ORIGINAL ARTICLE

# Long-term results of reverse Liss plate applied to unstable proximal femur extracapsular fractures in Istanbul, Turkey

Harun Mutlu,[1] Serhat Mutlu,[2] Engin Cetinkaya,[3] Armagan Arslan,[4] Ufuk Ozkaya,[5] Atilla Sancar Parmaksizoglu[6]

## Abstract

**Objective:** To evaluate the results of the minimally invasive internal fixation method using reverse Less Invasive Stabilisation System locking plate in unstable proximal femur extracapsular fractures.

**Methods:** The retrospective study was conducted at Department of Orthopaedics in Taksim Training and Research Hospital (Istanbul, Turkey) and comprised data of patients in whom osteosynthesis was applied with reverse Less Invasive Stabilisation System locking plate for an unstable extracapsular femur fracture between September 2006 and June 2011. Evaluation was made of the fracture reduction quality and degrees of varus-valgus and anteversion-retroversion on the postoperative radiographs which were compared to the healthy hip. At the final follow-up examination, evaluation was made using the Harris Hip Score and Visual Analogue Scale score. The follow-up period ranged from 12 to 35 months.

**Results:** Of the 42 patients, 16 (38%) were females and 26 (62%) were males, with an overall mean age of 64.2±22.25 years (range: 23-97 years). The trauma was low-energy in 24 (57%) patients and high-energy in 18 (43%). Union was achieved in 38 (90%) patients with secondary bone healing in mean 14 weeks (range: 12-20 weeks). Complications were seen in 4 (9%) patients and additional surgical interventions were made. Radiographically, reduction was anatomic in 33 (79%) patients, acceptable in 8 (19%) and poor in 1 (2%). At the 12-month follow-up, the mean Harris Hip Score was 88,6 (range: 59-100) and mean Visual Analogue Scale score was 2.19 (range: 0-9).

**Conclusion:** In the surgical treatment of unstable extracapsular proximal femur fractures, reverse Less Invasive Stabilisation System plate could be easily applied with a minimally invasive fixation method as an alternative to other treatment methods with successful results.

**Keywords:** Less-invasive stabilisation system (LISS), Minimally invasive osteosynthesis, Proximal femur, Unstable fracture. (JPMA 66: 1142; 2016)

## Introduction

The surgical treatment choices for unstable proximal femur fractures include angled plates, sliding hip screw-plate (HSP) systems, intramedullar (IM) nailing, external fixators and arthroplasty.[1] However, as several complications may be encountered with all these methods, there is still no ideal treatment choice.[2,3] The anatomic structure of the region and biomechanical properties make treatment difficult and increase the risk of complication-related additional surgical interventions.[4,5] However, in patients with unstable fracture patterns, the results have been poor due to sliding HSP systems and IM nails-related failure and lag screw cut-out.[6] Possible disadvantages of arthroplasty include prolonged operative time, higher intraoperative blood loss, hip dislocation and increased risk of infection.[1]

[1,4-6]Taksim Training and Research Hospital, Department of Orthopaedics, [2]Kanuni Sultan Süleyman Training and Research Hospital, Department of Orthopaedics, [3]Baltalimani Training and Research Hospital, Department of Orthopaedics, Istanbul, Turkey.

**Correspondence:** Serhat Mutlu. Email: serhatmutlu@hotmail.com

Locking plate systems are widely used in the treatment of unstable, complex proximal femur fractures.[7,8]

The Less Invasive Stabilisation System (LISS) (Depuy Synthes, Stratec Medical Ltd, Mezzovico, Switzerland) has been developed for use in the treatment of distal femur fractures. In the treatment of proximal femur fractures where nails cannot be applied within the canal because of increased anterior bowing of the femur, the use of an opposite extremity distal femur LISS plate has been described.[9] The sagittal bow of the femur, however, remains a concern with IM nails because the choices for implant curvature not only vary with manufacturers, but also can vary in accordance with the technique of insertion. The sagittal bow of the femur can also affect the level of difficulty of IM nail insertion.[10] Using a minimally invasive technique following indirect reduction achieves protection of the periosteal blood flow. The advantages of the reverse LISS plate application is the capability to advance screws in different planes and that it provides the possibility of biplanar fixation.[9,11]

The current study was planned to assess our results with reverse LISS locking plate (minimally invasive internal

fixation) as an alternative surgical technique in the treatment of unstable proximal femur fractures.

