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Preliminary results and technical aspects following stabilisation of fractures around the knee with liss

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Summary We present 16 patients with 17 fractures around the knee (eight distal femoral and nine proximal tibia fractures) which were stabilised using the less invasive stabilisation system (LISS) from January 2002 to September 2003, at John Radcliffe Hospital in Oxford. Functional assessment was performed using the modified hospital for special surgery (HSS) score. The time to union was assessed radiologically and clinically.

Our results were excellent in eight cases, good in five cases and fair in three cases. From the 3 patients that scored fair two were polytrauma patients and one had poor mobility pre-injury. We had a case that required revision twice, once due to malposition and once due to implant failure. One case was complicated due to superficial infection that was treated successfully. The mean time to union was 15.5 weeks for the tibia and 12.5 weeks for the femoral fractures.

Our data indicate favorable results using the LISS in stabilizing fractures around the knee. The system introduces a new technique in fracture fixation and as such, requires proper experience prior to its use.

We also report some technical tips that can improve the technique of the correct placement of the LISS and can result in fewer complications.

Introduction

Fractures around the knee joint typically require operative fixation to achieve an acceptable, functional outcome. Fracture care has evolved to provide new ways of achieving the balance between mechanical stability and fragment viability.[4–6,17,18] At each stage in the planning of operative fracture treatment, a decision is required as to whether the biological insult is worth the mechanical gain. It is contemporary wisdom to aim for anatomical reduction of the articular surfaces with restoration of

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bone length and joint alignment and rotation.[22] This usually involves direct manipulation of the articular fragments, assessment of the reduction by viewing the individual fracture lines and fixation, where possible, by interfragmentary compression. To achieve the correct length, rotation and alignment of the complex metaphyseal component of fractures around the knee, it is not necessary to see individual fracture lines or directly manipulate the fragments within the zone of injury. This may well be achievable with a small biological cost[2] by indirect reduction and a spanning fixation.

The less invasive stabilisation system (LISS)[7,15,23,31] allows stabilisation to be achieved with a smaller biological cost. A comparison between the condylar buttress plate and dynamic condylar screw (DCS) to LISS, in biomechanical studies, showed greater ability of the LISS to withstand higher loads thus, providing more stable fixation than the conventional implants.[21] Although LISS has been designed to allow movement only between the screw and bone interface, this characteristic has not yet been evaluated in the bone healing process. To take full advantage of the limited exposure required for the application of the stabilisation system a careful thought is required. It is more difficult to position fragments and assess the adequacy of reduction through a limited exposure.

Using this technique in our hospital the last years, we present our experience and report our results, in both distal femoral and proximal tibia fractures.

Materials and methods

Between January 2002 and September 2003, 19 patients with 20 fractures were treated surgically from the trauma service in our hospital, using the LISS for fractures around the knee. Ten were distal femoral fractures and ten were in the proximal tibia. One patient was included in both groups, with fractures of both the distal femur and proximal tibia on the same side (floating knee).

Demographic data (age, gender and profession), mechanism of injury, severity of the injury (AO classification,[25] open or closed fracture[8]), associated injuries (injury severity score[1]), initial management and time to definitive treatment were recorded (Table 1). Intra-operative events and difficulties, use of bone graft, post operative local or systemic complications, time to union and time required to return to pre-injury activities were documented (Table 2). All patients at their final assessment, underwent radiological and functional evaluation using the hospital for special surgery knee score (HSS)[9,20] (Table 3). Inclusion criteria

