



LISS plate for treatment of distal femur fracture. Clinical and functional outcomes

Juan Miguel RODRÍGUEZ-ROIZ, Roberto SEIJAS, Pilar CAMACHO-CARRASCO, José Alonso ZUMBADO,
Andrea SALLENT, Oscar ARES-RODRÍGUEZ

From the Department of Orthopedic Surgery and Trauma, Hospital Clinic de Barcelona, University of Barcelona, Spain

The aim of the present study is to evaluate the use of the Less Invasive Stabilization System (LISS) plate for distal femoral fractures, examining variables such as type of fracture and length of plate.

A retrospective study of 30 patients with a distal femoral fracture, treated with a distal femur LISS plate (Synthes) was performed. Average age was 71 years old (20-101). According to the AO classification, 16 fractures were type A, 5 type B, and 9 type C. The consolidation index and clinical outcomes measured with Knee Society Score (KSS) questionnaire were evaluated.

Fracture consolidation took an average time of 16 weeks (14-20). Mean KSS was 77,3 (50-97) at the 2-year follow-up visit, observing better outcomes on type C fractures (84,25). According to the KSS score, only two cases were described with bad functional outcomes (6%).

Distal femur fractures treated with the LISS plate achieved 94% of good and acceptable outcomes. Unlike the previously published, the best results were obtained with AO type C fractures, probably associated to the lower age (mean 53 years old) and better functional recovery capacity of this group.

Keywords : LISS plate ; distal femoral fracture ; femur ; Knee Society Score ; outcomes.

INTRODUCTION

In recent years the research for minimally invasive systems in the treatment of fractures has increased,

*No benefits or funds were received in support of this study.
The authors report no conflict of interests.*

allowing optimum internal fixation and recovery of the integrity of the affected joint with less surgical incisions and low soft tissue damage, emerging devices such as LISS (Less Invasive Stabilization System) *Synthes* plate (West Chester, PA. USA).

The LISS plate was initially used in proximal tibial fractures, and later with supracondylar femur fractures, especially fractures associated with osteoporosis, obtaining better outcomes in these patients (11,15).

According to previous biomechanical studies (8,16), the LISS plate has shown similar load resistance compared to other devices used in fractures of the distal femur, such as condylar plate 95° and DCS (Dynamic Condylar Screw), with

- Juan Miguel Rodríguez-Roiz¹.
- Roberto Seijas².
- Pilar Camacho-Carrasco¹.
- José Alonso Zumbado¹.
- Andrea Sallent³.
- Oscar Ares-Rodríguez¹.

¹ Department of Orthopedic Surgery and Trauma, Hospital Clinic de Barcelona, University of Barcelona, Spain.

² Fundación García Cugat, Hospital Quirón, Barcelona, Spain.

³ Hospital Vall d'Hebron, Barcelona, Spain.

Correspondence : Juan Miguel Rodríguez-Roiz, Department of Orthopedic Surgery and Trauma, Hospital Clinic de Barcelona, University of Barcelona, Spain. C/Villaruel 17, Postal Code 08036. Tel: 0034-717122032

E-mail : jmleon41@gmail.com

© 2018, Acta Orthopaedica Belgica.

greater stability to torsional forces and axial load (12,20).

The fracture consolidation rates of LISS plates in previous studies accounts for 80% (1,20). There is a complication rate of 20% according to the literature, being the main complication described within its technique fracture nonunion (with implant rupture or loosening) and malalignment (10).

The aim of the present study is to relate the complexity of the femoral distal fracture (classified according to the AO classification) and the length of the LISS plate used, with subsequent clinical-functional short-medium term outcomes (measured by test Knee Society Score (KSS), rate of fracture healing and complications (if any).

MATERIALS AND METHODS

A retrospective study of all patients with femoral distal fracture surgically treated in our center using LISS plate between September 2010 and September 2014 was performed. Inclusion criteria were: distal femur fracture treated by LISS plate, patient over 18 years old and minimum follow-up of two years. Exclusion criteria were: pathological fractures (Paget's disease, metastatic fractures, etc), peri-prosthetic or peri-implant fractures and distal femoral fracture treated with another type of treatment (other surgical implant or conservative treatment).

Fifty cases were reviewed, and 30 patients were finally included, with an average age of 71 years old (20-101 a). 90% of patients were women (27/3).

