Original Article

Reverse Contralateral Distal Femoral Locking Compression Plate for Subtrochanteric Femoral Fractures: A Comparative Retrospective Study with Cephalomedullary Nail and Technical Note

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Background: Cephalomedullary nails (CMN) have been proven to be the implant of choice in Subtrochanteric Femoral Fractures. The reverse contralateral distal femoral locking compression plate (DF-LCP) is an alternative fixation in cases that are unsuitable for nailing. The comparative studies made of these two fixation techniques are inadequate.

Objective: To retrospectively analyze and compare the outcomes of these two fixation techniques and demonstrate the apparent surgical technique for applying the reverse contralateral DF-LCP.

Materials and Methods: The present study included patients over 18 years of age diagnosed of subtrochanteric fractures and treated with either DF-LCP or CMN. Retrospective comparative analyses of union time, operative times, estimated blood loss, and complications were conducted from their medical records and serial radiographs. The surgical technique for reverse contralateral DF-LCP fixation is also described in the present study.

Results: The present study enrolled 106 eligible patients, in which 33 patients were treated with reverse contralateral DF-LCP, and 73 patients with CMN. There were no significant differences in age, gender, type of fracture, or history of smoking between the two groups. However, there were significant differences in the requirements of the open reduction technique with 26 fractures (78.8%) in the DF-LCP group and 17 fractures (23.3%) in the CMN group ($p<0.001$). The comparative outcomes of the DF-LCP and CMN groups demonstrated the statistically significant difference in the number of malreductions or malunions, comprising four events (12.1%) and 22 events (30.1%), respectively ($p=0.036$). There were no statistically significant differences in terms of union time, operative time, and the amounts of estimated blood loss.

Conclusion: The reverse contralateral DF-LCP fixation technique demonstrated comparable outcomes in terms of union time, operative time, and blood loss, and was deemed a safe procedure for subtrochanteric femoral fracture. Lower occurrences of malreduction or malunion complication were shown in DF-LCP group.

Keywords: Subtrochanteric fracture; Reverse contralateral distal femoral locking compression plate; Cephalomedullary nail

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Subtrochanteric fractures, characterized by a predominant fracture line within the area of 5 cm below the lesser trochanter, accounted for 20% of non-hip femoral fractures with rising incidence[1,2]. Since high stress concentration and deforming forces at this area, postoperative complications were also frequently reported including malunion, delayed union, nonunion, and implant failure[3-5]. The reduction and fixation techniques of these fractures represent the challenging issues for orthopedic surgeons.

There are several fixation options for subtrochanteric femoral fractures. Cephalomedullary nails (CMN) have been proven to be the implant of choice of these fractures over plate fixation systems[6]. Nevertheless, the plate fixation may be considered in cases unsuitable for nailing, such as patients with narrow femoral canal, or with associated multiple, intracranial, chest, spinal, or pelvic injuries. The proximal femoral locking compression plate was initially intended for managing these situations. However, complications have been frequently reported[7-10]. A reverse contralateral distal femoral locking compression plate (DF-LCP) is another

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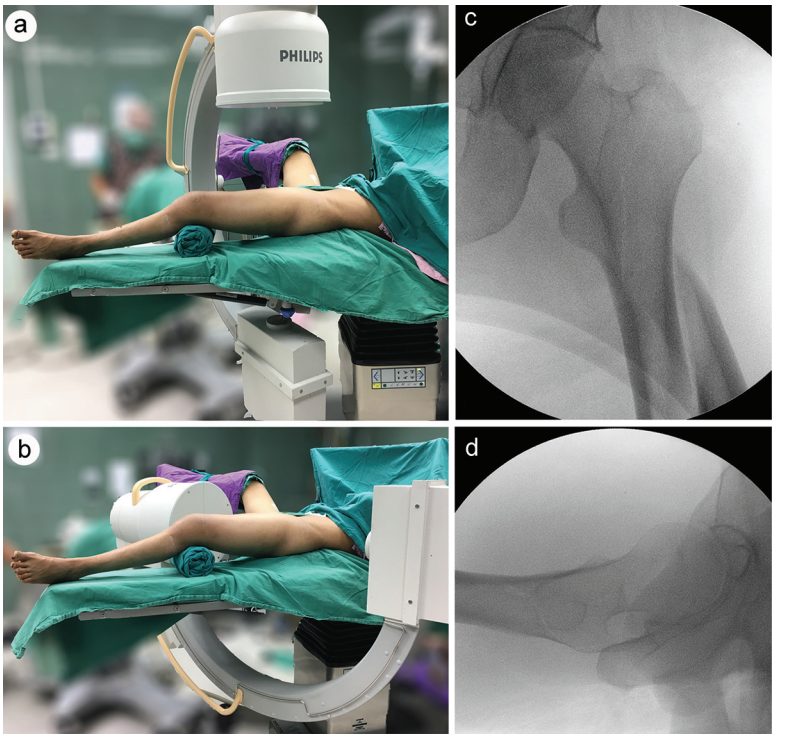

