

Double reverse traction repositior versus traction table for the treatment of intertrochanteric femur fracture: A comparative Study

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Abstract

Background The aim of this study was to compare the clinical results between double reverse traction retractor and traction table used for the treatment of unstable intertrochanteric femur fracture.

Methods This retrospective study included 95 patients with AO/OTA 31- A2 and A3 proximal femur fracture, who underwent double reverse traction retractor or traction table facilitated Asian proximal femoral nail antirotation (PFNA-II) nailing. The demographics, duration of operation, blood loss, part loading time after surgery, the period of union of fracture, complication were assessed. Clinical and radiological outcomes were evaluated.

Results There were no significant differences in respect to demographics and fracture characteristics. Duration of patient positioning and total operative time were significantly longer in traction table group than that in double reverse traction retractor group ($p < 0.001$). No differences were found intraoperative blood loss, part loading time after surgery, fracture healing time and Harris Hip Score between two groups.

Conclusion When treating unstable intertrochanteric fractures, double reverse traction retractor is superior to traction table in respect to operative time and duration of patient position, despite an additional ipsilateral anterior superior iliac spine (ASIS) incision and drilling of ASIS and femur condyle.

1. Introduction

The unstable intertrochanteric fracture usually involves the trochanter minor and posteromedial cortex, even extends into subtrochanteric region [1]. It is popular to manage unstable intertrochanteric fracture with closed reduction and cephalomedullary nailing [2]. The determinant factor that influences the prognosis is the quality of reduction, which is almost achieved through the application of a traction table (TT). However, some complications related with traction table usage have been reported, including extra time needed to set up traction table, neurological injuries, soft tissue contusions, compartment syndrome, crush syndrome and vascular injuries [3]. These complications may cause terrible consequences to patient, which compromises the use of traction table. In order to avoid these potential complications, the double reverse traction retractor was employed as an alternative to traction table for the closed reduction of the fragments and PFNA-II fixation.

Double reverse traction retractor (DRTR) is designed by Zhang et al to achieve the closed reduction of a displaced fracture based on a concept of skeletal distraction [4]. Zhang et al reported the patients with closed femoral shaft fracture who were treated by DRTR had a lower open reduction rate, fewer nonunion rate but higher Lysholm knee function than those managed with traction table [4]. However, the effect of DRTR application on unstable intertrochanteric fracture remains elusive. In this study, the displaced intertrochanteric fractures were closed reduced by DRTR or traction table and then fixed with PFNA-II. The outcomes and complications are compared.

The first purpose of this study was to present the novel reduction strategy for the management of unstable intertrochanteric fractures. The second aim was to compare the clinical and radiological results of the two techniques in the treatment of unstable intertrochanteric fractures.

2. Patients And Methods

2.1 Patients

This retrospective study was performed by approval and supervision of Central South University Ethical Committee. We conducted a retrospective review of unstable intertrochanteric fractures undergone surgery at the Second Xiangya hospital of Central South University between April 2015 and December 2018. The inclusion criteria were defined as AO/OTA classification type 31-A2 and 31-A3 proximal femur fractures, closed reduction and fixed with PFNA- β (Synthes, Oberdorf, Switzerland), \geq 18 years old, longer than 12 months follow-up. The exclusion criteria included pathologic fractures or additional fractures, ipsilateral femoral neck fracture and open injury, isolated fracture of greater or lesser trochanter. After reviewed, a total of 95 patients met all the inclusion criteria. Among them, 56 patients were treated with double reverse traction and other 39 patients were treated with traction table.

2.2 Preoperative examination and treatment.

After admission, the patient's lower limb was placed on a Blanc frame with skin traction. Based on the latest guideline of American Academy of Orthopedic Surgeons (AAOS), it is strongly recommended that elderly patients with intertrochanteric fracture should receive surgery within 48 hours after admission. However, elderly patients usually combined with medical comorbidities such as chronic heart disease, type 2 diabetes mellitus, pulmonary disease, which makes the elderly patients intolerable to surgery. Thus, it is of great importance to exam and evaluate the general condition of elderly patients before operation was performed.

