Does any device have superiority in treating Supracondylar femur fractures in patients above 40 years? A Randomized control trial between Retrograde intramedullary nail and Dynamic condylar

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Abstract:

Background:
The dynamic condylar screw has been used for a long time in treating distal femur fractures. However, it has the disadvantage of being an open procedure with large skin and muscle dissection. Retrograde intramedullary nailing provides adequate surgical fixation for patients with osteoporosis. Its main disadvantage is that it has less ability to control anatomical reduction of the shaft, especially in osteoporotic bones. Our study aimed to assess the feasibility, clinical, and radiological outcomes of treating distal femur fractures with retrograde intramedullary nails and DCS in patients above 40 years old with relatively osteopenic bone.

Patients and methods:
The inclusion criteria contained patients from 40-70 years old, males and females, with distal femur fracture type (33 A2 -33 A3) according to the AO classification. This study included 40 cases randomized using the even and odd numbers technique. They were equally divided into 2 groups, Group A 20 cases treated with femoral Retrograde Supracondylar Nails, and Group B 20 cases treated with Dynamic Condylar Screw (DCS).

Results:
The incidence of malalignment was slightly higher in the RN group, both groups had similar functional outcomes. This may be related to the relatively old age groups included in the study. The operative time, the blood loss, and the union time were significantly less in the RN group and this may be a crucial point in the old age group included in the study.

Conclusion:
Our study concluded that using RN has an advantage over DCS in patients with distal femur fractures above 40 years old although mal-alignment may occur. This is because RN provide satisfactory final functional outcomes with less union time, operative time, and intra-operative blood loss than DCS.

Keywords:
Supracondylar femur fractures; Retrograde intramedullary nail; Dynamic condylar screw.

Introduction

Distal femoral fractures either supracondylar or intercondylar are common fractures in orthopedic practice. This is because they have bimodal distribution as they occur in old age as a result of low-energy trauma, and also occur in young ages as a result of high-energy forces. Distal femur fractures usually have unstable patterns and may be comminuted with intra-articular extension. [1-3]

Historically, distal femoral fractures were treated by conservative management either in traction or in an above-knee cast but with several complications. With the evolution of several devices for fixation, open reduction, and internal fixation became the main option for management. The main concern in treating distal femur fractures with articular extension is to restore the articular congruity with rigid anatomical reduction and at the same time fixation of the distal femur with the shaft using a strong fixation device. [1-4]

Another concern is the associated soft tissue injury that occurs usually with distal femur fractures such as injury or tear to the quadriceps muscle, patella, patellar ligament, or other intra or extra-articular ligaments of the knee. Therefore, any fixation device used should provide the ability to fix the articular surface anatomically, restore the alignment of the shaft, allow for early mobilization, and at the same time respect the soft tissue. [5,6]

Dynamic condylar screw (DCS) has been used for a long time in treating distal femur fractures especially fractures with intra-articular extension. The main advantage of the DCS is that it allows for the reduction and compression of the intercondylar extension using the condylar lag screw. Also, the configuration of the plate taking the same contour of the distal femur allows it to

be used as a reduction tool for reducing the shaft to the condylar elements. However, it has the disadvantage of being an open procedure with large skin and muscle dissection. This may be reflected in the infection rate. [7-9]

Retrograde intramedullary nailing (RN) provides adequate surgical fixation for patients with osteoporosis due to thin cortices, comminution, osteopenic, and a wide medullary canal making secure internal fixation difficult to achieve. Retrograde Nails offer more stability than side plates, as the intramedullary position decreases the stresses over the fixation device and allows for better stress distribution than with eccentric side plates and screws. Their advantages involve minimal soft tissue injury and early mobilization. Its main disadvantage is that it has less ability to control the anatomical reduction of the shaft. [10-12]

Our study aimed to determine the feasibility, clinical, and radiological outcomes, and complication rates of treating distal femur fractures with retrograde intramedullary nails and DCS in patients above 40 years old with relatively osteopenic bone.

Patients and Methods

The study was done in a referral center for trauma management from the period of October 2017 to May 2020. The inclusion criteria contained patients from 40-70 years old, males and females, with distal femur fracture type (33 A2-33 A3) according to the AO classification. This study included 40 cases randomized using the even and odd numbers technique. They were equally divided into 2 groups, Group A 20 cases treated with femoral Retrograde Supracondylar Nails, and Group B 20 cases treated with Dynamic Condylar Screw (DCS). The minimum follow-up period was one year.