## Materials and Methods

The retrospective study was conducted at Department of Orthopaedics in Taksim Training and Research Hospital (Istanbul, Turkey) and comprised data of patients in whom osteosynthesis was applied with reverse LISS locking plate for unstable extracapsular femur fracture between September 2006 and June 2011. From the total patients presenting at our hospital, retrospective evaluation was made of patients who met the inclusion criteria according to which the fracture had to be unstable, as described by Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification (AO type 31.A 2.2, 31.A3.1 and 31.A3.3), the patient did not have dementia and was able to walk before the trauma. Patients with open fractures, pathological fractures, paediatric fractures, infection in the soft tissue or skin around the incision area, multiple injuries or those with less than one year of follow-up were excluded.

Approval for the study was granted by the Local Institutional Review Board.

On presentation, anterior-posterior (AP) and lateral radiographs were taken of both hips and AP radiographs of the femur on the fracture side, including the hip, in all patients (Figure-1). Of the patients included some had an intra-articular fracture in the lower third of the radius (classified as polytrauma) and these were treated in the same session as the femoral fractures.

For all the patients hospitalised for surgery, if there was no impediment, deep vein thrombosis (DVT) prophylaxis was started with low molecular weight heparin at a dose set by the weight of the patient on the day of admission and was continued for 3 weeks. Preoperatively, a single dose of 2g of first-generation cephalosporin was administered intravenously (IV).

The patient was placed on the fracture table. The fracture was reduced by manipulating the limb under fluoroscopic guidance. From a small incision (4-5cm) that was made at the level of the greater trochanter, the plate was inserted along the femoral shaft from proximal to distal under image-intensifier guidance and with the aid of an insertion handle that also served as a target device for the application of the distal shaft screws. The plate was temporarily secured with Kirschner wires. The self-drilling/self-tapping screws were then applied to the proximal fragment and finally to the shaft using the target device (Figure-2).

The quality of reduction was classified according to the degree of varus-valgus and anteversion-retroversion on the postoperative AP and lateral radiographs compared to the healthy hip (Figure-3). Up to 5° was classified as anatomic, 5°-10° as acceptable and over 10° as poor reduction.[12]

From the second day onwards, all the patients were mobilised on crutches with partial weight-bearing (just standing bedside with bilateral feet). Measurement of bone union was made clinically by full weight-bearing with no pain in the fracture area and radiologically by the visualisation of callus tissue on at least two cortices on radiographs.[13] From the second month onwards, 15-20% weight-bearing was started regardless of radiological healing and from the third month, weight-bearing as tolerated was started with a single crutch.

At the 12-month follow-up, the patients were evaluated functionally with the Harris Hip Score (HHS) and according to the Visual Analog Scale (VAS) score.[14,15] This procedure is a routine in the clinc for all patients undergoing hip surgery.

For statistical analyses, SPSS 20 was used. Descriptive data was expressed as mean and standard deviation. The distribution of data was examined with the Kolmogorov Smirnov test. In repeated measurements, paired sample t test was used.

## Results

Of the 250 patients having reported to the hospital, 42(16.8%) were included. Of them, 16 (38%) were female and 26 (62%) were male, with an overall mean age of 64.2 ± 22.25 years (range: 23-97 years). Low-energy trauma such as a fall while walking was seen in 24 (57%) cases, and high-energy trauma such as traffic accidents, work

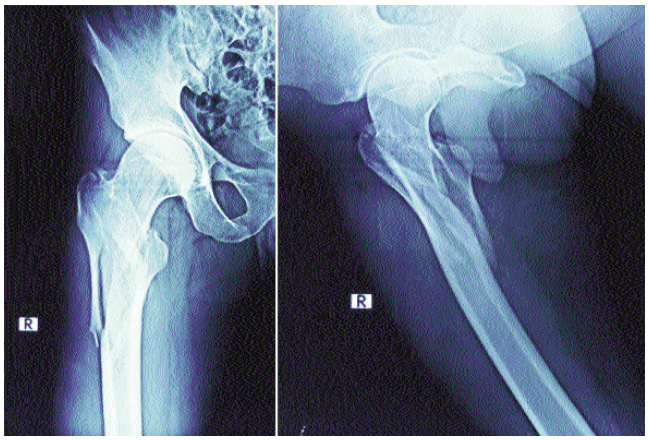


**Figure-1:** Anteroposterior and lateral radiographs illustrates an Arbeitsgemeinschaft für Osteosynthesefragen (AO) A3.3 unstable intertrochanteric fracture in a 48-year-old male patient.

