OUTCOME OF OPEN REDUCTION AND INTERNAL FIXATION WITH INTERLOCKING INTRA-MEDULLARY NAIL IN THE TREATMENT OF FRACTURE OF SHAFT OF FEMUR WITHOUT FLUOROSCOPY

Shambhu Sah[1], Ram Kumar Yadav[2], Shilabanta Sen Shrivastav[3], Subash Chandra Jha[4], Yagya Raj Kharel[5], Navin Kumar Karn[6], Shivam Karn[7], Prabin Jha[8]*

Affiliation

1. *Assistant Professor, NAMS and Consultant Orthopedic Surgeon, Koshi Hospital, Nepal*
2. *Orthopedic Surgeon, Koshi Hospital, Nepal*
3. *Assistant Professor, NAMS and Consultant Orthopedic Surgeon, Koshi Hospital, Nepal*
4. *Associate Professor, Birat Medical College Teaching Hospital*
5. *Associate Professor, NAMS and Consultant Orthopedic Surgeon, Koshi Hospital, Nepal*
6. *Professor, Neuro-Cardio and Multispecialty Hospital, Nepal*
7. *Physiotherapist, Koshi Hospital, Nepal*
8. *Anesthesiologist, Koshi Hospital, Nepal*

ARTICLE INFO

Received : 22 January, 2023

Accepted : 10 July, 2023

Published : 10 November, 2023

ORA 349

DOI: https://doi.org/10.3126/bjhs.v8i2.59850

Corresponding Author*

Dr. Shambhu Sah

Assistant Professor

NAMS and Consultant Orthopedic Surgeon

Koshi Hospital, Nepal

Email: drssah@yahoo.com

ORCID : https://orcid.org/0000-0002-8606-9564

Citation

Outcome of Open Reduction and Internal Fixation with Interlocking Intra-Medullary Nail in the Treatment of Fracture of Shaft of Femur without Fluoroscopy. Shambhu Sah, Ram Kumar Yadav, Shilbanta Sen Shrivastav, Subash Chandra Jha, Yagya Raj Kharel, Navin Kumar Karn, Shivam Karn, Prabin Jha . BJHS 2023;8(2)21. 2009 - 2013.

ABSTRACT

Introduction

Femoral shaft fractures are among the common fractures generally managed by close reduction and internal fixation (CRIF) with interlocking intramedullary nailing (ILIMN) as the nail provides the rotational as well as longitudinal stability along with good clinical and functional outcomes but requiring fluoroscopy guidance. Also, in delayed cases, the close reduction might not be possible intimidating the need of open reduction.

Objective

To assess the clinical outcome of the treatment from Open Reduction and Internal Fixation (ORIF) technique as well as placement tricks of locking screws in the absence of a traction table and fluoroscopy.

Methodology

Fourteen cases of close femur fractures with transverse and oblique type in the middle 1/3 shaft coming to Koshi Hospital, Nepal, from June 2019 to December 2021 were included in this study. All patients were treated with ORIF with ILIMN technique without the use of a traction table and fluoroscopy. Data collection included demography, mechanism of injury, mobilization time, union rate, infection, and complication. The study was also designed to evaluate the method of our technique which could be helpful in case of dysfunction of fluoroscopy during intra-operative of CRIF in a resource-limited setting.

Result

The average age of patients was 39.86±14.93, the average hospital stay duration was 12 ± 8.60 days, full weight-bearing walking was around 11.64 ± 3.15 weeks and the average union time was observed to be 14.54 ± 3.36 weeks.

Conclusion

This technique was successful with an efficient duration of the surgery and satisfactory results in early mobilization and fracture union time. Thus, concluding it to be a safe procedure in situations like old fracture (more than 3 weeks), pelvic injury with urethral injury, lack of traction table, and dysfunction of fluoroscopy.

KEYWORD

C-arm fluoroscopy, Locking screw, Traction table.