2.3 Surgical Technique

All operation were performed by the same experienced orthopedic surgeon. If the double reverse traction repositor (DRTR) was used, the surgical process was described as follow. The patients were placed in a supine position under general anesthesia on the radiolucent table. A folded compress were placed under the sacrum of the same side to elevate the injured hip. The leg were disinfected with iodine complex from ipsilateral costal margin to ankle. Then, the assembly of double reverse traction repositor on the surgical table was performed. The repositor consists of a reduction scaffold, traction bow, traction pin, radiolucent connecting rod, distal reduction pin and proximal anchor (Fig. 1). Firstly, a 2-cm incision and drill of the ipsilateral anterior superior iliac spine(ASIS) was applied to screw a 3-mm Schantz pin. The Schantz pin was linked to the proximal end of the radiolucent connecting rod via a cardan shaft. The optimal length of connecting rod was applied according to distance between ASIS and femoral condyle. Then, the distal end of rod was fixed to the traction scaffold with four legs that can be adjustable to fit the height. Another 2.5- mm K-wire was screwed at the femoral supracondylar level and connected to the traction bow. After

that, the link between traction bow and the rotary screw of scaffold was performed. Once firmly assembled, the intraoperative distraction and reduction was carried out by turning the rotary screw clockwise to pull the distal femoral fracture fragment distally under C-arm fluoroscope on anteroposterior and lateral views, thereby correcting the varus angulation of hip and restored the limb length. The external or internal rotation can also be addressed by adjusting the placement of rotary screw on traction bow. If the quality of fracture reduction was poor, the adjustment of distracted force direction was required. In such circumstance, the medial or lateral placement of traction scaffold on the operation table was performed to adjust the adduction or abduction of the distal fragment.

The fracture closed reduction in traction table was performed according the standard process. Closed reduction was obtained with longitudinal traction and rotational alignment of lower limb. The K wire, if needed, was used to facilitate the reduction. When satisfied reduction of fracture was achieved with double reverse traction or traction table, the PFNA- α was implanted in all patients. The optimal nail length and diameter was determined based on the femoral geometry of patients. With slightly adduction of injured lower limb, a 2-to 3- cm proximal and longitudinal incision was made through the fascia and gluteus to expose the entry point of PFNA- α , which was on the slightly lateral tip of greater trochanter. The guide wire was inserted manually under fluoroscopy control. After the manual insertion of PFNA- α , the guide wire of blade was located in the center of femoral neck both in anteroposterior (AP) and lateral view of C-arm. If the location of guide wire was unsatisfied, the adjustment of guide pin position was needed through rotation, deeper insertion or partial retraction of PFNA- α . The Tip-Apex was no more than 25 mm after insertion of PFNA- α - α blade. At last, the static distal locking were performed in all patients(Figure 2). Closed reduced of fracture under image intensifier was performed in all patients.

2.4 Postoperative rehabilitation

The isometric quadriceps and a ankle pump exercise were performed on the first day after surgery. The active flexion and extension of hip and knee were encourage and X-ray were reviewed on post-operative day two. The low molecular weight heparin was used for anticoagulation on the first day after surgery. Full weight-bearing was permitted when the disappearance of the fracture line on X-rays and pain on hip.

2.5 Clinical Data

The patients demographics, AO fracture type, duration of operative time and patient positioning, blood loss, fracture healing time, post-operative early and late complications, implant failure and partial weight-bearing were recorded. The position of blade within femoral head was analyzed to evaluate the fixation according to the Cleveland and Bosworth quadrants. The position of the implant was considered as optimal if the blade was placed central-central and inferior-central on both AP view and lateral view. All remaining placement of blades were considered as suboptimal fixation[5]. For evaluation of reduction quality, the cortical continuity was confirmed anatomic, 5-10⁰ varus/valgus was confirmed good, and more than 10⁰ varus/valgus was defined poor.[6]

2.6 Statistical analysis

The continuous variables were compared using 2-sample Student t test. The χ^2 test or Fish exact test were performed for categorical variables statistical analysis. Two-tailed $P < 0.05$ was considered significantly different. SPSS22.0 (SPSS Inc, Chicago, IL) was used to perform the statistical analysis.

