Research Article

Radiological and Functional Consequences of Open Reduction Internal Fixation with Locking Plate Versus Dynamic Condylar Screw in Type C1 Complete Articular Fracture of Distal Femur

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Abstract

Background: One of the body's main joints for bearing weight is the knee. Its issues are likewise difficult to resolve. Damage to this joint can cause abnormalities in the alignment, stability, and motion of the knee, which impairs function.

Objective: To compare the functional and radiological outcome in AO type C1 distal femur fractures fixed with locking plate versus dynamic condylar screw.

Methods: The study comprised 94 patients aged 18 to 60 years who had an isolated distal femur fracture and an Arbeitsgemeinschaft für Osteosynthesefragen (AO) type C1 closed fracture. Patients with diabetes mellitus, chronic renal disease, chronic liver disease, ischemic heart disease, pathological fractures, head injuries with a Glasgow coma scale of less than 14, and malignancy were excluded from the sample. The patients were assigned by lottery to groups A and B. In groups A and B, they were treated with dynamic condylar screws (DCS) and locking plate fixation, respectively..

Results: Of the 94 patients, 30 (63.8%) were men and 17 (36.2%) were women in Group A; similarly, 33 (70.2%) were men and 14 (29.8%) were women in Group B. Patients in group A had an average age of 38.8±6.19 years, whereas those in group B had an average age of 39.5±7.36 years. 02 patients (4.2%) in Group-A and 05 patients (10.6%) in Group-B experienced infection. The union rate was 45 (95.7%) in group A (locking plate fixation technique) and 40 (85.10%) in group B (dynamic condylar screw technique). 35 (74.46%) in group A, 08 (17.1%) in good, 03 (6.38%) in average, and 01 (2.1%) in poor; in group B, 25 (53.2%) in excellent, 09 (19.2%) in decent, and 10 (21.3%) had average and 03(6.3%) had poor functional outcome.

Conclusion: In terms of clinical and radiological evaluation, the type C1 distal shaft femur fixation with locking plate performs better than the dynamic condylar screw, which has a lower infection rate and better union and functional success.

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Keywords | Distal shaft of the femur, closed fracture, locking plate, dynamic condylar screw.

Introduction

One of the body's main joints for bearing weight is the knee. Its issues are likewise difficult to resolve. Damage to this joint can cause abnormalities in the alignment, stability, and motion of the knee, which impairs function. Less than 1% of all femur fractures are distal femur fractures, which make up 4–6% of all fractures. Distal femur fractures primarily afflict two populations: young patients who have been in high-energy accidents such as motorbike accidents and motor vehicle accidents, as well as sports trauma. Distal femur

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fractures are another consequence of low energy falls in the elderly caused by osteoporosis. Hip arthroplasty patients with periprosthetic fractures make up the third group of patients who experienced distal femur breaks.[4]

The usual course of treatment for supracondylar fractures is surgery.[5] Nevertheless, because of advancements in technology and implants, conservative treatment is nearly outdated these days. Based on fixed angled devices, such as blade plates, dynamic condylar screws, and nails, surgical therapy is always preferable to non-surgical treatment. This led to the development of locking plates.[6,7] Periarticular distal femur locking plates are the implants that are currently being used. The minimally invasive technique of inserting the plates submuscularly preserves blood circulation, fractures hematoma, and prevents significant soft tissue damage.[8-9]

Maintaining distal femur alignment to maintain extremities function is the primary goal of treatment for distal femur fractures.[10] A key component of treating a distal femur fracture is early range of motion in the knee. However, immobilisation can cause knee stiffness and loss of range of motion, which can lead to a worse outcome.[11] Treatment for supracondylar fractures, particularly intraarticular ones, can be difficult since there are a lot of potential side effects. There have been reports of 20% nonunion rates for conservative treatment approaches.[12,13] In addition, those with diabetes and obesity may experience wound complications and nonunion.[12] Likewise, a markedly elevated incidence of nonunion has been noted in stainless steel implants relative to titanium.[14] The aim of the research was to ascertain the functional and radiological results of a certain treatment regimen applied to a particular kind of distal femur intercondylar fracture. In order to provide our patients with an optimal course of treatment, we will thus compare our results with similar series in the international literature. It can be of great use in establishing our practice guidelines.

Methods

Approval for the study was taken from King Edward Medical University Ethical Review Committee (123/RC/KEMU. It was a randomized controlled trial (RCT) using convenient sampling. The study was conducted from October 2016 to January 2019 at Department of Orthopedic Surgery, Mayo Hospital, Lahore.

