

Pitfalls and Remedial Technique of Intramedullary Nail for Subtrochanteric Femur Fractures: A Case Series

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Technical note

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Abstract

Background: Intraoperative technical complications are occasionally encountered while implanting intramedullary nails for subtrochanteric fractures. Surgeons must pay attention to the pitfalls and remedial technique of this operation.

Methods: We report on three cases in which intraoperative difficulties occurred during the implantation of an intramedullary nail among Han Chinese patients from mainland China. In Case 1, during an operation on a 57-year-old man, a seinsheimer type V in a right subtrochanteric fracture was not fully realized, and the dislocation of intertrochanteric fracture was aggravated after reduction of the subtrochanteric fracture. The intramedullary nail fixation was completed with the aid of an additional anterolateral plate. Case 2 involved a transverse subtrochanteric fracture. The surgeon neglected the coronal dislocation when considering good sagittal reduction. Although an auxiliary reduction device was used during the operation, there was unacceptable coronal dislocation after the intramedullary nail was inserted. A temporary anterolateral locking plate fixation was used to complete the intramedullary nail fixation. Case 3 involved an old trochanteric fracture combined with a new subtrochanteric fracture in an 81-year-old woman. After reducing the subtrochanteric fractures, the intramedullary nail fixation was successfully completed by releasing the poorly healed intertrochanteric fractures and fixing the anterior lateral plate.

Results: With the development of techniques, reliable results can be obtained with fewer complications. Of the various internal fixation methods, we favor using a trochanteric start intramedullary nail.

Conclusions: The treatment of subtrochanteric fractures presents challenges. Good reduction and reliable temporary fixation are key to completing the intramedullary nailing. If percutaneous joysticks, finger reduction tools, blocking screws, clamps, and Schanz pins cannot be used for effective auxiliary reduction or temporary reliable fixation, reduction after intramedullary nailing will not be satisfactory. The temporary addition of a reconstruction locking plate can achieve good reduction and temporary stability, and an extra reconstruction locking plate should be retained when the temporary fixation device is removed to reduce the risk of internal fixation failure during fracture healing.

1 Background

A subtrochanteric fracture is a fracture within 5 cm below the trochanter of femur, and this type of fracture accounts for between 5–34% of all hip fractures.^[1,2] The age distribution of subtrochanteric fractures of femur show bimodal distribution. Young patients are mostly injured by high-energy violence, while the elderly patients were mostly injured by low-energy violence.^[2]

Due to the high concentration of stress in the subtrochanteric region of the femur, greater muscle attachment increases the difficulty of reduction. Nonsurgical treatment of subtrochanteric fractures often results in complications, such as nonunion, delayed healing, and malunion due to long-term bed immobilization. For these reasons, it is widely advocated that active surgical treatment be performed.^[3, 4]

There are several methods of internal fixation, including different designs of plate and intramedullary nails. Intramedullary nails have the advantages of center fixation, a short arm of force and effective stress dispersion, and they are the option most frequently recommended in clinics.^[5] Due to the traction of the iliopsoas muscle, abductor, and external rotation muscle group, proximal fracture blocks have a tendency toward flexion, abduction, external rotation, and shortening. This leads to difficulties in the closed reduction needed to achieve good alignment and delayed union or nonunion of secondary fracture, eventually leading to failure of internal fixation.^[1,2,6,7] Seyhan et al.^[8] reported that the nonunion rate of subtrochanteric fracture with poor alignment was as high as 7%, while that of anatomical reduction was only 2%. Auxiliary reduction techniques, such as percutaneous joysticks,^[9] steel wire cerclage,^[10] locking plate,^[11] cable fixation,^[12] clamp-assisted,^[8] and blocking screws,^[8] can be used for precise reduction to avoid non-union and failed osteosynthesis.^[6]

Surgeons must be cognizant of the difficulties they may encounter during reduction and during the implantation of intramedullary nailing. If the characteristics and treatment technique of subtrochanteric fracture are poorly understood and if sufficient preparation is not made before operation, compared with plate fixation, various intraoperative pitfalls can be encountered during intramedullary nailing surgery. This article presents three cases of treatment of subtrochanteric fractures with intramedullary nails.

2 Case Presentation

2.1 Case 1

A 57-year-old man fell to the floor from a six-meter-high building and was injured. He received treatment in an external emergency center and was transferred to our trauma center four days later. This patient was previously in good health. X-ray examination showed that the right subtrochanteric comminuted fracture combined with the no displacement ipsilateral femoral neck basal fracture fitted Seinsheimer type V of subtrochanteric fracture (Fig. 1). There was no deep vein thrombosis or other lateral trauma before operation.

The subtrochanteric fracture site was slightly open and reduced. First, a steel wire was tied around the fracture end. The deformity was corrected, and the guide pin of the intramedullary nail was inserted successfully with the help of a finger reduction tool. A steel wire was subsequently tightened to reduce the broken end of the fracture and maintain the good reduction (Fig. 2A-C). Under direct vision, the fracture end was well reduced, and there was no obvious displacement of the femoral neck basal fracture; therefore, reaming and intramedullary nailing were performed. However, in fluoroscopy after placing the head and neck guide pin, it was found that the distal end of the femoral neck basal fracture was obviously displaced, although the head and neck guide pin was still in the proper femoral neck (Fig. 2D).

