Retrograde nailing versus locked plating for distal femur fractures

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Purpose
Two major therapeutic principles can be employed for the treatment of distal femoral fractures: Retrograde Intramedullary Nail (RIN) or locked plating (LP). Both operative stabilizing systems follow the principle of biological osteosynthesis. Intramedullary nailing protects the soft tissue envelope owing to its minimally invasive approach and closed reduction techniques better than distal femoral LP. The purpose of this study was to evaluate and compare outcome of distal femur fracture stabilization using RIN or LP techniques.
Patients and methods
In a prospective study from 2014 to 2015, we analyzed 30 patients with distal femur fracture who had been treated by RIN (15 patients) or LP (15 patients). The patients had a mean age of 49 years (20–85 years). Mechanism of injury was high-energy impact in 66.7% and low-energy injury in 33.3%. Fractures were classified according to Association for Osteosynthesis (AO) classification: there were 17 type A fractures and 13 type C1 fractures. Functional and radiological outcomes were assessed.
Results
Clinical and radiographic evaluation according to the functional score of Sanders and colleagues demonstrated that, in RIN group, one (6.6%) case was excellent, nine (60%) cases were good, and four (26.8%) cases were fair, whereas in locked compression plates (LCP) group; eight (53.2%) cases were good, four (26.8%) cases were fair, and three (20%) cases were poor. In RIN group, the average time of fracture union was 19.5 weeks, with a range of 12–28 weeks. Of 15 cases, 14 (93.4%) cases progressed to union, and one (6.6%) case had delayed union and need dynamization. In LCP group, average time was 27.65 weeks, with a range of 12–32 weeks. Of 15 cases, 12 (80%) cases progressed to union, one (6.6%) case had nonunion, and two (13.4%) cases had delayed union.
Conclusion
Both femoral retrograde interlocking nail and LCP of distal femur appear to have statistically insignificant differences regarding knee motion, pain, resuming function, and rate of need of second surgery. However, retrograde nail is preferable to LP in terms of operative time, blood loss, image intensifier exposure time, early appearance of callus, weight bearing, and shorter time required for full union.

Keywords:
distal femoral fractures, locked plating, retrograde intramedullary nailing

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Introduction

Distal femoral fractures constitute 7% of all femoral fractures [1,2].

Open reduction and internal fixation using extramedullary implants has been used with high complication rates including nonunion rates of 7% and infection rates reported around 5%. Moreover, a stress-shielding and refracture rate of 10% was reported [3]. Moreover, the iatrogenic soft tissue trauma and devascularization of the periosteum needed to place the traditional extramedullary fixation might play another major role in the development of infection and delayed union. Supplemental bone grafting is therefore frequently needed [4].

Condylar locked compression plates (LCP) allows for percutaneous insertion of implants, thus becoming less destructive to soft tissues. Its locked screw heads make multiple fixed-angel screw-plate constructs that feature a threaded interlocking mechanism between the head of the fixation screws and the plate; such designs have been developed and are being used clinically. The theoretic advantage of these constructs is the elimination of toggle at the screw-plate interface and subsequent marked increase in rigidity, maintaining

periosteal blood supply, and providing improvement to osteoporotic bone [5].

Intramedullary (IM) nail offers a potential biomechanical advantage over side plates and screws because the IM location results in less stress over the implant and better stress distribution than with eccentric side plate and screws. They have the potential for load shearing [6]. Their use involves minimal soft tissue injury, short operative time, limited perioperative blood loss, and ability to mobilize patients early [7].

We seek to elucidate the respective advantages and disadvantages of each technique in a randomized trial. Patient-based radiologic and objective physical examination outcomes were collected and compared. These demonstrate similarity or differences between the treatments and would help orthopedic surgeons decide on the ultimate treatment for patients with this injury.

Patients and methods

A prospective study was conducted for comparison between fixation of distal femoral fractures using femoral Retrograde Intramedullary Nail (RIN) and distal femoral LCP. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Cairo University, Cairo, Egypt. The study was done in Cairo University Hospital from May 2014 to February 2015 (date of last surgeries).

The study was conducted on 30 patients with distal femoral fractures who were randomized one case after the other (alternatively) in a consecutive series to have either femoral RIN or distal femoral LCP. The association for osteosynthesis (AO)/orthopaedic trauma association (OTA) classification was used to grade the fractures. The series included 15 cases treated with femoral retrograde interlocking nails (RIN) and 15 cases treated with distal femoral LCP.