Patients with open fractures, associated vascular injury, or Pathological fractures were excluded from the study. All patients were evaluated preoperatively using: ATLS protocol, proper history taking, and physical examination. X-ray (AP-lateral) views were ordered for all patients and a CT scan was done if in doubt about intra-articular involvement.

The patients' demographics are shown in the following table. (Table 1)

Table 1: Patients' demographics

		RN group		***DCS group***		***P-value***
		NO.	***%***	***NO.***	***%***	
Age	40-60	12	60%	10	50%	0.53
	60-70	8	40%	10	50%	
Sex	Male	13	65%	16	80%	0.75
	Female	7	35%	4	20%	
Mode of trauma	Road traffic accident	11	55%	12	60%	0.241
	Fall from height	2	10%	3	15%	
	Fall to the ground	7	35%	5	25%	
Side	LT	4	20%	8	40 %	0.283
	RT	16	80%	12	60 %	
Fracture type	Type33 A2	14	70 %	13	65 %	0.745
	Type33 A3	6	30 %	7	35 %	
Comorbidity	DM	5	25%	6	30%	0.342
	HTN	4	20%	2	10%	

Intra-operative preparation for all patients in both groups

- The patients were operated on in a supine position and the knee was flexed to 30°by support to relax the gastrocnemius muscle to assist the reduction.
- Antibiotics are administered to all patients in the form of third-generation cephalosporins.
- The tools that aid reduction are: Schanz screw, bone hook, pointed reduction forceps, manual traction, use of the femoral distractor, or external fixator.

Operative details for Retrograde nail femur:

We made a two cm longitudinal incision, from the lower pole of the patella to the tibial tuberosity. Then, the patellar tendon was divided in the midline to allow for guide-wire insertion.

In the Antero-posterior view, the entry point was centralized in the mid-point of the inter-condylar notch. In the lateral view, the point was allocated at the distal end of the Blumensaat's line.

After that, we inserted the guidewire into the medullary canal, as far as approximately 12-14 cm proximal to the fracture zone. Reduction of the fracture was followed. Reduction was closed in 15

cases, and opened in 5 cases using a small direct lateral approach.

The medullary canal was opened using reamers, but a protective sleeve was used to protect the surrounding structures. Sequential reamers with gradually increasing diameters (0.5-1 mm). Then, the nail was inserted while continuous traction was applied.

Before interlocking, the correct position of the nail and the rotation of the femur must be verified. Finally, the distal locking screws were taken, followed by the proximal locking screws.

Figure 1: Midline infrapatellar incision for Retrograde Nail femur insertion.

Operative details of Dynamic Condylar Screw

The lateral approach to the distal femur allows for visualization, reduction, and fixation of simple articular fractures of the distal femur. If more exposure was needed lateral Para-patellar approach was extended.

The skin incision was made over the lateral aspect of the distal shaft of the femur and may be curved anteriorly if articular exposure was needed.

Then, the iliotibial band was divided in line with the skin incision. The vastus-lateralis muscle was elevated from the lateral inter-muscular septum to expose the femur starting distally and aiming proximally.

The ideal position of the DCS is two cm proximal to the articular surface of the femur. Laterally, the entry point is located just between the anterior one-third and the posterior two-thirds of the femur. Then, the guidewire was inserted and the length was measured.

The guidewire was inserted at the chosen entry site. To assess the exact length of the guidewire, obtain an AP view with 30° internal rotation of the lower extremity. After that, the hole for the DCS was reamed, and the DCS was inserted. Two or three mm of the screw should be left protruding to facilitate insertion of the plate and the barrel. The impactor was used to push the plate to the bone.

The key concept in fracture reduction when utilizing a DCS is that proper insertion of the barrel will allow the plate to act as a reduction tool to reduce the shaft to the distal fragment.

When proper reduction was checked, screws (4.5mm) were used to fix the plate to the shaft. Finally, closure was done in layers with a suction drain added.

Figure 2: lateral approach to the distal femur for DCS insertion.

Results

This randomized control trial was done between October 2017 to May 2020. The study included 20 cases treated with Femoral Retrograde Interlocking Nails and 20 cases treated with Dynamic Condylar Screw. Regarding the time to operative intervention, In the RN group, surgery was performed after 2.8 days (1-4 days). While in the DCS group, surgery occurred after 3.2 days (2-5 days). The results were statistically insignificant (P value 0.465)

The mean operative time in the RN (group); was 85 minutes (70 to 130) versus 110 minutes (90 to 150) in DCS (group) with a p-value of 0.355.

In the RN group, the mean operative blood loss was estimated to be 230 cc ranging from (140-450 cc) while in the DCS group; the mean blood loss was 550 cc ranging from (400-800 cc). the results were statistically significant (P-value < 0.05).