INTRODUCTION

Femoral shaft fractures are among the common fractures encountered in orthopedic practice that result from high-energy trauma. At present close reduction and internal fixation (CRIF) with interlocking intramedullary nailing (ILIMN) is recommended choice for femoral diaphyseal fracture and the nail provides the rotational as well as longitudinal stability along with good clinical and functional outcomes but requires fluoroscopy guidance. Therapeutic indications for surgical treatment of long bone have iterative development for few decades from the original works done by Kuntcsher. Locked intramedullary nailing gained popularity since the development and emergence of C-arm fluoroscopy. Interlocking nailing without the use of fluoroscopy was studied mainly in poor resource settings or low-income settings and its clinical outcome was studied by few authors. Closed interlocking nailing is the standard procedure for the treatment of close diaphyseal fractures but needs the help of C-arm fluoroscopy. Open reduction method can be considered when C-arm fluoroscopy and fracture table are not available or malfunction during CRIF with ILIMN, also other scenarios like overcrowded orthopedic wards, patient-associated injuries such as floating knee injury, urethra-pelvis injury, spinal injury, pregnant women, the small surgical team with limited access of equipment and instruments without hazards of radiation.[1,2]

The significant evolution of various techniques took place in the treatment of femoral shaft fracture management for a few decades. Various types of intramedullary devices have been introduced, among them interlocking nail is popular as load sharing device, maintaining alignment, stabilizing fracture fragments, and providing rotational stability to the bone both proximally and distally through the use of bolts. Early rehabilitation with muscle strengthening and joint range of motion exercises is possible in intramedullary stabilization than plates with screws and another implant. Physiologic loading is a combination of load acts on the nail such as torsion, tension, and compression.[3,4] The objective of the study is to assess the clinical outcome of the treatment from Open Reduction and Internal Fixation (ORIF) technique as well as placement tricks of locking screws in the absence of a traction table and fluoroscopy.

METHODOLOGY

This descriptive cross-sectional study was conducted from 1st of June 2019 to 31st of December 2021 in the department of orthopedics of Koshi Hospital, Nepal, with the aim to analyze outcomes and surgical techniques for the placement of locking screws. All patients signed an informed consent statement to undergo the surgical treatment. Ethical clearance was taken from the hospital authority. None of the patients was harmed either physically or economically for this study except for their regular expenditure for treatment. The data was analyzed using Microsoft excel program. The purpose of this study was to assess the results of ORIF with ILIMN and techniques for locking screw placement with the help of an external jig attached arm system for proximal and distal locking to the nail with some tricks about accuracy. This technique was successful in most cases. This technique is not recommended if fluoroscopy and fracture table are functioning properly along with the availability of the proper surgical team and instruments.

All the patients were assessed initially in the emergency department with a thorough examination to rule out any associated injuries. Each of the patients was operated within 3-5 days post admission into the orthopedic ward. They were provided with first aid with non-adhesive traction and necessary radiological and blood investigations for pre-anesthesia checkup concerns. Each patient had ORIF with ILIMN, and was started on isometric quadriceps and gluteus exercise as well as active-assisted/passive range of motion exercise of knee and hip joints at the 2nd-day post-operative day and axillary crutch aided non-weight bearing ambulation was started at 3rd day and the patients were discharged around 4-5gth day post-surgery. During the 1st follow-up period in 2nd week, each patient was assessed for ipsilateral knee and hip pain and stiffness, surgical site infection, shortening, and if there is any presence of mal-alignment of the limb. Each patient followed up at 6-weekly intervals at the outpatient department for plain radiographs of the treated limb for evaluation of callus formation to further aid in decision-making about full weight bearing with or without crutches. Delayed union was considered when no bridging callus was seen at 6 months and non-union was stated when there was no radiological evidence of bridging callus at 12 months post-surgery. In this government hospital, a large number of patients are attracted because of government subsidies, and the low cost of surgical procedures with satisfactory results.

Surgical techniques with tips and tricks step by step- for ORIF with ILIMN in shaft femur

Various surgical techniques have been developed for interlocking intramedullary nailing for the management of fracture of shaft of femoral according to their experience of the expertise on the different situations in operation theater and they gradually change in techniques, open reduction techniques, locking bold placement, without C-arm fluoroscopy, without traction table are a limited study in previous published.[5-9] Here our surgical team also tried some techniques along with previous published techniques.

