



## The LISS plate treatment of supracondylar fractures above a total knee replacement : a case-control study

Alan R. NORRISH, Zaid A. JIBRI, Phil HOPGOOD

*From the Norfolk and Norwich University Hospital, Norwich, United Kingdom*

The aim of this study was to assess the outcome of periprosthetic fractures above a total knee arthroplasty treated by LISS plate fixation. The primary outcome measure was the radiological union. Secondary outcome measures were knee function using the Oxford Knee Score, and quality of life using the SF-12 questionnaire.

Over a 4-year period we treated 16 supracondylar periprosthetic fractures with a LISS plate in 15 patients. Eleven patients (12 fractures) were followed up for an average of 8 months. Eleven out of these 12 fractures went on to unite in an average of 3.7 months. Functional outcome questionnaires were filled out by 9 patients. Suitable matches were found for a subgroup of 5 patients (6 LISS plates). No statistically significant differences were found in the Oxford knee scores ( $p = 0.749$ ) or quality of life scores ( $p = 0.440$ ) between the two groups. Our data suggest favourable outcomes after LISS plate fixation of supracondylar periprosthetic femoral fractures above total knee replacement.

**Keywords :** LISS plate ; periprosthetic fracture ; femur ; total knee replacement ; knee function.

### INTRODUCTION

The less invasive stabilisation system (LISS) implant is a commercially available precontoured locking plate (Synthes Ltd., Welwyn Garden City, UK). It has enjoyed recent popularity in the treatment of complex periarticular fractures in the lower limb.

When used to fix distal femoral fractures, the LISS plate has been shown to be as mechanically stable as the angled blade plate, but with the advantage that unicortical screws can be used (20). However, this stability is dependent upon the implant being placed in the correct rotation (11).

The clinical outcomes for LISS plate fixation of distal femoral fractures have shown it to be effective, both for high-energy injuries in young patients and low-energy injuries in the elderly (7,13,15,16,18,19). However, some of the most difficult periarticular fractures to treat are supracondylar periprosthetic fractures above total knee replacement (TKR) prostheses. There is little evidence in the literature regarding the outcomes of the LISS plate fixation of

---

■ Alan R. Norrish, LL.M. PhD FRCS (Orth), Consultant Orthopaedic Surgeon.

*Tropical Surgery Research Unit, Beit CURE International Hospital, Lusaka, Zambia.*

■ Zaid A. Jibri, MRCSEd, Specialty Registrar.

*Department of Radiology, University Hospital of Wales, Cardiff, United Kingdom.*

■ Phil Hopgood, MSc FRCS (Orth), Consultant Orthopaedic Surgeon.

*Norfolk & Norwich University Hospital, Norwich, United Kingdom.*

Correspondence : Dr Zaid A. Jibri, Specialty Registrar, Department of Radiology, University Hospital of Wales, Cardiff, CF14 4XW, United Kingdom.

E-mail : zjibri@doctors.org.uk

© 2009, Acta Orthopædica Belgica.

these fractures. Fulkerson *et al* have evaluated the outcome of LISS fixation in 24 patients with periprosthetic femoral fractures (18 were above a TKR) (6). Anakwe *et al* reviewed the outcome of 28 patients treated with LISS plate for periprosthetic femoral fractures and 12 of these patients had a TKR (1). O'Toole *et al* looked at the outcomes of 14 periprosthetic fractures above a TKR (14), and Kaab *et al* looked at 3 of these fractures (9). These studies have not used validated scores to assess the functional outcome; however, they assessed the fracture healing and their results suggested that LISS plates were useful in fixing supracondylar periprosthetic femoral fractures.

The aim of our study was to assess the outcome of periprosthetic fractures above TKRs treated by LISS plate fixation. The primary outcome measure was the number of these fractures progressing to radiological union. The secondary outcome was the knee function and quality of life following the LISS plate fixation of these fractures in comparison to matched controls.

## PATIENTS AND METHODS

All the patients that had received the LISS implant for a distal femoral fracture at our hospital over a four-year period between 2002 and 2006 were retrieved from our hospital database. Those patients who had an ipsilateral total knee replacement at the time of fracture were identified. We included these patients as a study group. All the patients sustained the fractures as a result of low-velocity injuries.