In relation to relevant associated comorbidities, 17 patients had previous diagnosis of osteoporosis (osteoporotic fracture densitometry or prior), 20 had hypertension and 7 Diabetes mellitus type II.

Fractures were described according to AO classification: extra-articular fractures (type A), partial articular affection (type B) and complete

articular affection (type C). Table I show the distribution of fractures within our sample. Most cases (24/30) were caused by low-energy trauma (fall from standing), and the remaining 6 by high-energy trauma (traffic accidents, high fall).

The average time between admission to the emergency room and surgery was four days (3-7 d). Cases were divided into two groups based on the LISS plate length used (counting number of holes). For the present study, short plate was defined as 5-10 holes (13 cases), and long plate as 11-16 holes (17 cases).

In all patients a fluoroscopy-guided reduction was performed, without using the distractor or provisional AO external fixator. The same surgical technique performed by the same surgical team, was carried out in all patients : first, the patient is placed supine with knee flexion at 60 °, lateral knee approach, temporary fixation of fracture fragments with Kirschner wires and subvastus LISS plate insertion. No grafts were required. All surgeries were performed at the same center. The leading surgeon chose the length of the plate intraoperatively, based on the type of fracture, following the guidelines of our service.

During postoperative care, patients were an average time of eight weeks with non-bearing of the affected limb (4-16 weeks), due to the high mean age of patients included (71 years old) and the difficulty in many cases of performing an partial weight-bearing, authorizing to start full weight bearing when the radiological callus was observed. The same physical therapy protocol was used in all patients, using continuous passive motion (CPM) by Kinetec during the first two postoperative weeks.

An X-ray (Fig. 1) was performed to all patients, following the follow-up protocol, at immediate postoperative, and further on at two, six and twelve months after surgery. Two years after surgery, the KSS questionnaire was given to all patients. This

Table 1. — Clinical and functional outcomes associated with LISS plate length

LISS plate length	Number of cases	Medium age (years old)	KSS (2 year post-op)	Consolidation time (weeks)	Pseudoarthrosis	Infection
Short	13	71,88	75	14	1	1
Long	17	73,95	79	20	0	0

LISS : less invasive stabilization system ; KSS : Knee Society Score.

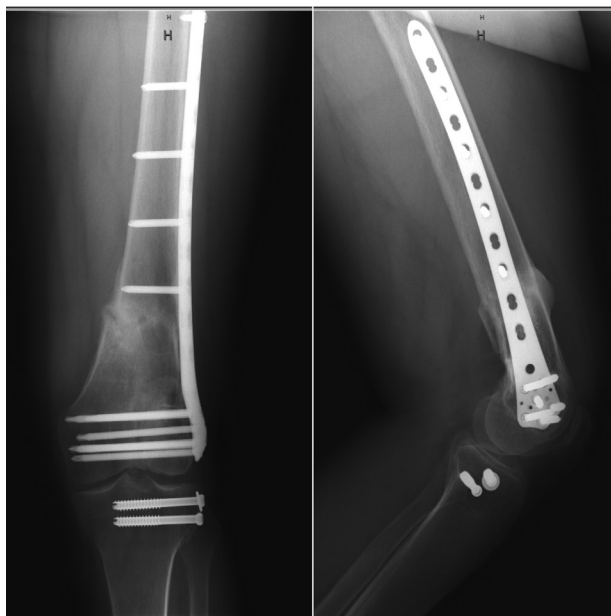


Fig. 1. — Radiological control of distal femur fracture AO type A (AP and lateral knee view). Consolidated without signs of poor alignment.

questionnaire was chosen as it is widely used in the literature and validated to Spanish (1). Furthermore, we considered a greater objectivity and reliability of its results as it does not only consider the knee joint's range of movement; it also evaluates the knee's function (ability functional patient), and associated symptoms (pain, instability). The test's outcomes are subdivided into good results (85-100 points), acceptable (60-85 points), and bad (less than 60 points).

RESULTS

Mean fracture healing was 16 weeks (range 14-20 weeks), considering consolidation of the fracture when the radiological callus was observed, without associated symptoms. Fracture healing according to the length of the LISS plate used is described in Table 1.

Table 2. — Type of distal femoral fracture associated with KSS mean score

Type of distal femoral fracture (AO classification)	Number of cases	Mean age (years old)	Men/Women	KSS mean score
A	16	77	0/16	75
B	5	70	1/4	74
C	9*	53	2/7	84,25

KSS : Knee Society Score. *1 open fracture (Gustilo type II).

