

Use of K-wire for fixation of lateral malleolar fractures, an alternative to plate fixation in a low resource settings

Abstract

Introduction: Our objective is to describe the technique and report the outcome of intramedullary (IM) Kirshner (K) wire of lateral malleolus in the surgical management of ankle fractures. The IM fixation of the fibula has been recently introduced as an alternative to the standard open reduction and internal fixation with plates and screws, mainly for some potential complicated situations with the potential benefit of soft tissue preservation, and provision of biomechanical efficiency.

Method: This is a retrospective study of Forty two consecutive patients between April 2015 and March 2022 who were managed with K wire fixation for lateral malleolar fractures. The fracture reduction was performed either percutaneously with a small pointed reduction clamp or use of longitudinal traction and rotation for closed fractures, or direct reduction in open fractures.

Results: The outcome measures were mainly based on radiological and clinical evaluation during follow. Out of the 42 patients in our study, thirty four (81%) patients had good results, 5 (11.8%) fair results, and three (7.2%) had poor results using Weber subjective assessment.

Conclusion: Fixation with K-wire is a viable option for the surgical treatment of lateral malleolus in ankle fractures almost similar to use of IM nail device and should be considered in the surgeon's choice of fixation procedure particularly in a limited resource environment.

Keywords: ankle fracture, kirschner wire, fibula fracture, intramedullary fixation

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Nuradeen Altine Aliyu,¹ Ibrahim Mustapha Usman,² Usman Zayyanu³

¹Consultant Orthopaedic and trauma Surgeon, Orthopaedic Hospital Wamakko, Sokoto, Nigeria

²Consultant Orthopaedics and trauma surgeon, Department of Orthopaedics, Aminu Kano Teaching Hospital, Nigeria

³Department of Anatomy, Faculty of Basic Medical Sciences, Usmanu Dan Fodio University, Nigeria

Correspondence: Nuradeen Altine Aliyu, MBBS, MPH, MRCS, FWACS, Consultant Orthopaedic and trauma, Surgeon, Orthopaedic Hospital Wamakko, Sokoto, Nigeria, Tel +2348038972174;

Email nralas@yahoo.co.uk, nuradeenaltin@gmail.com

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Introduction

Open reduction and internal fixation (ORIF) through the use of plate fixation (locked or non-locked) has been the standard method for fixation of lateral malleolus fractures.^{1,2} Notable satisfactory outcomes have been reported following use of plates and screw fixation of lateral malleolus by many surgeons in various orthopaedics and trauma centre. However, there has been associated higher rate of complications with use of plate as a treatment option for some specific groups of patients, mainly in osteoporotic elderly women and patients with poor soft-tissue thickness.^{1,3} It has been indicated that approximately one-fifth of perfectly reduced fractures yield unsatisfactory surgical results related to infection, postoperative wound breakdown, and protruding hardware requiring removal in the long run.⁴ Use of Kirschner (K) wire as an intramedullary (IM) device in the treatment of lateral malleolar fracture (Weber type B and C) has so many similarities with use of IM nailing device for the same fracture treatment with the advantages of being minimally invasive and cost-effective in low resource settings. Studies that were recently conducted have shown that fibular intramedullary nailing produces secure and stable fixation of ankle fractures, and the majority of patients have reported good to excellent outcomes with a mean union rate of 98%, and a significant lower rate of soft tissue breakdown compared to ORIF with plates and screws.⁵⁻⁷ Additionally, the biomechanical features of fibular nails can be compared to distal fibular locking plate with a greater torque to failure compared to non-locking plate in simple lateral malleolar fractures as demonstrated in cadaveric studies.^{8,9}

There has been an increasing frequency in the use of IM nailing for fixation of lateral malleolar fractures.^{5,10} Relative indications for

fibula IM nailing may include severe soft-tissue injuries affecting the lateral side of the ankle, multi-fragmentary fractures with long comminuted pattern, osteopenia and osteoporosis, and in the presence of severe comorbidities, particularly in patients with diabetes mellitus and compromised vascular network.¹ Fibular nailing has also been reported to be more cost-effective than in both one-stage ORIF and two-staged ORIF, which is particularly of great concern in the elderly patients group.^{11,12} In this article, we share our experience with use of K-wire as a fixation technique for the surgical management of lateral malleolar fractures.