Inclusion criteria included those who were skeletally mature, those with fracture of the metaphyseal distal femur with or without intraarticular extension (AO/OTA types A1–3 and C1), those with fracture requiring operative treatment amenable to either IM nail or plate, and those with provided informed consent.

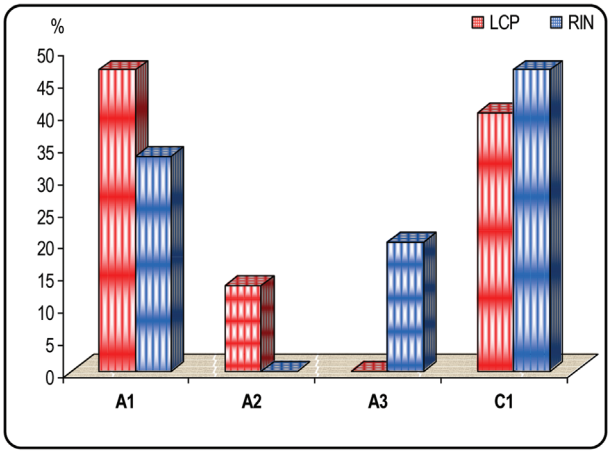
Exclusion criteria included AO/OTA types B, C2, and C3 fractures; open fractures; associated other skeletal injuries; medically unfit; or refusal to give consent.

All patients were evaluated preoperatively using ATLS protocol, comprising history taking; physical examination; radiological examination, including anterioposterior and Lateral views of the injured femur, axial skeleton evaluation in high-energy trauma, and computed tomography distal femur for evaluation of coronal plane fractures; routine preoperative laboratory examinations; and physician consultation for medical comorbidities evaluation and management.

The AO/OTA classification system was used. In the RIN group, there were nine (60%) type A fractures and six (40%) type C fractures. In the LCP group, there were eight (53.4%) type A fractures and seven (46.6%) type C fractures (Fig. 1 and Table 1).

In both groups, prophylactic low-molecular-weight heparin (Enoxaparin) 40 mg subcutaneously once daily was started immediately and continued until the patient was fully mobilized. Prophylactic intravenous antibiotics were used in all patients (1.5 g of cefuroxime) and was

Figure 1



Distribution of cases according to fracture classification.

Table 1 Distribution of cases according to fracture classification

Classification	RIN [*n* (%)]		LCP [*n* (%)]
OTA			
A1	7 (46.7)		5 (33.3)
A2	2 (13.3)		0
A3	0		3 (20.0)
C1	6 (40.0)		7 (46.7)
Total	15 (100)		15 (100)
χ^2			
χ^2		5.410	
P value		0.144	

LCP, locked compression plates; OTA, orthopaedic trauma association; RIN, retrograde intramedullary nailing.

given before incision, and continued as 750 mg 8 hourly for 24 h postoperatively.

In the RIN group, general anesthesia was used in 10 patients and spinal anesthesia in five patients.

In the LCP group, general anesthesia was used in nine patients and spinal anesthesia in six patients.

Retrograde intramedullary nailing group

The patient was positioned supine on a radiolucent table. A towel bump is then placed under the ipsilateral buttock to counteract the normal external rotation of the lower limb. If the pelvis is tilted up ~15° on the involved side and if the rotational profile of the injured femur is correctly re-established, the foot will be rotated 5–10° externally in most cases. The extremity is draped free and positioned over a large leg roll at ~40–60° of knee flexion. Rotational alignment is achieved by aligning the ASIS, patella, and first web space of the foot (Fig. 2).

In intraarticular fractures, the basic strategy was to assemble a condylar block and then fix it to the femoral shaft with the nail. The reconstruction was performed either closed or open using cannulated screws 6.5 mm. Reduction is aided by Schanz screw utilized as joy stick, large pointed reduction 'Weber' clamps or large pelvic clamp (Fig. 3a), and provisional K-wires, which can hold reduction of articular blocks until definitive lag screw fixation is achieved (Fig. 3b).

The surgical approach depends on the fracture type, either closed 'percutaneous transpatellar approach,' which was used in 13 (86.6%) fractures, or open 'medial parapatellar approach,' which was used in two (13.4%) intraarticular fractures; type C1 because closed reduction of articular surface was not anatomical.

