International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

An Overview on Treatment of Acute Ankle Fractures

Sami Ibrahim Sadek, Khaled Edris Abdelrahman, Mohamed AbdelAziz Gheith, Abdelrahman Moustafa Mahmoud

Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt.

Abstract

Ankle fracture is one of the most common lower limb fractures for they account for 9% of all fractures representing a significant portion of the trauma workload. Ankle fractures usually affect young men and older women, however, below the age of 50; ankle fractures are the commonest in men. Two commonly used classification systems for ankle fractures include the danis weber AO classification and the Lauge-Hansen classification. There is biomechanical evidence that posterior non-locking plates are superior in stability than laterally placed plates; however there is little clinical evidence. There are several different methods of ankle fracture fixation, however the goal of treatment remains a stable anatomic reduction of talus in the ankle mortise and correction of the fibula length as a 1 mm lateral shift of the talus in the ankle mortise reduces the contact area by 42%, and displacement (or shortening) of the fibula more than 2 mm will lead to significant increases in joint contact pressures. Further research both biomechanically and clinically needs to be undertaken in order to clarify a preferable choice of fixation.

Keywords: Acute Ankle Fractures, Fixation, Diabetic.

Full length article **Corresponding Author*, e-mail: Abdellrahmanmostafa48@gmail.com

1. Introduction

The principles of treatment are to restore anatomical alignment and joint congruity to ensure stability, this involves urgent reduction of grossly displaced or dislocated joints in the emergency department with documentation of neurovascular status before and after reduction, initial immobilization in a splint or cast is applied with a check X-ray [1]. Ankle fractures can be successfully treated non-operatively, the key to obtaining good results is selecting injuries that will respond well to non-operative treatment, these are generally isolated fractures of the lateral malleolus, and the talus must be maintained in the correct position in the mortise in order to restore ankle joint function once the fracture ultimately heals [1]. Fractures that are considered stable can be treated conservatively in a cast for a period of at least six weeks, stable fractures include those with an isolated undisplaced medial or lateral malleoli fractures without significant talar shift (less than 4 mm), posterior malleolus fractures are also treated non-operatively if they involve less than 25% of the articular surface [2]. When there is only one break in the ring, such as with an isolated lateral malleolar or isolated medial malleolar fracture - especially if non-displaced, non-shortened, or non-angulated - there is less potential for displacement, and thus, less indication for open reduction internal fixation , however, with two breaks in ring as seen with bimalleolar fractures, potential for displacement exists, thus making surgical management a more attractive option , If greater than 25% of articular surface of tibiotalar articular surface or a > 2 mm step off is noted, then ORIF is traditionally indicated for posterior malleolar fractures [3].

2. Principles of fixation

Operative treatment options for an ankle fracture are ORIF or external fixation, external fixator is often used as a temporary fixation, but can exceptionally be used as a definitive treatment modality or in combination with ORIF in complicated fractures requiring additional stability (30).

2.1. Timing

Fixation should be accomplished within the first two weeks of injury, due to presence of soft callus formation, often, the earlier fixation is accomplished, the less soft callus is encountered, and the less the need for re-osteotomy of the fracture site [4]. One important exception exists, if the soft tissue envelope is not appropriate for fixation, surgery is to be delayed. If fracture blisters seen more commonly with high energy ankle fractures are encountered, surgery is delayed until re-epithelization, re-epithelization is expected by 13 days in serous fracture blisters, and by 16 days in hemorrhagic fracture blisters, if an incision is made into a fracture blister, wound healing complications and infection may develop [5-6]. In diabetic patients, the zone of soft tissue injury is often greater than the blister itself, and incision placement should be made with caution, especially with hemorrhagic blisters [7].

2.2. Principles in lateral malleolar fixation

Multiple fixation methods have been described, including lateral versus posterolateral plating, nonlocked versus locked plating, and intramedullary fixation [7]. In the lateral plating technique, a one-third tubular plate or an

anatomic distal fibular plate is used, anatomic distal fibular plates are precontoured to match the anatomy of the lateral malleolus and allow for the placement of multiple screws in a nonlinear configuration [7-9].Posterolateral plating of the fibula takes advantage of an antiglide mode of fixation, although this is biomechanically the most stable construct, there has been concern for peroneal tendon irritation [10]. In highly comminuted fractures, patients with osteoporotic bone, or short metaphyseal segments, locking plates are often advocated, locking plates create a fixed-angle construct and rely on the strength of the screw head threading into plates, thereby enabling stability with unicortical fixation [11]. In patients with poor soft-tissue envelopes or high risk for wound healing complications, intramedullary fixation is another stabilization technique, fibular intramedullary nailing demonstrates greater resistance to torque to failure than traditional fibular plating with a lag screw and is a low-profile surgical implant [12].

