

Opening Wedge and Anatomic-Specific Plates in Foot and Ankle Applications

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KEYWORDS

• Anatomic • Plate • Fixation • Wedge • Contoured • Locking

As surgeons continually push to improve techniques and outcomes, anatomic-specific and procedure-specific fixation options are becoming increasingly available. The unique size, shape, and function of the foot provide an ideal framework for the use of anatomic-specific plates. These distinctive plate characteristics range from anatomic contouring and screw placements to incorporated step-offs and wedges. By optimizing support, compression, and stabilization, patients may return to weight bearing and activity sooner, improving outcomes. This article discusses anatomic-specific plates and their use in forefoot and rearfoot surgical procedures.

ANATOMY

The musculoskeletal anatomy of the foot is comprised of unique structures and relationships that are distinctive from anywhere else in the human body. The foot is complex in its makeup and function. The joints and bones of the foot not only provide for motion but also provide the framework required for human bipedal gait. The intricate interplay of these structures allows the motion for propulsion but at the same time provides the stability to remain upright. During normal gait the foot must be able to withstand a force that is 1.2 times that of body weight with each step and 3 times that of the body weight while running.¹

The shapes of the osseous structures that make up the human foot and ankle are unique. Foremost is the stable makeup of the medial longitudinal, lateral longitudinal, and transverse tarsal arches of the foot. Metatarsals are long bones each composed of unique articular shapes and surfaces. The bases of the metatarsal bones are mainly rectangular in appearance and articulate with the tarsal bones proximally, but with

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limited motion. These relationships are important in providing the shape, and therefore the stability, of the arches of the foot. The hind foot is comprised of the talus and calcaneus, with the articulation of these 2 bones allowing for the coupled triplanar motions of pronation and supination. The talus with its unique shape is almost completely covered in cartilage. This shape provides distinct articulations with the adjacent bones at the corresponding talo-calcaneal, tibial-talar, and talar-navicular joints; allowing for complex foot and ankle motion. The calcaneus provides stability and shape to the hind foot and has specialized osseous characteristics of a thin cortical outside shell and a soft cancellous filling.

These distinct anatomic features and complex interactions require special attention when addressing surgical correction of deformities and fractures. The importance of rigid internal fixation has been established as the standard in osseous surgery of the foot. However, applying this fixation to the anatomic constraints of the foot can be difficult. Historically, fixation devices that have been designed for other areas of the body have been used in the foot and altered as necessary to provide fixation. This procedure often requires additional operating room time, spent modifying and contouring traditional fixation. Bending plates to match the anatomy may not be ideal. Without proper contour, the plate does not allow for optimal compression in traditional fixation and may lead to suboptimal results. The goals to minimize morbidity, provide a stable mechanical alignment of the extremity and anatomic restoration of articular surfaces to maximize functional recovery have not changed, but advances in design and a better understanding of the biology of bone healing have provided new technology to better achieve these goals.

One of the major sources of morbidity associated with surgical procedures of the foot is the relatively prolonged course of nonweight bearing and the comorbidities that are often associated with this. Traditional fixation and plating systems have been designed to provide absolute stability by means of anatomic reduction and rigid internal fixation. The structural function of the bone is maintained in this situation and the major portion of the biomechanical loads remains with the bone.² The function of traditional plates and internal fixation in this instance is to provide compression, maintain reduction, and allow for primary bone healing. Traditional plating is typically not the main load-bearing element but more load-sharing. Because of this situation, weight bearing and loading of the surgery site are generally delayed until sufficient healing of bone has occurred, giving rise to a prolonged period of immobilization.³ However, relative stability can be obtained by using an implant to bridge a fracture area while maintaining the anatomic axis, length, and rotation of the bone until consolidation has occurred. Healing is accomplished by callus or secondary bone healing. Locked plating technology is often utilized in this manner. Locked plates can be thought of as internal external fixators and are mainly load-bearing elements.⁴ This technique produces stability and the potential to allow for earlier weight bearing, since the plate bears the load in the instance.

Numerous studies have supported the improved fixation behavior of locking plate technology compared with conventional plate fixation. Studies have shown favorable outcomes with locking plates, in particular when dealing with poor bone quality. Strength, number of cycles to failure, and displacement are all improved.³⁻⁷ New plate designs now allow for locking screws to be placed at variable angles within the plate, facilitating better bone purchase, or better anatomic positioning of screws (**Fig. 1**).

Anatomic plates for the foot have been designed to account for the unique structure and also for some of the specific requirements needed to correct the various deformities of the foot. This situation has undoubtedly led to improved techniques and outcomes. These plates also aim to optimize fixation to achieve maximum stability or provide relative stability and possible earlier load bearing. Anatomic-shaped locking

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