Components of the Wilson Osteotomy That Are Effective on Hallux Valgus Repair

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Wilson osteotomy of the first metatarsal is a technically simple and reliable operation for the correction of the hallux valgus (HV) deformity. The major anatomic components of the osteotomy are the osteotomy angle and the distance of the osteotomy to the first metatarsophalangeal (MTP) joint. Lateralization of the first metatarsal head is the rationale for correction of the deformity. The main disadvantage of the technique is the considerable shortening of the first metatarsal. The relation between the amount of HV correction, first metatarsal shortening, and the anatomic parameters of the osteotomy was evaluated. Radiographs of 46 feet of 32 patients were retrospectively evaluated after an average follow-up period of 31.4 months. From the preoperative, early postoperative, and last control radiographs, the amount of HV correction, first metatarsal shortening, the osteotomy angle, the distance of the osteotomy to the first MTP joint, and lateralization of the first metatarsal head were measured. The presented study indicated that the osteotomy angle and the lateral displacement of the metatarsal head have a significant correlation with the amount of HV correction. Distance of the osteotomy to the first MTP joint has no relevance with the repair of the deformity. A positive linear correlation was present between the osteotomy angle and the first metatarsal shortening. Because the amount of first metatarsal shortening has significant influence over the clinical result, the main aim in a Wilson osteotomy should be maximum lateral displacement of the metatarsal head with a minimum osteotomy angle. (The Journal of Foot & Ankle Surgery 46(1):21–26, 2007)

Key words: hallux valgus, Wilson osteotomy, osteotomy angle, osteotomy distance, metatarsal shortening

Numerous surgical procedures have been described for the treatment of hallux valgus (HV). The goal of operative treatment is to offer relief of pain and permanent correction of the forefoot deformity, as well as a biomechanically functional forefoot (1). The Wilson metatarsal oblique osteotomy has been reported to be a reliable and satisfactory treatment by various reviewers (2–4). Its merits are minimal soft tissue damage, technical simplicity, and good correction of the deformity (5). The surgical technique was originally described in 1963 as an oblique osteotomy of the distal third of the first metatarsal. The osteotomy is at a 45° angle to the long axis of the first metatarsal. The distal fragment is then displaced laterally, the metatarsal is shortened, and the position is stabilized by placing the hallux into a position of overcorrection in a below-knee, non–weight-bearing cast (6). The osteotomy angle and osteotomy location with respect to the first metatarsophalangeal (MTP) joint are the major anatomic components of the osteotomy.

The Wilson osteotomy is an inherently unstable osteotomy (1, 3, 4). The original concept of this osteotomy did not include any type of internal stabilization; the operation therefore frequently necessitated prolonged plaster cast immobilization because of the lack of mechanical stability (1). The stability of the osteotomy is mainly dependent on the obliquity of the osteotomy, and 45° was described as the best angle for stability (6). During the evolution of the technique, many authors advocate internal fixation to maintain the stability and prevent the loss of correction (1, 7–9). Despite the improvements of the osteotomy stability with internal fixation, the osteotomy angle remained unchanged. This may be because of a conviction that osteotomy angle is efficacious on the correction of the HV deformity. However, the relevance between the osteotomy angle and the HV correction was not thoroughly evaluated. One of the major drawbacks of the Wilson procedure is the first metatarsal shortening, which was presumed to be related with obliquity of the osteotomy (3, 4, 7, 8). A high-angled osteotomy

