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Retrograde nailing of femoral fractures: a retrospective study

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Abstract
Background Retrograde femoral nailing is a common method to repair femoral shaft fractures in polytrauma patients. Studies have reported varying incidences of complications associated with retrograde femoral nailing such as knee pain, nonunion, and arthrofibrosis. The objective of this retrospective study was to describe healing and complication rates of 31 patients who underwent retrograde femoral nailing at our academic medical center.
Methods Clinical notes and radiographs were reviewed retrospectively. Data points such as demographics, fracture location on femur, time to union after surgery, presence or absence of comminution, associated injuries, and complications were assessed.
Results Average time to union was 4.69 months with no statistically significant relationship found between time to union and age, sex, comminution, or location of fracture. Knee pain was present in 23 % of patients, and distal screw removal was necessary in 19.4 % of patients.
Discussion Retrograde femoral nailing is an effective method of femoral shaft fracture fixation in polytrauma patients. The healing rate of femoral shaft fractures fixed with a retrograde nail is the same regardless of location of fracture, age, sex, or comminution. Prevention of tip of nail lying into the knee and early physical therapy are important to prevent arthrofibrosis knee.

Keywords Retrograde femoral nail · Femoral shaft fractures · Retrospective study

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Introduction

Green first described the technique of retrograde intramedullary nailing through the intercondylar notch in 1970 [1]. This approach was described as an alternative to open reduction and internal fixation for several reasons. Compared to traditional plating, closed intramedullary nails require less soft tissue dissection at the fracture site, theoretically preserving periosteal blood flow [2, 3]. Femoral nailing has also been associated with excellent fracture healing and rapid recovery from surgery [4, 5]. The antegrade nailing approach is conventional; however, it is ineffective in stabilizing distal diaphysis and supracondylar femur fractures [2]. Retrograde nails of femoral fractures not only stabilize distal femur fractures, but also fix intraarticular fractures and fractures associated with the ipsilateral patella or tibia [2, 6, 7]. Another shortcoming of antegrade femoral nails is the limited application in ipsilateral femoral neck and shaft fractures [8]. Studies have reported the incidence of an ipsilateral femoral neck fracture to be up to 9 % in femoral shaft fractures associated with high-energy trauma [9–11]. A retrograde nail with a dynamic hip screw fixation has shown favorable outcomes with ipsilateral femoral shaft and neck or trochanteric fractures [12].

Additionally, retrograde femoral nailing has been an especially useful method of femur fixation in polytrauma patients who may have multiple fractures, multisystem injuries, or vascular compromise [13, 14]. First of all, retrograde femoral nailing is associated with less blood loss due to the use of a tourniquet. Secondly, it requires less operative time due to minimal need to reposition the patient during surgery [2]. Finally, placement on a fracture table is not necessary [13, 14].

A disadvantage of retrograde femoral nailing, or femoral nailing in general, is that correct limb length, axial alignment, and rotation must be assessed using means other than open reduction [15]. Some authors have reported rotational malalignment after intramedullary nail to be as high as 28 %, often leading to a cosmetic and functional disability [16, 17]. A surgeon must be especially careful to prevent malrotation, as further operation is the only way to correct the deformity once the screw is locked [17]. Braten et al. [18] described one method to prevent malrotation intraoperatively by using intraoperative fluoroscopy to measure the neck-horizontal (NH) and neck-femoral (NF) angles. Another method discussed by Krettek et al. [15, 18] is the lesser trochanter shape sign. With the patella strictly orientated anteriorly, they compared the frontal fluoroscopic shape of the lesser trochanter on the fractured and non-fractured sides. Identical views were obtained by rotation of the proximal fragment on the fracture side. This method is used especially because it is highly sensitive and fast and easy to perform [15].