The length of the nail was measured from the tip of the greater trochanter to the upper pole of the patella of the normal femur. The diameter of the nail was assessed according to the final reamer used at the time of surgery. The interlocking zig arm was mounted on the proximal end of nail and the accuracy of the position of the locking hole was checked by placing Steinman pin into the sleeve and inserting a guide wire inside the nail, hitting guide wire on Steinman pin metallic sound could be felt or the same size of guide wire could be placed outside of nail by comparing the

length from inserted guide wire tip to the interlocking hole. After spinal anesthesia, the patient on the operating table was placed in a lateral decubitus position. To be noted were two things that gave the confirmed accuracy of locking screw placement: one was metallic sound and another was a comparison of guide wire length being the same size.

Incision over the fracture site was not different from the standard procedure of K-nail except for the guide rod which was inserted through a fracture in a retrograde manner. The nail length was measured with a guide wire passed through the canal of both fragments to confirm the previously measured nail length to the normal femur. First small size cannulated manual reamed was used from the fracture site to the proximal femur to make a hole called an entry point in CRIF with ILIM nail and guide wire was inserted through cannulated reamer proximally and by giving incision a 4-5 cm over tip of the greater trochanter. Guide wire was pulled proximally till the distal tip was just inside the proximal fracture site.

Reduction of the fracture was done under direct vision. Reduction was done by using reduction forceps or with help of manual traction and then the guide wire was advanced into distal medullary cavity of the femur. The reduction was held by using Lowman bone clamp.

Reaming was done using cannulated manual reamer through guide wire proximally one by one and increasing size as in closed interlocking nailing manner (CRIF with ILIM nail) and by inserting nail of less diameter than the final reamer. Be remember before inserting nail repeat checking the accuracy of hole through zig arm, holes of zig arm was performed.

Before implying fixed distal locking, alignment and rotation of the femur was checked by putting fingers on Linea Aspera. Guide wire was removed after insertion of nail and drill bit was used in distal locking by using sleeve in zig arm as previously measured. Once drilling of the lateral cortex was done, the accuracy of the placement of the drill bit by feeling a metallic sound with help of guide wire hitting on drill bit or comparing similar size of guide wire was checked before drilling the medial cortex. Once drill bit was inside the nail hole then the measurement of the length of the locking screw was done by comparing same size drill bit from outside lateral cortex and estimating the length of the screw according to the drill bit which was not inserted into the medial cortex. Once lengths of the screw were measured then the medial cortex was drilled. After placement of locking screw, reconfirmed by using guide wire such as metallic sound or comparisons of same size guide wire. In similar manner, other locking screw in others locking hole from distally to proximally was done one by one. We needed to be sure guide wire should not be around drilling area better remove from guide wire during drilling. Position of femur should be parallel to bed and also should be semi-flexion of hip and knee.

Sometimes drill may not be in locking hole of the nail, in such situation nail removed and recheck that mounted zig arm to conform misalignment of zig with the help of sleeve and Steinman pin then reinserted in femur. Drill from sleeve and check the accuracy of drill bit inside nail sometime we may need to change the direction of drill towards anterior in distal locking if knee is in flexion position. The task of distal locking is more difficult in the metaphysis, in some cases use large drill bit to create a large hole in lateral cortex in the same position and direction of locking hole on nail. A small size of Steinman pin or K-wire insert that lateral cortex hole towards the nail to palpate the nail hole by moving tip around the nail, once nail hole is felt t advance it to medial cortex and confirm the accuracy of placement by using guide wire, on conformation use hammer or drilling machine to make medial cortex hole. Before hammer Steinman pin or K-wire, confirm the length of locking screw by using same size Steinman pin. Some authors enlarge the hole until the screw hole on the nail is visualized.

