INTRODUCTION

According to Daly et al (1), there are estimated to be around 5 million ankle injuries per year in the US alone, with the incidence rate of 187 per 100,000 person-years. The most common type of ankle fracture observed in the study was Weber type B/supination external rotational injury, accounting for 40-75% of all ankle fractures. Given the incidence of ankle fractures, podiatric surgeons must be proficient in both the diagnosis and treatment of all types of ankle fractures. With ankle fractures that require surgical intervention, the surgeon must be able to provide the proper indications, appropriate fixation construct, and understand the possible complications and risks of each treatment option. The purpose of the article is to discuss the types of internal fixation available for distal fibula fractures, specifically in Weber type B/supination external rotation type fractures. This article will also explore the biomechanical comparisons involved in these distal fibula internal fixation techniques, the complications observed with each type of internal fixation, and its specific role in stability construct in patients with osteoporotic bone.

INTERNAL FIXATION TYPES

Since the first report of rigid plate fixation performed by German surgeon Dr. Carl Hansmann in 1886 and then the introduction of the principle of axial compression of fractured ends by Dr. Robert Danis in 1949, methods of internal fixation of fractured bones have improved patient outcomes and the osteosynthesis of fractures. In order to provide osteosynthesis, hardware such as a plate must allow for a stable construct through 1 of 5 functions: compression, neutralization, buttress, tension band, and bridging. Currently, there are numerous types of plates that allow surgeons to achieve proper fixation. However, it is important to understand that the surgeon, not the plate’s design determines how the plate will function.

Types of internal fixation provided for ankle fractures are dependent on the mechanism of injury as well as the specific pattern of injury. The Lauge-Hansen classification for ankle fractures is currently the best-known classification for treatment and outcome assessment. It essentially allows the surgeon to understand the rotational mechanism of the injury for appropriate treatment. As previously mentioned, a Weber type B/supination external rotational injury is the most common type of rotational ankle fracture observed. In this type of injury, there is a spiral oblique fracture of the distal fibula that begins at the level of the ankle joint, allowing the fibula to glide posteriorly and superiorly, thereby shortening the length of the fibula. By understanding this specific mechanism of injury, an anti-glide or a posterior plate can be applied for proper fixation, which can prevent the displacement of the fracture fragment and stabilize the fracture (Figure 1). In posterior plating, the plate may be applied with a small bend of 5-10 degrees to assist with the anterior advancement of the distal fragment, as well as to aid in the rotary stability of the distal fragment. To reduce the fracture, a trick screw (first screw, Figure 1) can be applied in the hole just proximal to the fracture site. The goal of the trick screw is to cause a spring effect between the plate and the concave portion of the posterior surface of the fibula, which in turn will reduce the fracture. Then by inserting the distal screws directed postero-inferiorly to antero-superiorly, appropriate compression can be obtained for fracture stability.

Posterior anti-gliding and lateral neutralizing plating are two types of fixation that can be implemented for the treatment of Weber type B/supination external rotation type ankle fracture. Both of these fixation types have several advantages and disadvantages that can be taken into consideration prior to its application. Posterior anti-glide plates act to prevent the displacement or posteroinferior gliding of the distal fragment, thereby stabilizing the fracture. Therefore, in theory, posterior plating is more biomechanically stable than the lateral plating, since the lateral plate alone simply neutralizes the fracture and does not necessarily prevent the posterior-superior displacement of the distal fibula. Given the biomechanical stability of the fixation, anti-glide plating may be advocated in osteoporotic bone. Since the plate is applied posteriorly, the hardware is less prominent in comparison to the lateral plating and therefore less skin irritating. The posterior plating also reduces the risk of ankle joint violation, while in the lateral plating, the distal screws can violate the lateral gutter of the ankle joint.
There are reported complications for posterior plating including peroneal tendinopathy requiring hardware removal. As reported by Weber and Kraus (2), given the location of the plate and the anatomic route of the peroneal tendons, there is a risk of peroneal tendinopathy with posterior plating. They observed an incidence rate for peroneal tendinopathy of 43%, which required hardware removal. Most other studies have reported lower incidence rates of peroneal tendinopathy. Kilian et al (3), observed the frequency of complications in lateral and posterior plate fixation. In regard to hardware, removal was performed in symptomatic patients due to hardware irritation. Hardware was removed in 45% of the anti-glide group, in comparison to 79.2% in the lateral plate group. Peroneal tendinopathy was not observed in either group in the study. Ahn et al (4), observed the incidence of peroneal tendinopathy in posterior anti-glide plating, in which they observed that although hardware removal due to hardware-related discomfort was high at 58.57%, intra-operatively, none of the patients showed gross evidence of tendinopathy. Three patients clinically showed subjective evidence of peroneal tendonitis as reported by pain.