Materials and methods

Patients

Between April 2015 and March 2022, 42 patients with ankle fractures were retrospectively treated at Orthopaedic Hospital Wamakko, Sokoto, Nigeria. Ethical approval was formally obtained before commencement of the study. The entire patients had internal fixation with 2.8 to 3.0mm K-wire for lateral malleolar fractures. The inclusion criteria for the study were (1) Isolated lateral malleolar, bimalleolar, and trimalleolar displaced ankle fractures, and (2) Open ankle fractures. (3) And those with complete records of follow up period of at least 24months. Exclusion criteria were (1) simple and stable ankle fractures that can be treated conservatively, (2) multiply traumatised patients, (3) Lateral malleolar nonunions and malunions, and (4) previous surgery on the ankle. (5) And those with incomplete records or follow-ups period of <24months. A total of 68 records were found and only 42 records met the inclusion criteria. Patients had standard radiographs (antero-posterior, lateral, and mortise views) of the fractured ankle for both diagnosis and preoperative planning.

Weber ankle fracture classification was used to classify the lateral malleolar fractures. Twenty six cases were classified as Weber type B (38%), and 16 were classified as Weber type C (62%) as shown in Table 1; five cases were open fractures, the rest were all closed fractures. Although the time of presentation from the injury varies from less than 1 week to more than 3 weeks (Table 2), all our patients were operated within a mean time of 36 h (range 12 h to 5 days). Figures 1a, 2a, 3a and 4a show radiographs of selected patients on presentations with either Weber type B or C fractures.

Table 1 The mechanism of injury

	WEBER B (38%)	WEBER C (62%)	Total
Twisting	7	11	18 (43%)
RTA	5	9	14 (33)
Fall from Height	3	4	7 (17)
Miscellaneous	1	2	3 (7%)

Table 2 Time of presentation from the injury time

	<1 week	1 to 2 weeks	2 to 3 weeks	>3 weeks	Total
Number	29	6	2	5	
Percentage	69%	14%	5%	12%	

Technique

The patient was positioned supine with a sand bag beneath the ipsilateral buttock and hip to promote slight internal rotation of the leg. C-arm was positioned on the opposite side and used to guide fracture reduction either percutaneously with a small pointed reduction clamp in simple oblique fractures or longitudinal traction and rotation for the comminuted fractures (Figure 1b). A skin incision approximately 1 to 1.5cm distal to the tip of the lateral malleolus is made and in line with the longitudinal axis of the fibula. The tip of the distal fibula is identified under image intensifier, a forcep is used to verify the entry point; and after confirmation of the entry point, a 3.5-mm drill bit is used to create the entry point, and then a 3mm thick K-wire is gradually advanced into the medullary canal of the fibula (Figure 1b). Meanwhile, the position is continuously being confirmed by the C arm until the wire goes beyond the fracture site and advance more proximally (Figure 1c). The stability of the K-wire position is tested to ensure proper fracture reduction. Finally, the k-wire was bent to avoid proximal migration and for consequent fracture compression (Figure 2c, 3b, 4b). Among the 5 patients that presented after 3 weeks, the fracture site had to be open to facilitate reduction before K-wire fixations. Additionally, 2 patients below 19 years of age 2.8mm thickness K wire was used because of the narrow medullary canal in them. There was no intramedullary reaming of the fibula in all our patients. Wound was closed in layers for those patients that had open reduction. Dressing was later applied to protect the ankle, and elevation on pillow was recommended to alleviate pains and oedema postoperatively. All our patients had reinforcement with backslab plaster of Paris (P.O.P) which was usually removed at 6 weeks postoperatively (Figure 1d). Patients were continued on postoperative parenteral prophylactic antibiotics for 2 to 3 days, and analgesics for 5 days which were converted to oral and continued after discharge 3 days postoperatively. Immediate postoperative X-ray taken for assessment of hardware and further confirming the fracture reduction (Figures 2b, 4b); Light weight-bearing was allowed as soon as tolerated (usually at 4 to 6 weeks postoperatively) with use of axillary crutches, and the weight bearing was progressively increased over time as the fracture is healing. All the operated patients were followed-up at the orthopaedic outpatient clinics after discharge at