Our first outcome measure in evaluating the LISS plate fixation was the radiological union of the periprosthetic fracture. This was assessed by an experienced observer who is a consultant orthopaedic surgeon and part of the team conducting the study. He reviewed all the post-operative radiographs of the study group patients until their last outpatient clinic follow-up and the radiological union of the fractures was evaluated. The fracture was considered to be united if it had a visible bridging callus across at least 3 out of 4 cortical breaks on the two radiological views (AP and lateral) (3).

The second outcome measure was the knee function and the quality of life following fracture fixation with LISS plate. We contacted the patients by post asking them to fill a self-administered questionnaire that allowed calculation of the Oxford Knee Score and the

SF-12 score which assesses the quality of life. Where possible, for patients that completed the questionnaires, we found matching controls from our total knee replacement database. The controls have had total knee arthroplasty which was not complicated by lower limb fractures. These patients were matched for age, sex and length of time the TKR prosthesis has been *in situ*. The controls have also completed the self-administered questionnaires as part of their routine TKR follow-up. This has allowed calculation of the Oxford Knee Score and the SF-12 and the subsequent comparison between the two groups. The statistical analysis was carried out for normally distributed interval data using a 2-tailed, unpaired Student's t-test.

The surgical technique for the LISS group involved percutaneous insertion of the LISS plate and no bone grafting was used in any of the cases. In one case the fracture was open (Gustilo II) and wound washout was performed. In another case the patient had an associated intertrochanteric femoral fracture which had to be fixed with a dynamic hip screw (DHS).

## RESULTS

Fifteen patients sustaining 16 periprosthetic supracondylar femoral fractures above a total knee arthroplasty were identified (table I). There were 14 female and 1 male patients with a mean age of 79 years (range 58 to 104 years). Four of the patients also had a previous ipsilateral total hip replacement. Five of the 15 total knee replacements were of the posterior cruciate sacrificing type with a large central metal box in the femoral component to allow for the stabilising peg. For the 16 fractures, the mean time from joint replacement to fracture was 74 months (range 2 months to 18 years).

### Radiological outcome

Radiological follow-up was completed in 11 patients with 12 LISS plates (out of 16 fractures). There was only one open fracture in this group. The rest were closed injuries. One of the included patients sustained an associated ipsilateral extra-capsular fracture of the femoral neck which was treated with a DHS. The mean outpatient follow-up time in this group was 8 months. On assessing fracture union, 11 out of 12 fractures went into radiological union. The united fractures included

Table I. — The LISS group with follow-up data and outcome

LISS plate study number	Patient Age	Sex Female (F) Male (M)	Ipsilateral total hip replacement	Length of time between TKR and fracture (months)	Length of follow-up after fracture (months)	Length of time to radiographic union (months)	Time from fracture fixation to functional follow-up (months)	Completed functional assessment (C), Died (D), Lost to follow up (L), Excluded (E)
1	82	F	Yes	36	5	5	45	C
2	58	F	No	29	10	3	40	C
3	80	F	No	18	3	3	35	C
4	82	F	No	2	5	5	17	C
5	66	F	No	23	5	2	10	C
6	66	F	No	34	5	2	10	C
7	79	F	No	71	10	4	Excluded	E*
8	63	F	No	59	11	5	Excluded	E*
9	77	F	No	3	lost	lost	No matched control found	C <sup>o</sup>
10	75	F	Yes	182	lost	lost	Lost	L
11	77	F	No	196	lost	lost	No matched control found	C <sup>o</sup>
12	86	F	No	39	16	3	Died	D
13	104	F	Yes	143	died	plate failed	Died	D
14	84	M	No	56	8	5	Died	D
15	83	F	Yes	84	lost	lost	Died	D
16	91	F	No	215	4	4	Died	D

\* Excluded ; severe neurological impairment.

<sup>o</sup> No matches could be identified.

both the open injury and the one with the associated ipsilateral DHS. The average time to radiographic union was 3.7 months. One patient, who was 104 years old, had an early failure of the LISS plate which pulled off the femur in the first few days after the operation. She never recovered from her fracture and died in the perioperative period. Four out of the 15 patients did not attend outpatient follow-up and hence, no information was available regarding the radiological union of their fractures.

### Functional outcomes

When we contacted the LISS group for functional assessment, we learned that a total of 5 out of

15 patients had died. In 3 out of the 5 deceased patients, the fractures had united. One had an early failure of the prosthesis and the fifth one did not attend the follow-up clinic.