Because displacement is unacceptable, taking out the intramedullary nails to reduce the femoral neck basal fracture using Kirschner wire, forceps, and other tools was not able to effectively reduce and

maintain stability. Subsequently, a reconstruction locking plate was placed in the anterolateral part of the proximal femur, and two semi-cortical screws were used to fix the proximal end of the steel plate. The sinking fracture at the distal end was then reduced by tightening the steel wire around the steel plate and bone shaft using the suspension principle of the steel plate as a cantilever beam (Fig. 3A). The distal end was locked using two hemi-cortical screws to prevent swinging. Lastly, the intramedullary nail was placed and fixed (Fig. 3B). Six months after the operation, the fracture was healed, and the Harris score of the right hip was good (Fig. 4A-B).

2.2 Case 2

A 46-year-old woman was involved in a traffic accident that resulted in a fracture of the right subtrochanteric femur and a burst fracture of Lumbar 1. There was no special history. Intramedullary nail fixation was used to treat the subtrochanteric fracture of the femur. Open reduction and internal fixation of the spine were performed one week after intramedullary nail fixation. Tibial tuberosity was used for traction fixation for three days before the operation for the subtrochanteric fracture of the femur.

The left hip lithotomy position and right hip extension position were adopted during the operation (Fig. 5). In this simple transverse fracture, although percutaneous joysticks, blocking screws, and clamps were adopted, due to the unsatisfactory closed reduction, there was still unacceptable anteroposterior angular displacement after the intramedullary nail had successfully been inserted with the finger reduction tool (Fig. 6A-D). Therefore, limited open reduction was performed immediately using reduction forceps combined with steel plate-assisted reduction (Fig. 6E-F). After inserting a femoral intramedullary nail, the auxiliary reduction instrument was removed, and the fracture end was found to be unstable. As a result, a reconstruction locking plate was fixed on the anterolateral side of the fracture end, thus increasing the stability of the fracture end. The Harris score of the right hip function was excellent at three months after the operation. X-ray showed that the right subtrochanteric fracture of the femur and burst fracture of the L1 vertebral body were healed (Fig. 7A-B).

2.3 Case 3

An 81-year-old woman with Alzheimer's disease, bronchial asthma, and coronary heart disease fell to the ground while going to the bathroom at home, causing a left subtrochanteric fracture (Fig. 8A-B). She was transferred to the trauma center from the local community hospital 11 hours after her injury. She had previously received conservative treatment for a femoral intertrochanteric fracture caused by an ipsilateral hip fall five months prior and walked with a limp using crutches before her second injury.

Surgery was performed in the supine position using limited incision to expose the intertrochanteric and subtrochanteric fractures and reduction. The use of blocking screws and steel wire cerclage failed to achieve the ideal reduction, and additional anterior lateral locking reconstruction plate hemi-cortical screw fixation was finally completed after intramedullary nail internal fixation (Fig. 8C). Three months after operation, the Harris score of the right hip joint function was good.

3 Discussion

In general, three main factors determine the outcome of treatment of subtrochanteric fractures: fracture type, reduction quality, and adequacy of implantation. The latter two are important controllable factors.

3.1 Posture

Anatomical reduction is recommended for subtrochanteric fractures.^[6] Compared with intertrochanteric fractures, intraoperative traction reduction is suitable for most intertrochanteric fractures, though traction frames are rarely used for subtrochanteric fractures.^[9,13,14] A good reduction is obtained. A clear surgical position for subtrochanteric fractures is not proposed in the literature. In obese patients, taking the lateral position can make the greater trochanter more prominent and facilitate the confirmation of the needle entry point of the intramedullary nail.^[15] We prefer to adopt the same supine position as for intertrochanteric fractures, with the uninvolved side remaining in the lithotomy position and the affected limb straight and without traction, as this is more convenient for intraoperative fluoroscopy and intraoperative traction of the affected limb during the Auxiliary reset operation. Fixing the torso in an inclined position on the uninjured side can avoid interference with the intramedullary nail insertion operation.

3.2 Reduction tools and techniques

Whether closed reduction or limited open reduction is performed, a variety of auxiliary tools should be prepared before surgery, such as percutaneous joysticks, finger reduction tools, blocking screws, clamps,^[16] and Schanz pins. Even when muscle tension is relaxed by anesthesia, overcoming the deformation force of the subtrochanteric fracture under the condition of the assistant longitudinal traction and controlled rotation remains challenging. Therefore, an auxiliary reset must be performed before placing the guide pin. For simple two-part femoral subtrochanteric fractures, proximal and distal fractures can be operated on with a joystick through percutaneous puncture, and the guide wire can be guided using a finger reduction tool.

However, even if the fracture can be reset and the guide pin inserted, there may be poor anteroposterior alignment, similar to our case. This could be related to the needle insertion point being slightly forward; however, in the case of assisted reduction, it is difficult to position the nails at the precise insertion point. Therefore, temporary fixation, such as wire cerclage or reduction pliers for limited open reduction, is still the recommended method.