RESULTS

A total of 14 participants were enrolled for this study. Out of which 2 participants presented with delayed union. Mean while one of the participants presented with non-union. The average age of participants were 39 years, the average hospital stay duration was 12 ± 8.60 days, full weight bearing walking was around 11.64 ± 3.15 weeks and the average union time was observed to be 14.54 ± 3.36 weeks. The distribution of cases on the basis of gender is summarized in table 1.

Table 1. Distribution of data based on gender among the study subjects

Gender	No. of patients	Percentage	Right femur	Left femur
Male	8	57	5	3
Female	6	43	3	3
Total	14	100	8	6

Most of the participants (N=5) in this study belonged to an age group of 46-55 years (35.71%) followed by 15-25 years (28.57%) and 36-45 years (21.43%). A total of 7 out of 14 participants in this study had slip and fall accidents as a mode of injury followed by fall from height and road traffic accidents.

Table 2: Distribution of data based on age groups among the study subjects

Age in year	No. of patients	Percentage
15-25	4	28.57
26-35	1	7.14
36-45	3	21.43
46-55	5	35.71
56 and above	1	7.14

Table 3: distribution of data based on mechanism of injury

Mechanism of injury	No. of patients	Percentage
Road traffic accident (RTA)	3	21.43
Slip and fall accident	7	50
Fall from height	4	28.57

The most frequent indication observed in this study was a fracture which had occurred for more than 3 weeks, followed by dysfunction of C-arm fluoroscopy and urethra-pelvic injury.

Table 3: distribution of data based on mechanism of injury

Factors	No. of patients	Percentage
Dysfunction of C-arm fluoroscopy	4	28.57
Fracture more than 3 weeks	9	64.28
Uretho-pelvic injury	1	7.14

The most frequent indication observed in this study was a fracture which had occurred for more than 3 weeks, followed by dysfunction of C-arm fluoroscopy and urethra-pelvic injury.

Table 4: Distribution of data based on indication for open reduction

Factors	No. of patients	Percentage
Dysfunction of C-arm fluoroscopy	4	28.57
Fracture more than 3 weeks	9	64.28
Uretho-pelvic injury	1	7.14

The outcomes of this surgery were encouraging as there were minimal complications after the surgery with only 2 participants reporting superficial infection and delayed union each. Meanwhile, non-union was reported in one case. The delayed union dealt with the process of dynamization and exchange of nailing in closed reduction with larger diameter nail was done in the non-union case.

Table 5: distribution of data based on the complications

Complications	No. of patients	Percentage
Superficial infection	2	14.28
Delayed union	2	14.28
Non-union	1	7.14

DISCUSSION

Closed interlocking intramedullary nails are a common choice of treatment for femoral fractures. However, the use of a traction table, C-arm fluoroscopy, an experienced, qualified orthopedic surgeon, and proper instruments are required. Closed nailing preserves the original hematoma which remains intact, with less soft tissue damage, and during reaming of the intramedullary canal deposits bone graft material at the fracture site. On the contrary, open reduction and internal fixation (ORIF) comprise stripping of the periosteum which can subsequently reduce blood supply at the fracture site. ORIF often results in extensive damage causing increased blood loss with concerns of delayed fracture union, non-union, and infection. Some authors advocate open nailing in the poly-trauma patient and first-trimester pregnant patient for the least radiation exposure because it requires no special equipment and achieves quick reduction. ORIF is performed in certain situations like unavailability of C-arm fluoroscopy, traction table, minimal resources, to avoid radiation hazards, early disposal of the patient, and overcrowded orthopedic wards.[10, 11] We do not recommend ORIF as a routine procedure but with certain indications like dysfunction of C-arm fluoroscopy, old or neglected fracture more than 3 weeks and presence of uretho-pelvis injury which was not fit or traction table, ORIF was the only option. In this study we found ORIF to be a safe procedure for femoral shaft fracture with good functional and clinical results.

