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Analysis of trochanteric fractures with a detached greater trochanter

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Abstract

Objectives: Trochanteric fractures with a detached greater trochanter are often encountered during routine medical examinations. We analyzed cases of stable reconstruction following surgery for these fractures.

Methods: Forty-two patients who sustained a trochanteric fracture with a detached greater trochanter from 2015 to 2016 were clinically and radiographically reviewed. Fracture fixation was performed with 135° free-sliding plates. On postoperative day 14, the patients were classified into two groups based on their computed tomography findings: those in whom a lag screw could be inserted in the anterolateral part that continues to the diaphysis and those in whom the screw could not be inserted in this position. Outcome measures included the quality of reduction (postoperative neck–shaft angle on the lateral view, postoperative ratio of subtype A or subtype N according to Ikuta's classification), postoperative placement of the tip of the lag screw in the femoral head on the lateral view, and sliding distance of the lag screw on postoperative day 14.

Results: The mean neck–shaft angle on the lateral view and the mean sliding distance of the lag screw were significantly shorter in the group in which the lag screw could be inserted in the anterolateral part that continues to the diaphysis.

Conclusions: For trochanteric fractures with a detached greater trochanter, insertion of the lag screw in the anterolateral part that continues to the diaphysis is important and can achieve stable reconstruction. Moreover, caution should be employed with respect to the neck–shaft angle on the lateral view.

Keywords: Trochanteric fracture, Sliding hip screw, Greater trochanter, Posterolateral support, Neck–shaft angle

Introduction

Trochanteric fractures with a detached greater trochanter (Jensen's type III and V) require attention following surgical treatment.[1] These fractures do not have posterolateral support and are defined as unstable fractures. In these fractures, it is often considered that excessive sliding of the lag screws occurs postoperatively when conventional sliding hip screws are employed.[2] Because of the fragility of the lateral wall, use of a trochanteric stabilizing plate with a dynamic hip screw is recommended for stable reconstruction.[3,4]

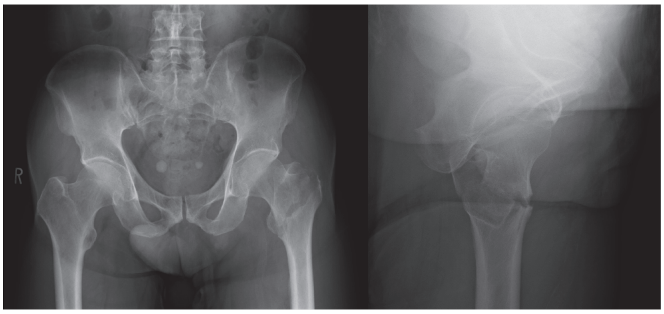
We hypothesized that the stable reconstruction of these fractures when treated with conventional sliding hip screws is achieved by support of the proximal fragment (femoral head and neck) using the anterolateral part that continues to the diaphysis, thereby decreasing the sliding distance.

The purpose of the present study was to verify this hypothesis and to investigate the parameters that influence the support of the proximal fragment using the anterolateral part that continues to the diaphysis. We analyzed age, sex, and other parameters that influence stable reconstruction, such as the type of fracture, quality of reduction, placement of the tip of the lag screw, and sliding distance of the lag screw.

Methods

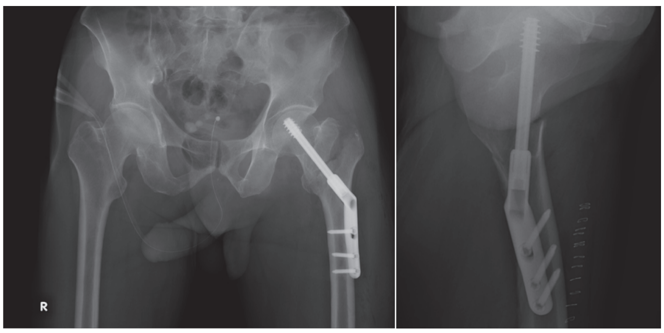
The study was approved by the ethics committee of Fujita Health University. Forty-two patients who sustained trochanteric fractures with a detached greater trochanter from 2015 to 2016 were clinically and radiographically reviewed (Figure 1). Fracture fixation was performed with 135° free-sliding plates (Figure 2). The patients included 10 males and 32 females, with

Figure 1.



Trochanteric fracture with a detached greater trochanter. The left-hand diagram indicates the anteroposterior view. The right-hand diagram indicates the lateral view.

Figure 2.



Free-sliding plate (135°). The left-hand diagram indicates the anteroposterior view. The right-hand diagram indicates the lateral view.