3. Result

Overall, 39 patients treated with traction table and 56 patients served with double reverse traction repositr were enrolled. As showed in Table 1, there were no significant differences regarding to the age, gender, fracture classification and mechanism of injury between two groups ($P > 0.05$). Duration of follow-up ranged from 12–31 months in total patients. The average follow-up was 19.2 ± 4.7 in double reverse traction repositr group and 19.8 ± 4.0 in traction table group, without significant difference.

Table 1
patient demographics and fracture characteristics

	DRTR group	TT group	P-value
Gender(female/male)	34/22	30/9	0.10
Age(years)	74.2 ± 12.2	78.8 ± 10.3	0.06
Mechanism of injury			0.75
Simple fall at home	46	33	
Traffic accident	10	6	
AO fracture classification			0.10
31 A2	50	30	
31 A3	6	9	
Follow-up (months)	19.1(range 10–31)	19.8(range 13–28)	0.46
Chi-square test			

As detailed in Table 2, the time needed for patients positioning in double reverse traction repositr group was significantly shorter than that in TT group ($P < 0.0001$). In addition, the total surgical time was longer for TT group compared with DRTR group ($P < 0.001$). However, the time from injury to surgery, intraoperative blood loss and fracture healing time were comparable between groups ($P > 0.05$). The mean part loading time of 31A2, 31A3 fracture after surgery was 29.7 ± 4.8 and 44.0 ± 6.3 days for DRTR group versus 28.8 ± 5.1 days and 47.2 ± 6.9 days for the TT group ($p = 0.43, p = 0.70$), without significant difference. At the last follow-up, the Harris Hip Score was excellent in 10 patients (18%), good in 36(64%), medium in 8(14%) and poor in 2(4%) for the DRTR group versus excellent in 8 patients (20%), good in 24 (62%), medium in 6 (15%),and poor in1 (3%) for the DRTR group ($P = 0.98$, Fish exact test).

Table 2
Comparison of surgical data and postoperative clinical outcome .

	DRTR group	TT group	P-value
Time from injury to surgery(days)	7.5 ± 2.3	6.9 ± 2.0	0.22
Duration of patient positioning (min)	6.5 ± 1.2	17.9 ± 7.3	< 0.0001
Operative time (min)	63.0 ± 4.1	72.5 ± 6.1	< 0.001
Intraoperative blood loss(ml)	168.9 ± 49.7	154.1 ± 38.9	0.12
Part loading time after surgery(days)			
A2	29.7 ± 4.8	28.8 ± 5.1	0.43
A3	44.0 ± 6.3	47.2 ± 6.9	0.70
Fracture healing time (weeks)	20.6 ± 2.3	21.4 ± 3.4	0.18
Harris hip Score (cases)			0.98*
Excellent	10	8	
Good	36	24	
Medium	8	6	
Poor	2	1	
* Fish exact test			

For radiological assessment of the quality of the reduction and fixation, the radiographs were taken on post-operative day two. As shown in Table 3, fractures reduction were accepted anatomic in 58 patients, good in 30 patients on the postoperative radiographs evaluation. In addition, the placement of blades were optimal in 80 patients. There were no significant differences between two groups in fracture reduction and implant position ($P > 0.05$).