Previously published studies show that no significant difference between the results of open nailing compared to close nailing of diaphyseal femoral fractures. The decision-making on whether to use ORIF or CRIF should be based on the pattern of injury, the surgeon's experience, and the availability of resources. The incidence of postoperative complication except for rotational mal-union in closed nailing others appear similar such as weight-bearing, rate of callus formation, and osseous healing but post-operative morbidity appeared greater for the fracture treated by open nailing. The open method is an acceptable method based on its advantages in comparison to the closed technique.[12, 13] In the published study authors had different opinions such as early surgical stabilization was associated with curtailment in complications and mortality. Closed nailing of femoral shaft fracture is still the first line of treatment but should not be hesitated to perform an open method to achieve the optimal outcome even if there is a little associated risk of side effects. Femoral nailing is generally considered a technically demanding procedure but the incidence of iatrogenic complications such as comminution and rarely femoral neck fracture has not been well documented. This study indicated a union time mean 15.53 weeks in open reduction while a mean 15.71 weeks in the closed nailing group.[14,15] We have not found any iatrogenic complication except in one case where a small butterfly fragment was seen during the reaming procedure which was managed by cerclage wire.

The participants in this study were subjected to the x-ray of the hip and knee along with the shaft of the femur to avoid any iatrogenic effect (like a fracture). Also, the participants were subjected to proper and systematic follow-up to deal with the delay union. The delayed union was dealt with by dynamization for optimal outcomes. The results of this study were similar to the earlier studies. The literature on delayed union and non-union has a variable interpretation. The traditional definitions of delayed union and nonunion were based on clinical experience, which states that most of fractures unite in a duration of 3 to 4 months. Thus, the ideal timing of dynamization is considered to be in between 3-6 months after the injury for femoral non-union or delayed union.[16,17] Our study assumes the delay union around 4 months according to clinical and radiological studies meanwhile, a duration of more than 6 months was

considered as non-union. Our study has no novel technique; it is an alternative technique desirable when even a single C-arm unit is available. With more experience and learning to avoid mistakes, the success rate might increase.

CONCLUSION

It is concluded from the findings of our study that Open reduction depends on pattern of injury, the experience of the surgeon and the availability of instruments. Orthopedic surgeon should be aware of the advantages, disadvantages and restrictions of various methods. The goal should be restoration of normal anatomy, stable fixation, and early mobilization of the hip and knee joints as well as early ambulation.

LIMITATIONS OF THE STUDY

Our study was a single-center study and had a small sample size. Hence, we recommend a larger sample size and a multi-centric study with a longer follow-up. A prospective study in this regard will perhaps shed light on the topic.

ACKNOWLEDGMENT

I am grateful to Dr. Ragin Kathet (oncologist) my best friend from Koshi Hospital for supporting and helping in this study.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest in conducting this research and writing and publication of this article.

FINANCIAL DISCLOSURE

This study was conducted because of the interest of the author in this topic. There is no financial involvement in this research and all the researchers contributed their time in volunteer basis.