3.3 Selection of needle entry point

Early intramedullary nails were designed to treat femoral shaft fractures. The entry point is located at the piriformis fossa. For proximal femoral fractures, this entry point is more likely to cause mal-reduction of the fracture.^[17] A greater trochanter needle entry point can be used to avoid piriformis entry-point complications, and the curved proximal end of the intramedullary nail helps prevent hip varus and facilitates needle entry. However, even when correct selection of the insertion point of the intramedullary nail is made, the initial reduction under the trochanter will be difficult if the special anatomy around the

trochanter not understood. If the fracture is not well reduced, the medulla is inserted into the medulla rashly. Internal nails can also lead to poor reduction and implantation failure, as in case 2 discussed in this article. Therefore, no matter how accurate the needle insertion point, normal anatomical structure cannot be restored before good reduction is achieved.^[6]

3.4 Remedial effect of additional plate in subtrochanteric fracture

As an auxiliary reduction method, an extra steel plate is not usually needed. However, for simple transverse fractures, such as in case 2, if the initial operation is unsuccessful, an additional plate is conducive to fracture reduction and increases the stability of the fracture end, facilitating the safe re-insertion of intramedullary nails and reducing the risk of nonunion fracture.

For Seinsheimer type V subtrochanteric fractures or those combined with old intertrochanteric fractures, it is necessary to attach a plate.^[15, 18] Seinsheimer type V fractures are a type of subtrochanteric fracture combined with intertrochanteric fracture.^[19] The fracture end has a large span and is unstable. The intertrochanteric and subtrochanteric parts should be considered during reduction and fixation. It is difficult to fix an intertrochanteric fracture with a steel wire, even if the reduction of the subtrochanteric fracture is aided by small incision. The candy-package technique is a complicated operation to perform,^[20] and the stability of Kirschner wire in maintaining reduction is poor. As in case 1, temporary reduction and fixation with auxiliary reconstruction locking plate can not only reduce distal subsidence by tightening the steel wire on the plate but can also increase the stability between the fractures, thus facilitating temporary reduction and fixation.

Old intertrochanteric fractures combined with conservative treatment may be the most difficult type of subtrochanteric fractures to treat because they are often accompanied by deformity. Even if the subtrochanteric fracture is reduced well, choosing a proper internal fixation is challenging. Fortunately, although case 3 was associated with an old intertrochanteric fracture, it had healed poorly. Therefore, it was possible to release and reposition the intertrochanteric fractures during the operation. It is particularly important to fix unstable fracture ends caused by a wide proximal medullary cavity with an additional reconstruction locking plate.^[18]

4 Conclusion

The treatment of subtrochanteric fractures remains a challenge. With the development of techniques, reliable results can be obtained with fewer complications. Of the various internal fixation methods, we favor using a trochanteric start intramedullary nail.

Good reduction and reliable temporary fixation are the basis for completing intramedullary nailing, which is quite different from the fracture site, such as a tibia shaft fracture. If percutaneous joysticks, finger reduction tools, blocking screws, clamps, and Schanz pins cannot be used for effective auxiliary reduction or temporary reliable fixation, reduction after intramedullary nailing is not satisfactory. In these

circumstances, the temporary addition of a reconstruction locking plate can help achieve good reduction and temporary stability.

An extra reconstruction locking plate should be retained when the temporary fixation device is removed to reduce the risk of internal fixation failure during fracture healing.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Hospital of Chengdu University of Traditional Chinese Medicine. Written informed consent was obtained from all participants.

Number of ethical certificate: JZ2019045

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article

Declaration of conflicting interests

The authors declare that they have no competing interests

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Authors' contributions

Chen BT have made substantial contributions to conception and design, Fan XH acquisition of data, analysis and interpretation of data; Chen BT and Fan XH have been involved in drafting the manuscript and revising it critically for important intellectual content; Chen BT and Fan XH have given final approval of the version to be published.

