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Effect of Mechanical Axis Correction on Outcomes of Hallux Valgus Surgery

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ABSTRACT

A new method of mechanical axis planning has recently been suggested to aid in corrective surgery for hallux valgus (HV) deformity, which aims to identify the ideal position for the first metatarsal after correction. We investigated the influence of the mechanical axis angle (MAA) correction on the outcomes of corrective HV surgery. We reviewed 50 radiographs to identify the "normal" MAA range within the population. We also reviewed the medical records of 100 patients who had undergone scarf osteotomy at our institution from January 2011 to December 2013. These patients were segregated into 2 groups according to their postoperative MAA: those within the normal range (normal group) and those outside this range (outlier group). We compared the pre- and postoperative functional scores between the 2 groups using statistical analysis. The normal MAA range within our population was 12.5° ± 0.8° (range 11.0° to 14.3°). We found that the physical component summary score of the short-form 36-item health survey was significantly poorer for the outlier group at 6 and 24 months postoperatively compared with the normal group, although the other postoperative scores were comparable. Surgical correction of the MAA to the normal range of the patient population can be recommended because it provides improved quality of life. However, further studies are required to investigate the influence of MAA planning on other standardized foot and ankle scores.

Hallux valgus (HV) deformity is the most common pathology affecting the first ray, with an estimated incidence of 30% of adults with HV deformity from epidemiologic studies (1). HV deformity is often complicated by pain and can progress despite conservative management (2) and, thus, is a common reason for visiting a foot and ankle specialist.

More than 150 different techniques and >100 first metatarsal osteotomy procedures have been described for the surgical treatment of hallux abducto valgus deformity. However, it has been historically accepted that for mild to moderate hallux abducto valgus deformity, distal osteotomies of the first metatarsal and the modified McBride procedure should be performed. For more severe deformities, more proximal first metatarsal osteotomies have been recommended (3). Determining the severity of HV deformity involves measurement of the intermetatarsal angle (IMA), also known as the M1–M2 anatomic axis angle, which is formed by bisecting the first and second metatarsal shafts.

The IMA has been the most-often used measure to choose the correct surgical procedure; however, the final position of the first metatarsal has varied among foot and ankle surgeons, with the postoperative position ranging from 0° to 12°. Recently, LaPorta et al (4) described the M1–M2 mechanical axis angle (MAA), seeking to provide foot and ankle surgeons with a simpler method for preoperative planning. They reported that using the MAA would allow surgeons to determine the amount of angular and translational correction necessary for the surgical procedure of their choice. They concluded that correction of the HV deformity to a normal value of 11° would result in restoration of the mechanical axis of the medial column and thus correction of the deformity. However, they did not investigate if restoration of the MAA to normal value correlated with functional outcome and quality of life after HV surgery (4).

The lack of studies reporting the effect of the MAA on the outcomes after HV surgery inspired us to evaluate the normal MAA in

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our population, whether this value will vary across different populations, and the influence of a normal MAA versus otherwise on the functional outcome and quality of life.

We hypothesized that correction of the M1–M2 MAA toward the norm (i.e., correction toward the MAA found in unaffected patients) would result in better postoperative outcomes. Such a finding would support its use in preoperative radiographic evaluation and planning for HV deformity surgery.

Patients and Methods

The hospital's ethic committee (central institutional review board approval no. 2015/2107) approved the present study, which was performed in accordance with the ethical standards from the 1964 Declaration of Helsinki. All the patients provided informed consent.

From January 2011 to December 2013, 100 female patients who had undergone scarf osteotomy and had postoperative weightbearing dorsoplantar (DP) radiographs of the affected foot available were included in the present study. Our indications for surgery were pain and deformity, and the goals of surgery were relief of pain and correction of the deformity. Those patients who smoked or had preexisting peripheral vascular disease were excluded from the present study. Patients with a diagnosis of rheumatoid arthritis or hallux rigidus and those who had undergone revision surgery for recurrent symptomatic HV were also excluded from the present study.

Weightbearing DP radiographs of the affected foot were performed with the patient standing on both feet with the knees in full extension. The X-ray beam was inclined 20° from the vertical in the sagittal plane at a distance of 100 cm. The direction of the X-ray beam was vertical to the cassette in the coronal plane and centered onto the third metatarsal.