REFERENCES

1. Bombah FM. Interloking Intramedullary Nailing without Fluoroscopy in Resource Limited Settings: Outcomes and Outlook. Orthopedics and Rheumatology Open Access Journal [Internet]. Juniper Publishers; 2021 Apr 16;18(10. [DOI: https://doi.org/10.19080/oroaj.2021.18.555978]
2. Meena RC, Kundnani V, Hussain Z. Fracture of the shaft of the femur: Close vs open interlocking nailing. Indian J Orthop. 2006 Oct;40(4):243-6. [DOI: https://doi.org/10.4103/0019-5413.34504]
3. Vécsei V, Hajdu S, Negrin LL. Intramedullary nailing in fracture treatment: history, science and Küntscher's revolutionary influence in Vienna, Austria. Injury. 2011 Sep 1;42:S1-5. [DOI: https://doi.org/10.1016/s0020-1383(11)00419-0]
4. Gadhe S, Ghorpade NA. Treatment of Unstable Diaphyseal Fracture Femur with Femur Intramedullary Interlocking Nailing. International Journal of Contemporary Medical Research [IJCMR] [INTERNET]. MarhahInfotech; 2020 Jan;7(1). [DOI: https://doi.org/10.21276/ijcmr.2020.7.1.14]
5. White NJ, Sorkin AT, Konopka G, McKinley TO. Surgical technique: static intramedullary nailing of the femur and tibia without intraoperative fluoroscopy. Clinical Orthopaedics and Related Research®. 2011 Dec;469(12):3469-76. [DOI: https://doi.org/10.1007/s11999-011-1829-7]
6. Liao JC, Hsieh PH, Chuang TY, Su JY, Chen CH, Chen YJ. Mini-open intramedullary nailing of acute femoral shaft fracture: reduction through a small incision without a fracture table. Chang Gung medical journal. 2003 Sep 1;26(9):660-8. [Google Scholar]
7. Bombah FM, Lékina FA, Eone DH, Dakouré PW, Sermon A. Focus on interlocking intramedullary nailing without fluoroscopy in resource-limited settings: strategies, outcomes, and outlook. International Orthopaedics. 2021 Sep 7:1-0. [DOI: https://doi.org/10.1007/s00264-021-05208-w]
8. Boopalan PR, Sait A, Jepegnanam TS, Matthai T, Varghese VD. The efficacy of single-stage open intramedullary nailing of neglected femur fractures. Clinical Orthopaedics and Related Research®. 2014 Feb;472(2):759-64. [DOI: https://doi.org/10.1007/s11999-013-3293-z]
9. Kanellopoulos AD, Yiannakopoulos CK, Vossinakis I, Badras LS. Distal locking of femoral nails under direct vision through a cortical window. Journal of orthopaedic trauma. 2003 Sep 1;17(8):574-7. [DOI : https://doi.org/10.1097/00005131-200309000-00006]
10. Manjhi LB, Suman SK, Kumar R, Singh SK. Open interlocking nailing of the fracture of the shaft of femur. International Journal of Orthopaedics Sciences. 2017;3(2):611-3. DOI: https://doi.org/10.22271/ortho.2017.v3.i2f.59]
11. Tahririan MA, Andalib A. Is there a place for open intramedullary nailing in femoral shaft fractures?. Advanced Biomedical Research. 2014;3. [DOI: https://doi.org/10.4103/2277-9175.137870]
12. Anisi CO, Abang IE, Asuquo JE. Early outcome of open locked intramedullary nailing of femoral diaphyseal fractures in a resource–poor setting. Nigerian Journal of Medicine. 2019 Apr 3;28(1):22-6. [DOI: https://doi.org/10.4103/1115-2613.278564]
13. Burç H, Atay T, Demirci D, Baykal YB, Kirdemir V, Yorgancigil H. The intramedullary nailing of adult femoral shaft fracture by the way of open reduction is a disadvantage or not?. Indian Journal of Surgery. 2015 Dec;77(2):583-8. [DOI: https://doi.org/10.1016/s0020-1383(12)70051-7]
14. Tahir M, Ahmed N, Faraz A, Shafiq H, Khan MN. Comparison of Open and Closed Nailing for Femoral Shaft Fractures: A Retrospective Analysis. Cureus. 2021 Jun 29;13(6). [DOI: https://doi.org/10.7759/cureus.16030]
15. Papadakis SA, Zalavras C, Mirzayan R, Shepherd L. Undetected iatrogenic lesions of the anterior femoral shaft during intramedullary nailing: a cadaveric study. Journal of Orthopaedic Surgery and Research. 2008 Dec;3(1):1-6. [DOI: https://doi.org/10.1186/1749-799x-3-30]
16. Tay WH, de Steiger R, Richardson M, Gruen R, Balogh ZJ. Health outcomes of delayed union and nonunion of femoral and tibial shaft fractures. Injury. 2014 Oct 1;45(10):1653-8. [DOI: https:// doi.org/10.1016/ j.injury.2014.06.025]
17. Vicenti G, Bizzoca D, Carrozzo M, Nappi V, Rifino F, Solarino G, Moretti B. The ideal timing for nail dynamization in femoral shaft delayed union and non-union. International Orthopaedics. 2019 Jan;43(1):217-22. [GOI: https://doi.org/10.1007/s00264-018-4129-y]