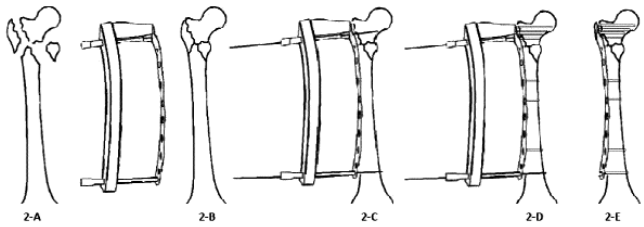


**Figure-2:** Application of the reverse Less Invasive Stabilisation System (LISS) plate system. 2-A) Illustration showing an unstable proximal femur fracture. 2-B) Fracture reduced on the fracture table and reverse LISS plate prepared.2-C) The plate was inserted along the femoral shaft from proximally to distally with the aid of an insertion handle and the plate was temporarily secured with Kirschner wires. 2-D) The proximal and distal fragment was fixed with the locking screws. 2-E) After fixation insertion handle and Kirchner wires were removed.

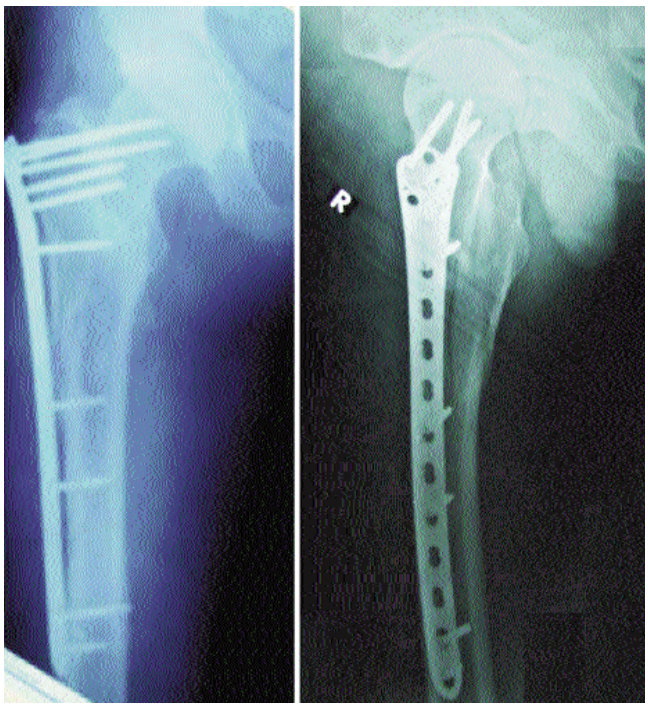

**Figure-3:** Immediate postoperative radiographs show reduction and internal fixation of the fracture using reverse Less Invasive Stabilisation System (LISS) locking plate.

accidents and falls from height in 18 (43%) cases. According to AO classification, 18 (43%) patients were determined with Type 31.A3.1, 17(40%) patients with Type 31.A3.3 and 7 (17%) patients with Type 31.A2.2 fractures.

The mean duration from trauma to surgery was 5.4 ± 3,4 days (range: 1-15 days). Most elderly patients were evaluated by an Internal Medicine team to prevent the intraoperative or postoperative complications that can result from prefracture medical problems. The average

**Figure-4:** Postoperative radiograph obtained at 18 months shows solid union of the fracture.

length of hospitalisation was 16,8 ±10,1 days (range: 7-27 days); extended stays were due to medical problems rather than surgical complications.

The mean follow-up period was 22.7± 7.44 months (range: 12-35 months). The mean operating time was 47 ± 19.3 minutes (range: 23-72 minutes). Union was achieved in 38 (90%) patients with secondary bone healing in mean 14 ± 2.53 weeks (range: 12-20 weeks). Additional surgical intervention was necessary in 4 (9%) patients. In the early postoperative radiographs, reduction was seen to be anatomic in 33 (79%) patients, acceptable in 8 (19%) and poor in 1 (2%).