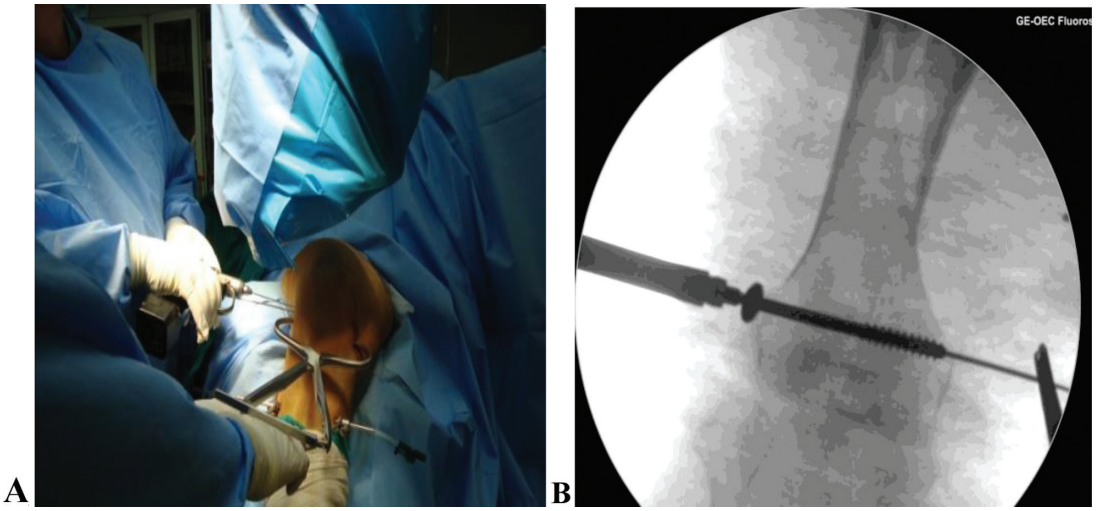
This entry point is in the intercondylar notch ~1 cm anterior to the attachment of the posterior cruciate ligament and at equidistant between medial and lateral articular cartilage edges. It is placed under fluoroscopic control, in line with the femoral shaft in both the anteroposterior and the lateral planes.

Location of a satisfactory starting position for the tip of curved awl or guide-wire was facilitated by placing the tip of the guide pin at the angulation produced by the

Figure 2

Positioning and draping of the patient for RIN. RIN, retrograde intramedullary nailing.

Figure 3



(A) Closed reduction of intercondylar fracture using large reduction clamp and (B) percutaneous fixation with 6.5 cm partially threaded canulated screw.

medullary canal in the lateral view (Blumensaat's line) (Fig. 4). After nail insertion, the knee was taken through a full range of motion to ensure articular function. It is of vital importance to perform a thorough irrigation of the knee before wound closure to wash out the bone debris, which originates during insertion of the nail.

Suction drainage was routinely used in all fractures, and the wound was closed in layers. Crepe bandage was then applied from toes to the high thigh.

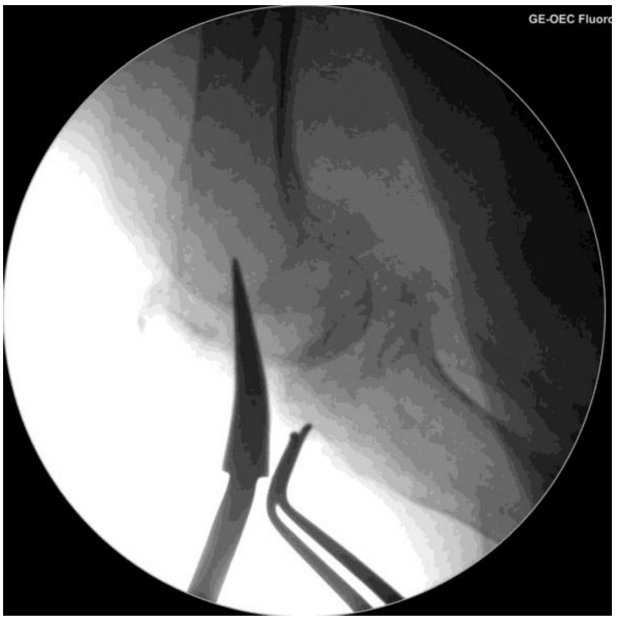
Locked compression plates group

The patient was positioned supine on a radiolucent table, which allows complete imaging of the lower leg. A towel bump is then placed under the ipsilateral buttock; the extremity is draped free and positioned over a large leg roll at ~45° of knee flexion. Rotational alignment is achieved by aligning the ASIS, patella, and first web space of the foot (Fig. 5).