Table 1 Patients details

Case number	Age	Gender	Mechanism of injury	AO classification	Type of fracture	ISS	Patients excluded from final assessment
1	43	M	MVA	33-C-2	Open G3b	36	
2	91	F	Fall	33-A-2	Closed	9	RIP
3	71	F	Fall	41-A-2 (pathological)	Closed	9	RIP
4	30	M	MVA	33-A-3	Open G2	36	
5	31	M	MVA	33-C-2 and 41-A-3	Closed	31	
6	67	F	Fall	33-C-2	Closed	9	RIP
7	69	M	Industrial accident	41-C-1	Closed	9	
8	74	F	Fall	33-A-1 (periprosthetic TKR)	Closed	9	
9	83	F	Fall	41-B-3	Open G1	9	
10	96	F	Fall	33-C-1	Closed	9	
11	70	F	Fall	41-C-3	Closed	9	
12	66	F	MVA	41-C-2	Closed	33	
13	28	M	MVA	33-C-1	Closed	9	
14	22	M	Industrial accident	41-B-1	Closed	9	
15	32	F	MVA	41-C-1	Closed	38	
16	20	M	Fall	41-C-2	Closed	9	
17	74	F	Fall	33-A-1 (periprosthetic TKR)	Closed	9	
18	51	M	MVA	41-C-3	Open G3b	38	
19	84	F	Fall	33-A-1 (periprosthetic below THR)	Closed	9	

MVA: motor vehicle accident; ISS: injury severity score; RIP: rest in peace; TKR: total knee replacement; THR: total hip replacement.

Table 2 Post-operative results

Case number	Time to radiological union (weeks)	RoM of knee joint	Use of graft	Complications	HSS score
1	12	0–70	No	None	67 (fair)
2			No	RIP	RIP
3			No	RIP	RIP
4	10	0–94	No	None	80 (good)
5	24 for Femur 16 for Tibia	0–125	Yes (second stage)	None	85 (excellent)
6			No	Deep infection RIP	RIP
7	16	5–125	Yes	None	85 (excellent)
8	12 [a]	0–120	Yes	Implant mal-position/ implant failure	80 (good)
9	16	0–95	Yes	Valgus mal-alignment	63 (fair)
10	10	0–110	No	None	85 (excellent)
11	12	0–115	No	None	85 (excellent)
12	12	0–105	No	Superficial infection	85 (excellent)
13	12	5–110	No	None	82 (good)
14	12	0–125	No	None	85 (excellent)
15	12	0–105	No	None	82 (good)
16	12	0–125	No	None	85 (excellent)
17	12	0–110	No	None	83 (good)
18	16	0–75	No	None	67 (fair)
19	8	0–100	No	None	85 (excellent)

RoM: range of movement; HSS: hospital for special surgery.
[a] Post revision with DCP and bone graft. No signs of callus formation prior to LISS failure (12 weeks).

for the study were any severity of distal femoral fractures with or without intra-articular extension or bone loss and open fractures of the distal femur and proximal tibia. Exclusion criteria were skeletal immaturity and severe articular comminution not possible to be reconstructed with internal fixation.

Of the 19 patients, three died within 3 months of surgery from causes unrelated to the injury or treatment and were excluded from the final functional assessment.

Table 3 HSS (hospital for special surgery) score

Pain
Walking (none to severe): points 15–0
At rest (none to severe): points 15–0
Function
Walking (unlimited to unable): points 12–0
Stairs (normal to with support): points 5–2
Transfer (normal to with support): points 5–2
RoM (80°–120°): points 10–15
Muscle strength (grade 5–0): points 15–0
Flexion deformity (none to >20°):points 10–0
Instability (none to >15°): points 5–0
Subtractions
One cane: 1 point
One crutch: 2 points
Two crutches: 3 points
Extention lag (5°–15°): 2–5 points
Deformity (every 5°): 1 point

Excellent = 85 points or more, good = 70–84 points, fair = 60–69 points, poor = less than 60 points.

The mean age of the surviving 16 patients, was 54.5 years ranging between 20 and 96 years. There were eight males and eight females. Seven injuries were due to simple falls predominantly in the elderly patients in our study and nine were the result of high-energy trauma (motor vehicle accident or industrial accident). Applying the AO classification there was one type 41A, two type 41B, six type 41C, four type 33A and four type 33C. Four fractures were classified as open, one grade 1, one grade 2 and two grade 3B. The mean injury severity score was 18.8 ranging from 9 to 38. Four patients from the high-energy trauma group with mean ISS score 34.5 were tertiary referrals from other hospitals that were transferred for definitive treatment to our unit.

All fractures were provisionally stabilised within 24 h from the time of the accident by means of splinting or a spanning external fixator; (this latter group included all the polytrauma patients and three with isolated proximal tibia fractures). Definitive treatment was achieved within an average 3 days of admission (range 1–9 days). All the open fractures were treated within 6 h of admission.