2.3. Principles in medial malleolar fixation

Avulsion fractures of the medial malleolus can often be treated closed if they are isolated, minimally displaced, and involve the distal portion of the malleolus [13]. Reduction of the medial malleolus can be accomplished by k-wires, tension banding, 4.0 cancellous screws, or hook plates, medial malleolar cannulated screws are often used [10]. Vertical fractures of the medial malleolus are fixed with cancellous screws placed perpendicular to the fracture site, it is important to buttress the fracture by placing a screw with a washer at the proximal apex of the fracture or to use a small tubular plate or T-plate as a buttress [4].

2.4. Principles in posterior malleolar fixation

ORIF has generally been recommended when more than 25% of the posterior articular surface is involved or the fracture is displaced more than 2 mm, more recently, there has been a trend towards fixation of posterior malleolus fractures which allow for more biomechanically sound fixation of the posterior malleolus and better results [14-15]. Fixation of the posterior malleolar fragment is achieved either through the direct or the indirect approach, the indirect approach can be accomplished through the lateral incision, in which a bone screw is inserted anterior to posterior [10]. Direct exposure is accomplished by placing a bone screw posterior to anterior, through either a posterior-medial or posterior-lateral incision, plates can also be used with screws superior to the fracture, blocking superior displacement of the posterior fragment with an antiglide or buttress effect [7].

2.6. Treatment of the ankle syndesmotic injury

The decision to stabilize the distal tibiofibular syndesmosis should always be based on intraoperative dynamic stress testing following malleolar fracture fixation, the intraoperative testing can be done with the Cotton test (lateral fibular translation test), external rotation stress test, or with sagittal plane stress test, the sensitivity of any of these tests alone is insufficient to adequately detect instability of the syndesmosis, thus a combination of various tests should probably be used [4]. Anatomic reduction of the syndesmosis is critical for optimizing patient outcome. The optimum fixation for the syndesmosis has not been defined yet, there is no consensus on how many cortices should be engaged, the ideal screw size, screw composition, the optimum level of placement above the tibial plafond [16]. Commonly, a 3.5 mm or 4.5 mm cortical screw are used, it has shown in some studies use of two cortical screws over one diastasis screw provide stronger construct biomechanically, 4.5 mm cortical screw provides significant support against forces acting on syndesmosis during walking weeks though [17-18]. An alternative to screw fixation is use of tightrope which consists of a non-biodegradable wire held in place by two cortical metal buttons at either end has shown similar outcome, but quicker time to recovery or return to work based on a systematic review of literature this does not routinely require removal, therefore eliminating risks of second anaesthetic and potential cost saving, drawback with this method is that some patients develop biological reaction to material [19].

2.7. Principles of operative fixation of diabetic ankle fractures

Insufficient stability of ankle fractures (treated operatively, or non-operatively) can trigger Charcot neuroarthropathy, and result in bone loss, deformity, ulceration, and the need for amputation [20]. The treating surgeon should also bear in mind that patients with complicated diabetes are usually of low functional demand and the goal of treatment should be limb salvage and to maintain an ambulatory status, this can be achieved by providing maximum rigidity to the fractured ankle, cast application is not rigid enough, whilst ‘standard’ fixation may fail due to development of charcot neuroarthropathy [21]. Rigid fixation followed in charcot foot reconstruction, can be adopted in ankle fracture fixation in neuropathic diabetics, using locking reconstruction plates and multiple screws, aiming at absolute stability [21-22]. The type of fixation that provides maximum rigidity is primary arthrodesis of the ankle +/- subtalar joints, this can be achieved using circular external fixation, internal fixation using compression/plate fixation, or retrograde tibiotalocalcaneal (TTC) nail fixation, that can actually be performed percutaneously or through small incisions without opening the fracture site (also reducing the risk of infection), the latter could be an excellent salvaging solution after failure of non-operative management, or initial ‘standard’ fixation, as well as for primary management of an ankle fracture in these high-risk patients with complicated DM [20].

Super construct was defined with regard to charcot surgery as fixation meeting the following criteria [23].