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Figures

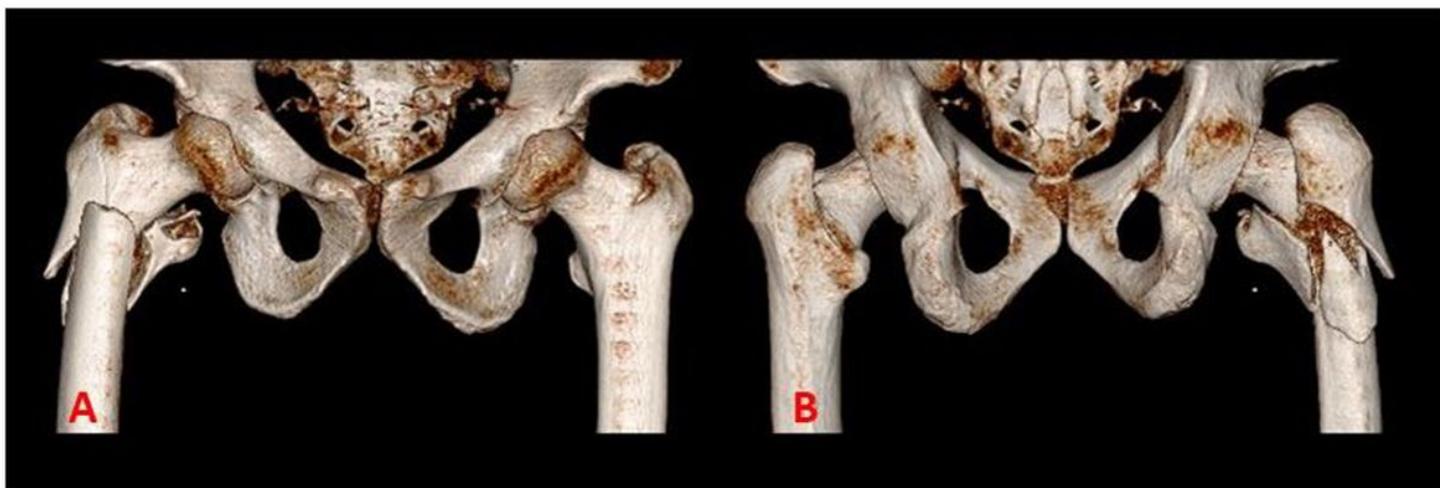


Figure 1

CT reconstruction of the right femoral subtrochanteric comminuted fracture in the anterior view, the fracture line extended upward to piriformis fossa (A), posterior view showed the posterior medial wall comminuted, lack of support (B).

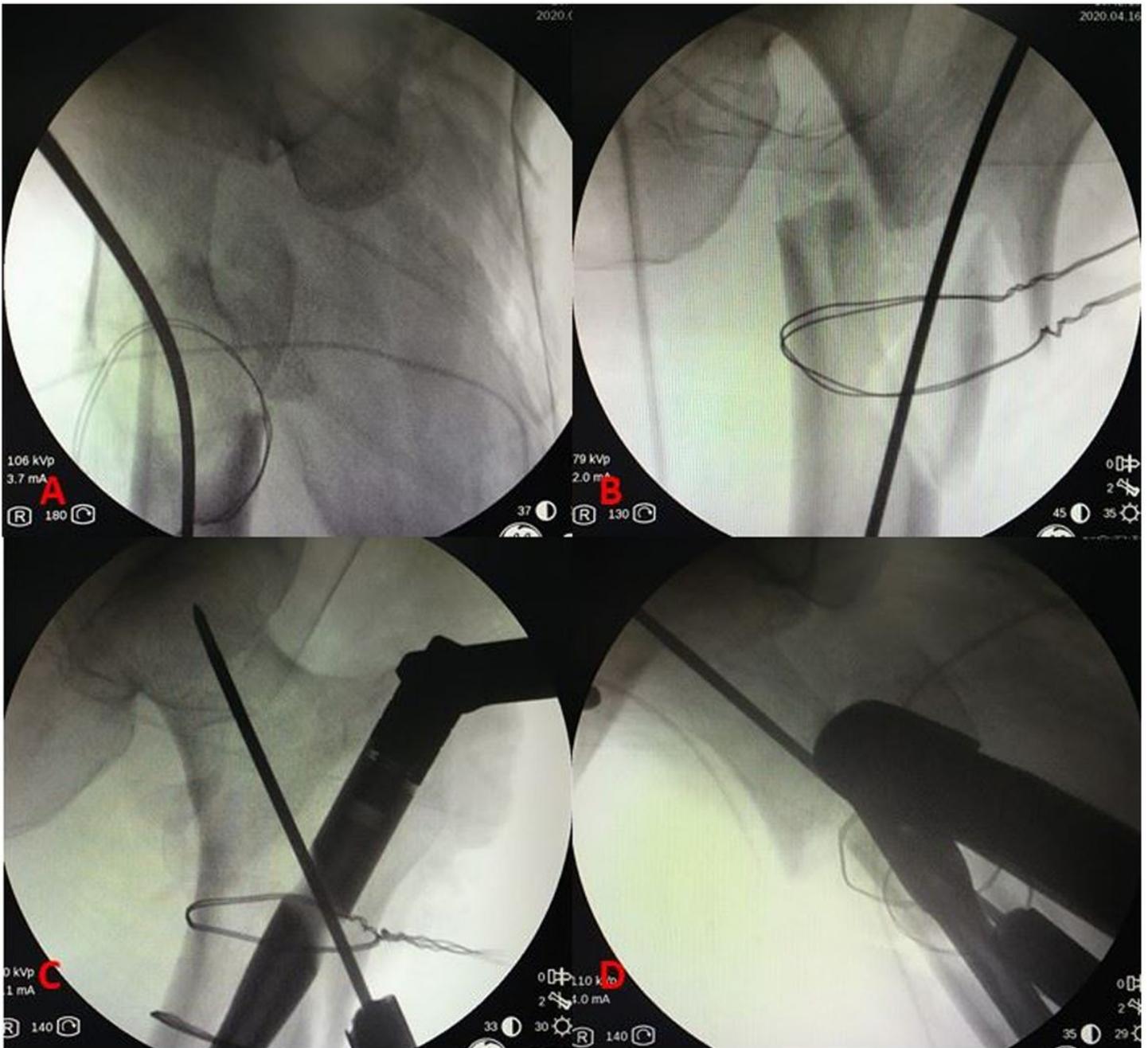


Figure 2

After limited incision of the fracture end, the steel wire was inserted and the guide pin of intramedullary nail was inserted. Lateral fluoroscopy (A) and anteroposterior fluoroscopy (B); tightening the steel wire and inserting intramedullary nail, the reduction of subtrochanteric fracture was good (C); lateral fluoroscopy showed that the dislocation of intertrochanteric fracture was aggravated, with proximal anterior and distal posterior subsidence displacement (D).