Joint mobilisation commenced immediately post-operatively with continuous passive motion (CPM) (the range was variable, depending on the severity of the fracture[24,26]). The weight bearing status was touch-weight bearing (TWB) for the initial 6 weeks, progressing through partial to full weight-bearing. In a few cases (elderly or polytrauma patients touch weight-bearing) was exceeded.

All the patients were followed up with regular radiological and functional assessments. The mean follow-up was 16 months (range 11—31 months).

Results

Intra-operative problems

We had one case (AO classification 41B-3, open G1) which after reduction of the articular surface and insertion of the LISS, optimal proximal positioning of the implant was not possible; the offset of the plate was incongruous with the cortical anatomy. This forced a 10° valgus angulation of the tibia shaft. In one case, (AO classification 33A-1, a periprosthetic fracture above a total knee replacement) (Figures 1 and 2), the post-operative radiological assessment revealed poor positioning of the proximal part of the LISS, which was placed dorsally without adequate fixation to the femoral cortex (Figures 3 and 4). This required revising 5 days after the initial operation (Figures 5 and 6). The same patient 3 months after the revision surgery and following a fall, required a second revision for implant failure (Figure 7). In another periprosthetic fracture (33A-1), below a sound cemented total hip replacement (THR), the most proximal screw of the

Figures 1 and 2 Anteroposterior (A/P) and lateral radiographs of a periprosthetic spiral fracture of DF.

Figures 3 and 4 Lateral and A/P radiographs of LISS misplacement. Note in the A/P film the broken K-wire that led to misjudgement of the implant positioning. The proximal screws did not achieve purchase with the lateral cortex of the femur.

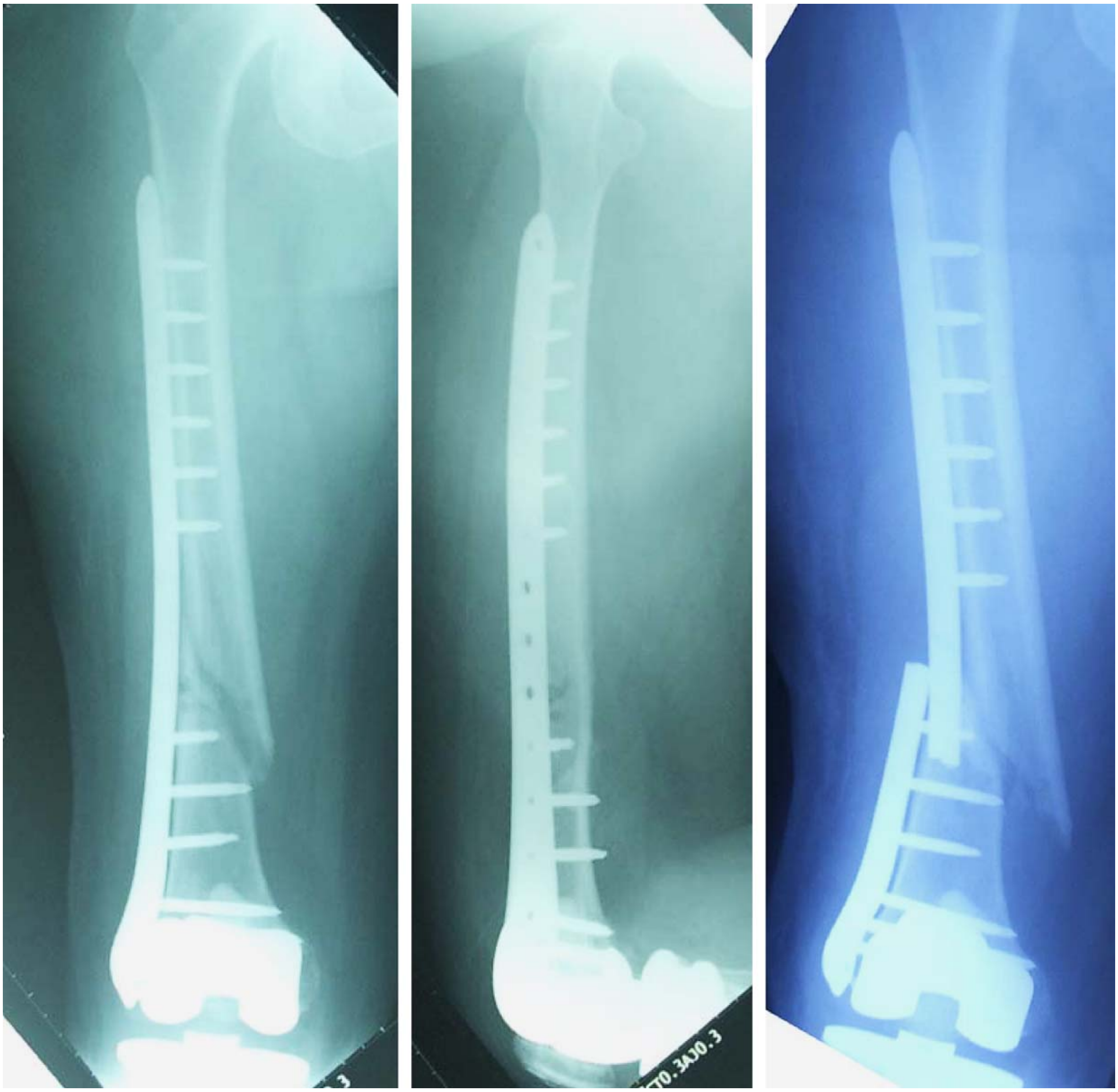
LISS that was positioned through the cement mantle, pulled out although without compromising the fixation or union. In all cases, the alignment of bone and joint was satisfactorily maintained with the LISS.