Out of the 10 survived patients, one could not be contacted for formal assessment, 2 patients had a longstanding significant neurological impairment pre-operatively and could not complete the self-administered questionnaires and therefore had to be excluded from the functional assessment. This left seven of the patients with a total of eight LISS plates available to follow-up by way of the Oxford Knee Score and the SF-12 forms. For five of these seven patients (6 LISS plates) with self-administered outcome data, control patients were identified.

Table II. — The respective patient ages and length of time the original total knee replacement had been *in situ* for the LISS treated periprosthetic fractures (1 to 6) and the controls (A to F)

Study numbers	Age		Time knee replacement in situ	
	LISS group	Control group	LISS group	Control group
1 & A	82	82	6yr 9m	6yr 4m
2 & B	58	59	5yr 9m	5yr 5m
3 & C	80	80	4yr 5m	4yr 5m
4 & D	82	82	1yr 7m	1 yr 9m
5 & E	66	65	2yr 9m	2yr 2m
6 & F	66	70	3yr 7m	5yr 0m

No matches could be found for the remaining two patients in our knee replacement database. The mean time to functional follow-up in this group was 26 months from the periprosthetic fracture fixation. Table II shows both the group that received a LISS plate (patients 1 to 6) and a group of controls that are matched for age, sex and length of time the knee replacement has been *in situ* (patients A to F).

Knee function and quality of life outcomes were compared between the two groups to identify what overall impact the periprosthetic fracture and its fixation had, compared to a control group of patients that had not suffered a fracture but had a TKR (table III). It was seen that for the Oxford Knee Score, where a lower score is better knee function, the mean score for the LISS group was 26.5 points (SD  $\pm$  10.3). For the control group the mean Oxford Knee Score was 28.8 points (SD  $\pm$  14.0). These scores were not significantly different ( $p = 0.749$ , Student's t-test).

For the SF-12 assessment of quality of life, two scores were given: a physical functioning component score and a mental functioning component score. These were also added to make a total score. The higher the score the better the quality of life of the patient. For physical functioning, the mean score for the LISS group was 37.7 points (SD  $\pm$  10.8) compared to a mean score of 31.3 points (SD  $\pm$  5.9) for the control group. The difference in these scores was not statistically significant ( $p = 0.233$ , Student's t-test). For the mental component of the SF-12 questionnaire, the mean score for the LISS group was 56.3 (SD  $\pm$  10.4)

compared to 55.8 (SD  $\pm$  8.5) for the control group. These scores were not significantly different ( $p = 0.924$ , Student's t-test). The mean total SF-12 score for the LISS group was 94.1 points (SD  $\pm$  17.4) whilst that of the control group was 87.1 points (SD  $\pm$  12.0). The total SF-12 scores were not significantly different between the two groups ( $p = 0.440$ , Student's t-test).

## DISCUSSION

The LISS is an extramedullary internal fixation system with features that include minimally invasive insertion and minimal bone contact with a locked fixed angle construct. Several studies have shown desirable outcome following the use of LISS plate in the treatment of distal femoral fractures (5,10,13,15,18). In one series of 99 patients with 103 distal femoral fractures, 93% of the fractures healed without secondary procedures. There were 5 losses of proximal fixation, 2 non-unions and 3 acute infections (13). The LISS was also shown to have favourable outcomes in terms of stable fixation and early healing in treating mechanically unstable comminuted fractures of the distal femur (18).

Periprosthetic fractures around a total knee replacement are relatively uncommon. Data from the Mayo clinic joint registry suggest a femur fracture rate of 1.3% following a TKR (2). These injuries are often difficult to treat and there is a lack of consensus on how they should be ideally treated. A wide variety of treatments have been described in

Table III. — The Oxford Knee Scores and SF-12 Quality of Life Scores for the LISS group and the control group

Study number	Oxford Knee Score	SF-12 score components		
		Physical	Mental	Total
LISS - 1	31	27.2	58.2	85.4
LISS - 2	19	54.8	57.1	111.9
LISS - 3	44	25.7	37.5	63.2
LISS - 4	29	43.9	53.7	97.6
LISS - 5	18	37.4	65.7	103.1
LISS - 6	18	37.4	65.7	103.1
Control - A	45	29.8	49.7	79.6
Control - B	29	39.8	56.4	96.2
Control - C	32	36.5	56.4	92.8
Control - D	42	23.2	42.8	66.0
Control - E	12	28.5	64.9	93.4
Control - F	13	30.2	64.5	94.7

the literature including closed non-operative treatment, fixation with an intra-medullary nail, non-locking plate fixation, locking plate fixation and also external fixation. A systematic review including 29 studies with a total 415 patients compared the results of different fixation techniques of these periprosthetic fractures. It suggested that retrograde intramedullary nailing and submuscular locked plating are superior to the other treatment options including non-operative treatment and non-locking plating methods (e.g. dynamic condylar screw and blade plate) in the treatment of distal femur fractures above a total knee arthroplasty. The functional outcome following these treatment methods was not addressed in this review (8).