Figure 1. Preoperative positioning for reverse contralateral distal femoral locking compression plating of a subtrochanteric femoral fracture. (a, b) The patient was prepared in the hemi-lithotomy position with popliteal support and verified through intraoperative imaging. (c, d) Intraoperative true anteroposterior and lateral radiographs of the proximal femur.

fixation option that has comparable biomechanics and has revealed satisfactory outcomes[11-14]. However, there exists a lack of comparative study of this fixation technique in CMN. The purpose of the present study was to retrospectively analyze and compare the surgical outcomes of these two fixations and demonstrate the apparent surgical technique of reverse contralateral DF-LCP.

Materials and Methods

Patients were over 18 years of age, diagnosed primarily with open or closed subtrochanteric fracture of the femur and treated with either DF-LCP or CMN, between January 2012 and December 2017, at Khon Kaen Hospital, and were retrospectively analyzed. Their medical records and serial radiographs were reviewed for demographic data, union times, operative times, estimated blood loss, and complications. The protocol of the present study was reviewed and approved by the Ethics Committee of Khon Kaen Hospital, Khon Kaen, Thailand (No. KE61087).

Study participants

The present study included the patients, over 18 years of age, presenting with acute subtrochanteric femoral fracture with or without coexisting non-displaced stable type or reverse oblique type of intertrochanteric fracture, within a week of the sustained injury. Patients were operated with either reverse contralateral DF-LCP or CMN fixation. Exclusion criteria were patients with previous ipsilateral lower limb injury or surgery, metabolic bone disease, pathological fracture, or any co-morbidity that might affect bone healing.

Surgical technique of reverse contralateral distal femoral locking compression plating for subtrochanteric fractures

The patient was set in the hemi-lithotomy position with buttock supported by a sandbag, and the true preoperative anteroposterior and lateral views were obtained and verified with image intensifier. The distal fragment was initially reduced and realigned to the proximal fragment through elevation by popliteal support (Figure 1). The greater trochanter and line of the femoral shaft were superficially identified and outlined. A longitudinal skin incision over the greater trochanter and femoral shaft were performed regarding

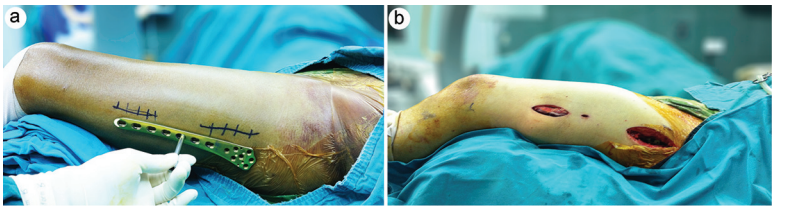

Figure 2. (a) Skin incisions were made in regard to the planned fixation. (b) The final surgical exposure of the subtrochanteric femoral fracture fixation with the reverse contralateral DF-LCP via a minimally invasive technique.

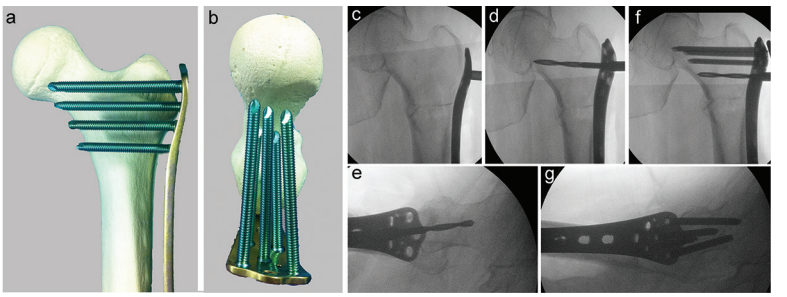

Figure 3. (a, b) Bone-plate models demonstrate the proper plate position, bone-plate curvature, and screws trajectories in the proximal femoral fragment. (c) Intraoperative fluoroscopic imaging of the appropriated plate position. (d, e) Insertion of the first screw in the proximal fragment should be at most center, confirmed by the center alignment of the femoral neck via the lateral view. (f, g) Subsequent screws were inserted sequentially in the proper position.