Despite a good healing rate [8], retrograde nails are associated with complications, most notably knee pain, at follow-up. Acharya reports knee pain in up to 70 % of patients following a retrograde nail [19]. The objective of this retrospective study is to describe healing and complication rates in 31 patients who underwent retrograde intramedullary nailing done by a single orthopedic trauma fellowship-trained surgeon at VCU Medical Center.

Materials and methods

Patient information

Thirty-one patients with 34 femoral fractures were retrospectively reviewed after being treated with retrograde intramedullary nails by a single orthopedic trauma attending in our institute. All patients with femoral shaft fractures were treated as per our institution's protocol to rule out fracture of the ipsilateral femoral neck. All patients had the following: preoperative radiographs of the pelvis, a CT scan of the hip in 2-mm slices, intraoperative fluoroscopy, and postoperative AP radiographs of the pelvis.

Thirty-four retrograde femoral nails were placed in 31 patients. Two patients were lost to follow-up. One moved to another country, and another could not be traced. Twenty-nine patients with 32 femur fractures were available for final analysis. Two patients had a lateral compression pelvic fracture on the ipsilateral side, and one patient had a fractured acetabulum. Two patients had ipsilateral femoral neck fractures treated with a dynamic hip screw. Three patients had ipsilateral tibia fractures treated with an intramedullary nail through same incision as the retrograde femoral nail.

Data collection

Following approval from the Institutional Review Board, clinical and operative notes, as well as radiographs, of each patient were reviewed retrospectively. Data collected includes patient w.

Bony union, or radiologic confirmation of fracture healing, was the primary endpoint in the study. We defined bony union as healing of three out of four cortices in an anteroposterior and lateral radiograph of the femur [20]. All the patients were followed up initially 2 weeks after surgery and then every 3 weeks until bony union was confirmed on radiograph. Radiographs were evaluated by the principal investigator and two trauma fellows. Inter-observer variability was resolved by repeated review of X-ray films until consensus between three investigators was obtained.

All the data were collected in a Microsoft Excel sheet and then transferred to IBM SPSS 21 statistical software for statistical analysis. Descriptive statistics were calculated using means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. A multivariable binary logistic regression model was then created to evaluate the adjusted associations of each potential explanatory variable to predict the likelihood of healing. Variables with a univariate significance level of 0.25 or less or those deemed to be clinically relevant were eligible for inclusion in the analysis. Then, variables that failed to achieve a p value of 0.15 or below were removed from the final model, and statistical significance was set at $p \leq 0.05$.

Results

The three endpoints measured were time to union, knee pain at follow-up, and distal screw removal (Table 1).

All fractures healed. One patient required an additional procedure with insertion of bone graft before healing. Average time to union of fracture was 4.69 months (range 2–15 months). The time to union in males was 4.7 months (range 3–15 months). The time to union in females was 4.67 months (range 2–11 months). There was no significant statistical difference in time to union between males compared to time to union in females ($p = 0.877$). Time to union was higher in open fractures (4.86 months) compared to closed fractures (4.56 months), but not statistically significant. Time to union was also higher in fractures not involving the distal third of the femur (5.31) compared to those involving the distal third (4.06), but this was also not

Table 1 Three endpoints of time to union, knee pain, and distal screw removal in the first row and the examined variables of sex, comminution, open versus closed, distal involvement, and age in the first column

	Time to union (months)	*p* value	Knee pain	*p* value	Distal screw removal	*p* value
Male	4.7	0.87	5/23 (21.7 %)	0.97	4/23 (17.4 %)	0.78
Female	4.67		2/9 (22.2 %)		2/9 (22.2 %)	
Comminuted	4.62	0.95	4/21 (19 %)	0.62	3/21 (14.3 %)	0.43
Non-comminuted	4.82		3/11 (27.3 %)		3/11 (27.3 %)	
Open fracture	4.86	0.9	3/14 (21.4 %)	0.95	3/14 (21.4 %)	0.75
Closed fracture	4.56		4/18 (22.2 %)		3/18 (16.7 %)	
Distal one-third	4.06	0.11	4/16 (25.0 %)	0.68	4/16 (25 %)	0.38
Proximal two-thirds	5.31		3/16 (18.8 %)		2/16 (12.5 %)	
Age 15–55	4.89	0.4	6/27 (22.2 %)	0.92	5/27 (18.5 %)	0.94
Age 55+	4.2		1/5 (20.0 %)		1/5 (20.0 %)	

