Surgical Technique

Supine Patient Position With the Contralateral Leg Elevated for Femoral Intramedullary Nailing

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Abstract

Background Intramedullary nailing can be performed with a fracture table or manual traction. Manual traction can be applied with the patient in either the supine or lateral decubitus (LD) position. However, in either of these positions, the reduction can be difficult because the fractured extremity is not positioned parallel to the floor and the contralateral leg on the operating room table overlaps the fractured limb while the fractured extremity is in full adduction. Therefore fluoroscopy time may be increased. Accordingly, we developed a technique with the patient supine and the contralateral leg elevated (SCLE).

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request. Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This work was performed at the Atatürk Training and Research Hospital, Ankara, Turkey.

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Description of Technique We performed antegrade femoral intramedullary nailing with the patient in the supine position with the contralateral leg elevated to allow easy nail entry, reduction, and locking. In this position, the uninjured leg was placed on the leg holder in a semilithotomy position to allow full hip adduction.

Methods We retrospectively reviewed 63 patients treated with intramedullary nailing: 30 with the SCLE position (mean age, 38 years; 30% female) and 33 with the LD position (mean age, 37 years; 36% female). From the medical records we extracted demographic information, fracture pattern, intramedullary nail diameter, duration of fluoroscopy and operation, and complications. At the last visit, extremity lengths, rotation, and alignment were determined. Minimum followup was 46 months (mean, 46 months; range, 20–72 months).

Results The mean durations of surgery and fluoroscopy were shorter for the SCLE group than the LD group: 98 versus 108 minutes and 3.4 versus 3.8 minutes, respectively. The open reduction rate was less in the SCLE group when compared with the LD group: 10% versus 36%.

Conclusions We believe the SCLE technique is a reasonable treatment choice for femoral intramedullary nailing as it facilitates obtaining orthogonal views of the femur while possibly shortening surgery and fluoroscopy times.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Reamed and statically locked intramedullary nailing has become the preferred treatment for femoral shaft fractures [2, 12, 14, 18]. Although anatomic reduction is more

difficult to maintain and the patient and operating room (OR) team are exposed to radiation with this technique, the closed method is preferred because of the lower incidence of nonunion and infection [19]. Intramedullary nailing can be performed with a fracture table or manual traction on a standard radiolucent OR table. Using a fracture table has the advantage of one's ability to maintain acceptable reduction with only one assistant. However, disadvantages of using a fracture table also have been reported, eg, pudendal nerve injury, compartment syndrome of the contralateral leg, perineal skin damage, and extra time needed for transferring the patient on and off the fracture table [1, 6]. Manual traction can be performed with the patient in either the supine or lateral decubitus (LD) position. In a study of intramedullary nailing by Karpos et al. [8] comparing the use of manual traction with a fracture table, the quality of reduction after using the two techniques was equivalent, but manual traction had a substantially shorter operative time.

In the standard supine and LD positions, because the fractured extremity is not positioned parallel to the floor and the contralateral leg overlaps the fractured limb on the OR table while the fractured extremity is in full adduction, determining the exact position of the fracture fragments and achieving anatomic reduction are difficult using fluoroscopy. To achieve and maintain easy reduction with a low duration of fluoroscopy time is important for closed intramedullary nailing of these fractures. This may depend on the position of the patient on the OR table. We therefore developed a technique with the patient supine and contralateral leg elevated (SCLE).

In this report, we describe our SCLE technique. We determined whether it affected surgery and fluoroscopy times, limb length difference, coronal-sagittal plane, rotational alignment, and open reduction rate.

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Patients were positioned on the radiolucent OR table in the supine position. While femoral intramedullary nailing, the fractured extremity usually needs to be positioned in full adduction during surgery for nail entry, reduction, and locking (owing to hardware in the proximal incision). Therefore the fractured extremity usually has to be placed over the contralateral extremity and thus both extremities generally overlap in the supine and LD positions. A parallel position of the injured extremity to the floor for an orthogonal fluoroscopic view therefore cannot be achieved, and nail entry, reduction, and long-time manual traction can be difficult. To solve these problems, we placed the uninjured leg on the leg holder in a semilithotomy position with the knee in 45° to 90° flexion, the hip in 45° to 90° flexion, and 30° to 45° abduction on the OR table. The final positions of the joints were decided according to the size of the patient so that adequate C-arm images could be taken (Fig. 1). After draping the patient, the injured extremity was placed in maximum adduction under the contralateral elevated leg by manual traction (Fig. 2). At this stage, the injured extremity was in contact with the OR table and positioned parallel to the floor while it was in full adduction. Under C-arm fluoroscopic control, the guide pin was placed and the nail entry point was marked (Fig. 3). The proximal segment was drilled with a 13-mm drill. While traction was applied manually, reduction was maintained by the 9-mm reduction rod. The length of the nail was determined by the guide pin and its diameter by the size of the reamer. All nails (Trigen®; Smith & Nephew, Memphis, TN, USA) were placed in an antegrade fashion with piriformis entry and locked statically. One oblique proximal locking and two distal screws were used. During insertion, if needed, we used a small pad under the fracture