There are other studies that have assessed fracture healing following LISS fixation of periprosthetic supracondylar fractures above a TKR. Fulkerson *et al* have evaluated the fracture union in 24 patients with periprosthetic femoral fractures (18 were above a TKR). Twenty one out of the twenty four went on to unite (6). Anakwe *et al* reviewed the outcome of 28 patients treated with LISS plate for periprosthetic femoral fractures (10 of these patients had TKR, 2 with both TKR and THR). The fractures showed evidence of union in 25 of these patients who completed the follow-up (1). O'Toole *et al* reported that 18 out of 19 femoral periprosthetic fractures (2 fractures above TKR and one patient with both a hip and knee

replacement) went on to unite (14). Kaab *et al* reported a series of 13 periprosthetic fractures (2 above a TKR and one with both TKR and THR). With a follow-up rate of 85%, all fractures showed radiographic healing without implant loosening (9). These studies have not assessed the functional outcomes using validated questionnaires.

In our series, 11 out of 12 patients who completed the follow-up showed radiographic union. This was achieved in an average of 3.7 months. The one patient where the fracture has not united was a 104-year-old female with severe osteoporosis who had an early failure with pull-off of the plate and died in the first 24 hours after the operation. This shows a limitation of LISS plate fixation and this type of fractures with severe osteoporosis continues to remain a significant challenge. This was the primary outcome objective of the study and the results suggest that LISS fixation in the situation of a periprosthetic fracture above a knee replacement has a high union rate.

The secondary outcome measures were for knee function and quality of life. A good mid-term functional outcome for periprosthetic fractures below a total hip arthroplasty treated with LISS plate was demonstrated in a study that included 16 patients (12). The assessment of functional outcome following LISS plate treatment of periprosthetic fractures above a TKR using validated scoring systems and comparing it to controls is unique

to our study. Undoubtedly, a well functioning limb and a good quality of life are the main objectives following the surgical treatment of these injuries. In order to assess these key outcomes, we used two functional tools ; the Oxford Knee Score and the SF-12 questionnaire and compared the results to those of matched controls who had primary TKR.

The Oxford knee questionnaire is a validated tool that allows accurate and reproducible assessment of knee function. It is made of 12 items and it is routinely used in many centres for follow-up of patients after TKR operations. The lower the OKS, the better the knee function (4). The SF12 is another validated questionnaire that assesses the patient quality of life. It has two components, physical and mental. The physical component evaluates the patients' ability to carry out different levels of daily activities whilst the mental component asks questions about the general mental and emotional state of the patient following the operation. The higher the score, the better the quality of life (17).

On comparing the Oxford knee scores and SF12 scores of the LISS group to those of the control group, there was no statistically significant difference in these scores. These results suggest favourable outcomes in terms of knee function and quality of life following the LISS plate fixation of these fractures.

There are limitations in our study. The data are limited by small numbers and the fact that there are no statistical differences between the fracture group and the matched group may suggest a good prognosis after successful treatment with LISS plate fixation or reflect a type 2 statistical error (falsely accepting the null hypothesis). Because the fracture is relatively uncommon, even in a large trauma centre we have only collected 15 patients over a 4 years period. On the other hand, this study is the only one in the literature that uses a controlled group to assess the functional outcomes following the LISS fixation of these significant injuries with the assistance of validated scoring systems.

In conclusion, both the radiological and functional outcome measures that we have used in this study suggest that the LISS plate is a useful device for the treatment of periprosthetic supracondylar fractures of the femur above total knee replacement.

#### Acknowledgements

The authors would like to thank Clare Darrah and Tracey Potter for their assistance in identifying matched controls.