Minimal invasive percutaneous plate osteosynthesis approach was used for plate insertion and screw fixation (Fig. 6).

Reduction of the articular surface can be done through arthrotomy and open reduction under vision or without arthrotomy under image control. This is helped by large reduction clamp or joy stick manipulation with a Schanz screw inserted from medial side. Fixation is then achieved by 6.5-mm partially threaded cancellous screws outside the planned position of the plate; further fixation can be achieved by partially threaded 5-mm conical screws through the plate distal holes if needed after plate insertion. Wound is closed in layers over radivac, taking care to avoid tight closure of the lateral retinaculum in cases that required arthrotomy to avoid anterior knee pain (patellofemoral pain).

Figure 4

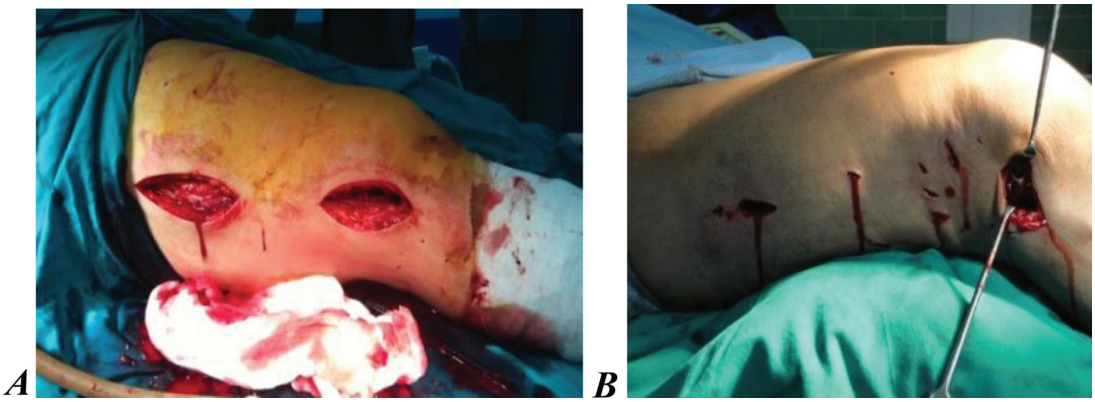


limage photos of entry point Lateral view in AO/OTA type A fracture.

Figure 5

Patient positioning and draping.

Figure 6



Lateral MIPPO approach, (A) proximal single incision, (A) proximal stab incision. MIPPO, minimal invasive percutaneous plate osteosynthesis.

Suction drain was removed 24–48 h and sutures after 2 weeks.

Unless there are other injuries, or complications, joint mobilization may be started immediately postoperatively. Both active and passive motion of the knee and hip can be initiated immediately postoperatively.

Weight bearing was not suggested until early callus formation was seen on radiographs. The patients were then started partial weight bearing, and gradually progressed to full weight bearing for another 6–8 weeks.

In RIN group, the hospital stay ranged from 4 to 11days. In LCP group, the hospital stay ranged from 4 to 9 days. In most patients, early rehabilitation was done inpatient.

First follow-up visit after leaving the hospital was after 2 weeks to inspect wound, remove stitches (if not removed), and confirmation of rehabilitation program. Then, the patient had follow-up visit at every 4 weeks till union, and then every 6 months. At each visit, patients were examined clinically and radiologically. The final results were rated according to the functional score of Sanders *et al.* (1991) [8], which include functional and anatomical assessments (Table 2).

Table 2 Rating system of Sanders *et al*.