Table 3
Details of early post-operative radiological evaluations for
reduction and fixation quality

	DRTR group	TT group	P-value
Quality of reduction			0.11*
Anatomic	39	19	
Good	14	16	
Poor	3	4	
Quality of fixation			0.93&
Optimal	47	33	
Suboptimal	9	6	
* Fish exact test; & χ^2 test			

As indicated in Table 4, one elderly patient with severe osteoporosis had iatrogenic ASIS fracture and then was assigned into tract table group. Give the ASIS fracture was not complete. The fracture was fixed by suture with 1 – 0 absorbable Ethicon. The ASIS fracture was union 6 weeks after the surgery without pain. Postoperative complications were developed in 14 patients of DRTR group and 7 patients of TT group. No significant differences were found between two groups in postoperative complications ($P > 0.05$). Cut-out of the blade occurred in 3 patients in DRTR group and 2 patients in TT group. Thigh pain was developed in 6 patients in DRTR group versus 3 patients in TT group. After administration of nonsteroidal anti-inflammatory drugs (NSAIDs) and physical therapy, those patients exhibited significant improvement of thigh pain. In DRTR group, four patients suffered from deep vein thrombosis, while this was observed in two patients in TT group.

Table 4
Intraoperative and postoperative complications

	DRTR group	TT group	P-value
Complications			0.83*
Cut-out of the blade	3	2	
Thigh pain	6	3	
Deep vein thrombosis	4	2	
Fracture of ASIS	1	0	
* Fish exact test			

4. Discussion

Based on our knowledge, this is the largest respective study to compare the use of double reverse traction retractor with traction facilitating PFNA- α fixation for the treatment of unstable intertrochanteric fracture.

We found total operative time was shorter for DRTR group compared with TT group. This can likely due to the decreased time required to patients positioning and easy abduction and adduction of the hip joint at will when inserting the guide wire and PFNA- α in DRTR group. In traction table group, the mean duration of patient positioning and fracture reduction was comparable with the published report [7]. However, mean duration of patient positioning in DRTR group was only 6.5 ± 1.2 minutes. This may be attributed to easy double reverse traction retractor assembly. Of note, the decreased operative time was a critical determinant of mortality in surgical treatment of hip fracture, especially for elderly who was extremely sick.

Recently, management unstable intertrochanteric fractures with PFNA- α has been a promising approach[1]. There is growing evidences that excellent intertrochanteric fractures reduction should be performed before intramedullary nailing, otherwise the failure of nail fixation may be inevitable[8]. In this study, we discovered that satisfied clinical efficacy was obtained when unstable intertrochanteric fractures were treated with double reverse traction facilitating PFNA- α . The results showed more than 80% patients obtained excellent-good Harris Hip Scores at the end of follow-up.

The quality of reduction takes the primary responsibility for the ideal position of PFNA- α and superior clinical outcomes. In DRTR group, postoperative X-ray evaluation showed a good-anatomic reduction in 95% of cases and central-central and inferior-central placement of blade in femoral neck was achieved in 47 cases (84%). This methods has obvious advantages over tradition traction table. As traction table usually placed between the perineum and distal extremity, it only produces skin traction force that steps over hip, knee and ankle joints before transmitting to the fracture site by soft tissue. This kind of skin traction may fail to provide sufficient force to correct the angular and rotational displacement[9]. The double reverse traction retractor is fixed to the ASIS and distal femur via traction bow, thereby, a skeletal traction system is formed. Once the distal tract handle was reverse rotated, two opposing directional forces was generated to distract and reduce the displaced intertrochanteric fractures. Therefore, the same reduction outcome can be achieved with less tractive force in patient treated with DRTR compared with traction table, which significantly decreased the occurrence of soft tissue injuries. Moreover, the resistant force by the ASIS via connection rod pulling can counter the distal femoral traction force. Therefore, there is no need to place perineal post required in traction table, which avoids the complication resulted from the compress of labia or scrotum[10]. In our study, no patients in DRTR group suffered from peroneal nerve palsy, perineal ulcers or nerve injury.