$n = Z1\text{-alpha}/2\sqrt{}\ [P1(1-P1)+P2(1-P2)]/d^2$

P_1 = population proportion 1 = 14%
P_2 = population proportion 2 =0%
Z_1-alpha= confidence level 90%= 1.645
n = 47 patients in each group.
d= absolute precision 10%

Group A included 47 patients which were treated with ORIF with locking plate

Group B included 47 patients which were treated with ORIF with DCS.

Nonprobability sampling – convenient sampling technique was used. After obtaining informed written consent, 47 patients ages between 18-60 years, Arbeitsgemeinschaft für Osteosynthesefragen (AO) type C1 closed, isolated distal femur fracture were included. Individuals with long-term medical conditions such as diabetes mellitus, persistent kidney disease, persistent liver disease, ischemic heart disease, pathological fractures, head injuries with a Glasgow coma score of less than 14, and malignancy that was ruled out during the physical examination and history were not admitted. The sample size of 47 patients was chosen.

The fracture's side, infection, radiological union, and functional result were all noted. Every patient was monitored for a minimum of a year. Patients were evaluated clinically in the out-patient department (OPD) in the following weeks: the second, sixth, twelve, sixteen, twenty, twenty-four, thirty-six, and forty-eight weeks following the procedure. The side of the fracture and the infection were also noted.

Type C1 fracture was diagnosed based upon Routine X rays(AP and Lateral view). Patients were further divided into two groups as group-A and group-B by randomization technique. Randomization was done using the lottery method. Patients in the group-A were managed with open reduction internal fixation (ORIF) using a locking plate (LP). Patients in the B-group were managed with open reduction internal fixation (ORIF) with dynamic condylar screws (stainless steel DCS). The perioperative complications e.g. periprosthetic fractures, bleeding aswell as postoperative complications e.g. infection, non union and malunion were recorded. All patients were followed up for a minimum of one year. Patients were followed up in the out-patient department (OPD) in the 2nd week, 6th weeks, 12th weeks,

16th weeks, 20th week, 24th weeks, 36th weeks, and 48th weeks after the surgery. No patient was lost to follow up. Regular X rays of distal femur(AP and LAT view) were taken on every visit. All Patients were followed up for a minimum of one year. The Side of the fracture and the infection were observed clinically. At the end of year, Union was observed by radiological union scale (RUST)[14] and functional outcome using American knee society score (AKSS)[15]. Debridement and culture and sensitivity was performed on all patients with superficial infections. Patients with deep infections were treated as per standard protocol.

The data were analyzed by using SPSS version 23.0. The mean and standard deviation were used to represent a quantitative variable, such as age. The presentation of qualitative factors, such as gender and fracture side, was done using percentages and frequencies. For qualitative variables, chi-square analysis or the Fisher exact is used when necessary (gender, presence or absence of infection and union). P-values less than 0.05 were regarded as significant.

Results

Amongst the total 94 patients, in group-A, 30(63.8%) were male and 17(36.2%) were females, and 33(70.2%) were males, and 14(29.8%) were females in Group-B. In group-A, the mean age of the patients was 38.8± 6.19 year, and in group-B, the mean age of the patients was 39.5±7.36year.

Both groups were treated by same surgical team led by a consultant. Group-A, patients with Right femur were 26(55.3%), and Left femur was in 21(44.7%), and in Group-B, Right femur fracture was in 28(59.6%) patients and Left femur Fracture was also in 19(40.4%). In Group-A, the infection rate was 02 (4.2%), and the infection occurred in Group-B patients was 05 (10.6%). Operative timing was also noted for both technique to rule out any possible delay in union due to this cofounding factor.

With the locking plate fixation technique, the union rate was 45(95.8%), while with the DCS technique, the union rate was 40 (85.10%). In group-A, 35 (74.46%) had excellent, 8(17.1%) good, 03(6.38%) had an average, and 01 (42.1%) had poor functional outcome. Similarly in group-B, 25 (53.2%) had excellent, 09 (19.2%) good, 10 (21.3%) had an average, and 03 (6.3%) poor functional outcome (Table 1)

Using the Chi-Square test, it was determined that the shaft of femur fracture union differed significantly between the two methods ($p<0.001$) and infection rate (Table 2).