Rating system of Sanders *et al*.		
Function	Result	Points
Range of motion (°)		
Flexion		
>125	Excellent	6
100–124	Good	4
90–99	Fair	2
<90	Poor	0
Extension		
0	Excellent	3
>5	Good	2
5–10	Fair	1
>10	Poor	0
Deformation		
Angulation (°)		
0	Excellent	3
<10	Good	2
10–15	Fair	1
>15	Poor	0
Shortening (cm)		
0	Excellent	3
<1.5	Good	2
1.5–2.5	Fair	1
>2.5	Poor	0
Pain		
None	Excellent	10
Occasional or with changes in weather, or both	Good	7
With fatigue	Fair	5
Constant	Poor	0
Ambulation		
Walking		
Unrestricted	Excellent	6
>30 min to <60 min	Good	4
<30 min	Fair	2
Walks at home, is confined to wheelchair, or is bedridden	Poor	0
Stair climbing		
No limitation	Excellent	3
Holds rail	Good	2
One stair at a time	Fair	1
Elevator only	Poor	0
Return to work (A or B)		
A. Employed before injury		
Returned to preinjury job	Excellent	6
Returned to preinjury job with difficulty	Good	4
Altered full time job	Fair	2
Part-time job or unemployed	Poor	0
B. Retired before injury		
Returned to preinjury lifestyle	Excellent	6
Needs occasional help with shopping or laundry	Good	4
Needs assistance at home with activities of daily living	Fair	2
Moved in with family or nursing home	Poor	0

Excellent=36–40; good=26–35; fair=16–25; poor=0–15 points.

Results

The operative time

In RIN group, the mean operative time was 100.41 min (range, 60–45 min).

In LCP group, the mean operative time was 157.6 min (range, 110–230 min).

P value was highly significant.

The operative blood loss

In RIN group, the estimated mean blood loss was 234 ml (range, 70–600 ml).

In LCP group, the estimated mean blood loss was 459 ml (range, 300–700 ml).

P value was highly significant.

Initial postoperative reduction

Initial postoperative reductions were assessed by a predetermined set of criteria shown in Table 3 (Marc *et al.*, 1995). Overall, eight cases were excellent [three cases in RIN group and five in locked plating (LP) group], 10 with good results (five in RIN and five in LP group), 11 cases with fair results (six in RIN and five

in LP group), and one case with poor result in RIN group. There was no statistical difference between the two groups (Tables 3–5).

Clinical and radiological results

In RIN group, the mean follow-up period was 10.4 months (range, 6–23 months).

In LCP group, the mean follow-up period was 9 months (range, 6–20 months).

P value equaled 0.885.

The final results were rated according to the functional score of Sanders *et al.* (1991).

In RIN group, 15 cases were available for final assessment: one (6.6%) case was excellent, nine (60%) cases were good, and four (26.8%) cases were fair.

In LCP group, 15 cases were available for final assessment: eight (53.2%) cases were good, four (26.8%) cases were fair, and three (20%) cases were poor. *P* value equaled 0.560.

Pain and knee motion and function were assessed according to Sanders *et al.* (1991), with no statistically significant difference.

Regarding union, in RIN group, the average time of fracture union was 19.5 weeks, with a range of 12–28 weeks. Of 15 cases, 14 (93.4%) cases progressed to union, and one (6.6%) case had delayed union and needed dynamization.

In LCP group, the average time was 27.65 weeks, with a range of 12–32 weeks. Of 15 cases, 12 (80%) cases progressed to union, 1 (6.6%) case had nonunion, and two (13.4%) cases had delayed union.

Complications

Regarding operative complications, in RIN group, one case had iatrogenic partial torn patellar tendon during reaming process and nail insertion. Tendon was repaired with Ethibond suture no 5, and delayed active quadriceps exercise for 4 weeks.

In LCP group, three cases had broken drill bits intraosseous while inserting screws through stab incisions.

Postoperative complications

Knee pain

In RIN group, in two cases had pain on the medial aspect of the knee due to locking screw protrusion on the medial aspect of the medial condyle; both cases were managed by screw removal after healing process established, on fourth and fifth months postoperatively, correspondingly.

One patient had anterior knee pain because of nail protrusion beyond the articular surface; in this case, nail was removed 8 months postoperatively.

Table 3 Initial postoperative reductions were assessed radiologically according to criteria of Marc (1995)

Excellent	No varus or valgus angulation on anteroposterior radiographs, no flexion or extension of the distal on proximal fragment on lateral radiographs, no rotation, articular congruency restored rotation, articular congruency restored
Good	Less than 5° of varus or valgus angulation, less than 10° of flexion or extension, articular incongruency of less than 2 mm
Fair	More than 5° of varus or valgus angulation, more than 10° of flexion or extension, articular incongruency of greater than 2 mm
Poor	Any of the variables exceed those see nonprereduction radiographs, 25° or greater of flexion or extension; greater than15° varus or valgus angulation

Table 4 Distribution of fractures according to initial postoperative reduction Marc (1995)

Marc criteria	RIN [*n* (%)]	LCP [*n* (%)]
Excellent	3 (20.0)	5 (33.3)
Good	5 (33.3)	5 (33.3)
Fair	6 (40.0)	5 (33.3)
Poor	1 (6.7)	0
Total	15 (100)	15 (100)
χ^2		
χ^2	1.591	
P value	0.661	

LCP, locked compression plates; RIN, retrograde intramedullary nailing.

