %).

**Conclusion :** Dans les fractures stables, l'utilisation d'une SHS et d'une plaque latérale à 2 perforations permet une chirurgie plus brève et cause moins de pertes sanguines et de transfusions que la plaque à 4 perforations, sans différence au plan de la survie. Dans les fractures instables, on observe un taux 2 fois plus élevé d'échecs lorsqu'on utilise une plaque latérale à 2 perforations.

The use of a sliding hip screw (SHS) and plate for the management of pertrochanteric femoral fractures introduced by Clawson in 1964<sup>1</sup> is well established as the gold standard of treatment. There is general consensus in the literature on the need to achieve medial and posterior cortical contact with the fracture reduction to improve physiologic distribution of force and on the positioning of the lag screw within the femoral head.<sup>2,3</sup> Controversy remains, however, on the length of the plate used.

By convention a 4-hole plate has been traditionally used and allows for immediate weight bearing postoperatively. The reported disadvantages of a 4-hole plate, over a shorter side plate, include a longer incision and greater dissection, longer duration of surgery, more blood loss and greater postoperative pain.<sup>4-8</sup> The evidence, however, of any increased stability conferred from the use of a 4-hole plate has been lacking.

In a biomechanical study conducted by Reich and colleagues,<sup>9</sup> the optimal length of side plate was evaluated; they concluded that no more than 4 screws were necessary. Another cadaveric study was performed using a 3-hole side plate, which was found to provide adequate fixation. In that study, however, the specimens were not physiologically loaded, and the lag screw was prevented from telescoping.<sup>10</sup> A comparison was performed by McLoughlin and colleagues<sup>11</sup> between 2- and 4-hole side plates in cadaveric specimens with unstable 3-part fractures. They found that the 2-hole plate was as biomechanically stable as a 4-hole plate under the conditions tested.

Clinical studies using a 2-hole plate have also been published, demonstrating satisfactory outcomes and minimal complications.<sup>4-8</sup> A study by Laohapoonrungeee and colleagues<sup>12</sup> also found satisfactory results using a 2-hole plate with only 2 of 70 cases of side plate failure in unstable fractures. However, more than 80% of the cases resulting in moderate or severe collapse, using the method published by Bendo and colleagues,<sup>13</sup> were in patients with an unstable fracture pattern.

Determining an outcome measure for these clinical studies is difficult, as mechanical failure of SHS is rare and these patients represent a group with multiple medical comorbidities and poor function preinjury. Objectively, however, Steinberg and colleagues<sup>14</sup> found an increased rate of failure with more than 15 mm of telescoping of the lag screw. This excessive sliding has also been shown to be associated with greater postoperative pain.<sup>15-16</sup>

It may be, therefore, that while a 2-hole plate is adequate for fixation of stable 2-part fractures, there may be an increased rate of failure with its use in patients with unstable fracture patterns.

The present study is a review of prospectively collected data for both stable and unstable pertrochanteric fractures treated at our institution with 2- or 4-hole side plates. We hypothesized that there would be a higher rate of failure associated with the use of 2-hole side plates in the management of unstable fractures.

## METHODS

All patients presenting to our level 1 trauma institution have prospective data collected in a database. This database includes demographic information; fracture type; duration of surgery; blood loss; length of stay in hospital; and follow-up data, including complications and reoperation. This study included all patients with stable and unstable pertrochanteric fractures treated between Jan. 1, 2004, and Apr. 30, 2009. Stable fractures were defined as AO/OTA type 31 A1 and A2.1, and unstable fractures were defined as AO/OTA type 31 A2.2, A2.3 and A3.

All surgeries were performed in a single institution by 1 of 5 staff surgeons, all of whom were subspecialty orthopedic trauma surgeons. Resident and fellow trainees were also involved in all cases; however, surgeries were performed under the direct supervision of the senior staff surgeon, who was present in the operating room at all times. All fractures were treated with 135° sliding hip screw (SHS; Synthes USA). The decision to use either a 2- or 4-hole side plate was based on surgeon preference in each case. At the time of the study, the preference was to use minimally invasive surgical techniques, favouring the 2-hole plate. However, there were no common criteria, and the decision was left entirely up to the surgeon. The plates were secured with 4.5 mm cortical screws.

Follow-up was attempted at intervals of 6 weeks until such time as fracture healing was determined both clinically and radiographically.

Failure of management was defined as the need for reoperation, implant failure, failure of fixation and nonunion. Excessive shortening was not used, as we did not have the ability to correlate this with follow-up data.

## RESULTS

We identified a total of 369 cases of pertrochanteric femur fractures treated during the study period. Nineteen patients died and were lost to follow-up, and 23 were excluded as they were not managed with a 2- or 4-hole side plate. There were therefore 320 patients with 327 pertrochanteric femoral fractures available for analysis (252 women, 75 men, mean age 85.5 yr, mean American Society of Anesthesiologists score 3.07; Table 1). There were 208 stable and 119 unstable fractures.

