Functional Outcomes of the Knee after Retrograde and Antegrade Intramedullary Nailing for Femoral Shaft Fractures

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Abstract

Background: Antegrade intramedullary nailing is currently considered the gold standard for treatment of femur shaft fractures although retrograde technique is gaining acceptance. Although introducing the nail through the knee has potential to damage the intra articular structures, several reports have indicated acceptable functional outcome. The results are not known in our centre that so far lacks an established patient selection and knee rehabilitative protocols in-spite of the widespread use of the retrograde technique.

Objective: To compare the functional outcome of the knee joint after retrograde and antegrade intramedullary nailing of femoral shaft fractures.

Methods: A comparative cross sectional study carried out on patients who were treated with retrograde and antegrade intramedullary nailing for femoral shaft fractures between January 2007 and December 2009. Functional outcome was determined using modified HSS score.

Results: A total of 124 patients participated in the study. According to the modified H.S.S knee rating system, overall, functional results were rated as excellent in 71.8%, good in 23.4% and poor in 3.2%.The retrograde group had poorer results than Antegrade group ($p<0.001$). There was a negative correlation between age and the functional outcome in the retrograde group ($p < .001$).The incidence of knee pain was higher in the retrograde group (37.5%) as compared to 10% in the Antegrade group, while the rate of knee stiffness was higher in the retrograde group (40.6%) compared to the Antegrade group (3%).

Conclusion: Retrograde nailing is associated with poorer knee scores in our patient population. Increasing age is a factor associated with poorer scores especially after retrograde nailing.

Background

Antegrade approach to the femur for intramedullary fixation of shaft fractures has been extensively described with union rates as high as 99% and has been considered the gold standard to date (1-5). However, retrograde approach through the femoral intercondylar notch has been popularized in the recent years as an alternative to antegrade nailing (6-12).

The SIGN® nail is a solid interlocking intramedullary device designed, manufactured and distributed by Surgical Instrument Generation Network (SIGN). The nail is designed for use in femur, tibia and humerus shaft fractures. It is designed for insertion without fluoroscopy or use of fracture table. Availability of the SIGN® nail in our setting and a number of peripheral hospitals in Kenya has provided orthopedic surgeons in these areas with an opportunity to use the interlocking nail to treat femoral shaft fractures in such resource poor settings (13). Retrograde nailing has potential of violating intraarticular structures and cartilage, raising the fear of knee complications and deterioration of knee function (14, 15). Studies looking at functional outcomes after retrograde nailing have reported acceptable results (16, 17).

However these studies have been performed using different types of nails, specifically designed for retrograde use, predominantly closed reduction of fractures and with specific post-operative rehabilitation by continuous passive motion or physical therapy of the knee (16-19). The use of continuous passive motion functional training of the knee after intramedullary nailing of the femur has been shown to be a significant determinant of outcome highlighting the importance of a postoperative knee rehabilitation protocol (20).

In the setting of this study, there is no established protocol of knee rehabilitation after antegrade or retrograde nailing. Furthermore, the fractures were reduced mainly by open method and this has potential to violate the extensors of the knee. This study compares the knee functional outcomes after retrograde and Antegrade nailing and evaluates its association with gender, fracture level and fracture type in our patient population. The results of this study are a first step in drawing patient selection.

Methodology

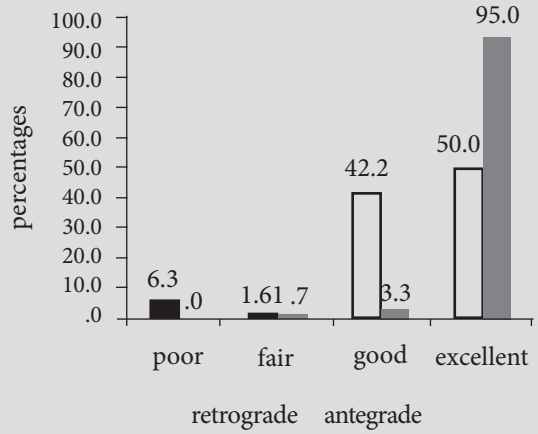
We carried out a hospital based cross sectional study in a 712-bed capacity Teaching and Referral Hospital in Western Kenya among patients aged 16 years and above who had undergone intramedullary fixation of femur shaft fractures using the SIGN® nail between January 2007 and December 2009. The participants clinical and demographic data was retrieved from their records and entered into a data sheet. Clinical examination of the knees was conducted and a goniometer was used to determine active range of motion. Fractures were classified according to the AO/OTA classification of fractures, while outcomes were determined using the modified Hospital for Special Surgery (H.S.S) knee functional score (16). Patients with obvious knee trauma/pre-existing knee pathology, incomplete medical records, bilateral femoral fractures or floating knee were excluded from the study leaving 124 patients in our study. Data analysis was done using SPSS version19 and the p value was set at ≤0.05.