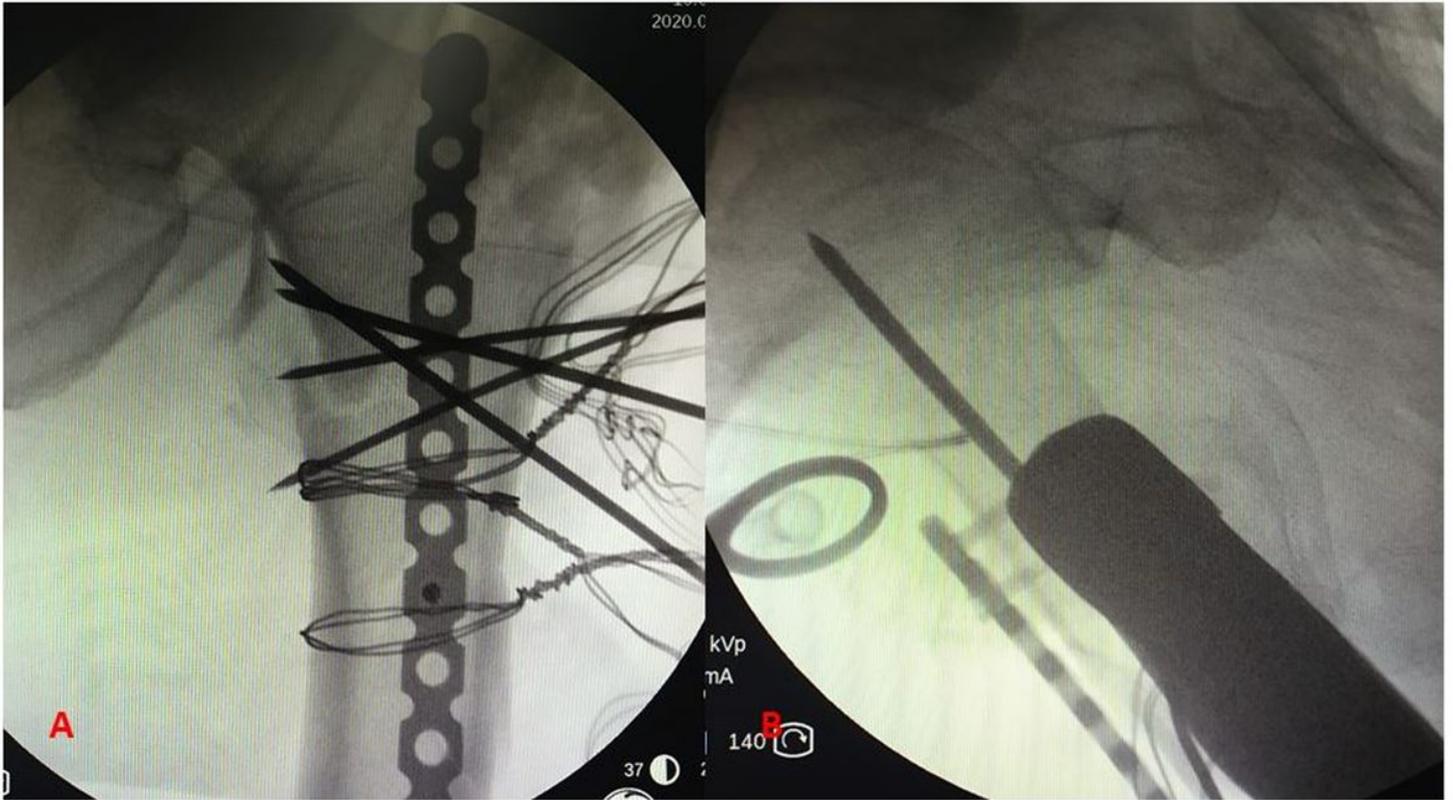


Figure 3

A variety of auxiliary reduction instruments were used(A). Finally, good reduction and temporary stability were achieved by additional reconstruction locking plate, and the intramedullary nail fixation was completed(B).