#### REFERENCES

1. **Anakwe RE, Aitken SA, Khan LAK.** Osteoporotic periprosthetic fractures of the femur in elderly patients : Outcome after fixation with the LISS plate. *Injury* 2008 ; 39 : 1191-1197.
2. **Berry DJ.** Epidemiology : hip and knee. *Orthop Clin North Am* 1999 ; 30 : 183-190.
3. **Corrales LA, Morshed S, Bhandari M, Miclau T.** Variability in the assessment of fracture-healing in orthopaedic trauma studies. *J Bone Joint Surg* 2008 ; 90-A : 1862-1868.
4. **Dawson J, Fitzpatrick R, Murray D et al.** Questionnaire on the perception of patients about total knee replacement. *J Bone Joint Surg* 1998 ; 80-B : 63-69.
5. **Fankhauser F, Gruber G, Schippinger G et al.** Minimal invasive treatment of distal femoral fractures with the LISS (Less Invasive Stabilization System) : a prospective study of 30 fractures with a follow up of 20 months. *Acta Orthop Scand* 2004 ; 75 : 56-60.
6. **Fulkerson E, Tejwani N, Stuchin S, Egol K.** Management of periprosthetic femur fractures with a first generation locking plate. *Injury* 2007 ; 38 : 965-972.
7. **Hernanz Gonzalez Y, Diaz Martin A, Jara Sanchez F, Resines Erasun C.** Early results with the new internal fixator systems LCP and LISS : a prospective study. *Acta Orthop Belg* 2007 ; 73 : 60-69.
8. **Herrera DA, Kregor PJ, Cole PA et al.** Treatment of acute distal femur fractures above a total knee arthroplasty. *Acta Orthop* 2008 ; 79 : 22-27.
9. **Kaab MJ, Stockle U, Schutz M et al.** Stabilisation of periprosthetic fractures with angular stable internal fixation : a report of 13 cases. *Arch Orthop Trauma Surg* 2006 ; 126 : 105-110.
10. **Kayali C, Agus H, Turgut A.** Successful results of minimally invasive surgery for comminuted supracondylar femoral fractures with LISS : comparative study of multiply injured and isolated femoral fractures. *J Orthop Sci* 2007 ; 12 : 458-465.
11. **Khalafi A, Curtiss S, Hazelwood S, Wolinsky P.** The effect of plate rotation on the stiffness of femoral LISS : a mechanical study. *J Orthop Trauma* 2006 ; 20 : 542-546.
12. **Kobbe P, Klemm R, Reilmann H, Hockertz TJ.** Less invasive stabilisation system (LISS) for the treatment of periprosthetic fractures : a 3-year follow up. *Injury* 2008 ; 39 : 472-479.
13. **Kregor PJ, Stannard JA, Zlowodzki M, Cole PA.** Treatment of distal femur fractures using the less invasive stabilization system : surgical experience and early clinical results in 103 fractures. *J Orthop Trauma* 2004 ; 18 : 509-520.

14. **O'Toole RV, Gobeze R, Hwang R et al.** Low complication rate of LISS for femur fractures adjacent to stable hip or knee arthroplasty. *Clin Orthop* 2006 ; 450 : 203-210.
15. **Schutz M, Muller M, Regazzoni P et al.** Use of the less invasive stabilization system (LISS) in patients with distal femoral (AO33) fractures : a prospective multicenter study. *Arch Orthop Trauma Surg* 2005 ; 125 : 102-108.
16. **Syed AA, Agarwal M, Giannoudis PV et al.** Distal femoral fractures : long-term outcome following stabilisation with the LISS. *Injury* 2004 ; 35 : 599-607.
17. **Ware JE, Kosinski M, Keller SD.** SF12 : How to score the SF12 physical and mental health summary scales. 2<sup>nd</sup> ed., 1995. The Health Institute, New England Medical Centre, Boston, MA, USA.
18. **Weight M, Collinge C.** Early results of the less invasive stabilization system for mechanically unstable fractures of the distal femur (AO/OTA types A2, A3, C2 and C3). *J Orthop Trauma* 2004 ; 18 : 503-508.
19. **Wong MK, Leung F, Chow SP.** Treatment of distal femoral fractures in the elderly using a less invasive plating technique. *Int Orthop* 2005 ; 29 : 117-120.
20. **Zlowodzki M, Williamson S, Zardiackas LD, Kregor PJ.** Biomechanical evaluation of the less invasive stabilization system and the 95 degree angled blade plate for the internal fixation of distal femur fractures in human cadaveric bones with high mineral density. *J Trauma* 2006 ; 60 : 836-840.