Local and systemic complications

Local complications included one superficial and one deep infection that were treated with oral and, intravenous antibiotics and wound washouts, respectively. The patient with the deep infection died 3 months post-operatively for reasons unrelated to the surgery or infection.

Fracture union

Bony union was achieved on average in 15.5 weeks for the tibia fractures and 12.5 weeks for the femoral fractures (patient no. 8 was not included since prior to LISS failure there was no evidence of callus formation). Union of the fracture is defined as the ability of the patient to fully weight-bear without discomfort in the presence of radiological bridging callus on three cortices, assessed on standard AP and lateral radiographs. We used cancellous bone grafting once at a planned second stage operation, three months after initial fixation, in a polytrauma patient with distal femoral bone loss and during the revision of LISS for an implant failure. Autologous



Figures 5—7 A/P and oblique radiographs after revising the malpositioned LISS. Failure of the implant due to a fall in the same patient.

bone graft was used twice primarily, for reconstruction of proximal tibial fracture subarticular defects.

Functional assessment

The HSS scores were eight excellent (above 85 points), five good (70—84 points) and three fair (60—69 points). For our cases, the mean knee flexion was 108° (range 70°—125°) and only two had a 5° lack of extension.

Of the three patients that scored fair two were polytrauma patients (ISSs of 36 and 38), with associated local severe soft tissue trauma and bone loss. The other patient was a frail elderly lady with poor mobility prior to injury; the HSS score failed to demonstrate her good recovery to her pre-injury level of mobility.

Discussion

The author's early experience with the distal femoral LISS (LISS-DF), for fractures around the knee, has demonstrated satisfactory results. It is significantly different from conventional plating techniques and previous experience is not directly transferable. Similarly, the complications that may arise and the tactics to avoid them need to be learned.

One of the most important stages using the LISS-DF devise is the correct positioning and alignment of the proximal part of the implant to the femoral shaft. This part of the operation, seems to be responsible for the majority of the LISS-DF misplacements[12,29,30] and perhaps surprising, it is quite possible to miss the diaphyseal bone completely with the screws. Because the operator gets a "screw tightening" sensation as the screw locks on the plate, the inexperienced may not appreciate the failure to engage bone cortex. We report one such implant misplacement using the LISS. In our case, the critical Kirshner wire (Figure 4), used for the temporary stabilisation in the optimal position of the proximal part of the implant on the femur, broke allowing the plate to shift dorsally. That was not recognised intra-operatively due to misinterpretation of the image-intensifier pictures and misevaluation of the screw purchase. The LISS-DF implant was revised successfully five days after the initial operation.