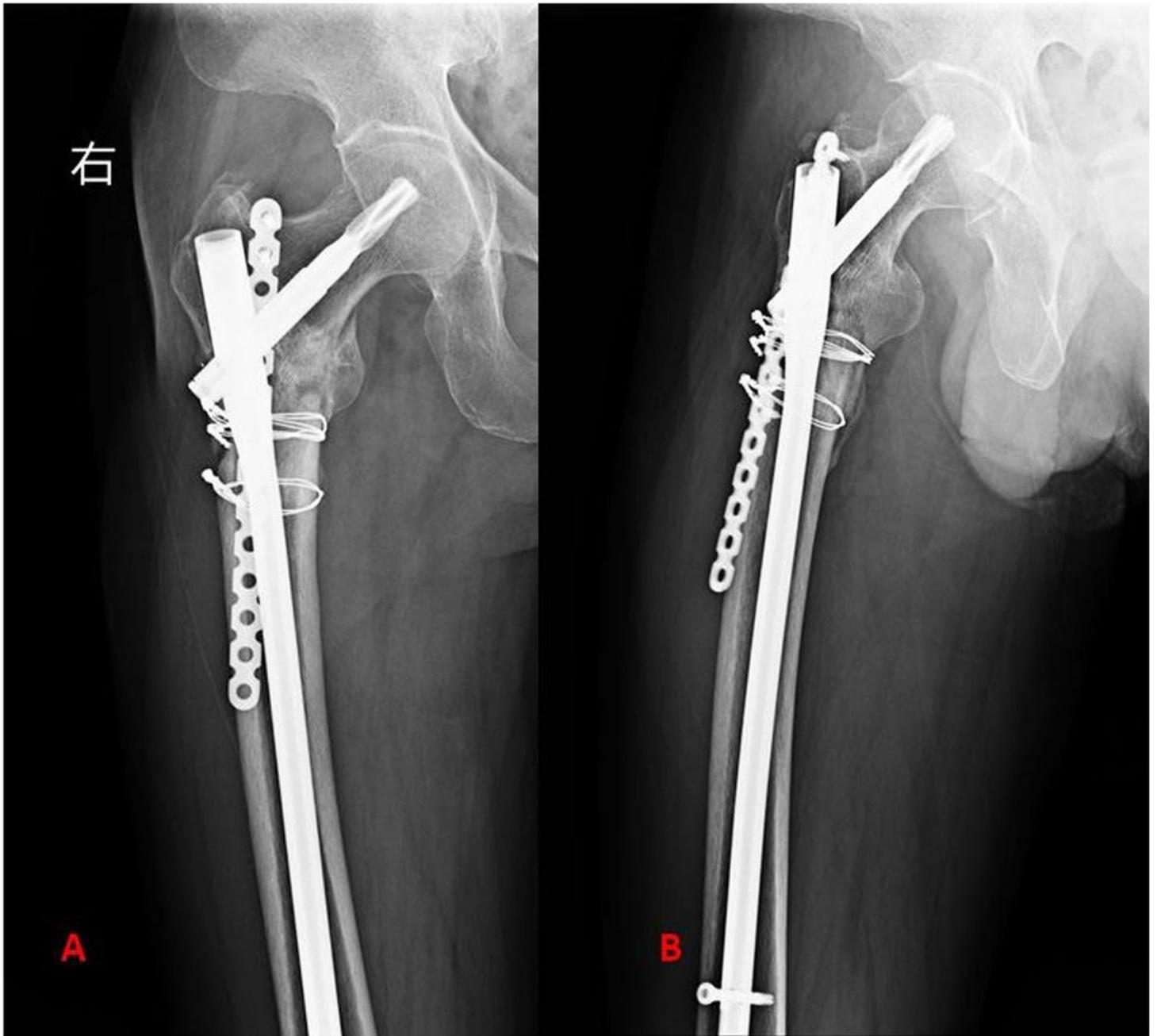


Figure 4

6 months after operation, X-ray showed that the fracture healed. Lateral fluoroscopy (A) and anteroposterior fluoroscopy (B).



Figure 5

The left hip lithotomy position and the right hip extension position were adopted during the operation.