Fig. 1A–B (A) The C-arm is placed to take an AP view for the femoral entry point in the SCLE position. (B) The position is shown from the lateral view.

Fig. 2 The injured extremity is moved to full adduction under the elevated contralateral leg with manual traction.

Fig. 3 The guide wire is placed at full adduction of the injured extremity under manual traction.

site to prevent placement in extension resulting from femoral sagittal alignment. As the nail was placed, rotation of the femur was evaluated by examining the trochanter minor and patellar views with the C-arm, as described by Krettek et al. [9]. The distal holes of the nail were locked under C-arm control (Fig. 4). Because the uninjured leg was in an elevated position, the lateral image of the injured extremity could be clearly obtained without additional movement of either leg (Fig. 5). Proximal locking was performed using the external guide, which was added on the nail application system. Femur length was compared with the preoperatively measured uninjured leg from the superior iliac spine to the proximal edge of the patella. In patients undergoing open reduction, the guide pin was inserted into the distal segment with the help of a finger through a short incision.

In patients treated in the LD position, side supports were used to bring the pelvic ring of the patient into a perpendicular position to the table. Nail insertion was identical to that described for the patients in the SCLE position. The distal holes were locked after the exact circular shape of the hole was obtained on the lateral view with the C-arm. Rotation and length were determined as described for the patients in the SCLE position.

During the early postoperative period, all patients performed regular hip and knee ROM and isometric exercises. Patients were mobilized with weightbearing permitted as tolerated after 3 weeks.

Patients and Methods

We retrospectively reviewed data from all 116 patients treated with AO/ASIF Type 32 [11] femoral shaft fractures with intramedullary nailing from November 2004 and July 2009. All operations were performed by three surgeons (AF, AO, MB) who were experienced with at least 5 years as trauma department specialists and with an equivalent degree of experience in both techniques. We first performed a series of LD position cases. After gaining experience with the SCLE position, it was used routinely. Data from 53 patients were not analyzed because the patients were in the standard supine position ($n = 11$) for surgery, had coexisting proximal or distal metaphyseal femoral fractures ($n = 15$), had coexisting ipsilateral or contralateral tibia or femoral fractures ($n = 7$), had multiple trauma ($n = 9$), had a pathologic fracture ($n = 1$), had a problem with the uninjured extremity that could affect rotational measurements ($n = 4$), and could not be reached for followup ($n = 6$). Among the remaining 63 patients, 30 were treated with the SCLE approach (mean age, 38 years; 30% female) and 33 with the LD approach (mean age, 37 years; 36% female). There were no differences in selection of patients. All patients were operated on with these techniques for the same indication. The indication for the SCLE approach was AO/ASIF Type 32 femoral shaft fractures. The contraindications were: (1) contralateral leg fractured; (2) contralateral hip or knee contracture; and (3) contralateral compartment syndrome or neurovascular injury. The indication for the LD approach was AO/ASIF Type 32 femoral shaft fractures. The contraindications were: (1) contralateral hip or leg fracture; (2) coexisting pelvic fracture; and (3) coexisting abdominal injury that required laparotomy. Minimum followup was 20 months (mean, 46 months; range, 20–72 months). The patients were informed about the surgical procedure and their informed consent was obtained before surgery. Our retrospective data were reviewed and approved by the institutional review board.

Fig. 4A–E Intraoperative fluoroscopic views show (A) the piriformis entry of the guide wire, (B) passing the guide wire from the fracture site, (C) placement of the nail (the guide wire is still inside), and (D) AP views of the distal locking and (E) proximal locking.

Fig. 5 The C-arm is placed to take the lateral view of the distal femur as required for distal locking of the nail.

We observed no differences in demographic characteristics and fracture patterns between the two groups (Table 1).