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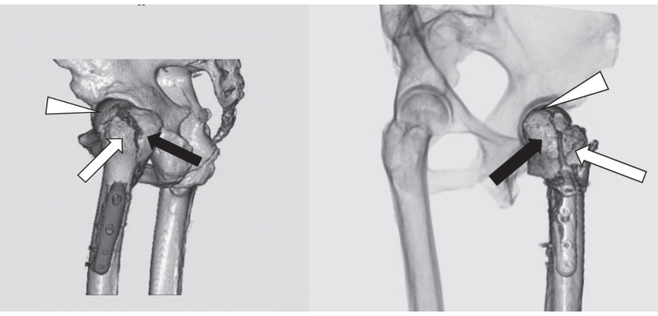
a mean age at the time of surgery of 83.0 years (range, 41–99 years). Surgery was performed under C-arm fluoroscopy on a standard traction table with the patient in the supine position. Routine closed-reduction maneuvers, including abduction, traction, and internal rotation, were performed to achieve fracture alignment, which was confirmed by fluoroscopy.

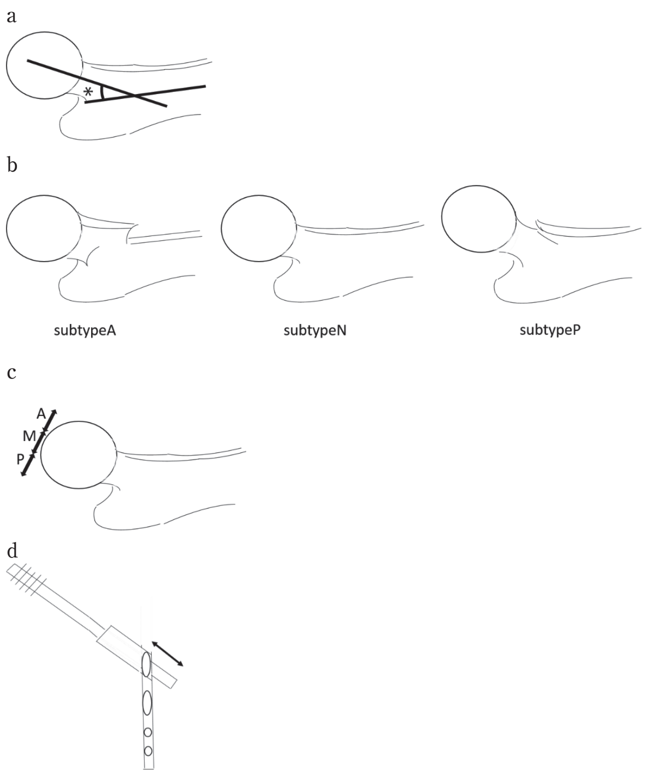
The patients were divided into two groups on postoperative day 14 based on their computed tomography findings: Group A comprised patients in whom a lag screw was inserted in the anterolateral part that continues to the diaphysis, and Group B comprised those in whom the screw was inserted in the posterolateral or fractured part (Figure 3). The following outcome measures were compared between Groups A and B: the quality of reduction, placement of the tip of the lag screw, and sliding distance of the lag screw. The quality of reduction included the mean neck–shaft angle on the postoperative X-ray (lateral view) (Figure 4a) and the ratio of subtype A (anterior femoral neck cortex anterior to the distal fragment) or subtype N (anterior femoral neck cortex continuous with the distal fragment) according to Ikuta's classification on the postoperative X-ray (lateral view) (Figure 4b).[5] The femoral head was divided into the anterior, middle, and posterior areas (A, M, and P, respectively) according to the placement of the tip of the lag screw on the postoperative X-ray (lateral view); the ratio of the middle area of the tip of the lag screw was measured (Figure 4c). The screw outside the barrel length was used to measure the sliding distance of the lag screw using the anteroposterior view on postoperative day 14 (Figure 4d).

Figure 3.



Three-dimensional computed tomography of the hip joint. The solid white arrow indicates the anterolateral part that continues to the diaphysis, the black arrow indicates the posterolateral part (detached greater trochanter), and the arrowhead indicates the proximal fragment. In the left-hand diagram, the lag screw is inserted in the anterolateral part that continues to the diaphysis. In the right-hand diagram, the lag screw is inserted in the fractured part.

