The lateral radiograph is useful in predicting shortening in 31A2 pertrochanteric hip fractures

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Accepted for publication
Aug. 28, 2012

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DOI: 10.1503/cjs.007412

Background: We sought to determine if angulation or translation measured on the lateral preoperative injury radiographs of patients with 31A2 pertrochanteric fractures is related to excessive postoperative shortening when treated with a sliding hip screw.

Methods: We retrospectively reviewed the radiographs of consecutive patients with hip fractures treated at a level I university trauma centre between 2003 and 2008. Patients with 31A2 pertrochanteric fractures treated with a sliding hip screw were identified through a search of medical records. The study variables were angulation and translation on the preoperative injury lateral radiograph. The outcome measure was radiographic evidence of fracture shortening, measured as the change in length of sliding hip screw visible outside the barrel between the time of fixation and final follow up.

Results: Of the 131 patients treated, 23 met our inclusion criteria and had sufficient follow-up (mean 6.4 mo). The average shortening for 31A2 fractures with angulation on the injury lateral radiograph was 1.83 (95% confidence interval [CI] 1.18–2.47) cm, compared with 0.93 (95% CI 0.49–1.36) cm for fractures with no angulation ($p = 0.019$). There was no statistical difference in quality of reduction, tip–apex distance, Orthopedic Trauma Association (AO/OTA) classification or incidence of lateral wall fracture across groups based on the presence of angulation.

Conclusion: Angulation on the lateral preoperative injury radiograph may be useful in predicting excessive shortening in 31A2 pertrochanteric fractures. Further investigation is warranted to confirm this result and to identify the role of other predictors, such as fracture comminution.

Contexte : Nous avons cherché à déterminer si la déviation ou la translation mesurée dans les radiographies latérales d'une blessure préopératoire chez les patients victimes d'une fracture pertrochantérienne 31A2 est liée au raccourcissement postopératoire excessif lorsqu'ils sont traités avec une vis coulissante pour la hanche.

Méthodes : Nous avons procédé à une analyse rétrospective des radiographies de patients consécutifs victimes d'une fracture de la hanche qui ont été traités à un centre de traumatologie universitaire de niveau I entre 2003 et 2008. Les patients victimes d'une fracture pertrochantérienne 31A2 traitée au moyen d'une vis coulissante pour la hanche ont été identifiés par une recherche effectuée dans les dossiers médicaux. La déviation et la translation dans la radiographie latérale préopératoire de la blessure ont constitué les variables de l'étude. Les données radiographiques sur le raccourcissement de la fracture mesuré par le changement de longueur de la vis coulissante visible en dehors du corps du fémur entre le moment de la fixation et celui du suivi final ont constitué la mesure de résultat.

Résultats : Sur les 131 patients traités, 23 satisfaisaient à nos critères d'inclusion et avaient fait l'objet d'un suivi suffisant (moyenne de 6,4 mois). Le raccourcissement moyen dans le cas des fractures 31A2 avec déviation révélée par la radiographie latérale de la blessure s'est établi à 1,83 (intervalle de confiance [IC] à 95 % 1,18–2,47) cm, comparativement à 0,93 (IC à 95 % 0,49–1,36) cm dans le cas des fractures sans déviation ($p = 0,019$). Il n'y avait pas de différence statistique entre les groupes aux niveaux de la qualité de la réduction, de la distance entre l'extrémité et le sommet, de la classification de l'Association de traumatologie orthopédique (AO/ATO) ou de l'incidence de la fracture de la paroi latérale compte tenu de la présence d'une déviation.

Conclusion : La déviation révélée par la radiographie préopératoire latérale de la blessure peut aider à prédire un raccourcissement excessif dans les cas de fractures pertrochantériennes 31A2. Une recherche plus poussée s'impose pour confirmer ce résultat et déterminer le rôle d'autres prédicteurs, comme la comminution de la fracture.