A single assessor (M.L.) performed all radiographic measurements for both groups of patients on computer-based digital radiographic films. The assessor was kept unaware of the clinical details and had not participated in the care of any of the patients. Evaluation of the HV angles using the picture archiving and communication systems has been shown to have excellent inter- and intraobserver agreement (5,6).

The HV mechanical axis was measured using the technique described by LaPorta et al (4). The definition of the mechanical axis used was that of a straight line connecting the joint centers of the proximal and distal joints and the anatomic axis as the middiaphyseal line (7).

Several points were determined on the weightbearing DP radiographs of the affected foot (Fig. 1). Point A was defined as the center of the proximal phalangeal base, point B as the center of the first metatarsal head, point C as the center of the second metatarsal phalangeal joint, and point D as the dorsal lateral proximal corner of the medial cuneiform. Two lines were drawn tangent to the curvature of the talar head and a line was then drawn perpendicular to each tangent line. The intersection of the 2 perpendicular lines was taken as the center of the talar head, defined as point E.

The mechanical axis of the medial column (talus, navicular, medial cuneiform, and first metatarsal) was represented by a line connecting the center of the talar head to the center of the base of the proximal phalanx (line EA). In a normal foot, this line would be parallel to the anatomic axis of the medial column (i.e., bisection of the first metatarsal shaft).

Another line was then drawn to connect the center of the talar head to the center of the second metatarsal phalangeal joint (line EC). Thus, the angle AEC represents the M1–M2 MAA.

In addition to the M1–M2 MAA, the pre- and postoperative HV angle (HVA) and IMA were determined by the same reviewer (M.L.) (Fig. 2). To improve the accuracy of measuring these angles, the reviewer (M.L.) used reference points on the first and second metatarsals and on the proximal phalanx of the hallux using a technique described by Coughlin et al (8). The HVA was subtended by lines bisecting the long axes of the first metatarsal and the proximal phalanx. The IMA, or M1–M2 anatomic axis angle, was subtended by lines bisecting the long axes of the first and second metatarsals.

A fellowship-trained foot and ankle surgeon performed all the surgeries. Two cannulated, self-tapping, headless compression screws were used to fix the metatarsal shaft scarf osteotomy cuts (9–11). The modified McBride soft tissue procedure was then performed, which involved release of the adductor hallucis from the base of the proximal phalanx of the big toe, release of the lateral sesamoid–phalangeal ligament, lateral capsulotomy, and medial capsular imbrication after excision of the bunion (12,13).

Under the same anesthesia setting, an Akin osteotomy was also performed for patients with associated HV interphalangeus. A staple was then used to fix the proximal phalanx medial closing wedge osteotomy. Similarly, Weil osteotomy of the lesser toes was also performed for patients with associated metatarsalgia. The osteotomy cuts were then fixed with cannulated, self-tapping, headless compression screws.

An independent healthcare professional (H.C.C.) reviewed the patients at 3 separate points: preoperatively and at 6 and 24 months postoperatively. Several outcome scores were recorded at each of these points, including the visual analog scale (VAS) for assessment of pain, the American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal (MT)–interphalangeal (IP) scale (AOFAS hallux MTP-IP scale), and the short-form 36-item health survey physical component summary (PCS) and mental component summary (MCS).

Fig. 1. Points A through E depicted on weightbearing dorsoplantar radiograph of a left foot. Line EA represents the mechanical axis of the medial column. The angle formed by the bisection of the mechanical axis of the medial column and second column (AEC) is described as the mechanical axis angle.

The VAS was scored from 0 to 10, with 0 indicating no pain and 10, the worst possible pain (14). It has been shown to have good validity and internal consistency when used as a measurement of pain.

The AOFAS hallux MTP-IP scale was scored from a total score of 100, with 40 points assigned to pain, 45 to function, and 15 to alignment (15). Thus, a full score of 100 points represents no pain, with a full range of MTP and IP motion, no MTP or IP instability, and good alignment. The AOFAS hallux MTP-IP scale has also been shown to have high reliability, validity, and responsiveness in clinical use (16,17).