In order to minimize the possibility of LISS-DF misplacement if exact lateral intra-operative images are not sufficient, we recommend a limited open exposure at the level of the diaphyseal end of the plate, in order to visualise the proper alignment of the implant with the diaphysis. This exposure will also confirm the plate has been tunneled through the correct layers. We also recommend the use of the longest possible plate in every case because it adds to the stability of the implant and has the advantage of distancing the diaphyseal incision from the zone of injury.

LISS-DF is not a reduction tool. The familiar techniques with angle blade plates and the DCS for the distal femur are not appropriate. After the initial placement of the LISS-DF and the fixation using the first locked screw of its distal part, the implant can be used as a joystick in order to correct the proper alignment of the metaphysial fragments. We found a very helpful to identify the varus/valgus alignment using the "cable technique" as described by Krettec.[14,19] The femoral rotation was corrected using the radiological "signs" as the shape of the lesser trochanter and the cortical step.[16] The corrections can then be maintained by securing the plate proximally.

Our results of the tibia LISS for proximal tibia fractures, with or without intra-articular involvement, are favorable (Table 2) and comparable with the results reported in literature. Using the tibia LISS we had one case where we experienced problems intra-operatively, between the positioning of the proximal offset of the plate and maintaining the optimal reduction and alignment resulting in mild (10°), valgus angulation of the tibia shaft. This was considered to be acceptable for the patient's age and poor pre operative mobility and knee function.

In our series we had one implant failure, which is consistent with the low incidence that is documented in the literature.[3,14,16,19,28,30,32] The failure presented three months post-operatively after the patient sustained a further, but low energy injury (fall). There was no convincing radiological evidence of callus formation at that presentation and the patient was still mobilizing touch weight bearing. The LISS was revised again using a dynamic compression plate (DCP) and bone graft. The intra-operative findings did not support the presence of infection. The final outcome of the patient was satisfactory with bone union at 6 months post injury and HSS of 80.

In several papers proximal screw pull-out has been reported.[27,30,32] We had one such case in a Type 33-A fracture below a THR that was stabilised with LISS-DF. The screw pull-out was not a result of mal-positioning of the plate or premature weight-bearing, as is commonly the case, but probably because it was a standard locking screw which impinged on the hip femoral component resulting in a poor cortical hold. It was not the purpose designed cement screws that are now available; they were not available in our unit at the time of surgery. The overall fixation was not compromised and the final outcome was satisfactory.

The infection rate in our series was low in spite of four open fractures. We had one case (5%) of superficial infection in a non-insulin dependant diabetes mellitus patient; that settled with appropriate oral antibiotics. One elderly patient (5%) with poorly controlled diabetes mellitus developed deep infection requiring two debridements and intravenous antibiotics. This patient died 3 months post injury from an unrelated disease. The low infection rate was compatible with the incidence reported in literature so far.[3,12,29,32]

Alignment was well maintained in all cases with no patient losing the reduction that was obtained in the operating room.

Our early experience suggests primary bone grafting seems unnecessary with this system and being reserved for when there is bone loss[3,12,13,29]

At the time of fracture union our results of the knee movement, are comparable with the results so far reported in the literature.[3,12,13,28,29]

In our series, we had three cases of periprosthetic fractures, two above total knee replacements and one below a total hip replacement that were treated utilizing the LISS. The LISS-DF allows stable reduction of osteoporotic bone without disturbance of the existing total joint replacement and is a useful alternative to distal femoral locked nailing through the prosthesis aperture. Our results have been satisfactory and in agreement with the limited reports in the literature.[3,10,11,28,32]

Conclusion

Our data indicate favorable results using the LISS in stabilizing fractures around the knee. It can be used in many different types of injuries around the knee, including intra-articular, peri-prosthetic and open fractures frequently without the use of bone graft.

Use of the system relies on a very different plate fixation concept and as such, requires proper thought, planning, and experience prior to its use.

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