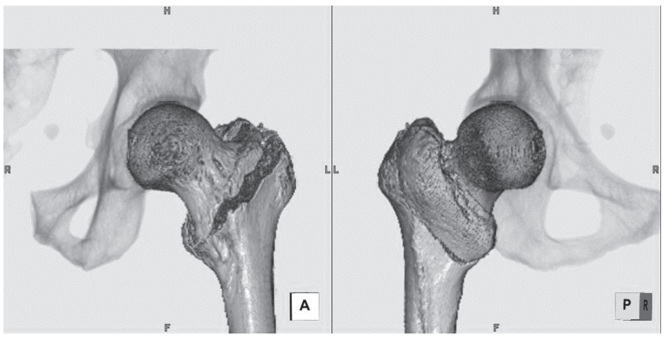
Figure 4.



a Mean neck–shaft angle in the lateral view (*).
b Ikuta's classification.[5] Subtype A: Anterior femoral neck cortex anterior to the distal fragment. Subtype N: Anterior femoral neck cortex continuous with the distal fragment. Subtype P: Anterior femoral neck cortex posterior to the distal fragment.
c Position of the tip of the lag screw in the femoral head, lateral view. A: Anterior area. M: Middle area. P: Posterior area.
d Method used to measure the sliding distance of the lag screw on anteroposterior radiographs. The two-directional arrow indicates the sliding distance of the lag screw.

Each fracture was preoperatively determined as one of four fracture types based on a report by Nakano[6]: Type I, 3-part A; Type I, 3-part B; Type I, 3-part C; and Type I, 4-part. Twenty-three patients had Type I, 3-part A fractures; eight had Type I, 3-part B; two had Type I, 3-part C; and nine had Type I, 4-part. The ratio of Nakano's Type I, 3-part B fractures was evaluated (Figure 5).

Figure 5.



Three-dimensional computed tomography of the hip joint. The left-hand diagram indicates Nakano's Type I, 3-part B fracture (three-fragment fracture with a detached fragment of both the greater and lesser trochanter) from the anterior surface. The right-hand diagram indicates the same from the posterior surface.

The inferential analysis comprised the nonparametric Mann–Whitney U test to compare age, the mean neck–shaft angle, and the mean sliding distance of the lag screw between Groups A and B. A nonparametric method was used because the variables did not present normal distribution, given that the hypothesis of normality was rejected by the Kolmogorov–Smirnov test. Fisher's exact probability test was used to compare sex, the ratio of Nakano's Type I, 3-part B fracture, the ratio of subtype A or subtype N according to Ikuta's classification, and the ratio of the placement of the screw tip in the middle area between Groups A and B. The criterion used to determine statistical significance was a level of 5% in all assessments.

Results

Twenty-eight patients were assigned to Group A and 14 to Group B. The data from the two groups are summarized in Table 1. No significant difference was noted in the ratio of subtype A or subtype N according to Ikuta's classification ($P = 0.729$) or in the ratio of the placement of the tip of the lag screw in the middle area ($P = 1.000$) between Groups A and B. The mean neck–shaft angle in Group A was 18.3° and that in Group B was 25.0° (average difference of 6.7° on our scale, which was significant; $P = 0.049$). Similarly, a significant difference was noted in the mean sliding distance of the lag screw between the two groups. The mean sliding distance of the lag screw in Group A was 1.6 mm, and that in Group B was 8.1 mm (average difference of 6.5 mm on our scale; $P = 0.031$).

The ratio of Nakano's Type I, 3-part B fracture was lower by 14.3% in Group A than in Group B. However, this difference did not reach statistical significance between the two groups because deflection was observed in the number of each type of fracture on our scale.

Table 1. Clinical and radiological findings of Groups A and B

	Group A (n = 28)	Group B (n =14)	P values
Age (years)	81.1 (84.5*)	86.6 (89.0*)	0.401
Sex (male/female)	8/20	2/12	0.451
Fracture type			
Type Ⅰ, 3-part B	4 (14.3 %)	4 (28.6 %)	0.406
Type Ⅰ, 3-part A	19 (67.9 %)	4 (28.6 %)	
Type Ⅰ, 3-part C	0 (0 %)	2 (14.2 %)	
Type Ⅰ, 4-part	5 (17.9 %)	4 (28.6 %)	
SubtypeA or N	20 (71.4 %)	9 (64.3 %)	0.729
Neck—shaft angle on lateral view (degree)	18.3 (19.4*)	25.0 (28.0*)	0.049
Placement of tip of lag screw			
middle area on lateral view	25 (89.3 %)	12 (85.7 %)	1.000
anterior area on lateral view	1 (3.6 %)	1 (7.1 %)	
posterior area on lateral view	2 (7.1 %)	1 (7.1 %)	
Sliding distance of lag screw (mm)	1.6 (0.0*)	8.1 (7.6*)	0.031

*Median

Discussion

Ineffective bone-on-bone impaction may lead to excessive sliding of the lag screw. Given that the posterior or posterolateral cortex is comminuted, especially in Jensen's type III and V fractures, the impaction can collapse the fracture site and lead to excessive sliding.[7,8] To decrease the sliding distance in trochanteric fractures with a detached greater trochanter, it is important to achieve anterior femoral neck cortex support (subtype A or subtype N according to Ikuta's classification).[8] In addition, using a trochanteric stabilizing plate with a dynamic hip screw is recommended to achieve stable reconstruction of the lateral wall.[4] One report recommends intramedullary nails for these fractures.[2] However, when a short femoral nail is employed, the nail is more likely to be inserted in the fractured part.[9]