There was a recent call for "a change in the status quo in the management of pertrochanteric hip fractures"[1] owing to poor functional outcomes[2] and high reoperation rates with current management.[3] Specifically, there was a call for research into the prevention of malunion secondary to shortening and shaft medialization. The Orthopaedic Trauma Association (AO/OTA) 31A2 pertrochanteric fracture group[4] is at risk for such malunion. The lateral wall in this group is at higher risk for fracture when treated with a sliding hip screw (SHS; 29.8% in the 31A2 group v. 7% in the 31A1 group), which leads to excessive shortening.[5] This group is also characterized by variable amounts of comminution along the intertrochanteric line,[4,6] which can lead to shortening despite an intact lateral wall.[3,7–10] Up to 2.5 cm of shortening has been described in these fractures,[3,10] while as little as 1.3 cm[11] and 1.7 cm[9] has been associated with reduced patient mobility[11] and poor functional results.[9] The AO/OTA classification accounts for comminution; however, inter-observer agreement within the 31A2 group is "poor"[12–14] by the Landis and Koch criteria,[15] and "moderate" with the use of a simplified classification.[6] Markers predictive of shortening, in addition to lateral wall integrity and quantity of comminution, would therefore be useful.

The senior author's (T.T.) observations have led to the hypothesis that angulation or translation on a routine lateral radiograph is predictive of difficulty with fracture reduction. This fracture characteristic may also be predictive of malunion in 31A2 fractures, specifically of shortening. Current classification systems do not consider the lateral radiograph and may be omitting important and readily available information.[4,6] The purpose of this paper is to establish whether the presence of angulation or translation on a cross-table lateral injury film predicts greater shortening in 31A2 hip fractures treated with a sliding hip screw.

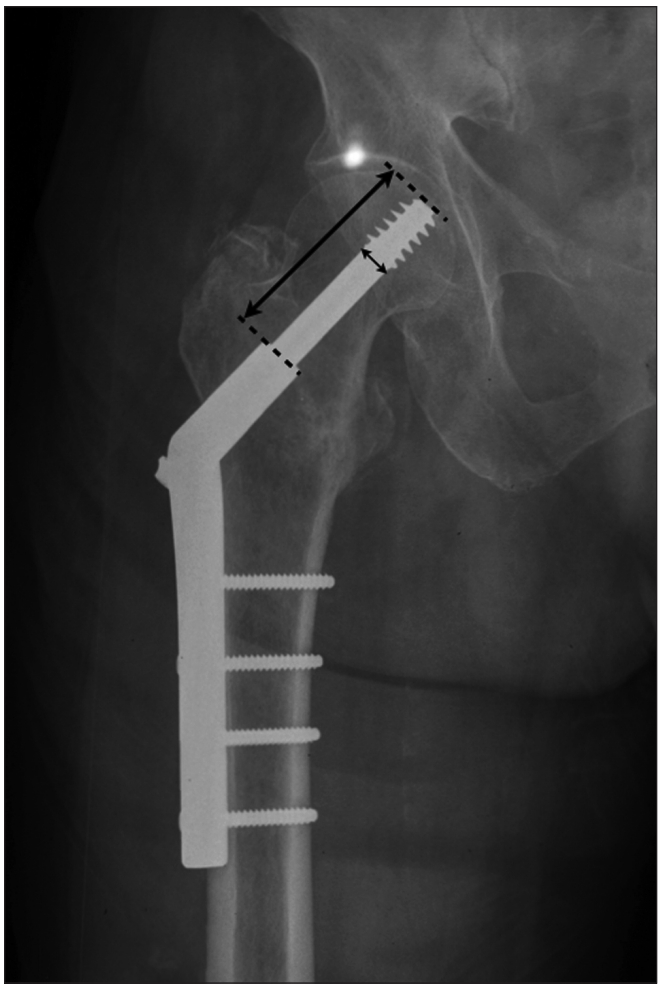

Fig. 1. The sliding hip screw allows shortening of the fracture along the lag screw, which can be quantified by measuring the portion of lag screw visible outside the barrel on anteroposterior films.