to preoperative planning (Figure 2). Proximal surgical exposure was performed with a longitudinal split of the proximal part of the vastus lateralis muscle. Either an open or closed reduction, or minimally invasive technique of the displaced fracture was performed depending on the location and complexity of the fracture. The quality of the reduction was checked via an image intensifier. Reverse contralateral DF-LCP was applied by insertion from the proximal surgical exposure, and set in the proper level and position, corresponding to the bone-plate curvature (Figure 3a, c). The first proximal locking screw applied should be the most center one. Confirmation of its direction in the center of the femoral neck was made from an intraoperative lateral view of the image intensifier (Figure 3d, e). The correct trajectory of the first screw acted as the main guidance for subsequent screw insertions. The proximal locking screws were inserted, using the longest length possible, which would not penetrate the far cortex, and avoiding the stress riser effect, which could lead to a peri-implant fracture. The subsequent proximal locking screws were inserted in a convergent direction to the plate design (Figure 3b, f, g). The distal locking screws were then inserted to the distal fragment, respective to their proper sequence, numbers, and figures, via a lateral or posterolateral surgical approach of the femoral shaft. Conventional post-operative care with protected weight bearing ambulation was applied.

Outcome measurement

The baseline characteristics of patients in both the reverse contralateral DF-LCP and CMN groups were recorded including age, gender, number of complex types and open fractures, history of smoking, and the number of open reductions. The comparative outcomes between these two groups were retrospectively recorded from the respective medical records and radiographs. The primary outcome of the present study was union time in weeks. At least three cortices healing in follow-up plain radiographs were defined as the fracture union (Figure 4). Secondary outcomes were operative times in minutes, time from skin incision was made to closure the skin, estimated blood loss in milliliters, numbers of the malreduction or malunion cases, more than 10 degrees of angulation in any directions or more than 15 mm of shortening. Data of any other form of complication were also recorded such as loss of reduction, peri-implant fracture, implant failure, and post-operative surgical site infection.

Statistical analysis

The calculated minimum sample size in each

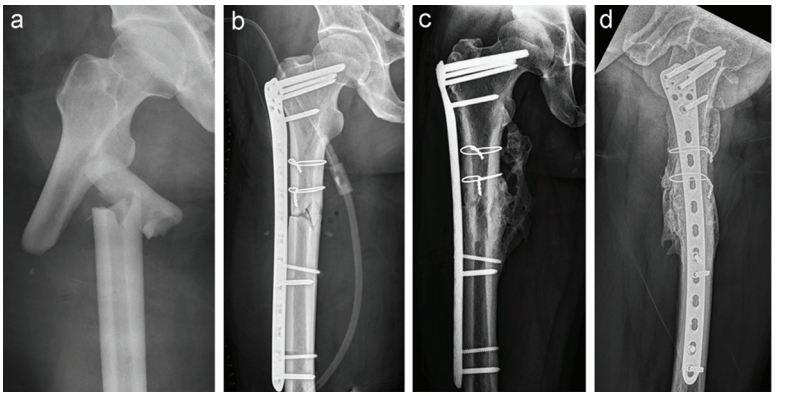

Figure 4. (a) The radiograph of a subtrochanteric fracture in a 28-year-old male patient who sustained a motor vehicle accident. (b) Immediate post-operative radiograph after treatment with reverse contralateral DF-LCP fixation. (c, d) Six-month post-operative radiographs demonstrate complete bone healing with callus formation.

group was 36 fractures. A power of 0.8, with a significance level of α=0.05, and a pooled standard deviation of 4.6 from the previous study of Shin et al, 2017[15] were used for sample size calculation for non-inferiority trial study.

The categorical data were reported as percentages, and the continuous data as both mean and standard deviation. Comparisons of union time, operative time, and estimated blood loss were reported as a mean difference, with a 95% confidence interval using an unpaired t-test or Mann-Whitney U test for the distribution of data. The value of 0.05 was set for α, in which p-value less than 0.05 was considered statistically significant. Numbers of malreduction/malunion and complications were analyzed via chi-square test.

