TECHNICAL NOTE

Minimally Invasive Surgical Approach to Distal Fibula Fractures: A Technique Tip

Tyler Gonzalez, MD, MBA; Bonnie Chien, MD; Mohammad Ghorbanhoseini, MD; John Y. Kwon, MD

Research performed at BIDMC, Harvard Medical School, Boston, Massachusetts, USA

Abstract

Wound complications following ankle fracture surgery are a major concern. Through the use of minimally invasive surgical techniques some of these complications can be mitigated. Recent investigations have reported on percutaneous fixation of distal fibula fractures demonstrating similar radiographic and functional outcomes to traditional open approaches. The purpose of this manuscript is to describe in detail the minimally invasive surgical approach for distal fibula fractures.

Keywords: Ankle fractures, Distal fibula fracture, Minimally invasive surgery, Wound complications

Introduction

Wound complications are a major concern for the orthopedic surgeon. Patient-specific factors such as diabetes, smoking and peripheral vascular disease all predispose patients to an increased risk of wound healing complications after surgery (1, 2). The anatomy around the ankle in- particular provides minimal soft tissue coverage for most orthopaedic implants as well as regions of poor vascularity that can be disrupted by trauma as well as surgical techniques.

Surgical site infection is one of the most common complications following ankle fracture surgery (3-5). While medial malleolar fractures can often be stabilized with less invasive techniques such as percutaneous screw fixation, fixation of the fibula is usually performed with open reduction and internal fixation (ORIF) utilizing a 7-10 cm skin incision directly over the lateral malleolus.

With the advent of lower profile fracture-specific implants and minimally invasive surgical techniques (MIS), wound complications may be mitigated. Several authors have previously reported minimally invasive techniques to address distal fibula fractures, although most achieved fixation without anatomic reduction of the fracture site (6-11). Recently, Chiang et al. published a comparative cohort study and demonstrated that MIS approaches for treating distal fibula fractures leads to equivalent radiographic and functional outcomes as compared to standard ORIF with fewer wound complications (12).

The purpose of this manuscript is to describe in detail the minimally invasive surgical approach for distal fibula fractures that allows for anatomic reduction, minimizes soft tissue disruption and provides the surgeon with the means of converting to the more conventional open procedure if required.

Operative Technique

The illustrative case presented is a 44 year old female with poorly controlled diabetes who sustained a twisting injury resulting in a bimalleolar-equivalent ankle fracture requiring surgical fixation [Figure 1].

(1) The patient is placed in the supine position with a small bump under the ipsilateral hip to slightly internally rotate the extremity. The fracture site is palpated and the exact location is marked on the skin after being confirmed fluoroscopically. A perfect lateral radiograph of the ankle is required for this purpose in order to accurately place the incision directly over the fracture site [Figure 2A,B].Slight misplacement proximally or distally makes this technique more challenging.

(2) Next, a 3-4 cm incision is made directly over the

Corresponding Author: Mohammad Ghorbanhoseini, Harvard Medical School, BIDMC, Carl J. Shapiro, Department of Orthopaedics, Boston, USA
Email: mghorban@bidmc.harvard.edu

AB&JS THE ONLINE VERSION OF THIS ARTICLE
ABJS.MUMS.AC.IR

Figure 1. Preoperative AP radiograph showing bimalleolar-equivalent ankle fracture with significant medial clear space widening.
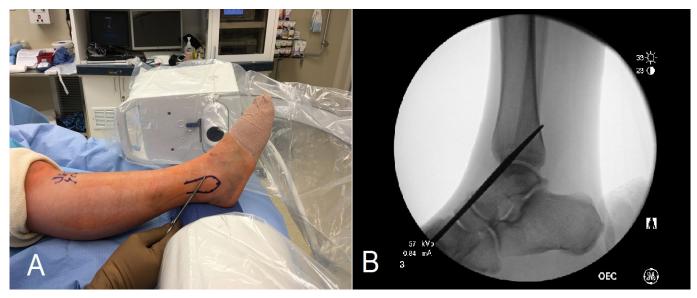
fracture site in an oblique fashion and the fracture site is identified. [Figure 3] Care is taken to avoid the superficial peroneal nerve. The fracture site is cleaned of any interposed soft-tissues, periosteum or hematoma

and the fracture is anatomically reduced using a pointed reduction clamp [Figure 4]. In the mini open approach, elevation of anterior and posterior periosteal flaps is necessary to place pointed reduction forceps. An interfragmentary lag screw can be placed in standard fashion through this incision.

If exposure is inadequate, the incision can be made extensile by gently curving the incision proximally and distally [Figure 5].

