COMPARISON OF RANGE OF MOTION, PERCEIVED PAIN, PLANTAR LOADING BEFORE AND AFTER SURGICAL CORRECTION USING THE AUSTIN PROCEDURE FOR HALLUX VALGUS - A 12 MONTH FOLLOW-UP

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INTRODUCTION

The hallux valgus (HV) deformity is an abnormality when there is lateral deviation of the distal end of the great toe accompanied with medial displacement of the distal end of the first metatarsal (Mann & Coughlin, 1981). The deformity is acquired, however, it has been suggested that a strong hereditary predisposition exists. The incidence ratio of females to males has been reported to be 8 or 9:1. Gender differences may be accounted for by combining the greater genetic predisposition and prolonged use of poor footwear. The etiology of this deformity remains unclear and is probably multifactorial (Scranton, 1983).

The goals of surgical intervention are to reduce the patients' level of discomfort, enhance the biomechanical alignment of the 1st. metatarsal and hallux, and improve cosmesis (Scranton, 1983). Numerous operative procedures are used to correct the HV deformity with no single procedure providing satisfactory postoperative results (Jahss, 1982).

Plantar loading patterns associated with a HV deformity seems to differ from those without the deformity. Blomgren et al. (1991) compared the pressure patterns of 66 patients with HV to 60 without the deformity. The HV group had greater maximum pressure in the small toe and tarsal regions, and less pressure in the 1st., 2nd., 3rd., and 4th. metatarsal and heel regions than controls. These results are similar to other studies where toe loading was reported to be lower with greater load on the lateral metatarsal heads for those with a HV deformity (Hutton & Dhanendran, 1981; Stokes et al. 1979). Both Grieve & Rashdi (1984) and Hutton & Dhanendran (1981) reported plantar load on the hallux decreased with an increased HV angle. Mitskewitch (1992) stated the greatest maximum pressure occurred in three locations depending on the severity of the deformity. The load distribution with HV was related to either pain under the lateral metatarsal phalangeal joints (Henry & Waugh, 1975) or pain associated with the lateral subluxation of the flexor mechanism and sesamoid complex caused by the deformity (Shereff, 1990).

The purpose of this study was to compare the perception of pain, range of motion (ROM) of the talocrural and first metatarsophalangeal joints, and plantar loading patterns before and after surgical correction for HV.

METHODS

Twenty five female participants with the diagnosis of a moderate or severe HV deformity were studied. All participants had an Austin osteotomy to correct their deformity. At the time of surgery, the mean HV angle was 31.7 ± 4.7°, while the mean intermetatarsal (IM) angle was 14.5 ± 1.7°. The primary surgeon performed all screening. The follow-up time was 12 ± 0.25 months. The mean age was 43 years (range 40 - 60 years).

The evaluation consisted of the participants completing an analog pain scale regarding their perceived pain during gait. Radiographs were then taken from dorsoplantar aspect in weight bearing and the HV and IM angles were measured. Seated talocrural joint and 1st. metatarsophalangeal joint ROM was measured using a goniometer. Pressure distribution measurements were performed barefoot for the involved limb on the second step. Data were collected using a capacitive pressure measurement platform (EMED SF Pedography Analyzer, Novel GMBH, Munich). The pressure platform consisted of a 32 X 62 sensor matrix with a resolution of 2 sensors/cm^2. The sampling frequency was fixed at 70 Hz. The platform was centered, flush within a walkway. Five trials were gathered for each participant. All procedures were repeated again 12 months after surgery.

Seven plantar regions on the foot were identified: 1 heel (HL) region, 1 midfoot (MF) region, 3 forefoot regions, and 2 toe regions. The 3 forefoot regions underneath the area of the metatarsal heads were divided into equal thirds. The medial forefoot (MFF) region was underneath the first metatarsal head, the central (CFF) region was underneath the 2nd. and 3rd. metatarsal heads, and the lateral (LFF) region was underneath the 4th. and 5th. metatarsal heads. The toe region was subdivided into 2 regions consisting of the hallux

(MT) and the lesser toes (LT). The following variables were generated for each of the 7 plantar regions of the foot: peak force (PF) in %BW, force time integral (FTI) in %BW•s, peak pressure (PP) in kPa, pressure time integral (PTI) in kPa•s, and contact time (CT) in ms. A repeated measures multivariate analysis of variance (RM MANOVA) was used to detect differences in the loading parameters and range of motion measures before and after surgery ($p < 0.05$). Pain measures were compared with a dependent t-test.