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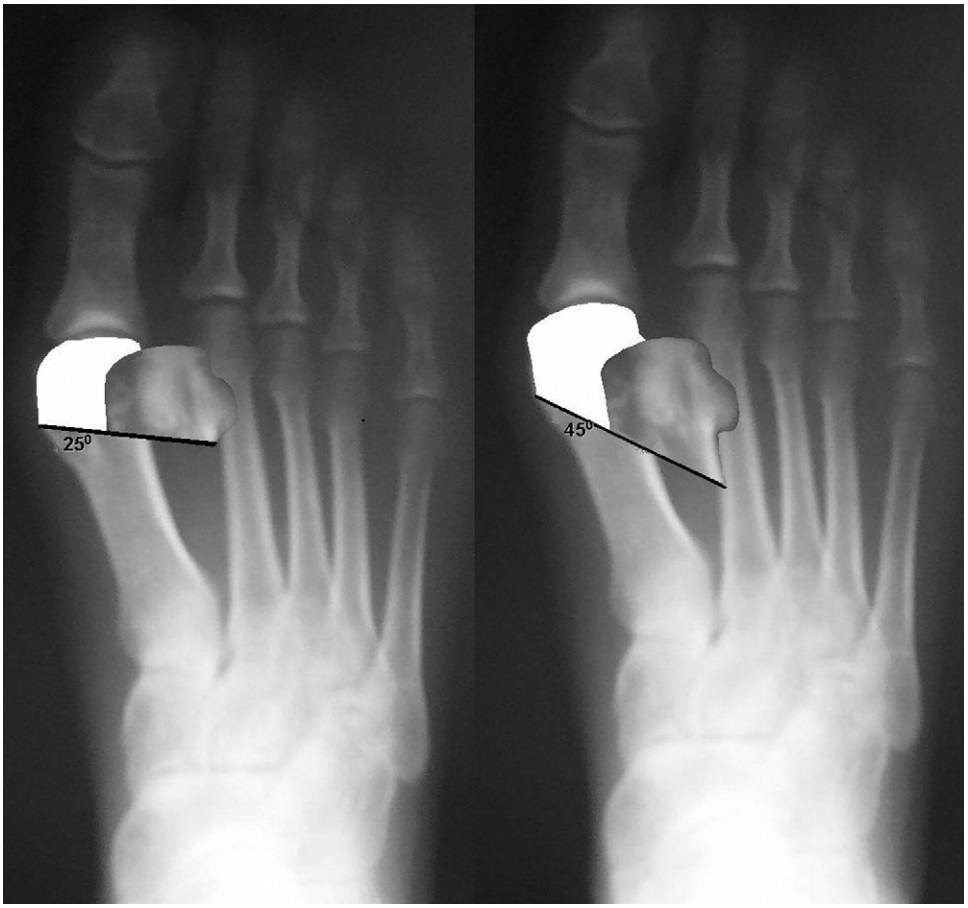

FIGURE 1 More shortening of the first metatarsal is obvious with a 45° osteotomy than with a 25° with the same amount of lateral displacement of the capital fragment in a simulated correction of the HV case.

might be a cause of excessive metatarsal shortening without having any additional benefit over the correction of the deformity. Thus, it is important to be informed of the significance of the osteotomy angle on the HV correction and the first metatarsal shortening.

Location of the osteotomy is another variable of the Wilson oblique osteotomy. An osteotomy placed too proximally was accused of insufficient correction (3, 4). On the contrary, osteotomies closer to the joint carry a risk for limited mobility of the first MTP joint because of dissection of the capsule and para-articular tissues that cause poor surgical result (1, 10, 11). However, it is not known whether there is any relatedness between the HV correction and the distance of the osteotomy to the first MTP joint.

Lateral displacement of the metatarsal head is the main rationale for correction of the deformity as in many distal metatarsal osteotomies (2, 3). The significance of the lateralization on the deformity correction is necessary for evaluating the success of the HV repair.

The aim of this study was to explore the effect of osteotomy angle, osteotomy distance to the first MTP joint, and lateral shifting of the metatarsal head on the success of the HV repair with the Wilson oblique distal metatarsal osteotomy.

Materials and Methods

From February 2001 to November 2004, the Wilson oblique osteotomy was performed on 46 feet in 32 patients. In all cases, the indication for operation was HV with a painful bunion and associated functional disability (ill-fitting shoes). According to the last radiographs obtained, the average follow-up time was 31.4 months, ranging from 14 to 51 months. Patients with hallux rigidus, arthrosis, and other diseases of the first MTP joint were not included in the study.