All these findings show that although peroneal tendinopathy is of concern when it comes to posterior anti-glide plate, evidence suggests that the incidence rate is low in comparison to findings suggested by Weber and Kraus. It has been proposed, to avoid placement of screws distal to the fracture, for they are not mechanically needed for the fixation construct and may increase the rate of peroneal tendinopathy.

When choosing a type of fixation, several factors are considered, one being biomechanical stability of a certain fixation construct. As mentioned previously, the posterior plate provides better biomechanical stability since the plate in itself will prevent the posterior-superior displacement of the distal fibula. Schaffer et al (5), studied the biomechanical comparison of the anti-glide with the lateral plate for distal fibular fixation. They measured the torque required to produce the fracture, which was then used to compare the torque required to disrupt the hardware in both fixation groups. The study revealed that lateral plate fixation failed when the torque met an average of 64.3% of torque required to produce the fracture while the posterior plate fixation failed when the torque met an average of 77.2% of torque required to produce the fracture. This showed that the posterior plate fixation construct required greater force to reproduce the fracture, thereby showing that it has a greater biomechanical stability than the lateral plate. Given this finding, it seems that the fixation construct that is biomechanically more stable should be used in patient demographics that require more biomechanical stability, such as in osteoporotic bones. A vast majority of the increased biomechanical stability comes from the orientation of the plate to the fracture line. The posterior anti-glide plate allows the proximal screw’s pull-out strength to be directly propionate to the torque needed for construct failure. When combined with the natural fact that osteoporotic bone is first affected in spongy bone, it is clear posterior anti-glide plates would have additional biomechanical strength rather than the distal uni-cortical screws in the lateral plate construct, which are dependent on spongy bone.

Osteoporosis is a factor that must be taken into consideration when choosing a fixation construct. Patients with osteoporosis, such as the elderly, require a longer
period of time for osteosynthesis, and a stable fixation construct to achieve fusion. With an ever-increasing elderly population and their increased activity level, ankle fractures are commonly seen in this population. According to Kannus et al (6), ankle fracture in the elderly increased by 3-fold, in comparison to the healthy adult population. Osteosynthesis in osteoporotic bone is a challenge due to difficulty in obtaining proper cortical purchase for stability of the distal fragment. Therefore, a fixation construct that is biomechanically stable is crucial. There have been many studies that compared the conventional lateral plate to a locking lateral plate and locking lateral plate to posterior anti-glide plate. A study performed by Switaj et al (7), looked at the biomechanical properties between modern locked plating and anti-glide plating in osteoporotic distal fibular fractures. In a total of 16 ankles, it showed that the lateral locking plate group had higher torque to failure and higher construct stiffness than the anti-glide plate. Minihane et al (8), looked at similar properties in their study but did not show similar result. In their study, the anti-glide plate method had higher mean torque to failure and construct stiffness. These studies show that there are conflicting results in regards to lateral locking plate and posterior anti-glide plate.

A meta-analysis performed by Schepers and Dingemans (9) included 13 articles that reviewed which of the 3 fixation constructs had the best biomechanical properties. They measured rotational stiffness and torque to failure in these 3 types of fixation constructs. There was no statistically significant difference between locking and conventional lateral plating in regard to torque to failure or torsional stiffness. The locking plate is independent of bone mineral density and therefore may be more suitable for fixation of osteoporotic bones. In the analysis, the anti-glide group showed higher torsional stiffness and torque to failure in comparison to both conventional and locking lateral plates. The meta-analysis showed that posterior anti-glide plate was more biomechanically stable.

Ankle fracture is a common injury that may require appropriate fixation for proper healing. There are a number of ways to provide stable fixation when it comes to hardware placement, such as lateral plating and posterior plating. When choosing a certain type of fixation, the surgeon chooses the fixation construct not solely based on preference but based on the mechanism of injury, anatomical alignment, risk factors, and biomechanical stability of certain fixation construct. Complications of the anti-glide plate, such as peroneal tendinopathy seem to be less prevalent than previously reported. In conclusion, studies show that posterior plating of the distal fibula seems to be the best choice of fixation given the biomechanical stability in comparison to the lateral plating for supination external rotation type fractures.

REFERENCES

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