RESULTS

Standing dorsoplanar radiographs were measured to determine HV angle and IM angle. The mean HV angle was 31.7 ± 4.7° pre surgically and post surgically was 17.7 ± 4.0°. The average surgical correction was 14.0°. Pre surgical mean IM angle was 14.5 ± 1.7° and 10.0 ± 1.6° degrees postoperatively. The mean correction was 4.5 degrees. Significant changes were found in all radiographic measures.

Pre surgical and post surgical talocrural joint ROM and 1st. metatarsal phalangeal joint dorsiflexion ROM was unchanged. First metatarsal phalangeal joint plantar flexion ROM improved post surgically from 12.1° to 17.5°. Perceived pain during gait was reduced post surgically from 4.2 to 1.0.

No differences were found in any of the plantar loading parameters pre and post surgically in the HL, MF, MFF, LFF, and LT regions. The means and standard deviations for the forefoot and toe regions are located in Table 1. There were similar loading patterns in these plantar regions post surgically. Peak force and PP for the CFF increased post surgically. However, PTI, FTI and CT were unchanged in the CFF region. Peak force for the MT region was unchanged post surgically. Peak pressure, PTI, FTI and CT all decreased post surgically for the MT region.

Table 1: Regional plantar loading means and standard deviations pre and post surgically for Hallux Valgus.

Region	PF	FTI	PP	PTI	CT
MFF					
Pre	23.5 (6.1)	8.5 (2.7)	360.8 (156.8)	128.5 (55.2)	670.5 (93.1)
Post	25.2 (5.8)	8.6 (2.8)	436.2 (203.1)	149.4 (75.4)	631.1 (116.2)
CFF					
Pre	43.2* (6.1)	16.8 (3.3)	494.9* (186.3)	186.1 (73.3)	718.8 (99.5)
Post	47.4* (7.4)	17.6 (4.7)	619.8* (218.7)	168.7 (33.1)	676.0 (123.7)
LFF					
Pre	14.9 (4.5)	5.2 (1.8)	252.2 (171.5)	87.4 (49.6)	695.5 (104.2)
Post	14.9 (4.7)	5.4 (1.7)	265.6 (178.4)	83.9 (39.0)	649.1 (130.1)
MT					
Pre	12.4 (7.5)	3.8* (2.1)	439.3* (250.5)	120.9* (73.2)	602.0* (105.8)
Post	12.4 (6.2)	2.5* (1.6)	289.8* (169.4)	58.1* (38.9)	446.9* (138.3)
LT					
Pre	7.6 (4.4)	2.1 (1.2)	160.4 (79.7)	47.0 (25.0)	589.8 (113.9)
Post	9.1 (5.6)	2.1 (1.2)	202.3 (96.3)	58.1 (33.3)	582.8 (145.1)

DISCUSSION

Decreases in perceived pain during gait post surgically did not seem to increase plantar loading in the MFF or MT regions. First metatarsophalangeal joint plantar flexion improved post surgically, however this did not improve force production in the MT region. Henry et al. (1975) stated that accentuated loading under the CFF region is representative of the HV foot. Surgical intervention does not seem to change this characteristic but rather makes this CFF loading more pronounced based on PF and PP. Similar FTI, PTI and CT were observed pre and post surgically in the CFF region. Researchers have reported reduced loading under the MFF and MT compared to the non-pathological foot (Stokes et al, 1979; Hutton & Dhanendran, 1981; Grieve & Rashdi 1984). No changes in plantar loading were demonstrated in the MFF region in the present study. However, PF, FTI, PP, and PTI did increase slightly post surgically. Similar PF were found in the MT region but reduced FTI, PP, PTI and CT were found post surgically.

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