Fig. 1 Distal locking screw that required removal from a patient 3 years postoperatively due to knee pain. The nail tip was found to extend 9.9 mm beyond the cortex of the medial epicondyle

statistically significant ($p = 0.113$). Multivariate logistic regression analysis using age, sex, comminution of fracture, and open compared to closed fracture did not show any statistically significant difference in time to healing of fracture in relation with age of the patients.

Seven patients in our series (23 %) had knee pain. There was no statistically significant relationship between knee pain and sex, age, site of fracture, comminution, or open compared to closed fractures.

Six patients (19.4 %) in our series had distal screws removed for pain. There was also no statistical difference in removal of screws in relation to age, sex, site of fracture, comminution, or open compared to closed fractures. All patients had relief from knee pain after removal of the distal screws. Two patients had pain due to prominence of the distal-most locking screw at the knee. Both had complete relief of pain after removal of the screw. Figure 1 shows a symptomatic distal screw that required removal.

Discussion

Retrograde femoral nailing was initially described for supracondylar femur fractures [1], but indications have been extended to femoral shaft fractures. The specific implants and instruments have been modified over time to limit technical difficulties [14]. The technique of retrograde intramedullary nailing also got modified over time. Recently, Gliatis et al. [21] have described the technique of insertion of a retrograde intramedullary nail under arthroscopic control to limit the size of incision while increasing the precision of the entry point. This technique is also beneficial over other methods of fixation in elderly patients and morbid patients with poor bone stock [22].

Time to union in our study was not associated with any variable including sex, communication, open versus closed, distal involvement of the fracture, or age. This is inconsistent, however, with a meta-analysis done by Papdokostakis et al. [23] in which the authors found that distal femur fractures treated with a retrograde nail had a small, but significantly greater, time to union compared to femoral shaft fractures treated with a retrograde nail. Their meta-analysis also showed a shorter time to union in a group of 553 femur fractures treated with a retrograde nail. They found time to union to be 3.4 months in distal femur

fractures and 3.2 months in femoral shaft fractures, compared to our finding of 4.69 months.

Becher et al. [24] describe a 6 % rate of arthrofibrosis that required manipulation in their series. All our patients were evaluated in the hospital by physical therapists on postoperative day one and started active and assisted range of motion exercises for the knee. We did not have any incidence of arthrofibrosis in our series and all patients had good range of motion at 2 months (range 95°–130°). Our results are similar to that reported by Ostrum et al. [25].

Cannada et al. [26] describe increased mortality (5.6 %) in patients treated with retrograde nails for bilateral femoral shaft fractures. Thoracic injury was found to be associated with the increased mortality. Three of our patients had bilateral femoral shaft fractures treated with retrograde intramedullary nails. There were no complications in these patients. One of these patients had a femoral neck fracture on the ipsilateral side treated with a dynamic hip screw. Another of these patients had fractured tibia treated with an intramedullary nail. No patients had thoracic injury.

Knee pain is one of the most common complications described after retrograde intramedullary nailing. It has been reported as high as 70 % in one series [19]. In our study, it was present in 23 % of patients. It is reported in the literature that injury to the knee is common in femoral shaft fractures, and that could be one of the causes of knee pain. The surgical technique and position of distal screws have been reported to be responsible for knee pain [19]. Placing appropriate length interlocking screws at the knee, and obtaining internal rotation oblique radiographs to confirm the length of the screw in view of the distal femur's rhomboid shape anatomy, would be of great help to prevent these patients from returning to OR for hardware removal due to screw prominence [27].