In the first patient, due to the development of infection on the 13th day, an external fixator was applied following extraction and debridement, then when union was

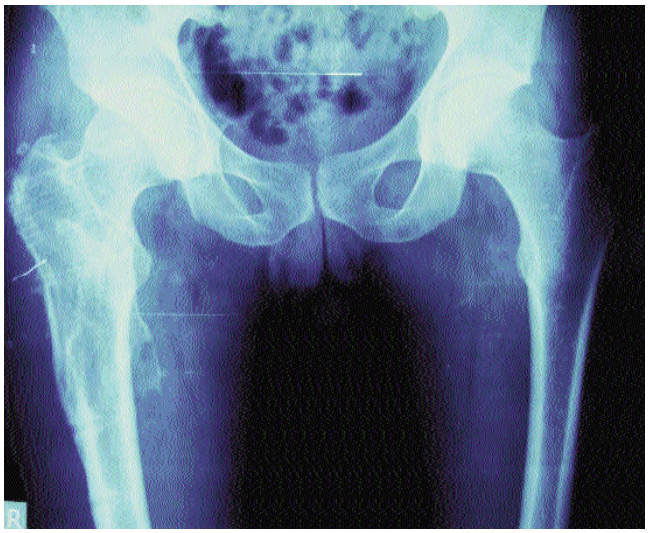

**Figure-5:** Anteroposterior radiographs of both hips after extraction at 24 months postoperatively.

achieved clinically and radiologically at 6 months, the external fixator was removed. In the second patient to whom the 13-hole LISS plate was applied, a peri-implant fracture developed as the result of a fall at the end of the 6th month. Following extraction and revision with LISS plate, union was achieved in the 10th month. In the third patient, there were surgical technique errors. As the screws placed in the proximal were short and unlocked, there was insufficient pull and as the most distal screw was not placed in the screw hole, implant failure developed in the proximal of the plate in the early period. Through plate extraction and applying osteosynthesis with proximal femoral nail (PFN), union was achieved in the 5th month. In the fourth patient re-operation was due to insufficient union on the fracture line at the end of 7 months and as the patient had clinical pain, an augmentation procedure was applied with autologous spongeous bone graft. On the 12-month follow-up radiographs, there was sufficient union and the patient had no complaints of pain.

In the early periods of the study, technical errors were seen due to the learning curve of different surgeons performing the operation. Only 1 patient devoloped implant failure and revision was done with PFN; in 2 patients, the apparatus broke intraoperatively and the broken pulling screw was left in the bone; and in another patient, one of the screws located in the proximal from the femoral neck towards the head was seen to be outside in the lateral plane but as the fracture fixation was considered sufficient, no additional intervention was made.

Avascular necrosis in the femoral head was not seen in any patient. Trochanteric bursitis developed in 7 (16%)

**Figure-6:** Clinical photographs of the same patient after implant extraction.

**Table:** Collodiaphyseal angles measured postoperatively and at the follow-up examinations.

| | Postoperatively | 1.Examination | 2. Examination | 3. Examination |
|---|---|---|---|---|
| Mean Collo-diaphyseal angle | 134 º | 130.8 º | 130.5 º | 130.3 º |

patients associated with irritation on the trochanter major by the LISS plate. The patients in whom trochanteric bursitis developed had complaints of pain and sound coming from the trochanteric area when walking. Therefore, at postoperative mean 18 months (range: 16-21 months) extraction operation was performed on all the 7 patients with trochanteric bursitis, after fracture healing was observed radiologically and clinically (Figures 4-6). In the other patients, no fracture reduction loss was seen on the radiological evaluations in the early postoperative period or at the final follow-up examinations.

The collodiaphyseal angles were measured in all the patients in the early postoperative period and at 1, 3 and 6 months of follow-up examinations. In the early postoperative period, the mean measurement was 134°, at 1 month 130.8°, at 3 months 130.5° and at 6 months 130.3° (Table). The change in angle of 4 degrees provided a support to the incurred loss of medial cortial support. The mean collodiaphyseal angle was 134.2º in the operated hips and 134.1º in the healthy hips and the difference was not statistically significant (p=0.940).

At the 12-month follow-up, mean HHS was 88.6± 12.86 (range: 59-100) and mean VAS was 2.19 ± 2.56(range: 0-9). The patients who had developed trochanteric bursitis had complaints of pain.