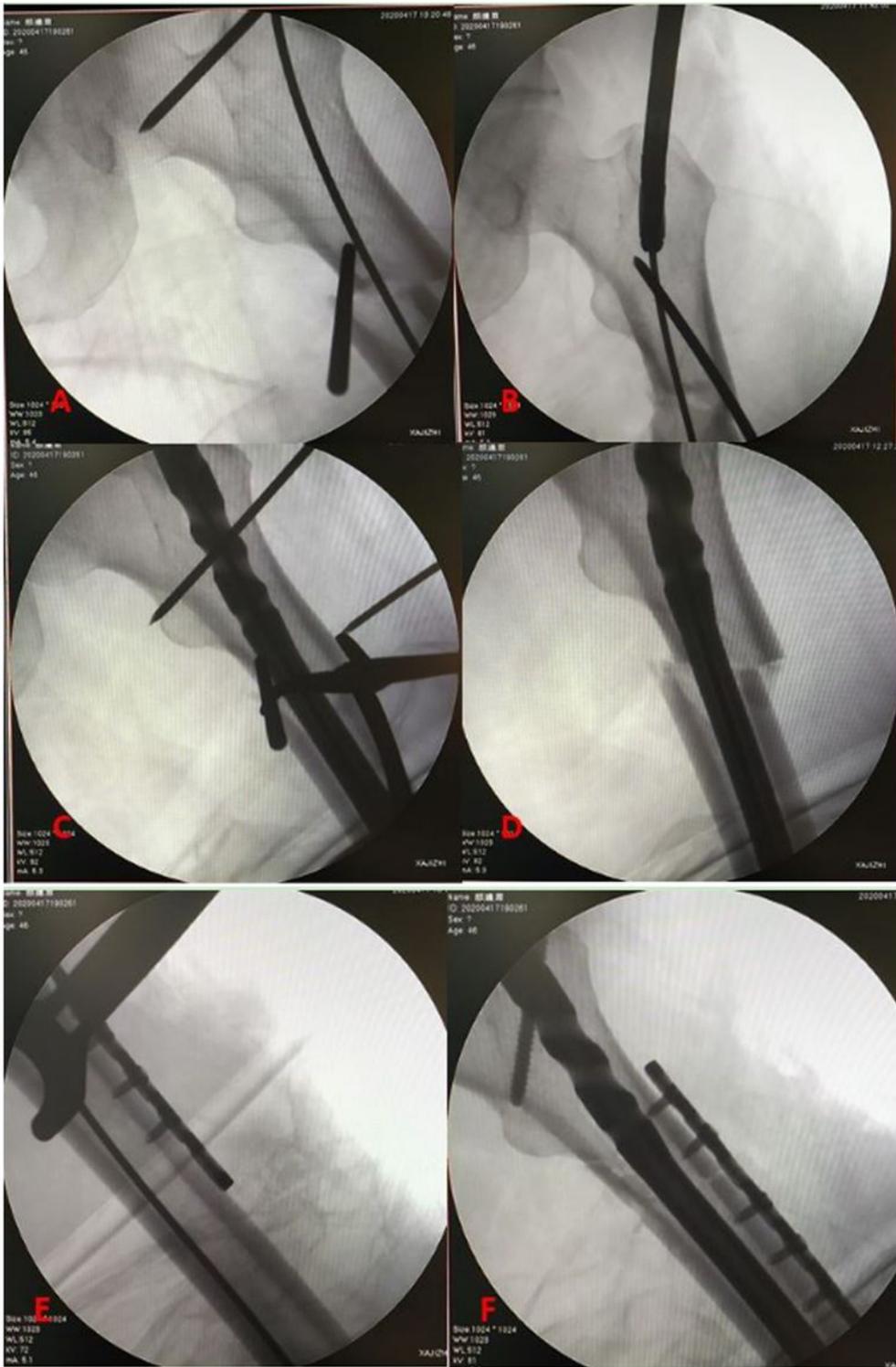


Figure 6

Application of various auxiliary methods. Blocking screws(A); Percutaneous joysticks(B); Clamps and Schanz pins (C). Fluoroscopy showed that the fracture alignment was still poor(D). Reconstruction locking plate assisted reduction, anteroposterior image(E), lateral image(F).