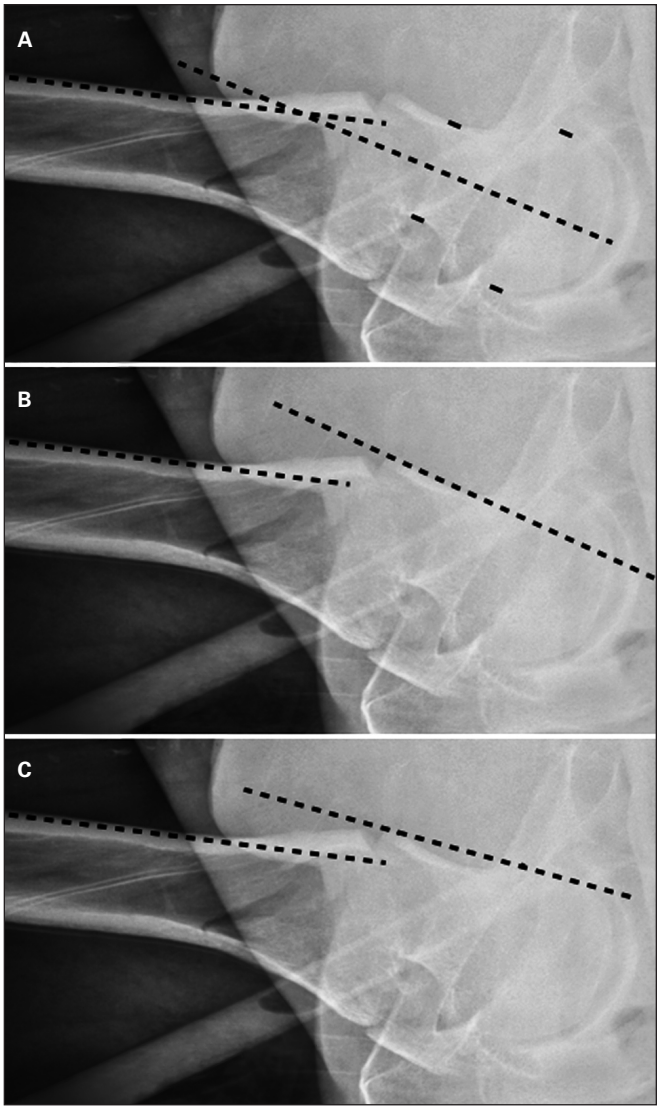

Fig. 2. The femoral neck axis drawn to show (**A**) the neck bisector angle, (**B**) the anterior cortex angle or (**C**) the 2-point angle.

Methods

We conducted a retrospective review of medical records and radiographs with approval from the University of Manitoba ethics board. A search was conducted through the medical records department for patients with a diagnosis of "hip fracture" or "intertrochanteric fracture." Films were available dating back to 2003; films predating 2003 were destroyed as per institution policy. Exclusion criteria consisted of use of a non-SHS implant (intramedullary nail or arthroplasty), lack of injury or operative radiographs, lack of a cross-table lateral injury radiographs, lack of follow-up radiographs, insufficient follow-up, nonpertrochanteric fractures, 31A1 pertrochanteric fractures and 31A3 pertrochanteric fractures.

Shortening was the primary outcome. The SHS allows shortening of the fracture along the lag screw, which can be quantified by measuring the portion of lag screw visible outside the barrel on anteroposterior films. The diameter of the lag screw is known to be 9 mm and provided scale[16] (Fig. 1). This was a variation on the method described by Doppelt.[8] We used intraoperative films with the limb in traction as a point of reference for subsequent shortening; we assumed that at this time the anatomy was restored. Shortening of 1.3 cm has been linked to gait and functional difficulties in patients with pertrochanteric fractures,[11] and was considered a primary outcome in this study.

The first study variable we assessed was angulation between the shaft and neck of the femur on the injury cross-table lateral radiograph. A clear method for this measurement was not identified in the literature. Furthermore, the quality of lateral hip radiographs is generally poor owing to osteopenia and superposition of the contralateral hip. For these reasons, we explored 3 methods and chose the one based on the radiographic landmarks most commonly visible. The shaft axis was always drawn along the anterior cortex of the femur. The neck axis was drawn either along the bisector of the femoral neck and head (neck bisector angle; Fig. 2A), the anterior cortex of the neck (anterior cortex angle; Fig. 2B) or the line joining a point on the anterior cortex near the fracture distally and a second point where the anterior cortex narrows proximally (2-point angle; Fig. 2C). Both authors used all 3 methods, and the one found to be most consistent was applied in the study.

The second study variable was translation on the cross-table lateral injury film. This was measured as a percentage of the femur diameter immediately distal to the fracture site (Fig. 3).

We categorized cases based on the absence or presence of angulation and of translation on the cross-table lateral injury radiograph. We compared shortening across groups with a *t* test and calculated 95% confidence intervals (CIs).