Table 1: *Demographics and comparison between both groups.*

Variables	Locking Plate Fixation (n=47) (%)	DCS Fixation n=(47) (%)	N= 94 (%)
Gender of the patient			
• Male	30 (63.8%)	33 (70.2%)	63 (67.1%)
• Female	17 (36.2%)	14 (29.8%)	31 (32.9%)
Age in years (Mean±SD)	38.8±6.19	39.5±7.36	
Side	26 (55.3%)	28 (59.6%)	54 (57.4%)
• Right	21 (44.7%)	19 (40.4%)	40 (40.6%)
• Left			
Infection			
• Yes	02 (4.2%)	05 (10.6%)	07 (7.4%)
• No	45 (95.8%)	42 (89.4%)	87 (92.6%)
Union of the bon			
• Yes	45 (95.8%)	40 (85.10%)	85(90.42%)
• No	02 (4.2%)	07 (14.98%)	09 (9.57%)
American Knee Society Score			
• Excellent	35 (74.46%)	25 (53.19%)	60 (63.82%)
• Good	08 (17.02%)	09 (19.2%)	17 (18.08%)
• Average	03(6.38%)	10 (21.3%)	13(13.82%)
• Poor	01 (2.12%)	03 (6.3%)	04 (4.25%)

**DCS= Dynamic condylar screw*

Table 2: *Chi-square test of union of the bone between the two groups.*

Groups	Union		N=94 (%)	P-value
	Yes (n=85) (%)	No (n=09) (%)		
Treatment groups of the patients				0.001
• Group- A (LP)	45 (51.1%)	02(22.2%)	47 (100%)	
• Group-B (DCS)	40 (42.6%)	07 (77.8%)	47 (100%)	

**LP= Locking plate, *DCS= dynamic condylar screw*

Discussion

Distal femur fractures are prevalent and usually happen to younger and older individuals, respectively, as a result of high-energy and low-energy traumas, along with related injuries and consequences.[16–21] A study of the literature indicated that while many studies have been published on the management of closed femur fractures, none of them focused on femur fractures in this particular patient population.[16,20,22,23]

For femur shaft fractures, locking plate fixation has been linked to a higher union rate.[20,22] The application of locking plates in open fractures or greater energy trauma can lead to increased intra-compartment pressures, increased endosteal necrosis, decreased cortical blood supply, and an increased risk of infection.[24,25] It is challenging and demanding to maintain the proper fracture reduction with unstable segments; extra plates, locking screws, or the open placement of a bone reduction clamp or bone holder to hold the segment are necessary during fracture fixation.[26,27] These procedures carry a higher risk of complications. To verify reduction, an image intensifier was utilized on a regular basis.

Regardless of the fixation method used, the correct initial anatomical reduction is crucial and directly correlates with a considerably faster healing time.[28] The extensive growth of callus and scarring in this age group make it impossible to achieve the secondary reduction. Following appropriate debridement of necrosed and dead bone and soft tissue in accordance with the protocol, the reduction is accomplished through a closed, minimally invasive approach that requires little to no soft stripping through the small incision or traumatic site. If necessary, screws can be used to fix the fractures while the picture is intensified.

The average age of the patients receiving LP treatment in this study was 38.8±6.19 years, which was comparable to the findings of Goodship et al.'s study from 29 that showed the patients' average age to be 35.01±8.78 years. According to Nowak et al.,[30] 01 (4%) of the patients receiving DCS had superficial infection.

The study's 95.8% union rate for patients treated with LP was comparable to the 95.5% union rate reported by Solanki et al.[31] in their case series of 44 patients treated for AO type C fractures with locking plates.

The union rate in this study is comparable to the findings of Kumar et al.

The functional outcomes of group A consisted of 35 (74.46%) good, 08 (17.1%) good, 03 (6.38%) average, and 01 (2.1%) poor. Group B had 25 (53.2%) excellent, 09 (19.2%) good, 10 (21.3%) average, and 03 (6.3%) poor functional outcomes. In 18 (34.6%) cases, Solanki et al.[31] reported outstanding results. Patients' ratings were satisfactory for 22 (42.3%), fair for 07 (13.5%), and poor for 05 (9.6%). The population of the elderly in Solanki et al.,[31] with a mean age of 41.77 years and complex intraarticular fractures, may be the cause of this variation in functional result. In terms of LP, the functional result of our investigation is comparable to that of Khajotia et al.[32]

Comparable to this study, Surulivel et al.[33] reported a good to outstanding functional result in 83.3% of instances of supracondylar fracture of the femur treated with DCS.

The technological challenges associated with implant application in both groups were overlooked. In addition, future research may examine a minimally invasive locking plate method.

Conclusion

The outcome of fixation of TYPE C1 distal femur fracture with locking plate is better than Dynamic condylar screw-in terms of union and functional outcome. The infection rate was also low with the locking plate.

Ethical Approval: The Institutional review board of KEMU approved the study vide letter No. 123/RC/KEMU/.

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Authors' Contribution:

AR: conceived the idea, data acquisition and interpretation, manuscript writing and final approval of the draft

SD: Data acquisition and interpretation

UKK: Interpretation and analysis, final approval of the draft

SA: Interpretation and analysis, final approval of the draft

MC: Data acquisition

MA: Revising it critically for important intellectual content.

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