When dealing with intertrochanteric fracture reduction, techniques have been employed to correct the varus angulation, external rotation and posterior sag of proximal fragment. Traditionally, the table traction has become a standard procedure for intertrochanteric fracture reduction via longitudinal traction and internal rotation of distal fragment. However, in certain intertrochanteric fracture, the external rotation

of proximal fragment because of forces by the short external rotators of hip can may compromise the reduction[11]. Some authors reported that fracture with more than 2 independent fragments, especially type A2 fracture with a posteromedial fragment, if applying internal rotation to the distal injury limb, can lead to malunion and deformity that need a revision surgery[12]. To avoid that, the surgeon can externally rotate lower injured limb to achieve the ideal reduction, which makes the whole extremity in the external rotation but complicate the implant insertion. With the elevation the injured limb by double reverse traction, the skeletal traction can not only correct the external rotation of proximal fragment to some extent but also lift the level of entry point in the great trochanter to ease the PFNA- β insertion.

This skeletal traction system also allow ipsilateral adduction or abduction required for fluoroscopy and PFNA- β nailing. The injury limb with double reverse traction can be placed in different position and is of great help for PFNA- β nailing. It is believed that the most key step of operation is locating the optimal entry point for PFNA- β insertion. Generally, the best entry point is usually positioned at the top of the greater trochanter or slightly medial[13].Therefore, moderate adduction of hip is required for surgeon to easily locate the top of great trochanter and insert the PFNA- β , especially dealing with fat patients. In the present study, the double traction technology represents a prone method to provide distinct internal rotation of hip for anatomic reduction as well as adduction for optimal insertion of PFNA- β .

It must be noted that one elderly patient from DTRD group had an iatrogenic ASIS fracture. When the DTRD applied in the elderly, the bone mineral density should be perform to rule out the severe osteoporosis, which may increase to ASIS fracture during the skeleton traction. Based on our experience, the technique to prevent ASIS fracture in DTRD group is that the position of drill is recommended more than 3 cm underneath the top surface of ASIS and size of Schantz pin used should be no more than 3-mm.

Although an extra incision of ASIS and drilling in ASIS and femoral condyle were required in DTRD group, no significant differences in mean blood loss and surgical time were found between two groups. The 2-cm incision without further tissue and muscle dissection may cause small amount of blood loss and did not reach the significantly statistical difference. Moreover, the cost of the double reverse device is less than 40.000 Yuan (5000 USD), which is highly cheaper than the traction table. Capital for expensive equipment cost can be saved due to no need of multiple, expensive fracture traction table, which is high cost effective, especially for the developing countries and primary hospital.

This study has several limitations. First, this report is retrospective with inherent drawbacks. Without patients divided randomly, the bias of fracture reduction strategy selection is evitable. An additional limitation was the small sample size and short follow-up in our study. Therefore, a prospective study with more patients enrolled should be conducted in order to further investigate the application of DTRD for the femoral intertrochanteric fracture treatment.

5. Conclusions

Double reverse traction reposer and traction table assisted PFNA- α treatment for unstable intertrochanteric fractures exhibited similarly successful result. However, DRTR is superior to tract table in respect to operative time and duration of patient positioning, despite an additional ASIS incision and drilling of ASIS and femur condyle.

Abbreviations

PFNA- α

Asian proximal femoral nail antirotation nailing; ASIS:anterior superior iliac spine; TT:raction table; DRTR:Double reverse traction repositor .

Declarations

Acknowledgements

Not applicable

Author's contributions

Jingdong Ni contributed to the design and concept of the study. Junjie Wang, Muliang Ding and Jun Huang contributed to the data analysis and interpretation. Mingming Yan and Letian Kuang contributed the patient follow-up. Deye Song contributed to the performance of surgery. All authors contributed to the writing and revisions and final approval of the article.

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Ethics approval and consent to participate

The study protocol was reviewed and approved by the Committee On Ethics board of the second Xiangya hospital of Central South University. Because the study was retrospective, the inform consent was not necessary.

Consent for publication

Not applicable

Declaration of interest

The authors report no conflict of interest.

Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to restrictions e.g. their containing information that could compromising the privacy of research participants.

Competing interests

All authors declares no competing interests.

References

[1]Rozell JC, Hasenauer M, Donegan DJ, Neuman M.Recent advances in the treatment of hip fractures in the elderly.F1000Res 2016; 5.

