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WEIGHT BEARING CT PRE-OPERATIVE PLANNING

3D PRINTING CUSTOM SURGICAL GUIDES

Arthrosis in Younger Patients: A Common But Challenging Problem

The mental and physical disability associated with end-stage ankle arthrosis is at least as severe as that associated with end-stage hip arthrosis (Glazebrook 2008). Osteo-arthritis typically develops in younger patients as a post-traumatic symptom. In 60 percent of cases, it presents as asymmetrical wear of the tibio-talar joint (Witteveen 2013). Younger patients with mild to moderate osteoarthritis may elect to avoid total ankle replacement or joint fusion as a treatment option (Krahenbuhl 2017) and instead consider realignment surgery.

The aim of realignment surgery is to shift the load away from more degenerated parts of the joint and unload the lateral component in valgus angles. Realignment surgery restores joint biomechanics, slows down the degenerative process, decreases pain and improves function.

A New Continuum of Care

Conventional pre-operative planning with 2D radiographs may not provide adequate information to fully appreciate the complexity of 3D deformity, particularly with regards to rotational malalignment. Recent advancements allow accurate 3D evaluation, and rapid prototyping technology allows development of patient-specific guides and implants (Byrne 2017).

Technological advancements enable 3D Labs to be hospital based, meaning the entire process from scan to printed custom guide can be done on site.

Computer simulation software is used to generate 3D virtual models.

Rotational and translational displacement are calculated by super-imposing affected bone onto a mirror image of the normal side.

Virtual osteotomies are simulated to produce a precise correction and optimal plate position.

Custom-made guides with guided drill holes and osteotomy cutting slots are designed via commercial software.

Custom guides are 3D printed as medical grade polyamide models and sterilized prior to surgery.

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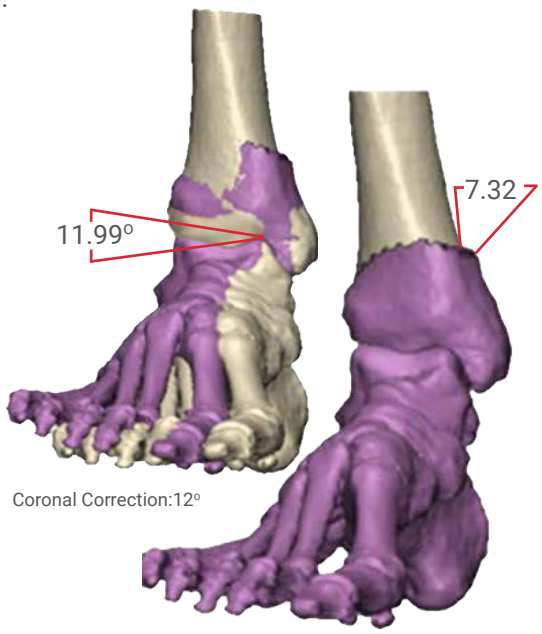
Case Study: Dome Osteotomy

Patient presented with instability in the ankle joint due to ligamentous laxity and a complex cavo-varus deformity with congruent varus deformity in the ankle joint. In addition, the patient's scan revealed a congenital varus at the calcaneal tuberosity and a rounded subtalar joint. During a Coleman Block Test, the patient exhibited a steep, stiff first ray. I performed a dome osteotomy to correct the center of rotation deformity (CORA) at the ankle joint, as well as an additional dorsiflexion osteotomy on the first ray to compensate for the devarisation of the ankle.



These cases tend not to be reproducible and difficult to operate on. However, with bilateral weight bearing CT imaging, my team was able to calculate the required correction using the healthy contralateral side. We loaded the scan into planning software that allowed us to build reference points and perform a virtual osteotomy. We then designed two pre-operative guides – one that could be used to guide the osteotomy and a second to attach the fixation once the anatomy was in the reduced position.

We created the guides using a 3D printer operated by the Maxillofacial Department of the hospital onto a sterile 3D model of the patient's ankle. The guides were used during surgery.

Post-Operative Evaluation

Post-operative scans showed the patient was well balanced, and he reported he was pain-free.

Pre-operative (left) and post-operative (right) comparison using weight bearing CT imaging to assess hindfoot alignment.

Sagittal and coronal views of the dorsiflexion osteotomy acquired via weight bearing CT imaging.

3D Printed Cutting Guide

3D Printed Reduction Guide

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