ANKLE AND FIRST METATARSOPHALANGEAL JOINT DORSIFLEXION IN CHILDREN WITH CLUBFOOT

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INTRODUCTION

Clubfoot (CF) is a foot deformity due to an abnormal relation between tarsal bones, such that the navicular and the calcaneus are displaced medially around the talus (Turco, 1997). Many qualitative rating systems that have been established to measure function include a measure of ankle dorsiflexion (DF) obtained by passive motion with a goniometer or by radiographs. CF children have abnormalities in toe-off (Hutchins, 1985) and thus the first metatarsal range of motion in addition to the lack of DF at the ankle may contribute to this lack of propulsion. The minimal range of first metatarsal DF is 60 - 65° so the hallux can act as a rigid lever for propulsion (Hetherington, 1990).

The purpose of this study was to examine the gait kinematics of bilateral CF patients who have undergone a posteromedial release to determine how active DF of the ankle and first metatarsophalangeal (MTP) joints affects DF during stance and subsequent push-off.

METHODOLOGY

Five bilateral CF subjects and five age and gender matched normal subjects participated in this study. Motion analysis using a four camera system was performed with three markers on the lower leg (head of fibula, mid-tibia, and distal fibula), three on the foot (head of the first metatarsal, back of the calcaneus, and head of fifth metatarsal), and one on the tip of the first phalange.

Each subject was shown how to actively dorsiflex first the ankle followed by the toe. Each motion was recorded two times in a standing position with the leg extended and raised. Each subject also performed three trials at a self-selected pace along a walkway to obtain gait characteristics. Data were tracked using EVa software (Motion Analysis Corp., Santa Rosa) and analyzed using Kintrak (University of Calgary).

RESULTS

The amounts of active DF of the ankle and first MTP joints were significantly different between normals and CF patients (Table 1). These were compared to the amount of DF during the stance phase of gait (Figures 1 and 2).

Fig. 1. DF at push-off was significantly (p ≤ 0.05) greater for normal subjects than for clubfoot by 3°.
DISCUSSION

Karol et al. (1997) found no significant decrease in the range of motion of the ankle of the CF during gait as compared to the contralateral. The ankle DF of our CF subjects was significantly lower than normals when measured both during the stance phase of gait and during active motion.

It has been shown that there is a correlation between function and amount of DF of the ankle based on an outcomes questionnaire (Hutchins, 1985). We also found a correlation between the amount of DF as determined by active motion and by gait (Pearson’s Coefficient = -0.393). This may have been due to the distortion of the talar dome or the navicular, but as radiographs were not used, this was not verified.

As with our study, Mann and Hagy (1979) found that the great toe was typically extended 20° from the axis of the metatarsals during the flatfoot phase of gait and was dorsiflexed 70-90° during push-off for the normal population. Our CF subjects exhibited extension during the flatfoot phase, but did not dorsiflex to the same degree during push-off. It is possible that the windlass mechanism of the plantar aponeurosis (Hicks, 1954) was not as effective in the CF due to the abnormal musculature.

CONCLUSIONS

Abnormal propulsion of CF subjects may be due to an insufficient DF motion of the first metatarsal, preventing the hallux from acting as a rigid lever for push-off in addition to the insufficient range of DF at the ankle joint.

REFERENCES


| Table 1: Dorsiflexion at the ankle during active motion. (* p ≤ 0.05) |
|------------------|------------------|------------------|
| Dorsiflexion (°) (mean ± SD) | Normal Subjects n=5 / group (10 limbs) | Clubfoot Subjects n=5 / group (10 limbs) |
| Active Ankle Toe | 22.9 ± 7.23 | 5.57 ± 5.92 * |
|                  | 65.1 ± 12.2 | 54.9 ± 13.3 * |