Stable nailing of bones using circular arc drills and arcuate nails, a considerable improvement in orthopaedic surgery

The operative treatment of fractures has revolutionized orthopaedic surgery and traumatology during last century. It has been demonstrated that immediate internal fixation of bone fragments of a fracture or of a destroyed joint to achieve fusion (so-called arthrodesis) may allow for undisturbed biological healing. Actually the amount of callus produced by nature to achieve sound stabilization is related to the interfragmentary motion. This means that immediate stable fixation of a fracture or arthrodesis does not produce relevant callus. Unfortunately, nature does not fix automatically the injured or diseased limb in an anatomical and functional alignment. In many cases, and with poor fixation means, callus formation is insufficient to stabilize the fragments and non-union ensues.

Fig. 1. Instrumentation designed to create a circular arc bore hole.

Stabilizing the hindfoot by fusing the bones from the lower leg to the heel in anatomical alignment allowing for weight bearing is a technical challenge. Normal anatomy demonstrates alignment of the heel, the subtalar joint facet, the talus, the ankle joint and the distal tibia on a circular arc. This arc lies on a vertical plane which is slightly angulated inwards in relation to the sagittal plane. Today’s available bone nails which are used in surgery are either straight or bent. Those implants thus do not respect the normal alignment of the hindfoot. Using straight or bent nails may cause plantar neuropraxia, hold poorly and tend to create a misaligned hindfoot varus. Orthopaedic surgeons often fear this kind of fusion and consider “never one operation in my experience”. Purpose of the study is to optimize the technique to stabilize the hindfoot in anatomical alignment.

A preliminary trial using 15 cadaveric feet was performed to find the optimal shape of a central hindfoot nail. An instrumentation was designed to *create a circular arc bore hole* (Fig. 1) crossing

the heel, the posterior subtalar joint facet, the tibio-talar joint and the distal tibia metaphysis. During the operation, the desired definitive position of the hindfoot is fixed temporarily with Kirschner wires. A guiding frame is fixed to three critical spots of the hindfoot to drill the central hole. Using an image amplifier the hole is bored using a motor driven end cutting flexible reamer which is seated within a rigid curved hull. The nail has the same shape than the hull and is impacted up to the distal tibia. A distal locking screw crossing the subtalar joint and a proximal locking screw within the tibia concludes the central fixation. 18 patients have been treated so far using this technique.

In vitro trials demonstrated an excellent spontaneous stability of the hindfoot after introduction of the nail. The pathology of the operated patients include post-traumatic, congenital and metabolic (diabetes) conditions. The mean follow-up is 12 months. We did observe 3 ruptures of the tibial locking screw which allowed for more spontaneous impaction. All cases went to *consolidation* without malunion or other complications (Fig. 2). One diabetic patient developed a stable pseudarthrosis at the midfoot joints. All patients were treated for 2 weeks post-op with a closed circular cast without weight bearing. After 2 weeks our patients did practise partial weight bearing using a cam walker for 6 other weeks.

Fig. 2. Consolidation without malunion or other complications 6 weeks post-operative.

Fusing the bones of the hindfoot by tibio-talo-calcaneal arthrodesis can be successful using a central circular arc shaped nail respecting form fit function within the bones. The anatomical bony alignment of the hindfoot is corrected or preserved. Due to the safe approaches, the technique may prevent shortcomings such as neurological complications and non-unions. We expect a shorter period between surgical fixation and full weight bearing.

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