The quality of reduction and the tip–apex distance (TAD) have been linked to outcome.[17,18] Similarly, the presence of a lateral wall fracture is associated with higher rates of failure in the 31A2 group of pertrochanteric fractures when treated with the SHS.[5] The AO/OTA classification takes into account fracture comminution, which may also affect shortening.[4,6] We compared these confounding variables across study groups with a *t* test for continuous data (TAD) and the Kruskal–Wallis test for categorical data

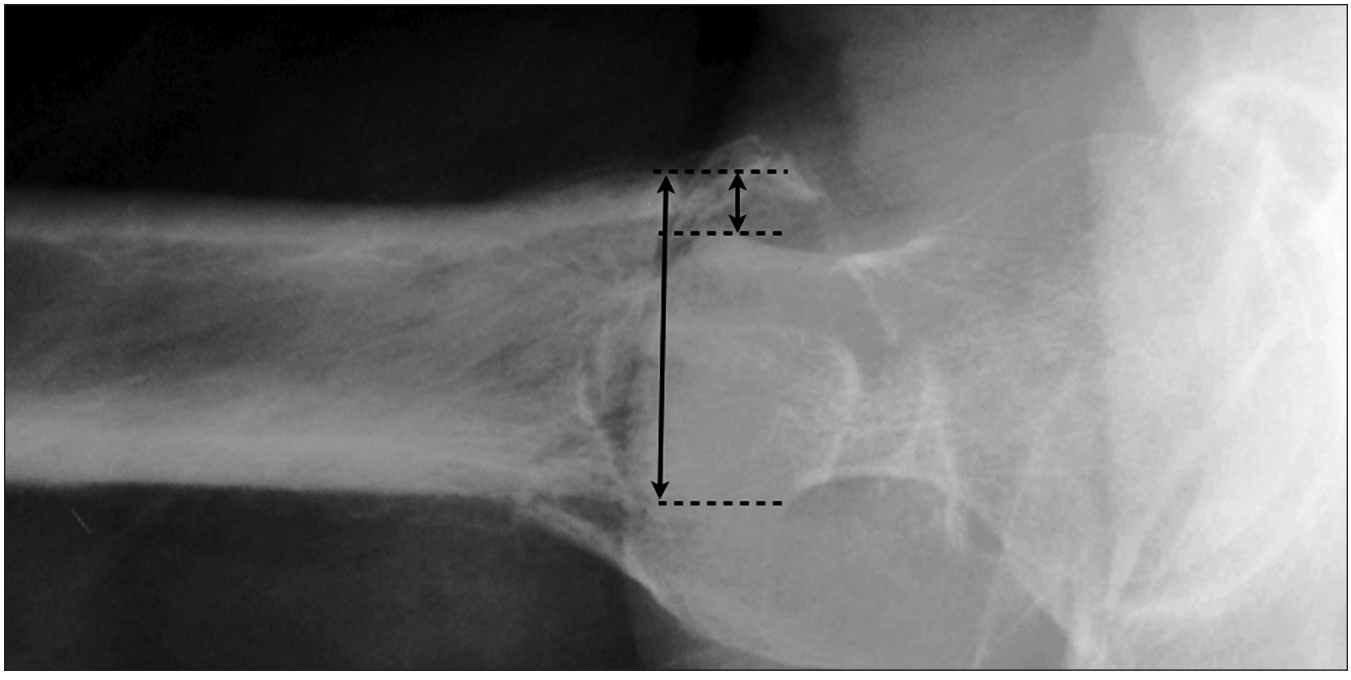

Fig. 3. Translation on the cross-table lateral injury film was measured as a percentage of the femur diameter immediately distal to the fracture site.

(quality of reduction, presence of a lateral wall fracture and AO/OTA classification).

Results

Radiographs were available for 131 patients. One of us (T.T.) reviewed the cases and excluded those deemed not to be part of the 31A2 group. Patients treated with an intramedullary nail and those lacking injury films, a cross-table lateral film, intraoperative films in traction and sufficient follow-up films were also excluded (Table 1). A total of 23 patients met our inclusion criteria and had sufficient follow-up (mean 6.4 mo). A total of 13% of patients had 31A2.1 fractures, 65% had 31A2.2 fractures and 22% had 31A2.3 fractures. Overall, 74% of reductions were good and 26% were adequate; no reductions were classified as poor.[17,18] The TAD was greater than 2.5 cm in 39% of patients. Three patients had lateral wall fractures. There were 2 cases of screw cutout, which were both associated with a TAD greater than 2.5 cm, and 1 unrecognized lateral wall fracture. There was 1 case of the plate pulling away from the femoral shaft, which was attributed to an unrecognized lateral wall fracture.