Results

One hundred six eligible patients were enrolled in the present study, in which no patient met the exclusion criteria. Thirty-three patients were treated with reverse contralateral DF-LCP and 73 patients with CMN. The mean age of patients in the DF-LCP group was 45.5±19.3 years, and 47.6±22.1 years in the CMN group. There were 25 male patients (75.8%) in the DF-LCP group and 49 (67.1%) were in the CMN group. There were 20 complex fractures (60.6%) and two open fractures (6.1%) within the DF-LCP group, and 40 complex (54.8%) and eight open (11.0%) fractures in the CMN group. Fourteen patients (42.4%) in the DF-LCP group and 32 patients (43.8%) in the CMN group had a history of smoking. The open-reduction technique was required in 26 fractures (78.8%) in the DF-LCP group and 17 fractures (23.3%) in the CMN group. There were no significant differences in age, gender, type of fracture, or history of smoking between these two groups. However, there was a significant difference in the requirement of the open reduction technique, as shown in Table 1.

Table 1. Demographic characteristics of the eligible patients

Characteristics	DF-LCP (n=33); n (%)	CMN (n=73); n (%)	p-value
Age (years); mean±SD	45.5±19.3	47.6±22.1	0.128
Sex: male	25 (75.8)	49 (67.1)	0.254
Type of fracture			
Complex type	20 (60.6)	40 (54.8)	0.366
Open fracture	2 (6.1)	8 (11.0)	0.343
History of smoking	14 (42.4)	32 (43.8)	0.532
Open reduction	26 (78.8)	17 (23.3)	<0.001

DF-LCP=distal femoral locking compression plate; CMN=cephalomedullary nail; SD=standard deviation

The DF-LCP and CMN groups had union time of 15.3±4.1 and 19.1±5.5 weeks, respectively, without any statistically significant difference (p=0.287). The operative time in the DF-LCP and CMN groups were 97.7±17.7 and 105.6±21.1 minutes, respectively, without statistically significant difference (p=0.102). There was no statistically significant difference (p=0.341) in the amount of estimated blood loss in the DF-LCP at 507.6±151.1 mL and CMN at 459.6±173.3 mL, groups. Regarding postoperative complications, the DF-LCP group demonstrated a statistically significant difference (p=0.036) in the number of malreductions and malunions with four events (12.1%), and postoperative complications with four events (12.1%), compared with the CMN group with 22 events (30.1%), and two events (2.7%),

Table 2. Comparative outcomes of two operative treatments

Outcomes	DF-LCP (n=33); mean±SD	CMN (n=73); mean±SD	Mean difference±SE	95% CI	p-value
Union time (weeks)	15.3±4.1	19.1±5.5	−3.8±1.1	−5.9 to −1.6	0.287
Operative time (minutes)	97.7±17.7	105.6±21.1	−7.8±4.2	−16.2 to 0.5	0.102
Estimated blood loss (mL)	507.6±151.1	459.6±173.3	48.0±35.0	−21.4 to 117.4	0.341
Malreduction/malunion; No. of events (%)	4 (12.1)	22 (30.1)	N/A	N/A	0.036
Complication; No. of events (%)	4 (12.1)	2 (2.7)	N/A	N/A	0.074

DF-LCP=distal femoral locking compression plate; CMN=cephalomedullary nail; SD=standard deviation; SE=standard error; CI=confidence interval; N/A=not available

Figure 5. (a, b) A case of complication after fixation with reverse contralateral DF-LCP, demonstrating the malreduction, malposition, and incorrect direction of the screws in proximal fragment.

respectively, as shown in Table 2. The most common cause of malreduction in the DF-LCP group was the malposition and incorrect application of proximal screws (Figure 5).

Discussion

The present study demonstrated the comparable, non-inferior outcomes of reverse contralateral DF-LCP and CMN fixation for subtrochanteric femoral fractures in the aspects of union time, operative time, estimated blood loss, and complication occurrences under similar baseline characteristics. There were statistically significant differences in the number of open-reduction technique requirements and the number of malreduction or malunion events. Fractures within the DF-LCP group required a significantly higher percentage of the open technique for reduction, as well as a lower percentage of numbers in malreduction or malunion events when compared to CMN group.