**Table 1. Patient demographics in the 4 treatment arms**

Plate; fracture type	Fractures, no.	Average age, yr	Average ASA
2 hole			
Stable	127	83.6	2.98
Unstable	45	85.1	3.18
4 hole			
Stable	81	87.1	3.08
Unstable	74	86.3	3.03

ASA = American Society of Anesthesiologists score.

The average duration of surgery was 38.44 minutes for procedures using a 2-hole side plate, which was significantly shorter than surgeries performed with a 4-hole plate (average duration 51.45 min,  $p < 0.001$ ).

The average change in hemoglobin pre- to postoperatively for cases involving a 2-hole plate was 26 g/L, with a transfusion rate of 43%. This was significantly less than that in cases using a 4-hole plate, which had an average change in hemoglobin of 31.3 g/L ( $p = 0.004$ ) and a transfusion rate of 60%.

The average length of stay in hospital for patients treated with a 2-hole side plate was 19 days, whereas that for patients treated with a 4-hole plate was 16 days ( $p = 0.10$ ).

There were 3 deep infections, 2 of which occurred in patients initially managed with a 2-hole side plate. One of these infections was successfully treated with irrigation, débridement and temporary antibiotic beads. The other required serial débridements and eventual conversion to a total hip arthroplasty. The third infection occurred in a patient treated with a 4-hole plate who was also managed successfully with irrigation, débridement and temporary antibiotic beads.

Fracture management with a 2-hole side plate failed in 19 of 172 (11%) patients. Seven failures were due to implant failure (plate pull-out and/or screw breakage). Seven were due to a loss of fixation, with lag screw cut-out from the femoral head. There were 3 cases of nonunion and 2 cases of deep infection requiring reoperation.

Fracture management with a 4-hole side-plate failed in 12 of 155 (7.7%) patients. There was 1 case of implant failure. Six cases were due to loss of fixation. Nonunion was diagnosed in 3 patients. There was 1 deep infection and 1 case of intraoperative fracture requiring revision.

The failure rate for stable fractures managed with a 2-hole plate was 8 of 127 (6.3%), and that for unstable fractures was 11 of 45 (24.4%). For stable fractures managed with a 4-hole side plate the failure rate was 4 of 81 (4.9%), and that for unstable fractures was 8 of 74 (10.8%; Table 2). There was no significant difference in failure rate between 2- and 4-hole fixation in patients with a stable

fracture pattern ( $p = 0.68$ ). There was a significantly higher rate of failure in those with unstable fractures when treated with a 2-hole side plate ( $p = 0.048$ ).

## DISCUSSION

Consistent with previous studies, we found that the less invasive procedure of using a 2-hole side plate resulted in reduced duration of surgery, blood loss and need for transfusion compared with the 4-hole plate. There was no difference, however, in the overall length of stay in hospital between the 2 groups. This is likely a reflection of the premorbid function and medical comorbidities of these patients and the resulting difficulties in returning them to their previous level of independence postoperatively.

Overall, there was a relatively low rate of failure using both 2- and 4-hole side plates. This finding is also consistent with the results of published biomechanical and clinical studies.<sup>4-8,11-12</sup> The previously reported clinical series, however, either compared the plates in the management of stable fractures specifically or had small samples of unstable fractures.

When we examined the failure rate allowing for fracture stability, there was a significantly higher rate of failure in patients with an unstable fracture pattern who were treated with a 2-hole side plate. This was in a much larger sample of patients with unstable fractures than previously reported.

The exact reason why 2-hole plates failed when used in patients with unstable fracture patterns is unclear, but it is interesting to note that there were 7 cases of implant failure with a 2-hole plate compared with only 1 implant failure with a 4-hole plate. It has been shown previously that most mechanical failures using SHS implants result in varus at the fracture site, which thereby increases tension at the screw-bone interface of the side plate.<sup>17</sup> A longer plate with more screws may cope better with such forces.

Stable 2-part fracture patterns have minimal varus load with full weight bearing when adequately reduced. This is not the case, however, with comminuted unstable fractures that have lost their medial support, resulting in greater varus stress.<sup>5</sup> These cases therefore have greater reliance on the fixation of the side plate to compensate for these increased forces.

## CONCLUSION

We believe, based on our experience, that stable intertrochanteric fractures (AO/OTA 31A1 and A2.1) should be stabilized with a 2-hole side plate SHS because of shorter duration of surgery and less need for blood transfusion. For unstable patterns (AO/OTA A2.2, A2.3, A3), however, a 4-hole side plate is necessary to reduce the risk of mechanical failure.

**Competing interests:** P.J. O'Brien has received speaker fees from Zimmer, and his department receives academic funding from Depuy/Synthes. No other competing interests declared.

**Table 2. Comparison of failure rates in patients with stable and unstable pertrochanteric fractures using 2- and 4-hole side plates**

Plate; fracture type	Group; no. (%)		
	Failure	Fracture healed	Total
2 hole			
Stable	8 (6.3)	119 (93.7)	127
Unstable	11 (24.4)	34 (75.6)	45
4 hole			
Stable	4 (4.9)	77 (95.1)	81
Unstable	8 (10.8)	66 (89.2)	74

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