Results

The ages of the study population ranged between 16 to 84 years with a mean age of 38.8 ±15.4 years. The male to female ratio was 3.3:1. On average, the duration between injury and nailing was 10 ±7.2 days, with a range of 0 to 40 days. The average follow-up (time of surgery to study) for retrograde group (70 weeks) and antegrade group (65 weeks) was not significantly different (p>0.05).

All fractures were reduced by open method as per the SIGN® Technical Manual. The retrograde method of nailing was used in 51.6% of the cases while antegrade accounted for 48.4%.In the retrograde group (N=64), all the fractures were either in the lower (60%) or middle third (40%) of the femoral shaft. While in the antegrade group (N=60), the level of fractures was 32%, 65% and 2% for upper, middle and lower 1/3rds of the femoral shafts respectively.

Figure 1: Ratings according to the modified HSS scoring



As shown in figure1, 98.3% and 92.2% of patients had excellent or good outcomes in the antegrade and retrograde groups respectively. Fifty per cent of patients in the retrograde group had excellent outcomes as compared to 95% in the antegrade group (p<0.001).

Overall there was a negative relationship between knee scores and the age of the patients, r = -.42, p < .001. The relationship between age and the outcome was not significant in antegrade group (r= -.085, p=0.519), but was significant in retrograde (r= -.445, p<0.001).

The differences in the average functional scores for the different fracture levels in the antegrade or retrograde group were not statistically significant: antegrade group p=0.82, retrograde group p=0.286.

Overall, male patients had insignificantly greater modified knee ratings x = 90.05, than their female counterparts x= 86.21, (p >0.05).

Table 1: Association between H.S.S knee scores and other variables

Variables		Modified knee ratings			
		N	Mean	Std. Deviation	P value
Method of nail insertion	Antegrade	60	94.52	4.265	<0.001
	Retrograde	64	84.13	11.834	
Level of fracture in Antegrade	Upper third	19	94.37	5.776	>0.05
	Middle third	40	94.65	3.453	
	lower third	1	92.00	.	
Level of fracture in retrograde	Middle third	28	85.93	12.241	>0.05
	Lower third	36	82.72	11.483	
Gender	Male	95	90.05	9.893	>0.05
	Female	29	86.21	11.512	
Gender in Antegrade	Male	46	95.02	2.871	>0.05
	Female	14	92.86	7.080	
Gender in Retrograde	Male	49	85.39	11.751	>0.05
	Female	15	80.00	11.533	

The prevalence of knee pain was significantly higher in the retrograde group (37.5%) as compared to 10% in the antegrade group (p<0.001). The whole study population had 23% incidence of knee stiffness. In the individual groups, the rate of knee stiffness was significantly higher in the retrograde group (40.6%) compared to the Antegrade group (3%)(p<0.001).

Discussion

The ages of the study population ranged between 16 to 84 years with a mean age of 38.8 ±15.4 years. This is consistent with Soren's finding of 41 years as the average age of the patients in a study on femoral fractures in a setting in rural Eastern Kenya (13). Internationally, the average age of patients in our study compares well with the Edinburg data review of 1988 to 1984 whose average was 38years (21)

In our study, males accounted for 77% of the patients with the male to female ratio being 3.3: 1. In the Edinburg data review, males accounted for 65% and females 35%. These demographics demonstrate that femoral shaft fractures are most common in males at their very productive age and this might have far reaching direct and indirect social economic effect within the society.

This study demonstrates that retrograde nailing has significantly poorer knee scores as compared to antegrade nailing in our patient population. The retrograde technique is widely being used in our setting without established knee rehabilitative protocol. Bei C, et al showed that after single factor analysis, continuous passive motion functional training of the knee after nailing was one the significant determinants of outcome (20).

Animal studies have suggested that retrograde intramedullary nail is associated with 49% and 52% reduction in blood supply to the posterior and anterior cruciate ligaments respectively (15). Such studies in humans have not been conducted and the effects on function of the knee are unknown. Furthermore it has been demonstrated that malposition of the entry portal may lead to encroachment of the patellafemoral articulation (14).