Thirty patients were women and 2 men; their average age was 51.3 years, ranging from 18 to 52 years. The preoperative duration of symptoms ranged from 6 months to 8 years (mean, 4.8 years).

The operations were performed while the patients were under general or regional anesthesia using a pneumatic high-thigh tourniquet. The neck of the first metatarsal bone was exposed through a 3- to 4-cm longitudinal dorsi-medial incision. An oblique osteotomy was performed with an oscillating saw commencing at 20° to 30° to the main axis of the bone, just proximal to the exostosis (1, 2, 7, 10). We have been performing the osteotomy more transverse than

the original description because stability of the osteotomy is not a concern because of the internal fixation (Fig 1). The distal fragment was shifted laterally as much as possible (2, 4), and the osteotomy was provisionally stabilized with a Kirschner wire that was placed perpendicular to the osteotomy line oriented from dorsal-proximal-medial to plantar-distal-lateral, extending to the most lateral aspect of the articular cartilage. A cannulated 2.7-mm cortical screw was used for permanent fixation with the guidance of the Kirschner wire. The provisional Kirschner wire was removed after screw fixation. The spike on the medial side of the proximal fragment was excised. A bunionectomy was performed only if there was still a medial prominence after maximum displacement.

The patients were immediately allowed to walk on the heel and the lateral side of the foot, depending on the comfort of the patient. Four weeks after the operation, anteroposterior (AP) and lateral roentgenogram was obtained. If no problem was detected, the patient was encouraged to walk normally.

The preoperative HV angles were measured from the weight-bearing AP views. The radiographs were made with the roentgen beam inclined 15° from the vertical at a distance of 100 cm. The osteotomy angle was measured from the early postoperative AP radiographs (obtained at the postoperative tenth day when it was possible for the patients to have weight-bearing radiographs) and defined as the angle formed between the osteotomy line and the line perpendicular to the metatarsal shaft. Osteotomy distance was measured from the middle of the first MTP joint (metatarsal articular surface) to the halfway point of the osteotomy line of the distal fragment (Fig 2).

At the last follow-up, HV angles were measured from the AP views. The first metatarsal axes, and thus the HV angles, were measured with a line drawn from the center of the first metatarsal head through the center of the base of the first metatarsal by the technique described by Miller (12). On the preoperative and last control AP radiographs, the distance from the center of the first metatarsal head to the midline of the second metatarsal shaft on a line vertical to the latter was measured. The difference of the measurements between the preoperative and the last control radiographs gave the lateral shifting of the first metatarsal head in millimeters (Fig 3) (5).

First metatarsal shortening was expressed as a percentage (relative shortening), and the apparent length of the second metatarsal was used as a control to eliminate errors resulting from different magnification or positioning between the preoperative and postoperative radiographs (9). To obtain an idea of the absolute amount of shortening, the relative amount was multiplied by the value for the preoperative length of the first metatarsal (11).

Multiple regression analysis was used to determine which of the variables (the amount of ostetotomy angle, distance of the osteotomy line to the first MTP joint, and the amount of lateral shifting of the metatarsal head) were most strongly correlated with the amount of HV correction. Pearson correlation coefficients were computed to examine the relationships between each of the anatomic variables and the amount of HV correction. The relation of the variables between each other and their individual relation to the metatarsal shortening was also investigated by Pearson correlation.