Functional outcomes were studied with the KSS questionnaire at the 2-year follow-up visit in all patients, observing a mean score of 77.3. Distribution according to the type of fracture is described in Table 2. According to score 8 cases with good results (26,7%), 20 cases acceptable (66,7%) and 2 bad results (6,7%). Medium Balance knee joint through 92-0 degrees (-5 to 140).

Two complications were observed during the study. One patient presented a pseudoarthrosis and the other a deep infection. Both cases had a short plate and required a second surgery to solve the complication. The first patient resolved after removal of plate, autograft and new synthesis with a longer plate, whereas the second case resolved with debridement and removal of the plate. There was no cases of breakage or loosening of the plate. Up to date, no patient has complaint of discomfort of the plate that would require removal.

DISCUSSION

The present study shows that the LISS plate is a safe method of osteosynthesis, especially in elderly patients with osteoporosis, with a low complication rate and good functional outcomes.

Historically, distal femoral fractures presented relatively high rates of complications in the literature describing non-union rates of 29% to 38% (7), and infection rates of 7 to 20% according to the literature (10,17).

The LISS plate offers great advantages in fracture fixation of distal femur, including the fact of requiring minimal soft tissue dissection and being a fixed angle device, which seems to favor lower infection rates and higher rates of consolidation, as described in the literature. In the present study we have had one nonunion (1/30) 3,3% and one infection (1/30) 3,3%.

Regarding the time of authorizing complete weight bearing, there is no agreement within the different studies. Kregor et al suggests that it is safe to start progressive and significant weight bearing when callus formation is evident (13).

Early onset weight bearing, implant length too short, improper implant placement, and insufficient fixation of the femoral shaft with monocortical screws, are major causes of implant failure in the studied series (15-18). Pakula *et al.* (18,19) recommend to verify proper placement of the plate intraoperative, finding several cases of bad reduction in axial plane (valgo-varus), and even intra-articular. In the present study, mean time to start allowing weight bearing was two months.

Studies advise against using the LISS shorter plate (5 holes) in osteoporotic fractures, indicating that the shorter plate may reduce the working length, causing loosening of the plate at its proximal portion, thereby recommending the use of longer plates for osteoporotic bone (20). We had no case loosening in the distal region of the plate, as described previously (6,16).

Regarding nonunion, the main risk factors described in the literature are: obesity, diabetes, open fracture, age > 70 years old, comminute fractures, alcoholism, smoking, and shorter length plates (5,8,21,22,23). We had one case in our series that had a short plate, as well as age over 70 years old.

When reviewing the present study, several limitations have to be taken into consideration. First, ours is a single-center and retrospective study. Furthermore, up to three surgeons performed all surgeries, despite all of them follow the same protocol, variabilities regarding the length decision may occur.

CONCLUSIONS

The use of the LISS plate has shown good or acceptable results in 94% of patients included in the present study. Therefore, we can conclude that the LISS plate is a good choice for complex fractures (supracondylar femur fracture AO type C) and especially in osteoporotic fracture. In the present study better outcomes were observed when longer

plates were used, especially in complex articular fractures (type C) in the elderly.