Table 5 Cases distribution according fracture healing in weeks

Fracture healing in weeks	RIN		LCP		*t* test	
	Mean	Range	Mean	Range	*t*	*P* value
Initial callus	5.5±2.3	4–10	7.95±3.1	4 to 16	2.458	0.020*
Union	19.5±4.2	12–28	27.65±3.4	12 to 32	5.841	<0.001*

LCP, locked compression plates; RIN, retrograde intramedullary nailing. Time of bone healing in nail and locked plate.

In LC group, one case complained of anterior knee pain with clicking sound with flexion and extension of the knee. Examination of the patient revealed tight lateral retinaculum, and radiograph showed no patellar tilt. The patient then underwent physiotherapy but with no improvement, so he had open lateral reticulum release.

Delayed union

In RIN group, one case showed delayed union and need dynamization, with clinical and radiological union achieved 3 months after dynamization.

In LCP group, two cases showed delayed union. One patient continued to have pain on weight bearing and tenderness at the fracture site. Radiograph showed no progress of healing process. Erythrocyte sedimentation rate and C-reactive protein were normal, with no local signs of infection. Computed tomography showed partial crossing of healing process and sclerosis at the fracture site. Bone graft and increased number of lag screws were performed. Almost 1 year postoperatively, clinical and radiological union was achieved. The other patient underwent bone graft on the sixth month due to delayed appearance and decreased amount of callus

Metal failure and nonunion

In RIN group and in LCP group, there were no cases of metal failure.

Infection

In RIN group, there were no cases of infection.

In LCP group, there was one case of deep infection in the early postoperative period; debridement, irrigation, and change of loose screws was done in the third week postoperatively. Wound improved; however, C-reactive protein was 13 and not increasing, nonunion in this case which needed bone graft later on.

Reoperation

In RIN group, five patients required second surgical procedures.

(1) Two cases asked for metal removal after bone union.
(2) Two cases required removal of one of the distal locking screws owing to pain on the medial aspect of the knee.
(3) One case required nail removal owing to anterior knee pain.

In LCP group, six patients required second surgical procedures.

(1) One case required lateral patellar release due to tethering of the lateral retinaculum by the plate. Then knee arthroscopy was performed and removal of metal after union.
(2) Two cases required bone grafting.
(3) One case required debridement of deep infection.
(4) Two cases asked for metal removal after bone union.

Discussion

This study was conducted on 30 patients with distal femoral fractures, who were randomized one case after the other (alternately) in a consecutive series to have either femoral RIN or distal femoral LCP. The AO/OTA classification was used to grade the fractures. The series included 15 cases treated with femoral retrograde interlocking nails (RIN) and 15 cases treated with distal femoral LCP.

Patients were examined clinically and radiologically. The final results were rated according to the functional score of Sanders *et al.* (1991), which included functional and anatomical assessments.

In RIN group, 15 cases were available for final assessment: one (6.6%) case was excellent, nine (60%) cases were good, and four (26.8%) cases were faire. For AO/OTA type A fractures, results of nine patients were available, being excellent in one (11.1%) case, good in six (66.7%) cases, and fair in two (22.2%) cases. However, in AO/OTA type C fractures, in RIN group, six cases were available for final results; their results were good in three (50%) cases, fair in two (33.3%) cases, and poor in one (16.7%) case.

In LCP group, 15 cases were available for final assessment: eight (53.2%) cases were good, four (26.8%) cases were fair, and three (20%) cases were poor. For AO/OTA type A fractures, results of eight patients were available, being good in five (62.5%) cases, fair in two (25%) cases, and poor in one (12.5%) case. However, in AO/OTA type C fractures, the final results were available for seven cases; the results were good in three (42.8) cases, fair in two (28.6%) cases, and poor in two (28.6%) cases (Table 6).

