



Comparison of Three-Dimensional Displacement Among Different Metatarsal Osteotomies

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KEYWORDS

• Hallux valgus • Three-dimensional displacement • Metatarsal osteotomy

KEY POINTS

- Metatarsal deformity of hallux valgus is a three-dimensional deformity including rotation in coronal plane.
- Theoretically, it is important to understand three-dimensional displacement of the first metatarsal and correct all of the deformities in three dimensions.
- Current methods of metatarsal osteotomy principally try to correct the transverse plane deformity while preserving metatarsal length and avoiding sagittal plane displacement.

INTRODUCTION

Hallux valgus (HV) is a slowly progressing complex three-dimensional biomechanical process. The vertical and horizontal components have been widely explored and are routinely taken into account in the various procedures of surgical correction; the frontal rotation component, in contrast, has been generally overlooked except in a few studies.¹⁻³ Only pronation of the hallux has been commonly addressed as a common finding in HV. Uniplanar correction on the anteroposterior view of foot would be insufficient, and rotation on frontal plane as well as sagittal alignment should also be well corrected. However, current surgical methods have been developed based on the correction of horizontal plane deformity, which would be inadequate to correct three-dimensional deformity.^{4,5} Each metatarsal osteotomy has a different ability to correct the deformity in different planes.

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THREE-DIMENSIONAL ASSESSMENT OF HALLUX VALGUS DEFORMITY

Weakening of medial soft tissues of the first metatarsophalangeal joint and erosion of the plantar ridge of the metatarsal head between the medial and lateral sesamoids occur early in the progression of HV.

The proximal phalanx drifts into valgus, and the metatarsal head deviates medially as the soft tissues on the medial side become attenuated. Medial deviation of the metatarsal head gives rise to the apparent prominence of the metatarsal head, and a longitudinal groove appears on the medial aspect of the articular cartilage in the metatarsal head.

As the metatarsal head moves medially, the medial sesamoid lies under the eroded metatarsal ridge, so that the lateral sesamoid articulates with the lateral side of the metatarsal head in the first intermetatarsal space.^{6,7}

SURGICAL TREATMENT OF HALLUX VALGUS

Surgical options for HV deformity can be classified into metatarsal osteotomy and arthrodesis. Osteotomy may be undertaken proximally or distally. Proximal osteotomies allow a greater correction of the increased intermetatarsal angle than distal osteotomies, which are usually used for mild or moderate deformities. In recent years, diaphyseal osteotomies such as the scarf and Ludloff procedures also have become popular.

On the other hand, the first metatarsophalangeal joint arthrodesis has been used for end-stage osteoarthritis or rheumatoid arthritis patients. The first tarsometatarsal arthrodesis is gaining popularity, because it can correct the intermetatarsal angle or pronation of the first metatarsal bone at its origin. There have been many reports about the outcome of Lapidus surgery. However, controversy over the effective correction of alignment and its maintenance still persists.

Three-Dimensional Consideration for Metatarsal Correction of Hallux Valgus

The procedure should be versatile so that the HVA, the IMA, and the DMAA can be corrected. The procedure should correct the rotation of metatarsal bone in coronal plane, aiming the reduction of the sesamoid bones at the same time. The length of the first metatarsal should be maintained to prevent the development of transfer lesions and metatarsalgia. The dorsiflexion malunion, with the resultant elevation of the metatarsal head, should be avoided. The more complex the shape of the osteotomy line, the stronger fixation stability of 2 fragments. The one with osteotomy taken parallel to the coronal plane has advantages on correction of rotation, but with less fixation stability. The wider contact area provides the lesser possibility of dorsal malunion.

COMPARISON OF THREE-DIMENSIONAL DISPLACEMENT AMONG DIFFERENT METATARSAL OSTEOTOMIES

Distal Metatarsal Osteotomies

Wilson osteotomy, Mitchell osteotomy, and distal chevron osteotomy are typical distal metatarsal osteotomies (Fig. 1). Correction after these 3 osteotomies mainly depends on lateral translation of the distal fragment. These osteotomies allow only minimal rotation.^{8,9}

The Wilson procedure

This is an oblique metaphyseal osteotomy from distal medial to proximal lateral, allowing displacement of the metatarsal head laterally and proximally. HV deformity was corrected by lateral translation and angulation of the distal fragment; however,

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