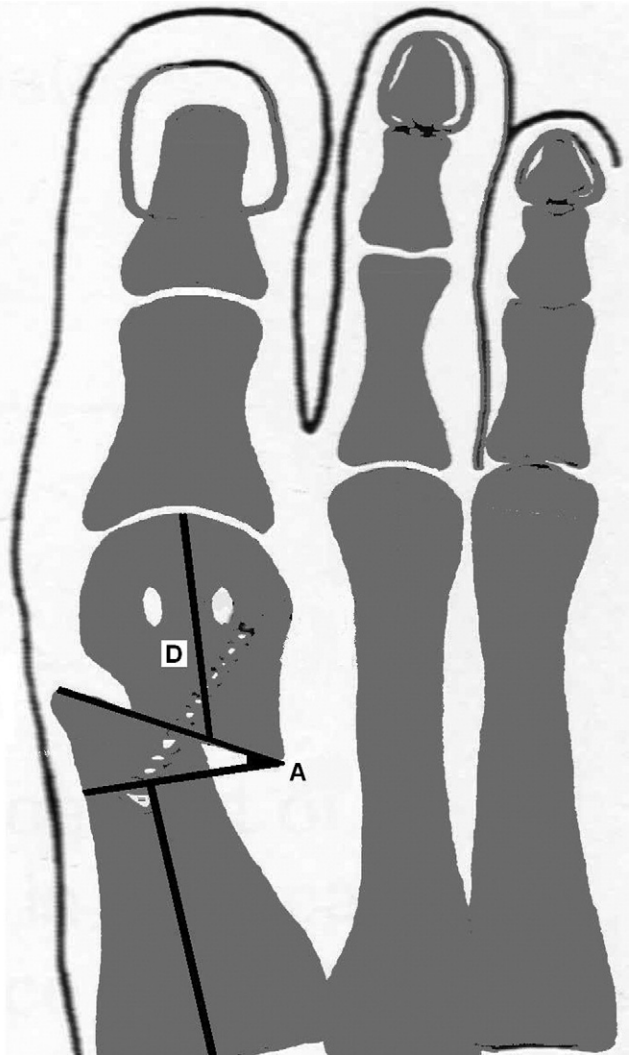

FIGURE 2 Measurement of the osteotomy angle and the distance of the osteotomy to the first MTP joint. A, osteotomy angle; D, distance of the osteotomy line to the first MTP joint.

Results

The average preoperative HV angle was 28.9°, the average postoperative HV angle was 8.9°, and the average angle correction was 20°.

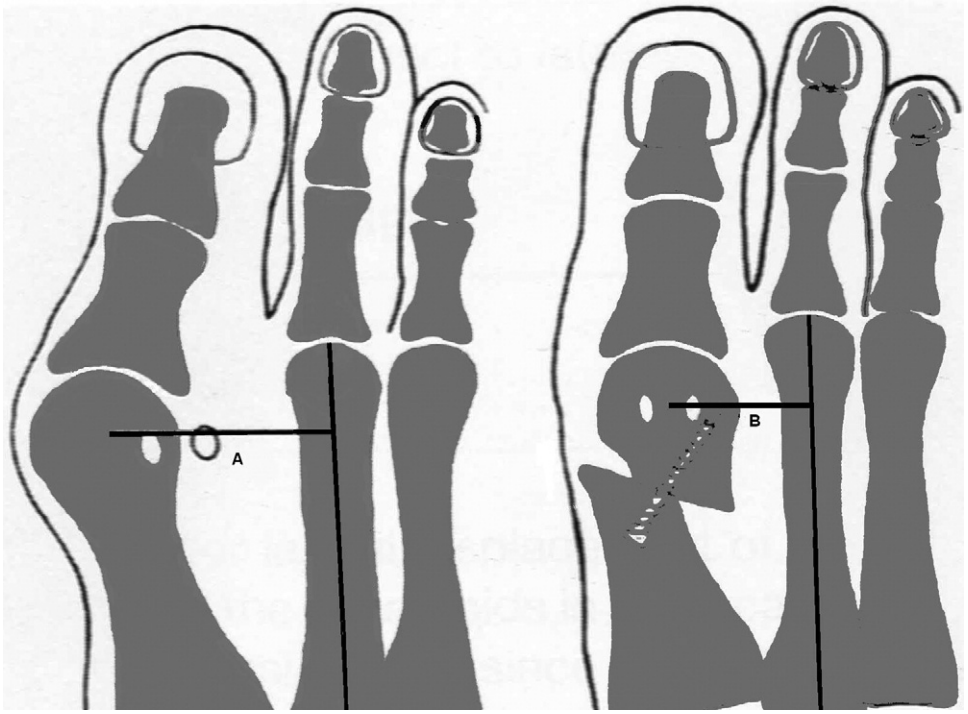

FIGURE 3 Measurement of the lateral shifting of the first metatarsal head. The difference of the preoperative (*A*) and the postoperative (*B*) measurements from the center of the first metatarsal head to the midline of the second metatarsal shaft.