In a retrospective study from 2003 to 2008 of AO/OTA type 33-A and C distal femur fractures, Hierholzer *et al.* [9] analyzed 115 patients with distal femur fracture who had been treated by RIN (59 patients) or plating (56 patients). Clinical and radiographic evaluation demonstrated osseous

Table 6 Cases distribution according to final result according to Sanders score

Sanders score	RIN [*n* (%)]	LCP [*n* (%)]
Excellent	1 (6.7)	0
Good	9 (60.0)	8 (53.3)
Faire	4 (26.7)	4 (26.7)
Poor	1 (6.7)	3 (20.0)
Total	15 (100)	15 (100)
χ^2		
χ^2	2.059	
P value	0.560	

LCP, locked compression plates; RIN, retrograde intramedullary nailing.

healing within 6 months following RIN and following plating in more than 90% of patients. However, no statistically significant differences were found for the parameters such as time to osseous healing, rate of nonunion, and postoperative complications. Accumulative result of functional outcome using the Knee and Osteoarthritis Outcome score demonstrated in type A fractures a score of 263 (RIN) and 260 [Less Invasive Stabilization System (LISS)], and in type C fractures 257 (RIN) and 218 (LISS). Differences between groups for type A were statistically insignificant; statistical analysis for type C fractures between the two groups was not possible, as in type C2 and C3 fractures, only LISS plating was performed. Moreover, they concluded that both RIN and angular stable plating are adequate treatment options for distal femur fractures. LP can be used for all distal femur fractures including complex type C fractures, periprosthetic fractures, as well as osteoporotic fractures. IM nailing provides favorable stability and can be successfully implanted in bilateral or multi segmental fractures of the lower extremity as well as in extra-articular fractures. However, this study was retrospective and not randomized, and it analyzed results of fracture distal femur AO/OTA type A and C1, 2, and 3 and periprosthetic fracture. Moreover, in this study, statistical analysis for type C fractures between the two groups was not possible, as in type C2 and C3 fractures, only LISS plating was performed. The Knee and Osteoarthritis Outcome score was used to compare the functional outcome.

On the contrary, in a retrospective study, Henderson *et al.* [10] reported that the amount of callus measured at the 12th week in the LISS plate group was significantly lower than in the RIN group [11]. A total of 174 distal femur fractures were reviewed to extract cases treated with RIN (nAIL group). These were then individually matched to cases treated with locking plates (plate group). Periosteal callus was measured on lateral and anteroposterior radiographs taken at 12 weeks after injury using validated software to objectively extract the size of peripheral callus from digital radiographs. The NAIL group had 2.4 times more callus area per location (231±304 mm^2) than the PLATE group (95±109 mm^2, P=0.028).

They concluded that significantly less periosteal callus formed in fractures stabilized with locking plates than with IM nails. This result is likely multifactorial, and further study of the interaction between construct stiffness and fracture healing in the distal femur is warranted [11]. However, this study was retrospective, and it depended only on radiological result and callus formation of the two groups, and it did not compare the clinical or functional results.

Markmiller *et al.* [12], reported in a prospective non randomized study that included 32 patients (16 patients were treated with the LISS and 16 were treated with a distal femoral nail) that there is no significant difference in the rate of nonunion between the LISS and the distal femoral nail. However, this study was not randomized, and it analyzed the results of fracture distal femur AO/OTA type A and C1, 2, and 3. Moreover, in this study, statistical analysis for type C fractures between the two groups was not possible, as in type C2 and C3 fractures, only LISS plating was performed.

In a retrospective study of AO/OTA type 33-A type distal femur fractures, Demirtaş *et al.* [13] examined 15 patients, with mean age of 36 years, who underwent bridge plating and 13 patients, with mean age of 31.1 years, who underwent RIN for the treatment of extra-articular distal femur fractures between 2007 and 2012. Functional results were evaluated using the Sanders criteria. The mean follow-up time was 31.3 and 26.7 months in the plate and the nail groups, respectively. The mean duration until union was 25.7 weeks in the plate group and 22.3 weeks in the nail group. Nonunion was observed in two patients in the plate group and in one in the nail group, delayed union in three patients in the plate and two in the nail groups, mal alignment (>10°) in two patients in the plate group and one in the nail group, and implant failure in one patient in the plate group. Excellent/good functional results were obtained in 12 and 10 patients in the plate and the nail groups, respectively. No significant difference was found between the groups in terms of duration of union, complications, and functional results (P>0.05).