[2]Palm H, Krasheninnikoff M, Holck K, Lemser T, Foss NB, Jacobsen S, Kehlet H, Gebuhr P.A new algorithm for hip fracture surgery. Reoperation rate reduced from 18 % to 12 % in 2,000 consecutive patients followed for 1 year.Acta Orthop 2012; 83:26-30.

[3]Sahin E, Songur M, Kalem M, Zehir S, Aksekili MA, Keser S, Bayar A.Traction table versus manual traction in the intramedullary nailing of unstable intertrochanteric fractures: A prospective randomized trial.Injury 2016; 47:1547-1554.

[4]Zhang R, Yin Y, Li S, Jin L, Hou Z, Zhang Y.Traction table versus double reverse traction repositior in the treatment of femoral shaft fractures.Sci Rep 2018; 8:5952.

[5]Cleveland M, Bosworth DM, Thompson FR, Wilson HJ, Jr., Ishizuka T.A ten-year analysis of intertrochanteric fractures of the femur.J Bone Joint Surg Am 1959; 41-A:1399-1408.

[6]Schipper IB, Steyerberg EW, Castelein RM, van der Heijden FH, den Hoed PT, Kerver AJ, van Vugt AB.Treatment of unstable trochanteric fractures. Randomised comparison of the gamma nail and the proximal femoral nail.J Bone Joint Surg Br 2004; 86:86-94.

[7]Wang Z, Hao W, Liu D, Zhang K, Jia L, Yang S, Wang Z, Zhang D, Zhang D.Prospective Study of Closed Reduction of Trochanteric Fractures via a Novel Intraoperative Femoral Fracture Reduction Device: Early Clinical Results.J Orthop Trauma 2018; 32:e309-e314.

[8]Jung EY, Oh IT, Shim SY, Yoon BH, Sung YB.The Effect of Valgus Reduction on the Position of the Blade of the Proximal Femoral Nail Antirotation in Intertrochanteric Hip Fractures.Clin Orthop Surg 2019; 11:36-42.

[9]Stephen DJ, Kreder HJ, Schemitsch EH, Conlan LB, Wild L, McKee MD.Femoral intramedullary nailing: comparison of fracture-table and manual traction. a prospective, randomized study.J Bone Joint Surg Am 2002; 84:1514-1521.

[10]Flierl MA, Stahel PF, Hak DJ, Morgan SJ, Smith WR.Traction table-related complications in orthopaedic surgery.J Am Acad Orthop Surg 2010; 18:668-675.

[11]DePalma AA, O'Halloran K, Shenoy K, Gruson KI, Sharan AD.A novel technique for reducing intertrochanteric hip fractures.Am J Orthop (Belle Mead NJ) 2014; 43:402-404.

[12]Riehl JT, Widmaier JC.Techniques of obtaining and maintaining reduction during nailing of femur fractures.Orthopedics 2009; 32:581.

[13]Li M, Wu L, Liu Y, Wang C.Clinical evaluation of the Asian proximal femur intramedullary nail antirotation system (PFNA-II) for treatment of intertrochanteric fractures.J Orthop Surg Res 2014; 9:112.

Figures



Figure 1

Intra-operative view of double reverse traction system application .(A) The double reverse traction system is connected to the ASIS via its proximal insertion and to the distal femur by traction bow at the distal end. (B)The minimal invasive incision for intertrochanteric fracture closed reduction and PFNA-II insertion.