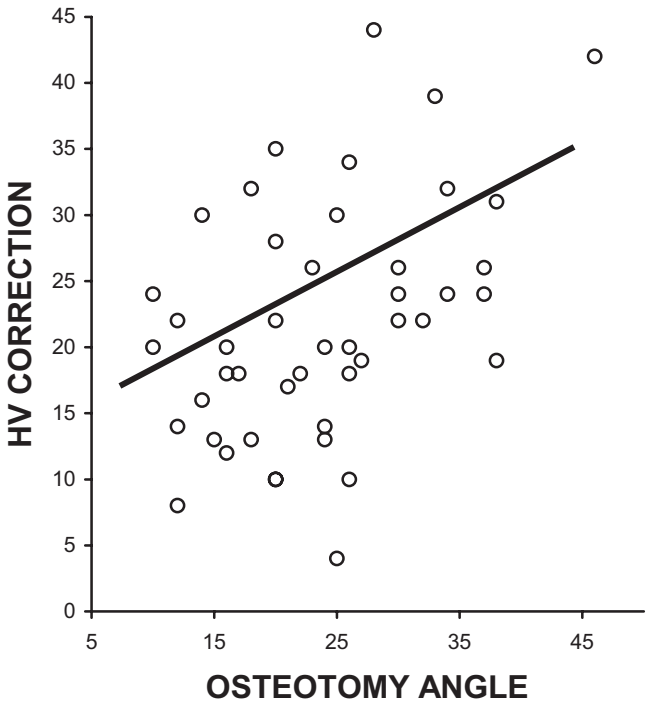

FIGURE 4 Graph demonstrating the relationship between the osteotomy angle and the amount of HV correction. The line generated by linear regression, HV correction = 0.4599 (osteotomy angle) + 10.95 ($r = 0.44$, $P < .01$), is shown.

The average osteotomy angle was 22.5° (range, 10°–34°), and the average distance of the osteotomy line to the first MTP joint was 20.2 mm (range, 17–25 mm). The mean lateral shifting of the metatarsal head was 8.6 mm (range, 1–17 mm). The average metatarsal shortening in percentage was 5.2% (range, 1%–12%) and 5.1 mm (range, 1–11.5 mm) in absolute measurement.

Among the investigated variables, osteotomy angle was found to be the most significant independent factor for HV correction ($P < .01$). Pearson correlation determined a significant correlation between the osteotomy angle and the amount of HV correction ($r = 0.44$, $P < .01$) (Fig 4). A significant correlation was also present between the metatarsal head lateralization and the amount of HV correction ($r = 0.32$, $P < .05$) (Fig 5). However, there was no correlation between the osteotomy distance and the amount of the HV correction.

There was no statistically significant difference between the percentage and absolute measurements of the metatarsal shortening. The osteotomy angle was found as the single statistically significant independent variable effective on metatarsal shortening among the investigated factors ($r = 0.36$, $P < .01$). No statistically significant correlation was found between the metatarsal shortening and the osteotomy distance and lateralization of the metatarsal head. No significant correlation was detected between each of the independent variables.

Discussion

Distal metatarsal osteotomies are commonly used surgical procedures for correction of HV deformity. The Wilson

