

Intramedullary Nailing of Intertrochanteric Fractures - Minimal Invasive Techniques for Reduction

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Abstract

Background: An intramedullary nail has become the implant of choice for intertrochanteric fractures. This paper introduced some minimal invasive techniques were used to improve quality of intertrochanteric fracture reduction.

Methods: Of 119 intertrochanteric fractures treated from January 2014 to October 2019. All patients who received internal fixation on traction bed, and who could not achieve satisfactory closed reduction through the process of "external rotation, abduction, traction, adduction and internal rotation". Reductions were classified as good, acceptable, or poor. We had acceptable reduction in 83 cases and poor reduction in 37 cases though closed reduction. The displacement was reduced using some minimal invasive techniques.

Results: After performing the relative techniques in these cases, no case had a poor result. 112(94.9%) cases were in a good reduction. Anatomical reduction should always be achieved in intertrochanteric fractures.

Conclusion: The minimal invasive techniques could help the surgeon achieve satisfactory reduction in intertrochanteric fractures. This work had the potential to improve the cognition of reduction of intertrochanteric fractures for surgeons, especially beginners and juniors.

Background

Intertrochanteric hip fracture is defined as fractures between the femoral neck and the lesser trochanter, which is one of the most common fractures in the elderly and become more common as the rate of elderly people increases.[1–2] Surgical treatment is generally indicated unless the patient has significant comorbidities that present an unacceptable risk.

An intramedullary nail has become the implant of choice for intertrochanteric fractures. The curative effect of intertrochanteric fracture depends on many aspects, in which the quality of fracture reduction is controlled by orthopedists during operation. Accurate reduction and rigid fixation are more important than fixator selection according to the class of the fracture.[3]

Most intertrochanteric fractures are amenable to closed reduction. Although these fractures can achieve satisfactory closed reduction through the process of "external rotation, abduction, traction, adduction and internal rotation", some specific patterns of intertrochanteric fractures need percutaneous procedures, and some may even need open reduction.[4] Minimal invasive techniques were crucial to achieve anatomic reduction or acceptable reduction of fractures. The reduction techniques involved in the operation are discussed as follows.

Patients And Methods

In this study, Between January 2014 and October 2019, 118 patients were selected (51 males and 67 females, aged 37–96 years, with an average age of 76 years). Among them, 71 cases were on the left side and 47 cases on the right. 93 cases were caused by falls, 17 cases caused by traffic accidents, 8 cases caused by cycling injury.

The inclusion criteria were closed intertrochanteric fracture patients who received internal fixation on traction bed, and who could not achieve satisfactory closed reduction through the process of "external rotation, abduction, traction, adduction and internal rotation". Attempted for closed reduction should be made no more than three times by senior attending physicians or professors.

The quality of fracture reduction was determined with the use of intra-operative fluoroscopic images and immediate postoperative radiographs. Evaluation of reduction quality during surgery was important. The distal fragment on the anteroposterior view and the anterior cortex on the lateral view was described in terms of cortical thickness. Fractures were graded as "good," "acceptable" or "poor" based on three radiographic criteria.[5]

1. Periosteum detacher pressing technique [Fig. 1]

When the medial cortical continuity was lost in anteroposterior view, a periosteum detacher was entered through the proximal intramedullary nail master incision, guided by fluoroscopy, along the trunk Angle and pressed the proximal end of the fracture to recover medial cortical continuity.

After the intramedullary nail was inserted, in anteroposterior view, One fragment displaced outwards was sometimes found and it could be reduced by periosteum detacher. Compared with Kirschner wire or Schneider wire, the cross section of periosteal detacher was relatively large, which avoid the risk of secondary fracture.

2. Caustic forceps clamping technique [Fig. 2]

When we met a sagittally unstable intertrochanteric fracture, the displacement of proximal fragment was significant determined by muscular forces. Gentle traction was applied to make the fractured main fragments to approximately the same level. Caustic forceps through the same incision used for insertion of head and neck screws as a clamping was helpful to achieve temporary anatomical reduction.