Papadokostakis et al. [23] also describe knee pain as a complication of retrograde femoral nailing; however, they found a significant difference in the incidence of knee pain in distal femur fractures compared to femoral shaft fractures. They describe knee pain in patients with distal femur fractures treated with a retrograde nail to be 16.5 %, whereas knee pain in patients with femoral shaft fractures was 24.5 %. In our study, we found no association between knee pain and involvement of the distal third of the femur compared to the proximal two-thirds of the femur.

The distal screw needed to be removed in 19 % of our patients. This was significantly associated with the presence of knee pain only. Our findings were consistent with Ostrum et al. [28] as they report that 21 % of patients in their study desired removal of symptomatic distal screws after union.

Compared to a similar cohort of patients who underwent antegrade nailing for femoral fractures, we found similar results for the presence of knee pain. Braten et al. [29] describe knee pain to present in 20 % of patients who received an antegrade femoral nail for femur fractures. We found a higher time to union compared to the time to union in antegrade femoral nails reported by Papadokostakis et al. Our results show a time to union of 4.69 months. In their meta-analysis, Papadokostakis et al. [23] report an average time to union of 4.2 months in a cohort of 939 femoral shaft fractures treated with antegrade nailing and 3.4 months in femoral shaft fractures treated with retrograde nailing.

There are few shortcomings of our study. One limitation is the retrospective design of the study. Secondly, this study represents operative experience of only one single fellowship-trained orthopedic surgeon at a level I trauma center, who was scrubbed in for all of the cases. Majority of the patients in our series were young with good quality of bone and did not represent old people with poor bone quality.

Other flaws of retrograde femoral nailing mentioned in the literature include refracture, angular and rotational deformities, and pulmonary embolism. In future studies, it would be beneficial to assess the incidence of these compared to the literature and other methods of fixation such as antegrade nailing.

Conclusion

From our study, we can conclude that retrograde femoral nailing is an efficient method to treat femoral shaft fractures in young patients with multiple traumatic injuries. The healing rate is the same for fractures involving the distal third of femur compared to factures involving the proximal two-thirds of the femur. To prevent arthrofibrosis of the knee, placing a distal screw of appropriate length and early physical therapy are important.

Compliance with Ethical Standards

Conflict of interest Mr. Shah declares that he does not have any conflict of interest. Dr. Desai declares that he has no conflict of interest. Dr. Mounasamy declares that he has no conflict of interest.

Ethical standard All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Green S (1988) Distal intramedullary fixation of supracondylar fractures of femur. Tech Orthop 3:71–76
2. Iannocone W, Bennett F, Delong W, Born C, Dalsey R (1994) Initial Experience with the treatment of supracondylar femoral fractures using the supracondylar intramedullary nail: a preliminary report. J Orthop Trauma 8:322–327