The significantly higher numbers of the open reduction procedures in the DF-LCP group that were revealed in the present study have been related to the proximity of the fracture location, as well as the concomitant skin incision, which would not permit a surgeon to perform the closed technique. The surgical outcomes were dependent on several factors, such as the surgical skill and familiarity with fixation technique of the individual surgeon, which should be the important confounding factor. Since malreduction, malposition, and improper plate position were the most frequent complications found within the present study, the quality of reduction and implant placement are the key procedures necessary to achieve a successful outcome. The higher percentage of malreduction in CMN group may have been caused by incorrect entry point of nailing, unreduced proximal fragment before making the entry point, high deforming force in this area, poor surgical technique, or unfamiliarity of nailing technique of individual surgeon.

Regarding the biomechanical issues for these two implants, previous literatures has demonstrated that the locking plate system was a reasonable fixation implant for subtrochanteric fractures, even if they had inferior mechanical properties[16]. Kim et al, 2011[11] conducted the biomechanical study of three implants, a locking plate, a dynamic condylar screw, and a long proximal femoral nail, which are present in subtrochanteric fractures of synthetic bones. The proximal femoral nail contained the strongest construction, and the reverse distal femoral locking plate proved stronger than the dynamic condylar screw. They still recommended the use of a locking plate for subtrochanteric fractures in cases that proved difficult for nailing, or when minimally invasive fixation was needed. Similarly, Wang et al, 2014[17] studied the biomechanical properties of internal fixations in subtrochanteric fractures and determined that the proximal femoral nail and proximal femoral locking plate could provide more stable and reliable

fixation for unstable subtrochanteric fractures. The highest stiffness ratio and failure load were presented in cases of proximal femoral nail fixation.

Several retrospective case series studies have been done of locking plate fixation in subtrochanteric fractures, in which satisfactory outcomes were also generated. Li et al[18] in 2014 presented 26 unstable subtrochanteric fractures, which were fixed via the reverse Less Invasive Stable System-distal femoral plate (LISS-DF). Both the reliable and effective fixations were successfully achieved though this implant. Ma et al, 2010[13] retrospectively reviewed the outcomes of LISS-DF in 20 unstable femoral fractures that were determined to be unsuitable for fixation with the nail system. The results showed satisfactory outcomes in terms of bony union, Park and Palmer mobility scores, and pain. More recently, Jang et al, 2017[12] retrospectively studied about the outcomes of biologic locking compression plate fixation in 28 subtrochanteric femoral fractures. They concluded that this fixation is a safe surgical option for subtrochanteric fractures.

Comparative studies of plate and proximal femoral nail systems have provided similar outcomes. Shin et al, 2017[15] conducted a comparative study between DF-LCP and the intramedullary nail in 81 subtrochanteric patients, demonstrating the similarities in outcomes of the DF-LCP with the intramedullary nail in terms of bony union and time to union. They noted that the coronal alignment was significantly reduced in the DF-LCP group. Comparable results were achieved in the 24 subtrochanteric fractures treated with reversed contralateral DF-LCP studied by Gogna et al, 2015[14]. Imerci et al, 2015[19] conducted a non-randomized comparative study of plating and nailing in 32 subtrochanteric femoral fractures. The plating group demonstrated a significantly longer time of fracture consolidation, greater radiation exposure, and a higher Harris hip score than those of the nailing group.

Alternatively, reverse DF-LCP might also be used for solution procedures in cases of nonunion proximal fractures, including those involving nail fixation[20,21].

Lastly, the present study had a small and insufficient sample size and was therefore conducted as a retrospective study. The authors recommend that further study be designed in a prospective randomized controlled trial to demonstrate the result of surgical outcomes between these two surgical techniques.

Conclusion

The reverse contralateral DF-LCP fixation technique demonstrated comparable outcomes in terms of union time, operative time, and blood loss, and proved to be a safe procedure for subtrochanteric femoral fracture. The malreduction or malunion complication was significantly less in the DF-LCP group, and the surgical technique of the reverse contralateral DF-LCP fixation was systematically described in the present article.

What is already known on this topic?

Cephalomedullary nail is the implant of choice for treating subtrochanteric femoral fracture. The proximal femoral locking compression plate is an alternative implant in case of unsuitable fracture for nailing, but complications were frequently reported.

What this study adds?

The reverse contralateral distal femoral locking compression plate is an alternative implant for fixation of subtrochanteric femoral fracture with satisfactory outcomes when retrospectively compared with cephalomedullary nail.

Conflicts of interest

All authors declare no conflict of interest within this article.