All patients were followed monthly from discharge to bony union and then every 3 months until the second year. On followup, we routinely examined ROM, muscle

strength, extremity length, and rotation. Additionally, plain radiographs were collected. All patient data including surgical and fluoroscopy times (from C-arm monitor) and complications were recorded routinely. Major complications were defined as deep infection, compartment syndrome, and neurovascular injury. A minor complication was defined as a superficial infection. Infections were diagnosed with microbiologic and hematologic tests, compartment syndrome with physical examination, and, if needed, using an intracompartmental pressure measuring device. Neurovascular complications were assessed with electroneuromyography and Doppler sonography.

We reviewed the patient charts and recorded demographic information, fracture pattern, intramedullary nail diameter, fluoroscopy and surgery times, complications, and whether open reduction was performed. Measurements of limb length, alignment, and rotation were performed independently by three surgeons (CI, RA, MA) who were not treating surgeons. Mean values were calculated. Limb lengths were measured from the hip to ankle with orthoroentgenograms which means an AP view of both lower extremities from hip to ankle, and the limb length differences compared with the contralateral side were noted (Fig. 6). Final extremity length was classified as one of five subgroups; equal limb, shortening 10 mm or less,

Table 1. Patient demographics and fracture characteristics

Demographics and fracture characteristics	SCLE	LD	p value
Patients			
Number	30	33	
Mean age (years)	38.1 (± 5.6 SD)	37.3 (± 4.8 SD)	0.120*
Sex (female)	9 (30%)	12 (36.3%)	0.593 [#]
Side (right)	18 (60%)	21 (63.6%)	0.767 [#]
Cause of injury			0.883 [#]
Fall	6 (20%)	9 (27.3%)	
Motor vehicle	13 (43.4%)	15 (45.4%)	
Industry	8 (26.6%)	7 (21.2%)	
Other	3 (10%)	2 (6.1%)	
Diaphyseal segment			0.553 [#]
Proximal	12 (40%)	9 (27.3%)	
Middle	13 (43.4%)	18 (54.5%)	
Distal	5 (16.6%)	6 (18.2%)	
AO fracture type			0.909 [#]
A	12 (40%)	15 (45.4%)	
B	12 (40%)	12 (36.4%)	
C	6 (20%)	6 (18.2%)	
Gustilo type			0.983 [#]
0	24 (80%)	27 (81.8%)	
1	4 (13.3%)	4 (12.1%)	
2	2 (6.7%)	2 (6.1%)	
3	0	0	
Average implant diameter (mm)	11.5 (range, 10–13)	11.5 (range, 10–13)	1.000*

SCLE = supine with contralateral leg elevated; LD = lateral decubitus; [#]categorical variables as sex, side, cause of injury, diaphyseal segment, AO fracture type, and Gustilo type were compared using chi-square and Fisher's exact tests; * mean age and implant diameter were compared using Student's t-test.

shortening greater than 10 mm, lengthening 10 mm or less, or lengthening greater than 10 mm. The number of patients in each group was determined [16]. A longer length than the uninjured leg was considered a positive value and a shorter length than the uninjured leg was considered a negative value. Coronal-sagittal plane alignments were evaluated with standard radiographs. According to the criteria of Thoresen et al. [17], greater than 5° varus-valgus angulation for the AP plane and greater than 10° ante-curvatum-recurvatum angulation for the sagittal plane denote fair and poor values. We considered the fair and poor values of these criteria as unsatisfactory. Rotational alignment of the uninjured and injured lower extremities was evaluated clinically by measuring the internal and external rotation using a goniometer while the hip was at 90° flexion with the patient supine and 0° hip flexion with the patient prone; the mean values in each position were

Fig. 6 An orthoroentgenogram, which is an x-ray with measurement calibration, is shown.

calculated [7]. The shift in ROM toward internal or external rotation determined the clinical rotational deformity. Internal and external rotational deficits were classified as greater or less than 15° [16]. Because a difference of as much as 15° may occur normally [5], we considered a difference in torsion angle greater than 15° as rotational malalignment [3]. External rotation was noted as a positive value and internal rotation as a negative value. The repeatability of the measurements of limb length, alignment, and rotation for the three observers was determined with Cronbach's alpha (alpha = 0.837).

The categorical variables of patient demographics and fracture characteristics such as sex, side, cause of injury, diaphyseal segment, AO fracture type, and Gustilo type were compared between groups using chi-square and Fisher's exact tests, and the mean age and implant diameter were compared using Student's t-test. We determined differences in surgery time between the SCLE and LD groups using the Mann-Whitney U test, fluoroscopy time using Student's t-test, and open reduction rate, rotational deformities, and limb length differences using the chi-square test. There were no missing data for any patients included in the study. Statistical analysis was performed using SPSS Version 15.0 (SPSS, Inc, Chicago, IL, USA).