REFERENCES

1. **Ares O, Castellet E, Maculé F, León V et al** . Translation and validation of 'The Knee Society Clinical Rating System into Spanish. *Knee Surg Sports Traumatol Arthrosc.* 2013 ; 21 : 2618-24
2. **Barei DP, Beingsner DM.** Open distal femur fractures treated with lateral locked implants : union, secondary bone grafting, and predictive parameters. *Orthopedics* 2012 ; 35 : e843-6.
3. Canadian Orthopaedic Trauma Society. Are Locking Constructs in Distal Femoral Fractures Always Best? A Prospective Multicenter Randomized Controlled Trial Comparing the Less Invasive Stabilization System With the Minimally Invasive Dynamic Condylar Screw System. *J Orthop Trauma* 2016 ; 30 : e1-6
4. **Chen YT, Yang JW, Hou HB et al** [Comparative study of less invasive stabilization system (LISS) and the condylar support plates for the treatment of AO type C distal femoral fractures in adults]. *Zhongguo Gu Shang.* 2015 ; 28 : 136-40.
5. **Edward K. Rodriguez a, Christina Boulton b, Michael J. Weaver c et al.** Predictive factors of distal femoral fracture nonunion after lateral locked plating : A retrospective multicenter case-control study of 283 fractures. *Injury, Int. J. Care Injured* 2014 ; 45 : 554-559
6. **Fankhauser F, Gruber G, Schippinger G, et al.** Minimally-invasive treatment of distal femoral fractures with the LISS (less in-vasive stabilization system). A prospective study of 30 fractures with a follow-up of 20 months. *Acta Orthop Scand.* 2014 ; 75 : 56-60
7. **Farouk O, Krettek C, Miclau T, et al.** The minimal invasive plate osteo-synthesis : is percutaneous plating biologically superior to the traditional technique? *J Orthop Trauma.* 1999 ; 13 : 401-406.
8. **Frigg R, Appenzeller A, Christensen R, et al.** The development of the distal femur Less Invasive Stabilization System (LISS). *Injury* 2001 ; 32 : SC24-SC31.
9. **Gavin Button, Philip Wolinsk, David Hak et al.** Failure of Less Invasive Stabilization System Plates in the Distal Femur. A Report of Four Cases. *J Orthop Trauma* 2004 ; 18.
10. **Henderson CE, Kuhl LL, Fitzpatrick DC et al.** Locking plates for distal femur fractures : is there a problem with fracture healing? *J Orthop Trauma* 2011 ; 25 : S8-14
11. **Huang H, Huang P, Su J, et al.** Indirect reduction and bridge plating of supracondylar fractures of the femur. *Injury* 2003 ; 34 : SC135-SC140.
12. **Jazrawi L, Kummer F, Simon J, et al.** New technique for treatment of unstable distal femur fractures by locked double-plating : case report and biomechanical evaluation. *J Trauma* 2000 ; 48 : 87-92.

13. **Kregor P, Stannard J, Zlowodzki M, et al.** Distal femoral fracture fixation utilizing the Less Invasive Stabilization System (L.I.S.S.) : the technique and early results. *Injury* 2001 ; 32 : SC32-SC47.
14. **Li X, Xu X, Liu L, Shao Q, Wu W.** Repeat LISS treatment for femoral shaft fractures due to hardware failure : a retrospective analysis of eleven cases. *Eur J Orthop Surg Traumatol* 2013 ; 23 : 797-802
15. **Man-Kwan Wong, Frankie Leung, Shew Ping Chow.** Treatment of distal femoral fractures in the elderly using a less-invasive plating technique. *Intern Orthop (SICOT)* 2005 ; 29 : 117-120
16. **Marti A, Fankhauser C, Frenk A, et al.** Biomechanical evaluation of the Less Invasive Stabilization System for the internal fixation of distal femur fractures. *J Orthop Trauma* 2001 ; 15 : 482-487.
17. **Mize RD, Bucholz RW, Grogan DP.** Surgical treatment of displaced, comminuted fractures of the distal end of the femur. *J Bone Joint Surg.* 1982 ; 64 : 871-879.
18. **Pakula G, Wodzislowski W, Fudalej P et al.** Errors in Treatment of Fractures of Distal Femur by LISS Method (Less Invasive Stabilization System) - Single-centre Experience. *Ortop Traumatol Rehabil* 2014 ; 16 : 275-84
19. **Pakula G, Słowiński J, Scigala K.** Biomechanics of distal femoral fracture fixed with an angular stable LISS plate. *Acta Bioeng Biomech* 2013 ; 15 : 57-65.
20. **Prayson M, Datta D, Marshall M.** Mechanical comparison of endosteal substitution and lateral plate fixation in supracondylar fractures of the femur. *J Orthop Trauma* 2001 ; 15 : 96-100.
21. **Ricci AR, Yue JJ, Taffet R et al.** Less invasive stabilization system for treatment of distal femur fractures. *Am J Orthop* 2004 ; 33 : 250-5.
22. **Schutz M, Muller M, Krettek C, et al.** Minimally invasive fracture stabilization of distal femoral fractures with the LISS : a prospective multicenter study. Results of a clinical study with special emphasis on difficult cases. *Injury.* 2001 ; 32 : SC48-54.
23. **Syed AA, Agarwal M, Giannoudis PV et al.** Distal femoral fractures : long-term outcome following stabilization with the LISS. *Injury* 2004 ; 35 : 599-607.