## Discussion

For successful results in the surgical treatment of unstable intertrochanteric fractures, it is necessary to have careful preoperative planning, to choose the appropriate implant and to use the surgical technique with care.[3,5-7] Dynamic hip screw (DHS) is the most commonly used implant in the treatment of intertrochanteric fractures and is still the accepted gold standard in stable fractures (AO/American Orthopaedic Trauma Association [OTA] A1 and A2.1) in this area.[16] However, it has been suggested that the use of this implant is not appropriate in unstable fractures (AO/OTA A2.2 and A2.3, AO/OTA 31-A3).[13] In the treatment of AO/OTA A1 and A2 fractures, no significant difference has been revealed in terms of fracture healing and function between plate application and proximal femoral nailing, but in reverse oblique, unstable (A3) fractures in particular, proximal femoral nailing has been reported to have a shorter operating time, easier reduction, less blood loss and a shorter hospital stay.[6,17,18]

The biological advantage of the reverse LISS method which is different from nailing is avoiding distruption of the IM canal. With the aid of a guiding system, it is possible to apply the plate submuscularly. As the screws are percutaneous, they can be applied with small incisions. This technique[19] is compatible with the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique, which reduces soft tissue damage to a minimum. Stress forces in the fracture side are very low because of the bridging effect of the plate and that there is no contact between the bone and the plate in the fracture side. As the plate is flexible, greater loads can be transferred to the bone and more movement is created in the fracture fragments, the result of which is secondary healing.[20-22]

A study of 214 hip fractures treated with 135° 4-hole DHS reported that re-operations were necessary because of failure in 5(3%) of 168 patients with an intact lateral wall, and in 10(22%) of 46 patients with a fracture of the lateral wall. The integrity of the lateral wall was reported to be the most important factor indicating re-operation in intertrochanteric fractures.[16,23] In a study of 46 unstable intertrochanteric fractures with fractured lateral wall, union was achieved with osteosynthesis with a trochanteric stabilisation plate combined with DHS and the authors drew attention to the importance of the lateral wall.[24] Gundle et al. emphasised that it was possible to minimise fixaton-related failure with fixed-angle implants in unstable intertrochanteric fractures.[25] In our study, in 1 patient who had undergone osteosynthesis operation with DHS at an external centre despite a lateral wall fracture and who developed implant failure with non-union in the 4th postoperative month, osteosynthesis revision was applied with reverse LISS plate and union was achieved in the 2nd month postoperatively.

Acklin et al. reported that re-operation was necessary in 2 patients of a series of 14 unstable fractures treated with the reverse LISS method. In 1 of the patients, the failure was due to insufficient reduction of the fracture and insufficient fixation, but in the other, the fracture line extended to the femoral neck and after the implant failure it was necessary to apply arthroplasty.[26] In our study, the vast majority of the additional surgical interventions were not due to the implant, but were seen to originate from

errors of technique at the reduction and fixation stages.

Hasanboehler et al. reported the surgical technique and results of patients treated with proximal femoral locking compression plate (PF-LCP) system.[7] Open reduction with a standard lateral approach and stable fixation together with early aggressive movements were recommended for unstable fractures. However, in the PF-LCP plate, only 3 screws can be sent to the proximal fragment in a single plane. The advantage of the reverse LISS plate system compared to the PF-LCP plate is that it can be used through a minimally invasive technique and with the possibility of biplanar use of 7 locking proximal screws when needed, and overall a more stable osteosynthesis is provided.

There is limited information in literature related to LISS applications in femoral upper third fractures. The application of reverse LISS in subtrochanteric fractures of patients with osteoporosis has been reported in 3 cases.[27,28] J.R. Pryce Lewis et al. reported the use of reverse LISS as an example of an orthopaedic approach with damage control in a segmental femur fracture which developed in a polytraumatised patient.[29]

In a study by Han et al. comparing the reverse LISS system with proximal femoral nail antirotation (PFNA) in the treatment of proximal femoral fractures, although it was emphasised that while early weight-bearing accelerated bone union in the PFNA patients, the LISS system was reported to be more effective in the prevention of coxa vara of the hip and provided more stable osteosynthesis in osteoporotic patients.[30] In our study only one patient had a poor reduction after surgery.