1. Fusion is extended beyond the zone of injury.
2. Bone resection is performed to allow for reduction of deformity and relief of soft tissue tension.
3. The strongest device that soft tissue envelope will allow should be utilized for fixation.
4. Fixation should be applied in a manner that maximizes Mechanical function.

These can be modified to apply to diabetic ankle fractures with the goals of extending fixation beyond the immediate zone of injury, planning incisions to allow for fixation placement in low-risk intervals for healing, utilization of the strongest available fixation device, and application of the device in a mechanically advantageous fashion (i.e., anti-glide plating) [24]. The advent of locking plate technology has revolutionized the orthopedic landscape, it allows surgeons to have better fixation while preserving vital periosteal blood supply, which is crucial for fracture healing, these plates achieve mechanically superior fixation,

often without increased fixation volume, in addition to locked plating technology, the utilization of multiple three to four cortical syndesmotic screws has been suggested [24-25].

3. Postoperative management

The postoperative programme is adapted to the stability of the ankle joint, and thus depends on the energy of injury, the condition of the tissues, the classification of the fracture and the patient profile [8]. Early weight bearing after operative management can help reduce stiffness, calf atrophy, and osteoporotic changes associated with disuse osteopenia, excluding diabetics, syndesmotic fixation, and posterior malleolar fixation [26]. Patient factors, such as their ability to correctly apply and use a temporary immobilization device, can influence the effectiveness of an intervention**.** The early goal is a plantigrade foot with good gait progression and controlled swelling, physical therapy can help to restore more ankle dorsiflexion and subtalar motion, but should be ordered carefully and only after there is good evidence that the fractures are healed [8]. Diabetes mellitus has been associated with slower bone healing, therefore prolonged immobilization and restricted weight bearing have been traditionally recommended, however, the latter has not been supported by strong scientific evidence and some publications are challenging the above concept, advocating early protected weight bearing in cast or boot, two weeks after surgery [20].To assess ankle movement, ROM measured in the sagittal plane of the tibiotarsal joint in closed and open chain with weight-bearing, comparing the operated side with the contralateral side, which served as a control [27-29].

References

[1] S. Seewoonarain, M. Prempeh, M. Shakokani, A. Magan. (2016). Journal of Arthritis.

[2] A.J. Lovy, J. Dowdell, A. Keswani, S. Koehler, J. Kim, S. Weinfeld, D. Joseph. (2017). Nonoperative versus operative treatment of displaced ankle fractures in diabetics. Foot & Ankle International. 38(3): 255-260.

[3] F. Wilson. (2000). Fractures of the ankle: pathogenesis and treatment. Journal of the Southern Orthopaedic Association. 9(2): 105-115.

[4] M. Ovaska. (2015). Complications in ankle fracture surgery. Acta Orthopaedica. 86(sup358): 1-35.

[5] E.J. Strauss, G. Petrucelli, M. Bong, K.J. Koval, K.A. Egol. (2006). Blisters associated with lower-extremity fracture: results of a prospective treatment protocol. Journal of orthopaedic trauma. 20(9): 618-622.

[6] S.S. Mehta, K. Rees, L. Cutler, J. Mangwani. (2014). Understanding risks and complications in the management of ankle fractures. Indian Journal of Orthopaedics. 48: 445-452.

[7] J.S. Xenos, W.J. Hopkinson, M.E. Mulligan, E.J. Olson, N.A. Popovic. (1995). The tibiofibular syndesmosis. Evaluation of the ligamentous structures, methods of fixation, and radiographic assessment. JBJS. 77(6): 847-856.

[8] L.M. Bachmann, E. Kolb, M.T. Koller, J. Steurer, G. ter Riet. (2003). Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. Bmj. 326(7386): 417.

[9] A.A. Aiyer, E.C. Zachwieja, C.M. Lawrie, J.R. Kaplan. (2019). Management of isolated lateral malleolus fractures. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 27(2): 50-59.

[10] J.T. Southerland, J.S. Boberg, M.S. Downey, A. Nakra, L.V. Rabjohn. (2012). McGlamry's comprehensive textbook of foot and ankle surgery. Lippincott Williams & Wilkins: pp.

[11] R. Aigner, P. Lechler, C.K. Boese, S. Ruchholtz, M. Frink. (2019). Operative treatment of geriatric ankle fractures with conventional or locking plates. A retrospective case-control study. Foot and Ankle Surgery. 25(6): 766-770.