(3) Next a Langenbeck or Cobb elevator is used to subcutaneously dissect proximally and distally over the fibula. We recommend the use of an elevator and not the implant itself as this can result in implant malpositioning, most commonly anteriorly. Malpositioning of the implant, in-particular proximally, can make later percutaneous screw fixation difficult. Both anatomic fibular plates and 1/3 tubular plates can be utilized per surgeon preference; however non-anatomic plates must be precontoured on the back table prior to insertion. The plate is then inserted into the incision, pushed proximally in order so that the distal aspect of the plate enters the incision and then is pushed distally. The plate can be held with an olive wire to help determine proper plate placement and allow rotation around a single axis point. Once proper positioning is confirmed fluoroscopically, we typically place a cortical screw through the incision in order to seat the plate against the fibula. Typically 2 screws can be placed through the mini-open incision.

(4) Next, the proximal and distal holes are identified either fluoroscopically or using another similar plate placed external to the skin as a template for identifying the screw hole locations. Small skin incisions are made and blunt dissection is performed so as to avoid iatrogenic injury to the superficial peroneal nerve. When placing fixation proximally, the drill

Figures 2A,B. Fluoroscopically guided incision placement.

Figure 3. 3-4 cm incision placed directly over the fracture site.

Figure 5. Extension of mini open approach to aid in exposure. The incision is extended by curving the incision proximally and distally if necessary.

tip should be used to feel the anterior and posterior cortices of the fibula so that an optimal trajectory can be determined prior to drilling. Given that fewer screws are placed in order to minimize additional skin incisions, locking screws should be considered in osteopenic bone to increase the rigidity of the rotation-neutralizing construct. The use of locking screws necessitates accurate precontouring prior to insertion as the locking screw will not contour the plate to the fibula.

(5) In order to assess the syndesmosis, the Cotton test can be easily performed by placing a pointed reduction clamp directly around the fibula through the MIS approach. Should syndesmotic stabilization be required, fixation can be placed directly via the MIS incision.

Figure 6 demonstrates that a 4 cm mini-open incision was utilized (plus three smaller incisions totaling approx. 1.5 cm) in comparison to Figure 7 which demonstrates that a 10 cm incision would have been commonly utilized if the mini-open approach was not performed. Figure 8 demonstrates an AP radiograph demonstrating the final construct.

Figure 4. Anatomic reduction with the aid of a pointed reduction clamp.

Figure 6. 4 cm MIS incision.

Figure 7. Standard incision measuring 10 cm if the MIS technique was not utilized.

Figure 8. Postoperative AP radiograph showing final construct.

Discussion

The treatment of ankle fractures can be associated with an increased rate of complications including skin necrosis, infection and nonunions in certain patient populations (2, 13, 16). With the advent of newer low profile implants, locking plate and screw technology and MIS approaches the armamentarium for the treatment of fibula fractures with associated soft tissue trauma and those who are at increased risk of wound complications has broadened.

Minimal invasive plate osteosynthesis (MIPO) is a form of MIS that was developed in an effort to prevent periosteal devascularization and major soft tissue dissection. Cadaver studies have demonstrated that MIPO techniques are better at preserving perforating vessels and subsequently the periosteal and medullary circulation of long bones (14-16). MIPO approaches to the fibula have also been described specifically using percutaneous fixation with intramedullary screws or plates. Hess, et al. reported on a series of 20 cases using a MIS approach with locking plates and screws to treat distal fibula fractures associated with distal tibia fractures. 17/20 fractures healed without complications and they concluded that this technique was a viable option for patients with complex fractures of the distal fibula with critical soft tissue conditions (6). Ray, et al. examined percutaneous intramedullary nailing of distal fibula fractures in diabetics and found that if closed reduction could be obtained, this technique was a viable option for fixation of the lateral malleolus with minimal soft tissue dissection and good to excellent results. While both groups demonstrated

good results and adequate stabilization of the fractures using MIPO technique, anatomic reduction with direct visualization at the fibula fracture site was not achieved nor attempted (17).

Recently, Chiang et al reported a comparative cohort study comparing MIS techniques to traditional ORIF for distal fibula fractures. The authors reported less postoperative pain and fewer wound complications in the MIS group as compared to the ORIF group. The authors described two MIS techniques and reported on 24 patients utilizing a technique similar to ours.

In contrast to Chiang's technique in which a straight incision in-line with the fibula is made over the fracture site (12), we utilize an oblique incision made in-line with the fracture site itself. We feel that this allows for greater exposure of the entire length of the fracture. Furthermore, the anterior position of the distal aspect of the oblique incision helps to identify the anterior portion of the fracture site to aid in reduction as well as allows for easier extension if the syndesmosis requires open reduction

If inadequate visualization of the fracture site or extension is required in order to gain reduction or place additional fixation, the MIS approach can be made extensile by simply extending the proximal and distal aspects in a gentle curvilinear fashion. This is preferable to excessive retraction which can result in contusion of the soft tissue envelope.