3. Reduction of Kirschner pin as a joystick [Fig. 3]

The sagittal displacement was reduced using a Kirschner pin. The tip of the Kirschner pin was placed at the medial cortex of the proximal fragment in the anteroposterior view and at the anterior cortex of the proximal fragment in the lateral view. When an good or acceptable degree of reduction was achieved with the Kirschner pin as a joystick technique, another pin was used to maintain of reduction.

4. Top rod technique [Fig. 4]

The anteroposterior view revealed Good alignment, while the lateral view showed the femoral shaft in front of the head and neck. For the top rod technique, the rod was inserted the anterior cortex of the distal fragment through an incision which was only one centimeter. The rod acted directly on the bone surface applied down vectored force to the malaligned fragment and leded to fracture reduction.

5. *Reduction of thyroid retractor traction* [Fig. 5]

For the displacement of the coronal plane, despite a good axial alignment in the lateral view, a small accessory lateral incision, at the level of the lesser trochanter, the proximal fragment could be pulled outward by the thyroid retractor traction to achieve reduction.

6. *Cerclage wire binding reduction* [Fig. 6]

When the intertrochanteric fracture involvement below lesser trochanter level, anatomical reduction through closed manipulation was of significant difficulty. Via a small lateral incision, a cerclage wire was frequently employed to achieve and maintain satisfactory reduction permanently. Additional banding was taken before intramedullary nailing had been performed. Meanwhile, the cerclage wire could effectively prevented loss of reduction of reaming and insertion of an intramedullary nail.

7. *Steinmann pin prying reduction* [Fig. 7]

Usually the proximal displacement of the fracture was not obvious. The Steinmann pin inserted along the anterior cortex of the proximal femur through a 2 mm stab wound and the tip was introduced between the proximal and distal fragment. We attempted at levering out the proximal fragment. Reduction was finished by prying the Steinmann pin.

8. *punctate reduction forceps clamping technique* [Fig. 8]

When the fracture line extended under the lesser trochanter, Especially existence the fracture line of coronal plane, punctate reduction forceps could better correct rotation and displacement, and there was no need for continuous traction during the operation.

Result

118 patients who could not achieve satisfactory closed reduction were selected in our study. Initial deformity was reduced with a combination of closed manipulation and minimal invasive reduction techniques. Reductions that were of at least "acceptable" were achieved in all cases.

We had acceptable reduction in 83 cases before using the minimal invasive techniques. After performing the relative techniques in these cases, we had a good reduction in 81(97.6%) cases and an acceptable outcome in two(2.4%) cases. About 37 other cases were in poor reduction, 31(83.8%) cases were managed good reductions using our techniques and no case had a poor result. No incision infection occurred. There were no complications such as neurovascular injury.

Discussion

Anatomical reduction is of critical importance in intertrochanteric fractures[6].

Improper reset and fixation will lead to disastrous consequences. Accurate reduction and rigid fixation are more important than fixator selection according to the class of the fracture.[7] Our experience is no reduction, no guide needle insertion, no reaming. Starting with proximal reaming only with the fracture reduced. Reduction is the prominent determinant of fracture healing and functional recovery. A poor anatomical reduction is related to a higher incidence of complications for the same severity of fracture. [8–9]Although in most cases, they can be reduced on the fracture table without additional manoeuvres. It is commonly believed that reduction can be achieved by internally rotating the affected limb and placing it in traction on a fracture table during operation. Incidence varies from 3–17% reported in the literature not amenable to closed reduction.[10]

The appearance of intramedullary nail provides the basis for closed reduction or minimally invasive open reduction.[11–12]In the process of implantation, the minimally invasive is often needed, and the concept of minimally invasive reduction should run through the whole operation process[13]. Although design and technology on implant have been developments, a better nail does not compensate for deficient surgical techniques.