References

1. Ng AC, Drake MT, Clarke BL, Sems SA, Atkinson EJ, Achenbach SJ, et al. Trends in subtrochanteric, diaphyseal, and distal femur fractures, 1984-2007. Osteoporos Int 2012;23:1721-6.
2. Loizou CL, McNamara I, Ahmed K, Pryor GA, Parker MJ. Classification of subtrochanteric femoral fractures. Injury 2010;41:739-45.
3. Toridis TG. Stress analysis of the femur. J Biomech 1969;2:163-74.
4. Bedi A, Toan Le T. Subtrochanteric femur fractures. Orthop Clin North Am 2004;35:473-83.
5. Hak DJ, Wu H, Dou C, Mauffrey C, Stahel PF. Challenges in Subtrochanteric Femur Fracture Management. Orthopedics 2015;38:498-502.
6. Mittal R, Banerjee S. Proximal femoral fractures: Principles of management and review of literature. J Clin Orthop Trauma 2012;3:15-23.
7. Pieske O, Landersdorfer C, Trumm C, Greiner A, Wallmichrath J, Gottschalk O, et al. CT-guided sacroiliac percutaneous screw placement in unstable posterior pelvic ring injuries: accuracy of screw position, injury reduction and complications in 71 patients with 136 screws. Injury 2015;46:333-9.
8. Shah MD, Kapoor CS, Soni RJ, Patwa JJ, Golwala PP. Evaluation of outcome of proximal femur locking compression plate (PFLCP) in unstable proximal

femur fractures. J Clin Orthop Trauma 2017;8:308-12.
9. Glassner PJ, Tejwani NC. Failure of proximal femoral locking compression plate: a case series. J Orthop Trauma 2011;25:76-83.
10. Wirtz C, Abbassi F, Evangelopoulos DS, Kohl S, Siebenrock KA, Krüger A. High failure rate of trochanteric fracture osteosynthesis with proximal femoral locking compression plate. Injury 2013;44:751-6.
11. Kim JW, Oh CW, Byun YS, Oh JK, Kim HJ, Min WK, et al. A biomechanical analysis of locking plate fixation with minimally invasive plate osteosynthesis in a subtrochanteric fracture model. J Trauma 2011;70:E19-23.
12. Jang JH, Ahn JM, Lee HJ, Moon NH. Surgical outcomes of biologic fixation for subtrochanteric fracture using locking compression plates. Hip Pelvis 2017;29:68-76.
13. Ma CH, Tu YK, Yu SW, Yen CY, Yeh JH, Wu CH. Reverse LISS plates for unstable proximal femoral fractures. Injury 2010;41:827-33.
14. Gogna P, Mukhopadhyay R, Singh A, Devgan A, Arora S, Batra A, et al. Contralateral reversed distal femoral locking plate for fixation of subtrochanteric femoral fractures. Chin J Traumatol 2015;18:279-83.
15. Shin WC, Moon NH, Jang JH, Lee HJ, Suh KT. Comparative study between biologic plating and intramedullary nailing for the treatment of subtrochanteric fractures: Is biologic plating using LCP-DF superior to intramedullary nailing? Injury 2017;48:2207-13.
16. Ozkan K, Türkmen İ, Sahin A, Yildiz Y, Erturk S, Soylemez MS. A biomechanical comparison of proximal femoral nails and locking proximal anatomic femoral plates in femoral fracture fixation: A study on synthetic bones. Indian J Orthop 2015;49:347-51.
17. Wang J, Ma XL, Ma JX, Xing D, Yang Y, Zhu SW, et al. Biomechanical analysis of four types of internal fixation in subtrochanteric fracture models. Orthop Surg 2014;6:128-36.
18. Li G, Li Z, Han N, Lu Q. A retrospective analysis of reversed femoral Less Invasive Stable System (LISS) for treatment of subtrochanteric femoral fracture. Int J Surg 2014;12:432-6.
19. Imerci A, Canbek U, Karatosun V, Karapınar L, Yeşil M. Nailing or plating for subtrochanteric femoral fractures: a non-randomized comparative study. Eur J Orthop Surg Traumatol 2015;25:889-94.
20. Dumbre Patil SS, Karkamkar SS, Patil VS, Patil SS, Ranaware AS. Reverse distal femoral locking compression plate a salvage option in nonunion of proximal femoral fractures. Indian J Orthop 2016;50:374-8.
21. Vaishya R, Agarwal AK, Gupta N, Vijay V. Reversed distal femoral locking plate for failed proximal femoral nail with non-union of proximal femoral fractures. Int Orthop 2016;40:1709-15.