3. Rokkanen P, Slatis P, Vankka E, Kelsinki F (1969) Closed or open intramedullary nailing of femoral shaft fractures. J Bone Joint Surg 51-BL:313–323
4. Winquist R, Hansen S, Clawson D (1984) Closed intramedullary nailing of femoral fractures. J Bone Joint Surg 66-A:529–539
5. Kempf I, Grosse A, Beck G (1985) Closed locked intramedullary nailing: its application to comminuted fractures of the femur. J Bone Joint Surg 67-A:709–720
6. Gregory P, DiCicco J, Karpik K (1996) Ipsilateral fractures of the femur and tibia: treatment with retrograde femoral nailing and undreamed tibial nailing. J Orthop Trauma 10:309–316
7. Ostrum RF (2000) Treatment of floating knee injuries through a single percutaneous approach. Clin Orthop Relat Res 375:43–50
8. Ricci WM, Bellabarba C, Evanoff B (2001) Retrograde versus antegrade nailing of femoral shaft fractures. J Orthop Trauma 15:161–169
9. Tsai C, Hsu H, Fong Y, Lin C, Chen Y, Hsu C (2009) Treatment of ipsilateral fractures of femoral neck and shaft. Injury 40:778–782
10. Watson J, Moed B (2002) Ipsilateral femoral neck and shaft fractures: complications and their treatment. Clin Orthop Relat Res 399:78–86
11. Alho A (1996) Concurrent ipsilateral fractures of the hip and shaft of the femur. A systematic review of 722 cases. Ann Chir Gynaecol 86:326–336
12. Oh C, Oh J, Park B, Jeon I, Kyung H, Kim S, Park I, Sohn O, Min W (2006) Retrograde nailing with subsequent screw fixation for ipsilateral femoral shaft and neck fractures. Arch Orthop Trauma Surg 126:448–453
13. Moed B, Watson J (1995) Retrograde intramedullary nailing without reaming of fractures of the femoral shaft in multiply injured patients. J Bone Joint Surg 77:1520–1527
14. Moed B, Watson J (1999) Retrograde nailing of the femoral shaft. J Am Acad Orthop Surg 7:209–216
15. Krettek C, Miclau T, Grun O, Schandelmaier P, Tscherne H (1998) Intraoperative control of axes, rotation and length of femoral and tibial fractures. Injury 29:S-C29–S-C39
16. Jaarsma R, Pakvis D, Verdonschot Biert J, van Kampen A (2004) Rotational malalignment after intramedullary nailing of femoral fractures. J Orthop Trauma 18:403–409
17. Deshmukh R, Lou K, Neo C, Yew K, Rozman I, George J (1998) A technique to obtain correct rotational alignment during closed locked intramedullary nailing of the femur. Injury 29:207–210
18. Braten M, Tveit K, Junk S, Aamodt A, Anda S, Terjesen T (2000) The role of fluoroscopy in avoiding rotational deformity of treated femoral shaft fractures: an anatomical and clinical study. Injury 31:311–315
19. Acharya K, Rao M (2006) Retrograde nailing for distal third femoral shaft fractures: a prospective study. J Orthop Surg 14:253–258
20. Morshed S (2014) Current options for determining fracture union. Adv Med 2014:1–12
21. Gilatis J, Kouzelis A, Matzaroglou C, Lambris E (2006) Arthroscopically assisted retrograde intramedullary fixation for fractures of the distal femur: technique, indication and results. Knee Surg Sports Traumatol Arthrosc 14:114–119
22. El-Kawy S, Ansara S, Moftah A, Shalaby H, Varughese V (2006) Retrograde femoral nailing in elderly patients with supracondylar fracture femur; is it the answer for a clinical problem? Int Orthop 31:83–86
23. Papadokostakis G, Papakostidis C, Dimitriou R, Giannoudis P (2004) The role and efficacy of retrograding nailing for the treatment of diaphyseal and distal femoral fractures: a systematic review of the literature. Injury 36:813–822
24. Becher S, Ziran B (2012) Retrograde intramedullary nailing of open femoral shaft fractures: a retrospective case series. J Trauma Acute Care Surg 72:696–698
25. Ostrum R, Maurer J (2009) Distal third femur fractures treated with retrograde femoral nailing and blocking screws. J Orthop Trauma 23:681–684
26. Cannada L, Taghizadeh S, Murali J, Obremskey W, DeCook C, Bosse M (2008) Retrograde intramedullary nailing in treatment of bilateral femur fractures. J Orthop Trauma 22:530–534
27. Lucas E, Seligson D, Henry S (1993) Intramedullary supracondylar nailing of femoral fractures: a preliminary report of the GSH supracondylar nail. Clin Orthop Relat Res 296:200–206
28. Ostrum R, DiCicco J, Lakatos R, Poka A (1998) Retrograde intramedullary nailing of femoral diaphysis fractures. J Orthop Trauma 12:464–468
29. Braten M, Terjesen T, Rossvoll I (1995) Femoral shaft fractures treated by intramedullary nailing. A follow-up study focusing on problems related to the method. Injury 26:379–383