Results

The mean surgery time was shorter ($p = 0.001$) in the SCLE group (98 minutes) than in the LD group (108 minutes). The mean fluoroscopy time was shorter ($p = 0.003$) in the SCLE group (3.4 minutes) than in the LD group (3.8 minutes) (Table 2).

The mean difference in limb length was +0.4 mm (range, -14 to +17 mm) in the SCLE group and -1.6 mm (range, -12 to +14 mm) in the LD group. When the number of patients in the subgroups were compared between groups, there were more patients ($p < 0.001$) in the shortening 10 mm or less subgroup in the LD group (Table 3). There were no differences among subgroups.

We detected no coronal-sagittal plane malalignment in either group. Mean rotational differences between injured and uninjured extremities were +1.2° (range, -17° to +19°) in the SCLE group and -2.6° (range, -24° to +22°) in the LD group. When the two groups were compared for malrotation, there were more patients ($p < 0.001$) who had greater than 15° internal rotation in the LD group (six patients [18%]). Five of six patients were those with AO/ASIF

Type C fractures (Fig. 7). There were no differences for other values between groups (Table 3).

Three of 30 patients (10%) in the SCLE group and 12 of 33 patients (36%) in the LD group needed open reduction through a minimal incision for passage of the reduction guide wire to the distal fragment during surgery. The open reduction rate was lower ($p = 0.001$) in the SCLE group when compared with the LD group.

Fig. 7 An AP view of an AO 32-C2 segmental femoral shaft fracture is shown.

Table 2. Comparison of mean operative and fluoroscopy times between treatment groups

Time	SCLE	LD	p value
Mean operative time (minutes)*	98.4 ± 3.7	108.2 ± 6.3	0.001
Mean fluoroscopy time (minutes)†	3.4 ± 0.5	3.8 ± 0.7	0.003

* Operative time is the time from the beginning of incision to wound closure; †fluoroscopy time used during surgery; SCLE = supine with contralateral leg elevated; LD = lateral decubitus.

Table 3. Limb length discrepancy and malrotation

Parameter	Groups	SCLE	LD
Limb length discrepancy (mm)*		+0.4 (-14 to +17)	-1.6 (-12 to +14)
	Equal limb lengths [#]	19 (63.3%)	18 (54.5%)
	Shortening ≤ 10 mm [#]	3 (10%)	10 (30.3%)
	Shortening > 10 mm [#]	2 (6.7%)	2 (6.1%)
	Lengthening ≤ 10 mm [#]	4 (13.3%)	2 (6.1%)
	Lengthening > 10 mm [#]	2 (6.7%)	1 (3%)
Malrotation†		+1.2 (-17 to +19)	-2.6 (-24 to +22)
	None	15 (50%)	14 (42.4%)
	Internal malrotation ≤ 15° [#]	8 (26.7%)	10 (30.3%)
	Internal malrotation > 15° [#]	2 (6.7%)	6 (18.2%)
	External malrotation ≤ 15° [#]	4 (13.3%)	2 (6.1%)
	External malrotation > 15° [#]	1 (3.3%)	1 (3%)

* Negative values represent shortening and positive values represent lengthening relative to the normal side; †negative values represent internal malrotation and positive values represent external malrotation relative to the contralateral side; SCLE = supine with contralateral leg elevated; LD = lateral decubitus; [#]values for these categorical variables are given as the number of affected individuals followed by the percentage in parentheses.

Fig. 8A–B Early postoperative (A) AP and (B) lateral view radiographs show the fractured femur with an intramedullary nail.

At the last followup, all fractures had healed. None of the patients underwent revision surgery as a result of limb length discrepancy or rotational deformity (Fig. 8). Two patients in the SCLE group and four in the LD group developed superficial infections, which all resolved with oral antibiotics. One patient in the LD group experienced a deep infection after a Grade 2 open fracture, treated with sequential débridement and antibiotics. No patient had compartment syndrome or peroneal nerve injury of the uninjured leg.

Discussion

Manual traction for femoral intramedullary nailing can be performed with the patient in either the standard supine or LD position [8, 15, 20, 21]. In the standard supine position, some surgeons elevate the injured extremity with a bump; some surgeons also use a fracture table for controlled adduction to obtain a proper entry point for the nail [8, 13, 15, 17, 20]. Although this position permits full adduction and facilitates nail entry, taking true orthogonal views with the C-arm becomes difficult as a result of oblique placement of the extremity. In the LD position, the fractured extremity is directed anterior and downward on the contralateral extremity to obtain hip adduction so that the patient's pelvis is rotating on the table from the absolute lateral position [10]. In both positions, because the fractured extremity needs to be positioned in full adduction during surgery, the extremity is not able to be positioned parallel to the floor owing to overlapping of the extremities while it contacts with the OR table. Therefore achieving

and maintaining anatomic reduction is difficult as a result of placement of the femur off the table during manual traction. It mostly depends on the position of the patient on the OR table. This also complicates taking true AP and lateral fluoroscopic views of the fracture and results in much more radiation exposure. We, therefore, developed a technique of positioning the patient supine with the contralateral leg elevated.