The MIS approach described is amenable to distal oblique fibula fractures. Weber C fractures are typically not amenable to this technique given increasing soft tissue thickness more proximally which necessitates

a greater exposure. Obese patients similarly may require more formal exposure. Additionally, highly comminuted distal fibula fractures may require a bridge-plating technique and direct visualization of the fracture site is not recommended as it may lead to increased bone devascularization. Finally, patients with cresting of the lateral fibula, a normal anatomic variation occasionally encountered, may require an extensile approach as the plate often needs to be applied posterolaterally in these cases.

We have utilized this MIS approach for 21 patients with distal fibula fractures (2 patients were converted to a traditional approach due to 1. Mal positioned mini-open incision and 2. Need for posterior lateral fibular plating) [Table 1] and have compared our results to a matched cohort of 14 patients that underwent traditional ORIF during the same time period [Table 2]. Although not randomized, the cohorts were matched demographically and for medical comorbidities. Average incision length was 4.2 cm (3.8-5.0cm) and 11.50 cm (6.0-17.0cm) for the MIS group as compared to the traditional ORIF group. Average operative time from skin incision to completion of fibular fixation was 37.5 minutes (30-48 minutes) and 38.6 minutes (17-53 minutes) for the MIS group as compared to the traditional ORIF group. 2/19 patients in the MIS

	Table 1. Demographic, Surgical, and Complication Rate Data Associated with Minimally Invasive Approach									
Patient	Gender (M/F)	Age (Years)	Fracture type	Incision length (mm)	Operative time for fibula ORIF only (minutes)	Tscherne classification	Anatomic reduction	Comorbidities	Complications	Treatment for complication
1	M	47	Trimalleolar	38	35	0	Yes		Deep infection	OR for I&D
2	F	48	Bimalleolar equivalent	40	32	0	Yes	Diabetes Mellitus II	None	
3	F	71	Bimalleolar equivalent	42	30	0	Yes		None	
4	M	66	Bimalleolar equivalent	45	40	0	Yes	Peripheral Vascular Disease, alcohol abuse	None	
5	F	54	Bimalleolar equivalent + syndesmotic injury	40	42	0	Yes	Diabetes Mellitus I	Wound dehiscence	Local wound care
6	F	24	Trimalleolar	45	37	0	Yes		None	
7	F	29	Bimalleolar equivalent	40	35	0	Yes		None	
8	M	37	Bimalleolar equivalent + syndesmotic injury	50	45	0	Yes		None	
9	F	63	Bimalleolar equivalent	40	43	0	Yes		None	
10	M	28	Bimalleolar equivalent + syndesmotic injury	50	48	1	Yes		None	
11	F	36	Bimalleolar equivalent	40	30	0	Yes		None	
12	F	73	Bimalleolar equivalent + syndesmotic injury	40	30	1	Yes		None	
13	M	52	Bimalleolar equivalent + syndesmotic injury	40	30	1	Yes		None	
14	F	55	Bimalleolar equivalent	40	41	1	Yes	Diabetes Mellitus I	None	
15	M	55	Bimalleolar equivalent	40	30	0	Yes	Tobacco use	None	
16	M	59	Trimalleolar	42	40	1	No	Diabetes Mellitus I, Peripheral Vascular Disease, documented noncompliance	None	
17	F	30	Bimalleolar equivalent + syndesmotic injury	40	38	1	Yes		None	
18	F	54	Bimalleolar equivalent	45	42	0	Yes	Diabetes Mellitus I	None	
19	F	18	Bimalleolar equivalent	45	40	0	Yes		None	
20	F	41	Bimalleolar	80	40	0	Yes	Tobacco use	None	
21	F	41	Bimalleolar equivalent + syndesmotic injury	90	40	0	Yes		None	

*Mean and range of incision lengths were calculated excluding Patient 20 & 21 due to conversion to traditional approach.

Table 2. Comparison of Minimally Invasive to Traditional Approach		
	Minimally Invasive	**Traditional**
Patient number	19	14
Average incision length	4.2 cm (3.8-5.0cm)	11.50 cm (6.0-17.0cm)
Average operative time for fibula fixation	37.5 minutes (30-48 minutes)	38.6 minutes (17-53 minutes)
Wound complications	2/19 (10.5%)	3/14 (21.4%)
Anatomic reduction	17/19 (89.5%)	12/14 (85.7%)

cohort sustained a wound healing complication. One patient had a superficial dehiscence treated with local wound care and the other had a deep infection treated with irrigation & debridement. In the traditional ORIF group 3/14 sustained a wound complication with 2 cases of infection treated by irrigation & debridement and 1 case of superficial dehiscence and infection treated by local wound care and IV antibiotics. Seventeen of the 19 patients in the MIS cohort achieved an anatomically aligned mortise at final follow up as compared to 12/14 patients in the traditional ORIF as assessed by an independent orthopaedic surgeon blinded to the approach.