regular intervals of 2, 4, 6, and 12 weeks; then at 6 and 12 months, and once a year after that. Serial radiographs were taken at follow up as the fracture progressively heals (Figure 3b, 4c). Radiographs of patients obtained at the 12 weeks' visit and have shown presence of appropriate healing capacity, they will be allowed to gradually return to activities as tolerated. At 14 to 18 weeks from the operation time, the K-wire routine removal was based on radiological healing and clinical improvement (Table 1). Outcome evaluation was used at the final follow-up assessment (Table 6 & 7).



Figure 1a Type B Weber fracture in a 28 year old Man.



Figure 1b Intraoperative manipulation and K wire fixation.



Figure 1c Arm check to guide accurate k wire positioning.



Figure 1d Back slab applied to further stabilize the fixation.



Figure 2c Hardware was removed after fracture healing.

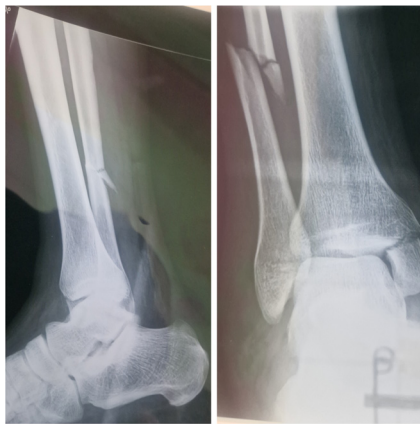


Figure 2a Weber Type C in a 45year old man.



Figure 2d Healed fibula fracture with Lateral side scar.



Figure 2b Post-operative X-ray indicating proper K wire position.



Figure 3a 29 year old Man with Weber type C ankle fracture.



Figure 3b Four months postop indicating fracture healing.



Figure 4a 50yr old Lady with Weber type B.



Figure 4b Postoperative radiograph.



Figure 4c Follow up radiograph, the K wire was for removal.

Results

The entire group's mean follow-up for the total of 42 patients was 2.2 years (range, 1-5 years). The range in age was from 14 to 73 years (Table 3 & 4). Thirty one patients were males, and 11 were females; the right ankles fractures occurred in 24 patients, while the left ankle fractures occurred in 18 patients. Among the 42 patients, those who sustained twisting injuries were 18 (43%), followed by those with vehicular accidents 14 (33%), then fall from a height 7 (17%), and miscellaneous injuries with 3 (7%) This is shown in Table 1. Among the 42 patients operated, 34 had complete fracture healing with no residual symptoms; 3 had chronic ankle pain and have been on intermittent analgesic and physiotherapy; out of these, 1 was subsequently treated with ankle arthrodesis; 2 developed pin tract infections that were treated with wound dressing and oral antibiotics and had completely resolved following pin removal; 2 among the open fracture patients had non-union and were later operated with ORIF with plate and screws; and 1 patient developed complex regional pain syndrome (CRPS) that was managed by medications and physiotherapy. The outcome measures were mainly based on radiological and clinical evaluation during follow up at 3 to 6 months (Table 5), and then at two years or more using Weber subjective results (Table 6 & 7). Thirty four (81%) patients had good, 5 (11.8%) fair, and three (7.2%) had poor results. Among the thirty four patients with good results, 22 (52.4%) fractures were Weber type C and 12 (28.6%) were Weber type B. The 5 (11.8%) patients with fair results consisted of 2 (4.8%) Weber type B fractures, and 3 (7%) type C fractures of the fibula. One patient with poor results had type C fractures and 2 had type B fractures.