Regarding the mean hospital stay, in the RN group, the meantime was 5.6 days (3-7 days). In the DCS group, the meantime hospital stay was 6.3 days (4-8 days). The results were statistically insignificant as the P-value was=0.421.

Weight-bearing was allowed after radiological union which occurred in the RN group after an

average of 17 weeks with a range of 12 to 22 weeks. In the DCS group, the average time was 21 weeks with a range of 12 to 27 Weeks. P-value showed a statistically significant difference, the union time was earlier in the RN group. (Figure 3,4)

Figure 3: X-rays after union in a case treated by RN.

Figure 4: X-rays after union in a case treated by DCS.

At the last follow-up visit, all patients had a complete examination of the lower limb, and the knee range of motion was measured using a goniometer. In the RN group, 16 patients had full knee range of motion, 1 patient had limited flexion (0-120 degrees), and the other 3 patients had extension lag of 5 degrees. In the DCS group, 17 patients had full knee range of motion, 2 patients had limited flexion (0-120 degrees), and the other 1 patient had an extension lag of 10 degrees. The range of motion of the knee showed a statistically insignificant difference in both the RN and the DCS groups (P value>0.05).

All patients were assessed using the **Modified Hospital for Special Surgery Knee Scoring** System (modified HSS scoring system) for functional assessment. In the RN group, 10 (50%) had excellent scores, 7(35%) had good scores, 2(10%) patients had moderate and the other 1 (5%) case had fair results. In the DCS group, 9(45%) had excellent scores, 7(35%) had good scores, 2(10%) patients had moderate and the other 2 (10%) cases had fair results (p-value=0.077).

Table 2: Modified HSS Scores in the retrograde nail and DCS groups.

	RN group	**DCS group**
Excellent	10(50%)	9(45%)
Good	7(35%)	7(35%)
Moderate	2(10%)	2(10%)
Fair	1 (5%)	2 (10%)

Regarding the radiographic alignment disorders, in the RN group, 2 patients had varus malalignment (0-10 degrees), and 1 patient had posterior angulation (20 degrees). In the DCS group, 1 patient had varus malalignment (0-10 degrees). The differences between both groups were statistically significant (p-value= 0.027).

Post-operative complications

Three cases of the DCS group developed infection, two of them in the form of superficial infection which resolved on medication, and another one developed a deep infection, surgical debridement was done and antibiotic was given according to culture and sensitivity test. One case of the Retrograde Nail group had a superficial infection that resolved on medications.

One patient in the RN group had delayed union, union occurred after 29 weeks, compared to 2 patients in the DCS group, union occurred after 30,32 weeks respectively.

In the DCS group, non-union occurred in one patient, a medial plate was added together with a bone graft. In the RN group, 4 patients complained of anterior knee versus 2 patients in the DCS group who had lateral knee pain. (Table 3)

Table 3: shows complications in both groups.

	RN		**DCS**		P-value
	NO	**%**	**NO**	**%**	
Superficial Infection	1	5	2	10	0.351
Deep infection	-	-	1	5	
Delayed union	1	5	2	10	
Malunion	3	15	1	5	
Nonunion	-	-	1	5	
Knee pain	4	20	2	10	

Discussion

Distal femoral fractures either supracondylar or intercondylar are common fractures in orthopedic practice. Distal femur fractures usually have unstable patterns and may be comminuted with intra-articular extension. Any fixation device used should provide the ability to fix the articular surface anatomically, restore the alignment of the shaft, allow for early mobilization, and at the same time respect the soft tissue. [1-5]

Dynamic condylar screws have been used for a long time in treating distal femur fractures especially fractures with intra-articular extension. The main advantage of the DCS is that it allows for the reduction and compression of the intercondylar extension using the condylar lag screw. However, it has the disadvantage of being an open procedure with large skin and muscle dissection. This may be reflected in the infection rate. [7-9]

Retrograde intramedullary nailing provides adequate surgical fixation for patients with osteoporosis due to thin cortices, comminution, osteopenic, and a wide medullary canal making secure internal fixation difficult to achieve. Its main disadvantage is that it has less ability to control the anatomical reduction of the shaft. [10-11]

Our study aimed to assess the feasibility, clinical, and radiological outcomes, and complication rates of treating distal femur fractures with retrograde intramedullary nails and DCS in patients above 40 years old with relatively osteopenic bone.