Hanakawa and Satou[10] highlighted that insertion of the lag screw in the anterolateral part that continues to the diaphysis decreases the sliding distance. Although no significant difference was noted in the ratio of subtype A or subtype N according to Ikuta's classification between the two groups in our data, the mean sliding distance of the lag screw in Group A was significantly shorter than that in Group B, reinforcing the theory proposed by Hanakawa and Satou.[10]

It is a common practice to insert the lag screw parallel to the transcervical axis and place the tip of the lag screw in the middle of the femoral head.[11-13] In conformance with this principle, we examined the insertion position of the tip of the lag screw on horizontal tomographic images to support the proximal fragment using the diaphysis. Considering that the femoral neck forms an anteversion angle with the diaphysis, the lag screw should be inserted in the posterolateral part[14] (Figure 6a). For trochanteric fractures with a detached greater trochanter, the neck–shaft angle on the preoperative lateral view is often seen to increase under the influence of backward displacement of the posterolateral part (including the great trochanter) by gravity on a standard traction table with the patient in the supine position. When the lag screw is inserted in the posterolateral part for treatment of these fractures, the lag screw has the potential to be inserted in the part that does not continue to the diaphysis. In addition, under the influence of an excessive neck–shaft angle on the lateral view, there is a risk of posterior femoral neck cortex damage (Figure 6b). Meanwhile, when the lag screw is inserted in the anterolateral part that continues to the diaphysis, there is a risk of damage to the cortex of the anterior femoral neck (Figure 6c). Therefore, reducing the neck–shaft angle on the lateral view is important to support the proximal fragment using the anterolateral part that continues to the diaphysis. In the present study, this was evidenced by the fact that the neck–shaft angle on the postoperative X-ray (lateral view) in Group A was significantly shorter than that in Group B. Therefore, reduction should be performed with upward displacement of the posterolateral part, including the greater trochanter (Figure 6d).

Figure 6.

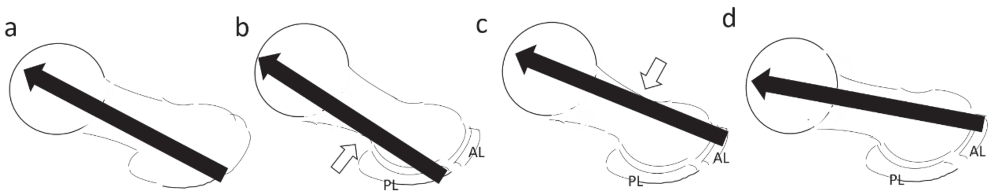


Diagram indicating the insertion position of the lag screw on a horizontal tomographic image. Black arrow indicates the direction of the lag screw.
a Trochanteric fracture with posterolateral (PL) support. The lag screw is inserted in the PL part.
b Trochanteric fracture without PL support. The lag screw is not inserted in the anterolateral (AL) part that continues to the diaphysis but is inserted in the PL part. The posterior femoral neck cortex is damaged by the lag screw (solid white arrow).
c Trochanteric fracture without PL support. The lag screw is inserted in the AL part that continues to the diaphysis. The anterior femoral neck cortex is damaged by the lag screw (solid white arrow).
d The lag screw is inserted in the AL part that continues to the diaphysis.

Nakano's Type I, 3-part B fracture and Type I, 4-part fracture are reportedly unstable.[15] Ochi et al.[16] found that the mean sliding distance of the lag screw in Nakano's Type I, 3-part B fracture and Type I, 4-part fracture was longer than that of the screw in other fractures. We hypothesized that attention is paid to the weight of the posterolateral part, including the greater trochanter, considering that the posterolateral part is preoperatively displaced backward by gravity and that there is an excessive neck–shaft angle on the lateral view. Because Nakano's Type I, 3-part B fracture is accompanied by the detached fragment with both the greater and lesser trochanter, the posterolateral part in this type of fracture is more likely to become heavy and displaced backward than with other types of fractures. Therefore, in this type of fracture, it may be difficult to reduce the posterolateral part, including the greater trochanter, and to decrease the neck–shaft angle on the lateral view. Although a significant difference was not noted between the two groups in the present study, the ratio of Nakano's Type I, 3-part B fracture in Group A was lower than that in Group B. We have too little experience to judge this hypothesis; however, the present study may support this.

In summary, for trochanteric fractures with a detached greater trochanter, insertion of the lag screws in the anterolateral part that continues to the diaphysis is important and can help to achieve stable reconstruction. Moreover, caution should be employed with respect to the neck–shaft angle on the lateral view, especially in Nakano's Type I, 3-part B fracture.

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Conflicts of interest

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

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