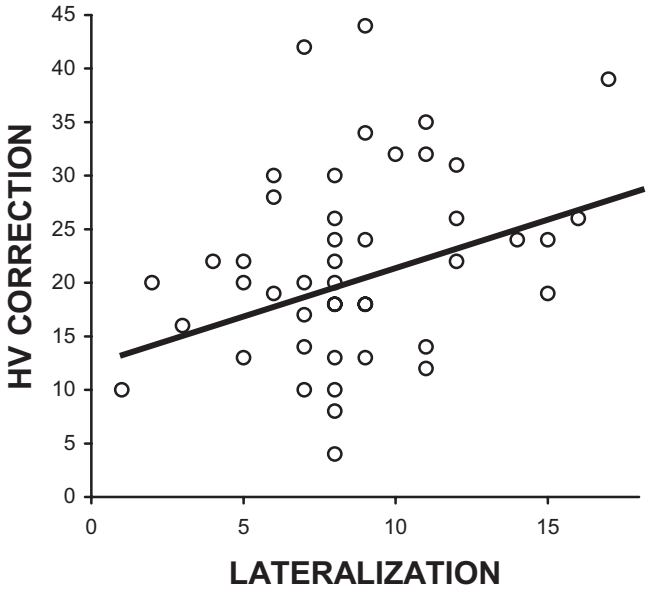

FIGURE 5 Graph demonstrating the relationship between the lateral displacement of the metatarsal head and the amount of HV correction. The line generated by linear regression, HV correction = 0.8432 (lateralization) + 14.59 ($r = 0.32$, $P < .05$), is shown.

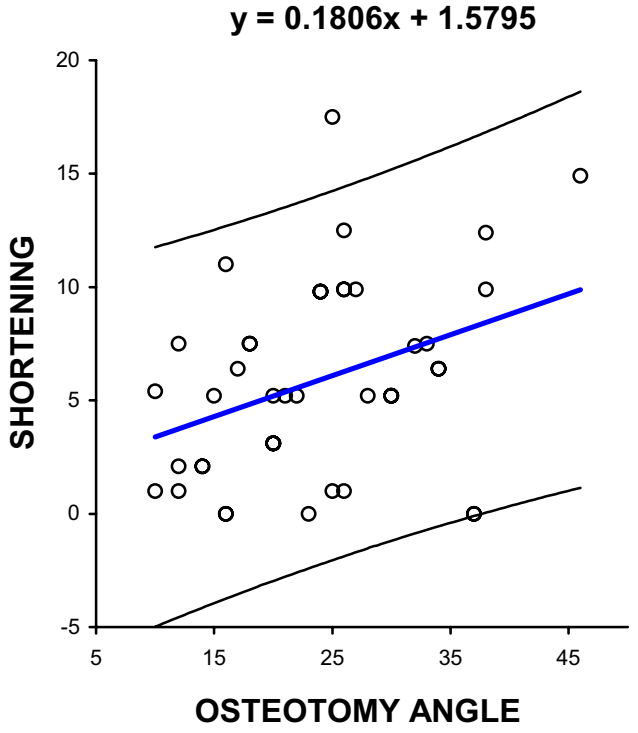

FIGURE 6 Graph demonstrating the linear relationship between the osteotomy angle and the amount of first metatarsal shortening ($r = 0.362$, $P < .01$).

oblique osteotomy differs from the geometric osteotomies by its technical simplicity and the capability for greater lateral displacement of the distal fragment (9, 13). The oblique osteotomy is a plane osteotomy with 2 major anatomic components: the osteotomy angle and the location of the osteotomy relative to the first MTP joint. Lateral displacement of the first metatarsal head is the main mechanism for correction of the deformity. Although a certain amount of osteotomy obliquity is required for lateral displacement of the capital fragment, knowing its effect on the correction of the deformity is substantial.

Among the investigated variables, osteotomy angle was found to be the most significant factor on correction of the HV deformity. However, 22.5° mean osteotomy angle, which was half of the original angle, resulted in an average of 20° of HV angle correction. This amount of correction is comparable with the average 19.25° of HV angle correction that was obtained by a 45° angled Wilson osteotomy (1, 7–9, 13–16). In his original description, Wilson recommended a high- angled osteotomy to preserve the stability (6). Internal fixation incorporated during the progress of the technique and used in the current study controlled the position of the osteotomy and lessened the prerequisite for a high-angled osteotomy.