We recognize limitations of our study. First, we had a relatively small number of patients although sufficient to describe the technique and report operating and fluoroscopy times. Second, we compared only two positions excluding the standard supine position. While we began to use the original SCLE position we continued using LD position. Therefore we used the SCLE and the LD positions for comparison. Third, we did not evaluate the durations of each surgical and fluoroscopic step (such as patient preparation, nail entry, reduction, locking). Because the SCLE position facilitated the various steps of the operation, we considered it important to record the total surgical and fluoroscopic times. Fourth, we have no randomization. However, the indications for both positions were similar.

Wolinsky et al. reported mean operative times of 107 ± 36 minutes for femoral interlocking nailing with the patient in the supine position without a fracture table [21]. We found the operative time for patients in the SCLE position (mean duration, 98 minutes) was shorter than that of the patients in the LD position (mean duration, 108 minutes). Surgery time is affected by several steps, like preoperative preparation, nail entry, reduction, nail placement, and locking. Although nail entry and locking steps are performed in the same manner, we suggest that time spent for reduction may be different between two positions. Although this result is statistically meaningful, it has no practical importance. However, this is a new technique with better logic. We believe that it can be improved with time.

In the supine position with 30° hip elevation, because of the angle between the fractured femur and the table, the AP view must be obtained by rotating the C-arm. In the SCLE position, the C-arm is easily placed around the OR table and the true AP view can easily be obtained. As a result of these factors, fluoroscopy time for patients in the SCLE position (mean duration, 3.4 minutes) in our study was less than for patients in the LD position (mean duration, 3.8 minutes). Less fluoroscopy time was probably the result of the easier reduction and nail placement that the SCLE position afforded, although this difference would have no practical importance for individual patients.

Limb length discrepancy after intramedullary nailing of femoral shaft fractures is not uncommon [20, 22]. We measured the limb length discrepancy with standing

orthoroentgenograms and less than 10 mm shortening was observed more often in the LD group than the SCLE group. Although this amount of limb length discrepancy is not clinically important, it serves as an indication of the greater difficulty in maintaining anatomic reduction with the patient in the LD position.

Liu et al. [10] reported some disadvantages of the LD position. They emphasized that it is difficult to take the true AP view with fluoroscopy and varus or valgus deformity may occur in fractures adjacent to the distal part of the femur. In addition, they reported it is difficult to perform reduction of comminuted (Winqvist-Hansen Type 3 or 4 [19]) fractures in this position. We did not detect any varus or valgus malalignment in six patients with AO/ASIF Type C fractures when they were in the SCLE position during the operation.

In patients with comminuted fractures, rotational deformities and limb length discrepancies are more common [4, 7]. Reducing comminuted fractures is especially difficult with the patient in the LD position. However, in the SCLE position, the fractured extremity is supported by the OR table, making control of the fractured fragments much easier. More of our patients in the LD position than the SCLE position had greater than 15° internal rotation. For patients in the LD position, five of the six who had greater than 15° rotational deformity were those with AO/ASIF Type C fractures. In the treatment of AO/ASIF Type C fractures, the SCLE position may be the preferred position.

Several techniques have been described for reduction of femur fractures during closed intramedullary femoral nailing [13]. In all these techniques, two reduction maneuvers are needed for passing the guide wire and nail placement. Between these stages the first reduction is usually lost because of the intermittent and decreased powered manual traction by the assistant. In the SCLE position, with the support provided by the table, less effort is needed to maintain the reduction. In our study, the SCLE position also resulted in fewer patients needing a limited open reduction procedure when compared with patients in the LD position. We recognize that our open reduction rate is high in both groups. This problem is most likely attributable to our relative inexperience with closed nailing and our lack of modern equipment. We suspect that with the correction of these issues, our need for open reduction will decrease substantially. However, this situation in no way detracts from our overall findings. We believe the SCLE technique is a reasonable choice of treatment, as it facilitates obtaining orthogonal views of the femur thereby shortening surgery and fluoroscopy times for femoral intramedullary nailing.

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