Darglar et al concluded that the two methods of nailing have similar functional outcome (17). This is in contrast to the findings of our study. Leggon and Feldmann in 2001 observed an average H.S.S knee score of 80.4 in their study that focused on retrograde nailing for femoral shaft fractures (22). In our study, the average H.S.S score for retrograde group was 84.1 which are slightly better than the Leggon and Feldmann study.

Overall, this study found a negative relationship between the functional knee scores with increasing age ($r = -.42$, $p < .001$.) regardless of the method of nailing, though only statistically significant in the retrograde group ($r= -.445$, $p<0.001$). This study agrees with Darglar et al, who found a negative correlation between age and knee functional outcome regardless of the method of nailing used (17).The reason for this negative relationship between age and outcome is not clear but is probably related to onset of arthritis with increasing age, motivational issues such as willingness to move the knee after surgery.

The difference in the average functional scores for the different fracture levels in the Antegrade group was not statistically significant in this study (p=0.82). This also applied for the retrograde group (p=0.286). The influence of the fracture level to the knee outcome is minimally reported in literature. However, some investigators have reported acceptable outcomes after retrograde nailing of supracondylar and simple intra-articular fractures of the distal femur (16). Papadokostakis et al demonstrated in their meta-analysis that although distal femur factures had poorer knee range of motion when compared to shaft fractures after retrograde nailing (104.6° versus 127.6°) the shaft group had higher rates of knee pain than distal femur group.(24.5% versus 16.5%) (23). Pain and range of motion are some of the key components of the functional scores and their variability depending on fracture level may have an unpredictable influence the scores at different fracture levels of the femoral shaft.

Although male patients had better overall outcomes than their female counterparts, the difference was not significant in both groups. Bei et al showed that the H.S.S Knee scores were not influenced by patients' gender in their study of retrograde nailing of supracondylar femur fractures (20).

The prevalence of knee pain was 37.5% in the retrograde group as compared to 10% in the antegrade group. This is in agreement with most conclusions in literature that retrograde nailing is associated with higher incidence of knee pain than antegrade nailing (24, 25). The rates of knee pain after retrograde nailing of the femur ranges from 23-55% (26, 9, 24, 22). Ostrum et al, in contrast, found equal rates of knee pain when comparing retrograde and antegrade nailing in a prospective study (19). The cause of knee pain after retrograde nailing is not known but is probably related to cartilage injury at time of trauma or iatrogenic injury at surgery or due to associated quadriceps muscle atrophy (18) that results from trauma or surgery as in our cases of open reduction of fractures.

In our study, the rate of knee stiffness was higher in the retrograde group (40.6%) compared to the antegrade group (3%). This was a patient reported complaint and not related to the measured range of motion on clinical examination. This high rate of knee stiffness is probably due to lack of established knee rehabilitation protocols after retrograde nailing in MTRH. Bei C, et al showed that after single factor analysis, continuous passive motion functional training of the knee after nailing was one the significant determinants of outcome. Others were age, fracture type and reduction quality (20). However the focus of the fractures was in the distal femoral metaphysis and intercondylar fractures. Knee stiffness is a known complication of operative and none-operative management of femoral fractures. The incidence of knee stiffness after a femoral diaphyseal fracture depends on a number of factors, such as the severity of the injury, the willingness of the patient to move the knee postoperatively, the state of the knee before injury, and whether a coexisting knee injury is present. It is more associated with none-operative and external fixation for femoral shaft fractures. Although the AO classification is not directly correlated with the soft tissue injury, significant displacement of fragments in type B and C fractures could lead to healing with significant muscle to bone adhesions that lead to stiffness (21).

Although other potential complications of the knee such as infection, instability and osteoarthritis were not the focus of this study, there were no cases of patients who had been returned to theatre due to infection. There was also no case of knee instability noted during clinical evaluation of the knee.

Conclusions and Recommendations

Retrograde nailing for femoral shaft fractures results in poorer functional outcomes of the knee when compared to antegrade nailing in our patient population. Therefore without specific indications for retrograde nailing, antegrade nailing should be the preferred treatment for fracture of the femur shaft in MTRH. A well-controlled prospective study to determine the long term outcomes of the knee in our patients after intramedullary nailing is needed.

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