[12] T.O. White, K. Bugler, P. Appleton, E. Will, M. McQueen. (2016). A prospective randomised controlled trial of the fibular nail versus standard open reduction and internal fixation for fixation of ankle fractures in elderly patients. The bone & joint journal. 98(9): 1248-1252.

[13] E. Delahunt, C.M. Bleakley, D.S. Bossard, B.M. Caulfield, C.L. Docherty, C. Doherty, F. Fourchet, D.T. Fong, J. Hertel, C.E. Hiller. (2018). Clinical assessment of acute lateral ankle sprain injuries (ROAST): 2019 consensus statement and recommendations of the International Ankle Consortium. British journal of sports medicine. 52(20): 1304-1310.

[14] R. Khare, N. Kumar, N. Arora, K. Khare. (1999). POTT'S FRACTURE. Medical Journal Armed Forces India. 55(4): 335-338.

[15] H. Kyriacou, A.M. Mostafa, B.M. Davies, W.S. Khan. (2021). Principles and guidelines in the management of ankle fractures in adults. Journal of Perioperative Practice. 31(11): 427-434.

[16] A. Magan, P. Golano, N. Maffulli, V. Khanduja. (2014). Evaluation and management of injuries of the tibiofibular syndesmosis. British Medical Bulletin. 111(1): 101-115.

[17] M. Hansen, L. Le, S. Wertheimer, E. Meyer, R. Haut. (2006). Syndesmosis fixation: analysis of shear stress via axial load on 3.5-mm and 4.5-mm quadricortical syndesmotic screws. The Journal of Foot and Ankle Surgery. 45(2): 65-69.

[18] A. Beumer, M.M. Campo, R. Niesing, J. Day, G.-J. Kleinrensink, B.A. Swierstra. (2005). Screw fixation of the syndesmosis: a cadaver model comparing stainless steel and titanium screws and three and four cortical fixation. Injury. 36(1): 60-64.

[19] A. Kheiran, J. Mangwani. (2017). Addressing Controversies in the Management of Ankle Fractures. Journal of Foot and Ankle Surgery (Asia Pacific). 5(1): 27-34.

[20] N. Gougoulias, H. Oshba, A. Dimitroulias, A. Sakellariou, A. Wee. (2020). Ankle fractures in diabetic patients. EFORT open reviews. 5(8): 457-463.

[21] M.P. Ebaugh, B. Umbel, D. Goss, B.C. Taylor. (2019). Outcomes of primary tibiotalocalcaneal nailing for complicated diabetic ankle fractures. Foot & Ankle International. 40(12): 1382-1387.

[22] D.K. Wukich, A.J. Kline. (2008). The management of ankle fractures in patients with diabetes. JBJS. 90(7): 1570-1578.

[23] V.J. Sammarco. (2009). Superconstructs in the treatment of charcot foot deformity: plantar plating, locked plating, and axial screw fixation. Foot and Ankle Clinics. 14(3): 393-407.

[24] J.M. Manway, C.D. Blazek, P.R. Burns. (2018). Special considerations in the management of diabetic ankle fractures. Current Reviews in Musculoskeletal Medicine. 11: 445-455.

[25] S. Tsukada, M. Otsuji, A. Shiozaki, A. Yamamoto, S. Komatsu, H. Yoshimura, H. Ikeda, A. Hoshino. (2013). Locking versus non-locking neutralization plates for treatment of lateral malleolar fractures: a randomized controlled trial. International orthopaedics. 37: 2451-2456.

[26] R. Firoozabadi, E. Harnden, J.C. Krieg. (2015). Immediate Weight-Bearing after Ankle Fracture Fixation. Advances in orthopedics. 2015(1): 491976.

[27] C.M. de Pinho Tavares, R.Z. de Almeida Pinto, F.A.S. Lopes, R.S. Castilho, T.A.A. Silva, D.S. Baumfeld. (2020). Isolated subtalar arthrodesis causes loss of ankle mobility. Journal of the Foot & Ankle. 14(1): 41-45.

[28] U. LindsjÖ. (1985). Operative treatment of ankle fracture-dislocations: a follow-up study of 306/321 consecutive cases. Clinical Orthopaedics and Related Research®. 199: 28-38.

[29] S.K. Grimston, B.M. Nigg, D.A. Hanley, J.R. Engsberg. (1993). Differences in ankle joint complex range of motion as a function of age. Foot & ankle. 14(4): 215-222.