A retrospective study of AO/OTA type distal femur fractures was done by Gao *et al.* [14] from January 2004

to March 2009 on 36 patients with extra-articular distal femoral fractures. The patients were divided into two groups according to the treatment method, with 19 patients being treated by LP (LP group) and 17 patients via RIN (RIN group). The demographics of age and sex in both LP and RIN groups were similar. No differences were found with respect to postoperative malreduction, deep infection, hardware failure, operating time, knee pain, and range of knee movement. They concluded that the overall union disturbance rate in the LP group was higher than in the RIN group. However, further analysis revealed that clinical outcome may largely depend on surgical technique rather than on the choice of implant. Therefore, correct rules (the same for every procedure) should be strictly adhered to, especially in the application of LP.Studies comparing RIN and LP methods in distal femur fractures reported similar results in both groups despite the use of different functional scoring systems [9,10,12,14]. In our study using the score of Sanders and colleagues there was no statistically difference between the two groups

Using the Knee and Osteoarthritis Outcome scoring system in type A fractures, Hierholzer *et al.* [9] reported no significant differences between the two groups in terms of functional results at the end of a 14-month follow-up, and they reported that both methods are sufficient treatment options for distal femur fractures.

Using the Lysholm-Gillquist score, Markmiller and colleagues reported that there was no significant difference between the two groups in terms of functional outcomes after a mean follow-up of 1 year and that both methods were suitable for the treatment of distal femur fractures. In addition, Gao and colleagues used the Hospital for Special Surgery knee score and reported no significant difference in functional outcomes at the 23rd and 26th month follow-up of the plate and RIN groups, respectively [15]. However, a higher rate of union disturbance was observed in the LP group (36.8%) compared with the RIN group (5.9%) (P=0.044). The overall union disturbance rate in the LP group was higher than in the RIN group.

Demirtaş and colleagues used the Sanders criteria and found no significant difference in the functional outcomes of the two groups. Bridge plating and RIN methods appear to both be suitable methods for the treatment of extra-articular distal femur fractures.

There was no difference in postoperative rehabilitation in both groups in our study, and most of authors had the same postoperative rehabilitation program. Cost of both implants was almost similar.

Most scoring systems did not consider the preexisting knee disability or associated injuries at the time of the fracture; both can lead to lower scores. The elderly patients lost points primarily because of decreased knee motion that was related in large measure to their age. One other problem is the method of evaluation; this can include only functional criteria, radiological criteria, or both. From the different rating systems, we basically favor that of Sanders *et al*. (1991), although did not consider bone healing in their scoring system; however, it is simple and assesses the knee function using objective and subjective findings, considering retired patients, which makes statistical comparison of studies relatively easier.

The short-term follow-up and low patient number of the current study may be considered as its limitations.

Conclusion

Our results demonstrated that retrograde nail is a favorable option through medial parapatellar approach than LCP regarding many aspects, such as operative parameters (operative time, blood loss, blood transfusion, and image time) which are very critical especially for elderly patients and also for the surgical team, being highly significant in favor of the nail. The overall rate of reoperation although was comparable in both groups, the procedures done for those patients in plate group required more operative time, added more surgical risks and morbidities (e.g. iliac bone graft) and required read mission and interrupted rehabilitation for longer periods than those procedures in the nail group.

The initial appearance of callus and in turn the start of weight bearing was significantly shorter in nail than plate. There was one case of delayed union in nail group and two in plate group. The time of full union was shorter in nail group. These factors facilitated more the care and rehabilitation, which are also critical for elderly population. The functional outcome rated according to Sanders *et al.* (1991) was marginally significantly better in nail than plate group.

The main disadvantages of nail according to Demirtaş and colleagues are the frequent failure of distal locking screws, which is the main cause of reoperation in the nail group. The possibility is of repeated arthrotomy if the nail is removed and frontal plane angulations

in values higher than that occurred with LCP. This problem in great part is related to the initial reduction and can be decreased by improving the quality of reduction.

The LCP although has more fixation points than nail and presents more versatility, better screw anchorage in osteoporotic bone, and resists angular deformation, it still has higher incidence of delayed union, nonunion, and reoperation, and still there is varus angulation, although of values less than that with nail and in great part related to initial reduction.

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Conflicts of interest
There are no conflicts of interest.

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