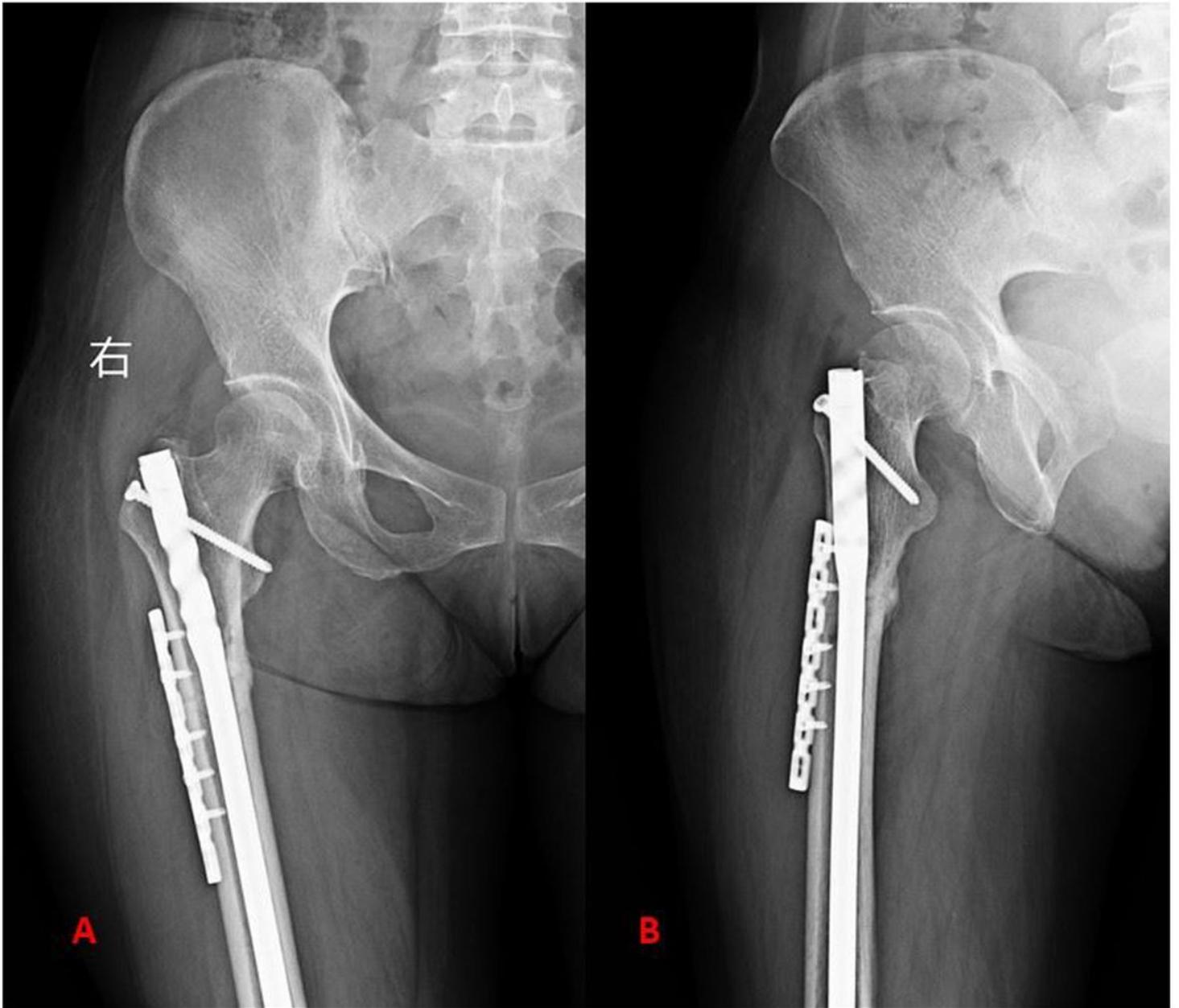


Figure 7

At 6 months after operation, X-ray showed fracture healing. anteroposterior image(A), lateral image(B).

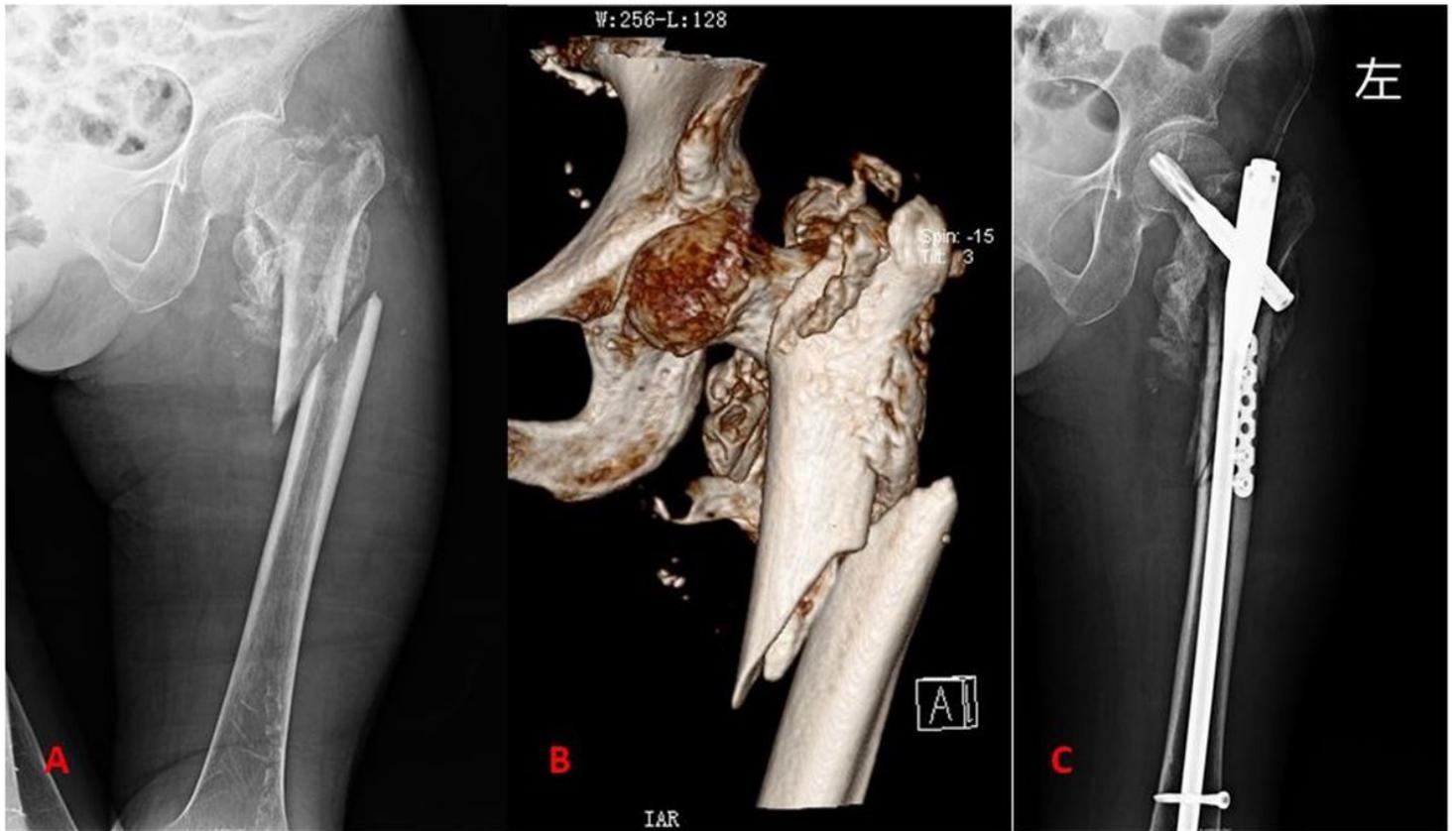


Figure 8

X-ray(A) and CT reconstruction image(B) showed old intertrochanteric fracture and fresh subtrochanteric fracture, old intertrochanteric fracture deformity and poor healing. X-ray images after intramedullary nailing and locking plate fixation(C).