A randomized control trial made by Osman Çiloğlu et al compared the results of distal femur fractures fixed by retrograde femur nails and percutaneous locked plates. The study included 47 patients classified into 34 males and 13 females, classified into 2 groups. The first group included Twenty-three patients treated by retrograde femur nails, and the second group included twenty-four patients fixed by percutaneous locked plates. They were followed up and assessed for healing union time, and complication rates. In the first group, the mean union time was 25.3±5.7 weeks. While in the second group, the mean union time was 22.3±9 weeks. According to the functional classification, in the RN group, 8 patients had excellent scores, 7 moderate, and 2 fair results. In the locked plate group, 12 patients had excellent results, 9 good, and 3 cases had moderate results. Regarding the knee range of motion, in the first group, the ROM was 102.6±16.5° and in the second group, the ROM was 115.8±18.3°. [13]

Christodoulou et al made a randomized control trial on 72 patients with distal femur fractures but only supracondylar fractures were included. The trial was done on Twenty-five male patients and forty-seven females with a mean follow-up period of 28 months. The first group was treated by RN and included 35 patients, and the second group was treated by DCS and included 37 cases. Regarding the operative time, the meantime in the RN group was 92 minutes (76–110 minutes] versus 145 minutes (115–180 minutes) in the DCS group. The average blood loss was 118 mm (90–165 mm) in the RN group while in the DCS group, the average blood loss was 310 mm (120-450 mm). Those results were significant with a p-value less than 0.001. Functional assessment according to Schatzker and Lambert, in the RN group 18(51%) had excellent results, 11 (31%) had good results, 3 (9%) had moderate, and 3 (9%) had poor results. While in the DCS group, 19 (51%) had excellent results, 11 (30%) had good results, 4 (11%) had moderate, and 3 (8%) had poor results. Their results were statistically significant among the RN and DCS groups regarding the bone union, knee ROM, and complications rate. However, the RN had better results than the DCS group regarding intra-operative blood loss with less operative time. [7]

Gh Nabi Dar et al, made a comparative study that included 68 patients with closed distal femur fractures. Thirty-seven patients were treated by RN and thirty-one patients were treated by minimally invasive DCS. The average follow-up period was 30 months (24-36 months). Regarding the operative time, the minimally invasive DCS had less operative time but had significantly more blood loss than the RN group. However, the other variables such as rate of union, knee range of motion, and the incidence of complications showed an insignificant statistical difference between both groups. Therefore, they concluded that both biologically inserted DCS and the RN are efficient alternatives in treating supracondylar fractures of the femur. [14]

Our study was a randomized control trial that included 20 cases treated with Femoral Retrograde Interlocking Nails and 20 cases treated with Dynamic Condylar Screw.

The mean operative time in the In RN (group); was 85 minutes. (70 to 130) versus 110 minutes (90 to 150) in DCS (group) with a p-value 0.355. In the RN group, the mean operative blood loss was estimated to be 230 ccs ranging from (140-450 cc) while in the DCS group; the mean blood loss was 550cc ranging from (400-800 cc). The results were statistically significant (P-value < 0.05). Union occurred in the RN group after an average of 17 weeks with a range of 12 to 22 weeks.

In the DCS group, the average time was 21 weeks with a range of 12 to 27 Weeks. P-value showed a statistically significant difference between the two groups when considering the union time, with an earlier time of union in the RN group. At the last follow-up visit, all patients had a complete examination of the lower limb, and the knee range of motion was measured using a goniometer. In the RN group, 16 patients had full knee range of motion, 1 patient had limited flexion (0-120 degrees), and the other 3 patients had extension lag of 5 degrees. In the DCS group, 17 patients had full knee range of motion, 2 patients had limited flexion (0-120 degrees), and the other 1 patient had an extension lag of 10 degrees.

The range of motion of the knee and the functional assessment showed a statistically insignificant difference in both the RN and the DCS groups (P value>0.05). One patient in the RN group had delayed union, union occurred after 29 weeks. In the DCS group, non-union occurred in one patient, the medial plate was added together with a bone graft. In the RN group, 4 patients complained of anterior knee versus 2 patients in the DCS group who had lateral knee pain.

When comparing our results with the other studies that adopted the same or different techniques regardless of the age group, we had comparable results. We found that although the incidence of malalignment was slightly higher in the RN group, both groups had similar functional outcomes. This may be related to the relatively old age groups included in the study. Also, the operative time, the blood loss, and the union time were significantly less in the RN group and this may be a crucial point in the old age group included in the study.

Conclusion:

Our study concluded that using RN has an advantage over DCS in patients with distal femur fractures above 40 years old although mal-alignment may occur. This is because RN provide satisfactory final functional outcomes with less union time, operative time, and intra-operative blood loss than DCS.

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