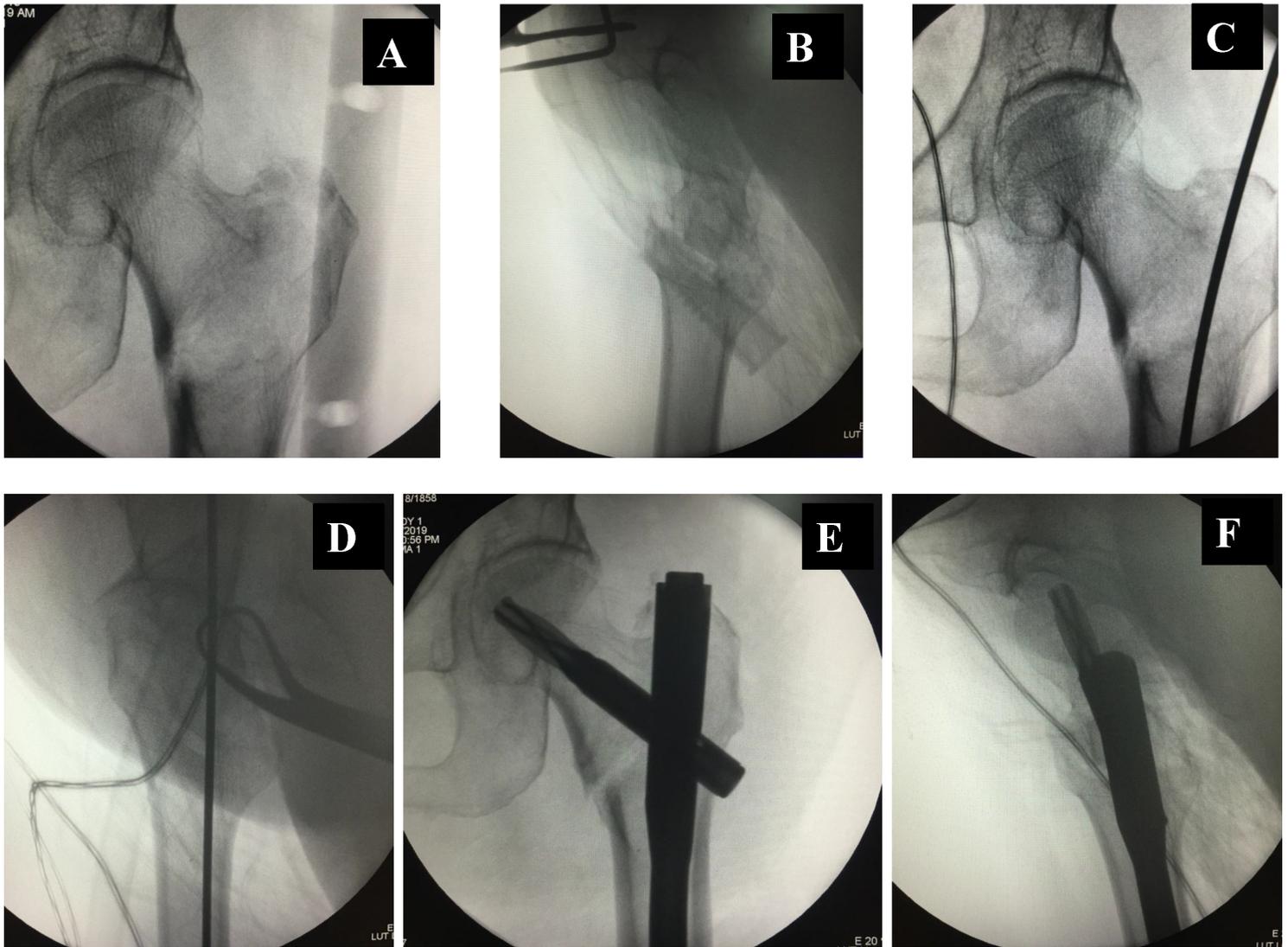


Figure 2

Intro-operative fluoroscopy images. The antero-posterior (A) and lateral (B) radiographic images of closed reduction facilitated by double reverse traction system. Quality of reduction is accepted as "anatomic". The arrow indicated the radiolucent connecting rod . The antero-posterior (C) and lateral (D) radiographic images of the guide wire insertion. The antero-posterior (E) and lateral (F) radiographic images of the PFNA nailing demonstrated the anatomic reduction was maintained by double reverse traction system and fixation quality was excellent.