We describe the use of a minimally invasive approach for fixation of distal fibula fractures. This approach allows for minimal soft tissue dissection with recent reports demonstrating decreased wound healing complications. Direct visualization of the fracture site and anatomic reduction of the fracture are achieved with the use of this MIS approach.

The authors declare that they have no conflict of interest.

Tyler A. Gonzalez MD MBA
Bonnie Chien MD
Department of Orthopaedic Surgery, Massachusetts General Hospital, Boston, USA

Mohammad Ghorbanhoseini MD
Orthopedic Surgeon, Harvard Medical School, BIDMC, Carl J. Shapiro Department of Orthopaedics, Boston, USA

John Y. Kwon MD
Department of Orthopaedic Surgery, Harvard Medical School, Division of Foot and Ankle Surgery, BIDMC, Department of Orthopaedic Surgery, BIDMC, Boston, USA

References

1. Nåsell H, Ottosson C, Törnqvist H, Lindé J, Ponzer S. The impact of smoking on complications after operatively treated ankle fractures--a follow-up study of 906 patients. J Orthop Trauma. 2011; 25(12):748-55.
2. Wukich DK, Lowery NJ, McMillen RL, Frykberg RG. Postoperative infection rates in foot and ankle surgery: a comparison of patients with and without diabetes mellitus. J Bone Joint Surg Am. 2010; 92(2):287-95.
3. Miller AG, Margules A, Raikin SM. Risk factors for wound complications after ankle fracture surgery. J Bone Joint Surg Am. 2012; 94(22):2047-52.
4. Ovaska MT, Mäkinen TJ, Madanat R, Huotari K, Vahlberg T, Hirvensalo E, et al. Risk factors for deep surgical site infection following operative treatment of ankle fractures. J Bone Joint Surg Am. 2013; 95(4):348-53.
5. Chien B, Hofmann K, Ghorbanhoseini M, Zurakowski D, Rodriguez EK, Appleton P, et al. Relationship of self-reported ability to weight-bear immediately after injury as predictor of stability for ankle fractures. Foot Ankle Int. 2016; 37(9):983-8.
6. Hess F, Sommer C. Minimally invasive plate osteosynthesis of the distal fibula with the locking compression plate: first experience of 20 cases. J Orthop Trauma. 2011; 25(2):110-5.
7. Hoffer MM. Percutaneous lateral malleolar transtibial pin fixation of unstable ankle fractures. J Trauma. 1976; 16(5):374-6.
8. Carlile GS, Giles NC. Surgical technique for minimally invasive fibula fracture fixation. Foot Ankle Surg. 2011; 17(3):119-23.
9. Kong C, Kolla L, Wing K, Younger AS. Arthroscopy-assisted closed reduction and percutaneous nail fixation of unstable ankle fractures: description of a minimally

invasive procedure. Arthrosc Tech. 2014; 3(1):e181-4.

10. Iacobellis C, Chemello C, Zornetta A, Aldegheri R. Minimally invasive plate osteosynthesis in type B fibular fractures versus open surgery. Musculoskelet Surg. 2013; 97(3):229-35.

11. Pires RE, Mauffrey C, de Andrade MA, Figueiredo LB, Giordano V, Belloti JC, et al. Minimally invasive percutaneous plate osteosynthesis for ankle fractures: a prospective observational cohort study. Eur J Orthop Surg Traumatol. 2014; 24(7):1297-303.

12. Chiang CC, Tzeng YH, Lin CC, Huang CK, Chang MC. Minimally invasive versus open distal fibular plating for AO/OTA 44-B ankle fractures. Foot Ankle Int. 2016; 37(6):611-9.

13. Chaudhary SB, Liporace FA, Gandhi A, Donley BG, Pinzur MS, Lin SS. Complications of ankle fracture in patients with diabetes. J Am Acad Orthop Surg. 2008; 16(3):159-70.

14. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis and vascularity: preliminary results of a cadaver injection study. Injury. 1997; 28(Suppl 1):A7-12.

15. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique? J Orthop Trauma. 1999; 13(6):401-6.

16. Helfet DL, Suk M. Minimally invasive percutaneous plate osteosynthesis of fractures of the distal tibia. Instr Course Lect. 2003; 53(2):471-5.

17. Ray TD, Nimityongskul P, Anderson LD. Percutaneous intramedullary fixation of lateral malleolus fractures: technique and report of early results. J Trauma. 1994; 36(5):669-75.