Mehlhorn et al. reported the results of revision surgery using reverse LISS plate applied to 10 osteoporotic patients in whom implant failure developed after treatment with other internal fixation methods and the method was reported to be a salvage method in patients with circulation problems or low bone quality.[31]

Although the biological and biomechanical superiority of IM nailing techniques is supported in literature in the treatment of extracapsular unstable intertrochanteric fractures, the intramedullar nailing technique is not suitable for fractures extending to the priformis fossa or for fragmented fractures in the trochanter major, in patients with excessive anterior bowing of the femur, in patients with chest trauma or polytrauma which would contra-indicate the IM reaming procedure in terms of emboli, or in patients with a narrow (<8mm) IM canal. In these patients, osteosynthesis with reverse LISS plate applied with an appropriate MIPO technique is a successful method with high union rates, shorter hospital stay and less blood loss.[32-34] In our cases, there was anterior bowing of the femur in 11 (26%) patients and polytrauma in 1. Embolism was not observed in any case.

Despite the advantages, failure may develop in the system. This technique does not guarantee fracture healing or the prevention of implant failure. Full weight-bearing before fracture healing is observed radiologically has been reported to be a possible reason for implant failure.[32-34] In our study, 15-20% weight-bearing with a single crutch was started from the 2nd postoperative month without waiting for radiological healing, and full weight-bearing was permitted from the 3rd month, and only one implant failure was encountered.

## Conclusion

The LISS plate screw system can be thought of as an alternative treatment to other methods in proximal femur fractures, providing reliable stabilisation, reducing the rates of complications, and allowing for early movement and secondary bone healing. However, further randomised studies are needed to confirm and clarify these results with comparisons of various methods of fixation.

## References


1. Bonnevialle P, Saragaglia D, Ehlinger M, Tonetti J, Maisse N, Adam P, et al. Trochanteric locking nail versus arthroplasty in unstable intertrochanteric fracture in patients aged over 75 years. Orthop Traumatol Surg Res 2011; 97 (6 Suppl): S95-100.
2. Baumgaertner MR. The pertrochanteric external fixator reduced pain, hospital stay, and mechanical complications in comparison with the sliding hip screw. J Bone Joint Surg Am 2002; 84: 1488.
3. Adams CI, Robinson CM, Court-Brown CM, Mc Queen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. J Orthop Trauma 2001; 15: 394-400.
4. Ahrengart L, Tornkvist H, Fornander P, Thorngren KG, Pasanen L, Wahlström P, et al. A randomized study of the compression hip screw and Gamma nail in 426 fractures.Clin Orthop 2002; 401: 209-22
5. Ekstrom W, Karlsson-Thur C, Larsson S, Ragnarsson B, Alberts K A. Functional outcome in treatment of unstable trochanteric and subtrochanteric fractures with the proximal femoral nail and the Medoff sliding plate. J Orthopaedic Trauma 2007; 21: 18-25
6. Sadowski C, Lubbeke A, Saudan M, Riand N, Stern R, Hoffmeyer P.Treatment of reverse oblique and transverse intertrochanteric fractures with use of an intramedullary nail or a 95 degree screw-plate: a prospective, randomized study. J Bone Joint Surg Am 2002; 84: 372-81
7. Hasenboehler EA, Agudelo JF, Morgan SJ, Smith WR, Hak DJ, Stahel PF. Treatment of complex proximal femoral fractures with the proximal femur locking compression plate. Orthopedics 2007; 30: 618-23.
8. Erhardt JB, Grob K, Roderer G, Hoffmann A, Forster TN, Kuster MS. Treatment of periprosthetic femur fractures with the non-contact bridging plate: a new angular stable implant. Arch Orthop Trauma Surg 2008; 128: 409-16.
9. Zhang CQ, Sun Y, Jin DX, Yao C, Chen SB, Zeng BF. Reverse LISS

