Can modification of the Weil osteotomy reduce the risk of dorsiflexion contracture? - A biomechanical cadaveric analysis

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Disclosures

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  – None

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  – None

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  – None
Introduction

Background

• The Weil osteotomy is proven to be very successful in the management of metatarsalgia and toe deformity.
• It is an oblique osteotomy of the distal metatarsal neck and shaft that is as parallel to the ground as possible. The aim is to achieve controlled shortening whilst avoiding plantarflexion.
• Recognised complications of the Weil osteotomy include a ‘floating toe’ in up to 20% or more of cases\(^1,2\).

Aim

• To investigate whether modification of the Weil osteotomy can avoid the metatarsal head plantarflexion and subsequent dorsal subluxation of the interosseous muscle that is implicated in the development of a ‘floating toe’.
The ‘Floating toe’

- The ‘floating toe’ complication is a dorsiflexion contracture of toe associated with stiffness and in particular loss of plantarflexion.

- Trnka\(^2\) showed that it was not possible to avoid plantarflexion of the metatarsal head due to the angle of the osteotomy.
Altered Biomechanics after a Weil

- In normal toes the centre of rotation of the metatarsal head is in line with the interosseous muscle.

- Trnka et al. showed that in contracted toes the interosseous muscle is dorsal to this and therefore it acts as an MTP dorsiflexor.

- They also showed that after a Weil osteotomy the interosseous muscle remains dorsal to MTP CORA due to the plantarflexion of the metatarsal head.

Trnka et al. Foot Ankle Int, 1: 47-50, 2001
Study Design

Methodology

• The 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} rays were dissected out en bloc with all tendons attached from 6 pairs of fresh frozen cadavers.

• The ray was fixed to a board and the tendons balanced using traction via low-friction pulleys and light weights. This model is highly sensitive to alterations in moment arm of the tendons. Once the MTP joint was balanced these weights were not altered.
Study Design

Methodology

• After standard release of the dorsal capsule a Maceira or ‘triple-cut’ osteotomy was performed.

• This osteotomy was developed in order to permit shortening without plantar flexion of the metatarsal head.

• The osteotomy was performed using an image intensifier in order to maintain uniformity of the osteotomy cut. The neck was shortened by removing a 2mm slice of bone made with parallel cuts.

• The osteotomy was then fixed using a K wire cut flush in place of a screw.

• The ray was photographed and x-rayed pre and post ‘surgery’ and the relationships of the interosseous tendon and head, tendon balance and toe posture were recorded.
Results

• The Maceira osteotomy can avoid plantarflexion of the metatarsal head.

• The line of pull of the interosseous tendon (marked with a horizontal K wire in Fig A) maintains it’s normal relationship with the centre of rotation of the metatarsal head.

• None of the toes developed dorsiflexion at the MTP joint. In fact, plantarflexion at the MTP joint was seen in (Fig B).

• PIP ‘fusion’ using a K wire across the PIP and DIP joints resulted in dorsiflexion at the MTP joint.
Discussion

• The Maceira osteotomy can avoid the muscle imbalances that can lead to a ‘floating toe’ by avoiding:
  – plantarflexion of the metatarsal head
  – and dorsal subluxation of the interosseous tendon in relation to the metatarsal head.

• In fact the MTP could be seen to plantarflex at the MTP joint. This is likely to be due to the greater effect that metatarsal shortening has on the intrinsic muscles than the extrinsics due to the significant difference in their relative lengths.

• It does not alter the problems resulting from dorsal soft tissue contracture and plantar plate insufficiency and these need to be addressed separately irrespective of the osteotomy-type performed.

• PIP fusion alters the balance between intrinsics and extrinsics increasing the MTP dorsiflexion.
References

1. O’Kane C, Kilmartin TE. The surgical management of central metatarsalgia. Foot Ankle Int 23(5); 415-420, 2002

2. Trnka H-J, Nyska M, Parks BG, Myerson MS. Dorsiflexion contracture after the Weil osteotomy: Results of cadaver study and three dimensional analysis. Foot Ankle Int, 22: 47-51, 2001