Both of us independently and successfully applied the neck bisector method of measuring angulation on the lateral radiograph in 95% of cases. The anterior cortex and 2-point angle methods resulted in successful measurements in only 89% and 88% of cases, respectively; therefore, we chose the neck bisector method to measure angulation on the lateral film.

Fracture shortening was greater in the group with angulation on the cross-table lateral injury radiograph than in the group with no angulation ($p = 0.019$). Translation was not associated with a difference in fracture shortening ($p = 0.19$). The mean shortening in 31A2 pertrochanteric fractures without angulation was 0.93 (95% CI 0.49–1.36) cm, and in those with angulation it was 1.83 (95% CI 1.18–2.47) cm.

There was no statistical difference in quality of reduction ($p = 0.90$), TAD ($p = 0.53$), AO/OTA classification ($p = 0.17$) or incidence of lateral wall fractures ($p = 0.60$) across angulation groups (Table 2).

Table 1. Exclusions from the study

Exclusion	No.
IM nail/arthroplasty	13
No injury and/or operative radiographs	51
No cross-table lateral injury radiograph	6
No follow-up radiographs	4
Insufficient follow-up	19
Nonpertrochanteric fracture	5
31A1 fracture	8
31A3 fracture	2

IM = intramedullary.

Discussion

Based on the results of this study, angulation observed on the lateral injury radiograph may be predictive of excessive collapse of 31A2 fractures treated with the SHS. That is, if any angulation is noted on the cross-table lateral injury radiograph, one may expect an average of 1.83 cm of fracture collapse with the use of the SHS, with most cases displaying collapse of 1.18 cm or more. However, if no angulation is observed on the lateral injury radiograph, one may expect shortening of only 0.93 cm, with most cases displaying less than 1.36 cm of shortening. Since shortening of 1.3 cm has been associated with gait and functional difficulties in pertrochanteric fractures,[11] the amount of shortening observed in fractures with angulation on the lateral injury radiograph should be avoided.

The use of intramedullary devices has been proposed for more unstable fracture patterns where excessive shortening is anticipated, and may offer a means to limit shortening in fractures with lateral angulation. Hardy and colleagues[3] found an average shortening of 2.2 cm with the

Table 2. Comparison of quality of reduction, tip–apex distance, AO/OTA classification and presence of lateral wall fracture across the "no angulation" and "angulation" groups

	Group, %*		
Factor	No angulation, $n = 11$	Angulation, $n = 12$	p value
Quality of reduction			0.90†
Good	72.7	75	
Acceptable	27.3	25	
Tip–apex distance, cm	2.24	2.50	0.53
AO/OTA classification			0.17†
31A2.1	18.2	8.3	
31A2.2	72.7	58.3	
31A2.3	9.1	33.3	
Lateral wall fracture present	9.1	16.7	0.60†

AO/OTA = Orthopedic Trauma Association.
*Unless otherwise indicated.
†Kruskal–Wallis test.

use of the SHS and an average of only 1.1 cm with the use of an intramedullary nail. The same study found improved short-term function and superior long-term walking ability with the use of an intramedullary nail. These results could not be reproduced by other studies, including a recent report from 2010[18] and a number of papers included in a 2010 update of the Cochrane review.[19] This may be because of inconsistent methods in measuring clinical outcomes and shortening.

Limitations

While our study suggests that alignment on the lateral radiograph may be an important consideration for future research, it is important to acknowledge that our sample size was small despite the inclusion of patients treated over a 5-year period. There is a high attrition rate for hip fracture follow-up, which presents a major setback to retrospective studies such as ours. This is further complicated by the small number of hip fractures treated at our hospital, a tertiary care trauma centre, in comparison to hospitals with a smaller burden of high-energy trauma. Finally, the confusion as to the best implant for 31A2 fracture treatment seems to have led surgeons to err on what they believe to be the side of caution by choosing an intramedullary nail, which was an exclusion criterion for this study.

Conclusion

Taken together, the literature and our study results call for further investigation on the effectiveness of the lateral radiograph in predicting shortening in 31A2 hip fractures and on the role of other predictors, such as lateral wall fracture and comminution.

Competing interests: None declared.

Contributors: T. Tufescu designed the study, acquired and analyzed the data and wrote the article. B. Sharkey acquired and analyzed the data. Both authors reviewed the article and approved the final version for publication.

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