It was reported hook leverage technique could achieve a good reduction with adequate cortical contact[5]. Actually, the ways of reduction of intertrochanteric fracture are various, each has its own pros and cons. Because an anatomic reduction is needed to offer the best results, several methods of reduction, using periosteum detacher, clamping, top rod, thyroid retractor traction, Kirschner pin, Steinmann pin and wires have been described in our study and reported our results in a series of patients. We need to use these common tools flexibly. Reduction should be carefully planned according to the specific position of each bone fragment.[14] The reduction techniques are constantly improved, and meanwhile, unnecessary peeling is avoided as far as possible. Percutaneous methods or open reduction are performed for anatomical reduction to achieve clinically and radio-logically excellent outcomes.[15]

The intraoperative evaluation of reduction quality for treatment of intertrochanteric fracture is crucial essential. Anatomical reduction of the posteromedial cortex is important component in the reduction of fracture. [7]Restoration of neck-shaft angle and anteversion are essential in intertrochanteric fractures[16]. Cortical continuity is stressed for evaluating the accuracy of reduction for intertrochanteric fracture. Kim suggested the evaluation of reduction using bone-to-bone contact.[5]

Since this study was not prospective or randomized, the results could not be considered conclusive. we still had the limitation of a small group for this study and needed a long-term follow-up study for a valid prognosis. As an open reduction with wide exposure could do more harm than these minimal invasive techniques, a control group was not designed. However, with some tips and tricks were shared, the results of this work had the potential to improve the cognition of reduction of intertrochanteric fractures for surgeons, especially for beginners and juniors who tried to achieve anatomic reduction and a perfect

implant positioning. By adding these simple techniques, it might be possible to treat difficult fractures in the same way as simple fractures.

Conclusion

Anatomical reduction should always be achieved in intertrochanteric fractures. In practice, spending time on repeated attempts for closed reduction was ill-advised. The minimal invasive techniques could help the surgeon achieve satisfactory reduction in intertrochanteric fractures. Using these technique, we had improved reset quality and achieved favorable clinical outcomes.

Declarations

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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None.

Authors' contributions

Xuzhou Duan collected, analyzed, and interpreted the data and wrote the paper. Dake Tong, Hao Zhang were involved in the study design and conception and in critically reviewing and revising the article content. All authors collected, analyzed, and interpreted the data. All authors read and approved the final manuscript.

Availability of data and materials

Because no data sets were generated or analyzed during the current study, data sharing is not applicable to this article.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

All participants provided written informed consent. This study was approved by the Changhai Hospital Clinical Research Ethics Committee.

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Figures



Figure 1

1a In anteroposterior view, the medial cortical continuity was lost. 1b Corrective reduction was performed with periosteum detacher. 1c One fragment was displaced outwards. 1d The fragment could be reduced by periosteum detacher. 1e The reduction was confirmed on the final image.

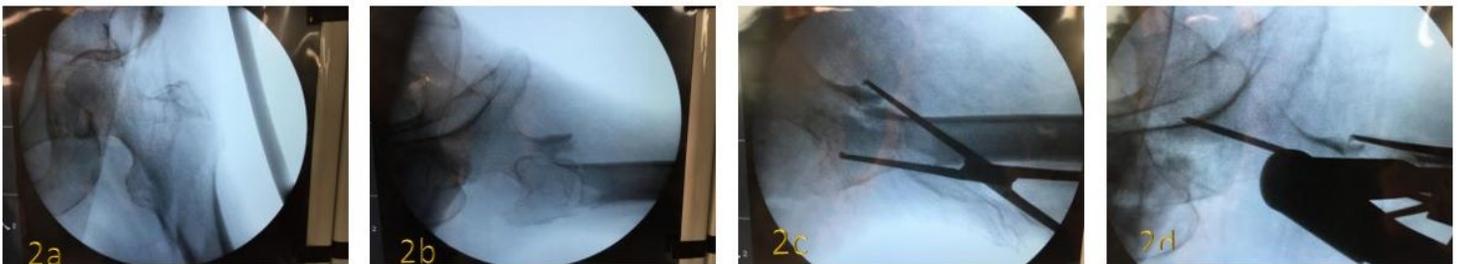


Figure 2

2a, 2b In anteroposterior view, the fracture looked well reduced, the lateral view of the same patient, however, showed that the sagittal geometry was unstable. 2c The displacement was reduced using a caustic forceps as a clamping. 2d A caustic forceps could be maintained during the insertion of nail device.