One of the major disadvantages of the Wilson oblique osteotomy is metatarsal shortening that inevitably occurs. Several authors have reported that the Wilson osteotomy causes callosities and metatarsalgia because of a shift of the forefoot load distribution onto the lateral metatarsals (8, 11, 17). This is mainly attributed to the shortening of the first metatarsal. Merkel et al concluded that more than 10 mm of shortening resulted in a higher degree of patient dissatisfaction and an increased frequency of metatarsalgia (18). Geldwert et al found that first metatarsal shortening over 6 mm deteriorates the dynamic mechanism of the hallux, which leads to lateralization of weight bearing and an increase in loading under the second metatarsal (7). Similarly, Carr and Boyd considered 4 to 5 mm as the maximum amount of shortening that was acceptable (19). The amount of metatarsal shortening can be controlled by regulating the obliquity of the osteotomy (7). The less oblique the osteotomy, the less short the metatarsal becomes after the capital fragment is displaced laterally. Standardizing the osteotomy angle to 45° without cognizance about its effect on the amount of correction may cause undesirable clinical results by excessive first metatarsal shortening.

A correlation between the osteotomy angle and the amount of metatarsal shortening was found in the current study. This was a linear correlation with an equation of $y = 0.1806(x) + 1.5795$, where y was for the amount of shortening and x was the osteotomy angle (Fig 6). According to this equation, a 45° osteotomy angle should produce approximately 9 to 10 mm shortening of the first metatarsal, which is concordant with the literature. Klosok et al found an average shortening of 10 mm with a 45° osteotomy (14). The mean shortening of the first metatarsal was 8 mm in the

study from Klareskov et al (16), and it was 8.5 mm in the study from Pouliart et al (11). In the current study, 22.5° of average osteotomy angle caused a mean of 5.1-mm first metatarsal shortening, which was within the acceptable limits for not disrupting the weight-bearing mechanism of the hallux (7, 19).

Klosok et al reported stiffness of the first MTP joint as the commonest cause of poor result in their series, relating to the extent of soft tissue dissection around the joint (14). Soft tissue dissection is thought to be responsible in proportion to its extent for both joint stiffness and avascular necrosis in distal metatarsal osteotomies (10). On the other hand, Lindgren and Turan reported proximally located osteotomy as a technical error, and this was accused of minimal displacement and insufficient correction of the deformity (4). In the current study, no correlation was found between the location of the osteotomy and the amount of HV correction. Although the first MTP joint arc of motion was not clinically evaluated, it can be said that a mean distance of 20 mm to the first MTP joint may be considered as a safe span for mobility of the joint without having any effect on correction of the deformity.

As in most distal metatarsal osteotomies (chevron, Mitchell, Hohmann), lateral displacement of the metatarsal head is the aim of the surgery in the Wilson osteotomy as well. Lateral displacement of the distal fragment is important for not only correction of the deformity but also reduction of the subluxation of the first MTP joint and the sesamoid mechanism (2, 13). A linear correlation was found between the lateral displacement of the metatarsal head and the amount of HV correction. Although there is an equation for the slope of the correlation, it can be roughly estimated that 1 mm of lateral displacement of the metatarsal head ensued an average of 2.3° of correction for the HV angle.

Although the osteotomy angle and the lateralization of the metatarsal head are variables that are effective on HV correction, the latter has the advantage of having no correlation with first metatarsal shortening. While investigating the factors effective on metatarsal head lateralization, no correlation was detected with the other variables (for example, osteotomy angle and osteotomy distance). The diversity at the amount of lateral displacement of the metatarsal head (range, 1–17 mm) may be related with the ability of the surgeon and the details of the surgical technique. Helal mentioned failure to divide the lateral periosteum as a technical error for inadequate displacement of the metatarsal head (3).

Conclusion

In summary, osteotomy angle and the lateral displacement of the first metatarsal head were the factors effective on correction of the HV deformity. There was a high correlation between the osteotomy angle and the amount of first metatarsal shortening. Because such a relation did not exist between the lateral displacement of the first metatarsal head, the main aim in the Wilson oblique osteotomy should be maximum lateral displacement of the capital fragment with a low-angled osteotomy to avoid redundant first metatarsal shortening.

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