Table 3 Patient age distribution

Years	14-19	20-29	30-39	40-49	>50
Number	4	8	11	5	14
Percentage	10%	19%	26%	12%	33%

Table 4 Hardware removal time

	At 14 weeks	At 18 weeks	>18 weeks
Number	34	6	2
Percentage	81%	14%	5%

Table 5 Outcome (at 3 to 6 months follow up)

	Uncomplicated (Healed)	Chronic ankle pain	Pin tract infection	Non-union	Complex regional pain syndrome
Number	34	3	2	2	1
Percentage	81%	7%	5%	5%	2%

Table 6 Classification of subjective results

Criteria	Results
Good	Complete recovery; full capacity for work and athletics; slight pain, swelling, or stiffness after excessive use; no pain medication
Fair	Full or only slightly reduced capacity for work and athletics; moderate pain, swelling, or stiffness after excessive use; occasional pain medication
Poor	Significantly reduced capacity for work and athletics; severe pain, swelling, or stiffness after exertion; pain medication used more than occasionally

Table 7 Outcome based on subjective results by Weber classification (at minimum 2 year follow up)

	Good	Fair	Poor
Weber B	12 (28.6%)	2 (4.8%)	2 (4.8%)
Weber C	22 (52.4%)	3 (7%)	1 (2.4%)
Total	34 (81%)	5 (11.8%)	3 (7.2%)

Discussion

The use of IM fixation for long bone fractures has been widely practised as the treatment option because of its relative shorter operative time and lower morbidity.¹³ The technique preserves fracture hematoma and periosteal damage is minimal. As devices and techniques are being developed for this application, the concepts are currently applied in treatment of smaller long bones.¹⁴ K-wire just like IM nail fixation can be applied to the fibula with greater operative ease and desirable outcome. The technique we employed in applying it conformed to the standard widely used by AO guideline.¹⁵ This is evident by the satisfactory outcome of our study in which 34 (81%) out of total 42 patients in the study had complete fracture healing. Additionally, similar to what was obtained with regards to soft tissue preservation; there have been reports of significant reduction of wound breakdown and irritation by the fixed hardware compared with traditional and standard AO techniques by several studies researching on intramedullary fixation of fibular fractures.¹⁶⁻¹⁸ Open reduction and internal fixation of distal fibular fractures with plates and screws has a complication rate up to 30%, mostly from soft tissue breakdown and infection.¹⁹ Such complications are higher in certain high-risk patients including, diabetics, smokers and patients older than 65 years of age.²⁰ As our technique did not involve the use of locking system, the pitfall with unlocked designs was still present and was as high as 20% compared to 5% in a more contemporary locked design.²¹ The use in low resource settings is still beneficial as our study indicated good outcome in majority of our patients with lesser complications (Table 5 & 6).

A recent literature reviews for the Implants used for IM fixation of distal fibula fractures identified 10 different surgical technologies for IM fixation of lateral malleolar fractures across 12 articles, including both improvised and custom-designed Orthopaedic implant found out that the Intra-medullary fixation may outperform lateral malleolus extramedullary fixation, particularly in patients at high risk of soft tissue complications.² Our study did not take into consideration a

particular technique to take care of syndesmotic tear in Weber type B ankle fracture, many similar studies reported use of different intramedullary devices for lateral fibular fracture in their studies; they made use of ANK (Ayhan Nedim Kara) nail for comminuted and oblique fractures that had associated syndesmotic ligament tear with great postoperative success.^{22,23} Although our study made use of non-locked 3mm K-wire, the biomechanical strength cannot be compared with both conventional locked nail and plate fixation as reported by other biomechanical studies performed to compare use of IM nail and plates for treatment of both comminuted and non-comminuted fractures of the distal third of fibula.^{8,9} However, use of K-wire as an implant for the fixation is quite relevant and justifiable as the fibula is not a full-weight bearing bone, though its distal part is integral to the stability of the ankle joint.²⁴ Furthermore, the biomechanical strength and the role of K-wires in children long bones fractures fixations have been reported by various studies indicating excellent outcome.²⁵

Conclusion

The use of nails, including K-wires as intramedullary devices, may outperform plate and screws for fixations of the lateral malleolus fractures, especially in elderly patients at high risk of soft tissue complications and in open ankle fractures. This study highlighted the use of more accessible K wires as an alternative to nail in fixing lateral malleolar fractures in a financially constraint settings.

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Conflicts of interest

There are no conflicts of interest to declare.

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