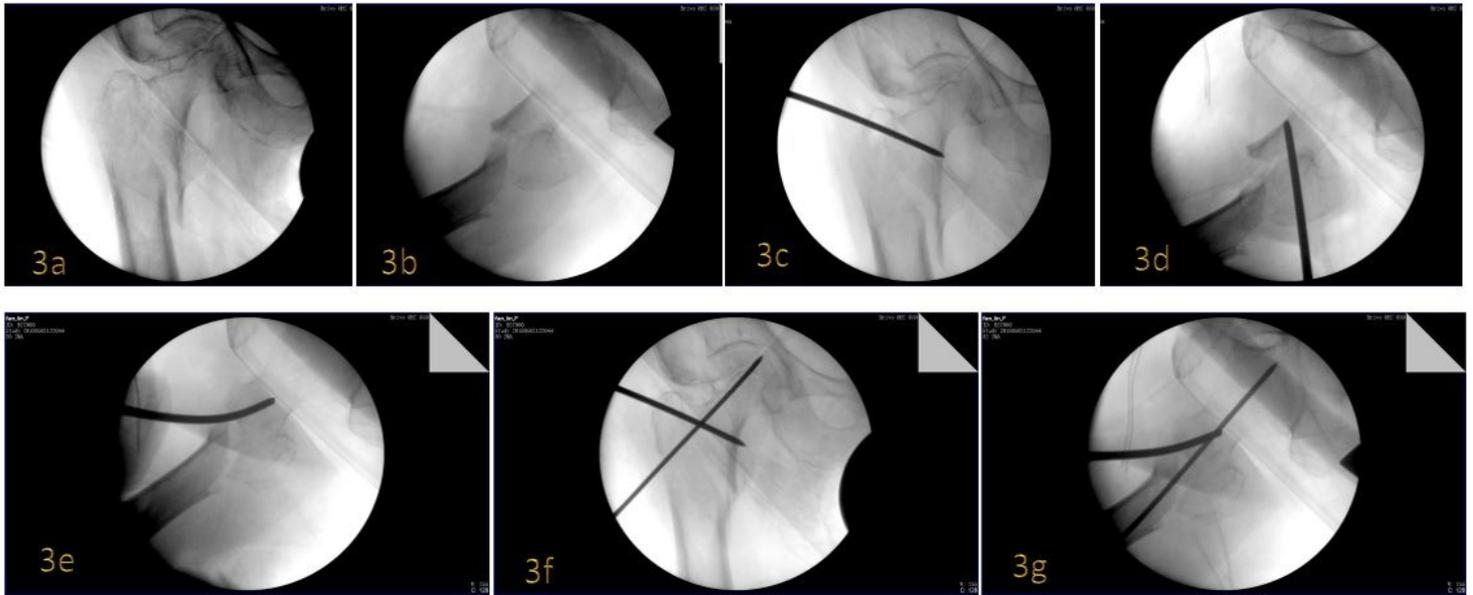


Figure 3

3a.b The closed reduction was determined to be poor. 3c.d The tip of the Kirschner pin was placed at the medial and anterior cortex of the proximal fragment. 3e The anterior angulation was restored as a joystick technique 3f.g Another pin was used to maintain of reduction.



Figure 4

4a The lateral view showed the femoral shaft in front of the head and neck. 4b Using a top rod to press the anterior cortex of the distal fragment. The lateral view shows previous displacement was no longer in existence. 4c The incision was only one centimeter.



Figure 5

5a The displacement of fracture was mainly in coronal plane 5b At the level of the lesser trochanter, the thyroid retractor traction was sited the medial surface of proximal fragment. 5c The proximal fragment could be pulled outward by the thyroid retractor traction



Figure 6

6a This fracture involved below lesser trochanter level 6b A cerclage wire was used to augment anatomical reduction 6c The reduction was confirmed on the final image. 6d. e This was a wire guide.



Figure 7

7a The tip of steinmann pin was introduced between the proximal and distal fragment. 7b Reduction was carried out by prying the Steinmann pin.



Figure 8

8a.b Characteristics of this intertrochanteric fracture, the lateral femoral wall was broken. On coronal plane, we found fracture line. 8c.d Open reduction with the help of the punctate reduction forceps.