plating for intertrochanteric Hip Fractures in elderly patients. BMC Musculoskeletal Disorders 2010, 11:166
10. Buford WL Jr, Turnbow BJ, Gugala Z, Lindsey RW. Three-dimensional computed tomography-based modeling of sagittal cadaveric femoral bowing and implications for intramedullary nailing. J Orthop Trauma 2014; 28: 10-6.
11. Tarnowski JR, Holck KL. Osteosynthesis of a periprosthetic fracture of the proximal femur with the distal femur LISS system. Acta Orthop Belg. 2008; 74: 125-7.
12. Schipper IB, Steyerberg EW, Castelein RM, van der Heijden FH, den Hoed PT, Kerver AJ, et al. Treatment of unstable trochanteric fractures. Randomized comparison of the gamma nail and the proximal nail. J Bone Joint Surg Br 2004; 86-B: 86-94.
13. Haidukewych GJ, Israel TA, Berry DJ. Reverse obliquity fractures of the intertrochanteric region of the femur. J Bone Joint Surg 2001; 83-A: 643-50
14. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An endresult study using a new method of result evaluation. J Bone Joint Surg Am 1969; 51: 737-55.
15. McQuay H, Moore A. An Evidence-Based Resource for Pain Relief. Oxford: Oxford University Press; 1998
16. Lorich DG, Geller DS, Nielson JH. Osteoporotic Pertrochanteric Hip Fractures. Management and Current Controversies. J Bone Joint Surg Am 2004; 86: 398-410.
17. Barton TM, Gleeson R, Topliss C, Greenwood R, Harries WJ, Chesser TJ. A comparison of the long gamma nail with the sliding hip screw for the treatment of AO/OTA 31-A2 fractures of the proximal part of the femur: a prospective randomized trial. J Bone Joint Surg Am 2010; 92: 792-8.
18. Taylor DC, Erpelding JM, Whitman CS, Kragh JF Jr. Treatment of comminuted subtrochanteric femoral fractures in a young population with a reconstruction nail. Mil Med 1996; 161:735-8.
19. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique? J Orthop Trauma 1999; 13: 401-6.
20. Cegonino J, Aznar JMG, Doblare M, Palanca D, Seral B, Seral F. A Comparative Analysis of Different Treatments for Distal Femur Fractures using the Finite Element Method. Computer Methods in Biomechanics and Biomedical Engineering 2004; 7: 245-56.
21. Duffy P, Trask K, Hennigar A, Barron L, Leighton RK, Dunbar MJ. Assessment of fragment micromotion in distal femur fracture fixation with RSA. Clin Orthop Relat Res 2006; 448: 105-13
22. Buton G, Wolinsky P, Hak D. Failure of Less Invasive Stabilization System Plates in the Distal Femur A report of four cases. J Orthop Trauma 2004; 18: 565-70
23. Palm H, Jacobsen S, Sonne-Holm S, Gebuhr P. Hip Fracture Study Group. Integrity of the lateral femoral wall in intertrochanteric hip fractures: an important predictor of a reoperation. J Bone Joint Surg Am 2007; 89: 470-5.
24. Gupta RK, Sangwan K, Kamboj P, Punia SS, Walecha P. Unstable trochanteric fractures: the role of lateral wall reconstruction. Int Orthop 2010; 34: 125-9
25. Gundle R, Gargan MF, Simpson AH. How to minimize failures of fixation of unstable intertrochanteric fractures. Injury 1995; 26: 611-4.
26. Acklin YP, Bereiter H, Sommer C. Reversed LISS-DF in selected cases of complex proximal femur fractures. Injury 2010; 41: 427-9.
27. Ramakrishnan M, Shaw NJ. Bilateral reverse femoral Liss plate fixation for pathological proximal femoral fracture in a case of osteopetrosis. Orthop Proc 2006; 88.
28. Sidhom SA, Pinder R, Shaw DL. Reverse LISS plate stabilisation of a subtrochanteric fracture of the femur in a patient with osteopetrosis: Is this the answer? ?njury Extra 2006; 37: 113-5
29. Pryce Lewia JR, Ashcroft GP. Reverse LISS plating for proximal segmental femoral fractures in the polytrauma patient: A case report. Injury 2007; 38: 235-9
30. Han N, Sun GX, Li ZC, Li GF, Lu QY, Han QH, et al. Comparison of proximal femoral nail antirotation blade and reverse less invasive stabilization system-distal femur systems in the treatment of proximal femoral fractures. Orthop Surg 2011; 3: 7-13
31. Mehlhorn AT, Strohm PC, Müller CA, Konstantinidis L, Schmal H, Südkamp NP. The reversed locked internal plate fixator as an alternative internal fixation of problematic proximal femur fractures. Z Orthop Unfall 2009; 147: 561-6.
32. 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.
33. Zhou F, Zhang ZS, Yang H, Tan Y, Ji HQ, Guo Y, et al. Less invasive stabilization system (LISS) versus proximal femoral nail anti-rotation (PFNA) in treating proximal femoral fractures: a prospective randomized study. J Orthop Trauma 2012; 26: 155-62
34. Quyang Y, Wang Y, Fan C, Liu Z, Liu S, Li F. Using the contralateral reverse less invasive plating system for subtrochanteric femur fractures in elderly patients. Med Princ Pract 2012; 21: 334-9.