INSUFFICIENCY OF THE TIBIALIS POSTERIOR MUSCLE

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INTRODUCTION: The function of the tibialis posterior muscle lies mainly in supination control and also guarantees the stability of the foot arch. Post-traumatic tibialis posterior dysfunction is a well known syndrome, mainly leading to flat foot, forefoot abduction and pes valgus (Mann & Thompson, 1985; Funk et al., 1986; Johnson & Strohm, 1989; Mueller, 1991; Hintermann, 1995; Hintermann & Gächter, 1996) The aim of this study was to analyze the pronation-supination equilibrium in normal test persons and in patients with suspected tibialis posterior insufficiency.

METHODS: Ten normal test-persons and five patients with suspected tibialis posterior insufficiency were examined. The suspected muscle insufficiency resulted from ski traumas with hyper-dorsiflexion of the foot, affecting the medial collateral ligament of the ankle. The following examination was performed 1 to 3 years after the trauma. A computer-axiometry system (Fuss, 1993, 1994) was used to analyze the kinematics (position and direction of the finite helical axes, helical translation and rotation, and helical axes surfaces) of the plantar extension, beginning in the normal zero position (lower leg perpendicular to the floor) progressing to a tiptoeing position. The subjects tiptoed on both feet simultaneously, while holding-onto the examination table. The complete movement was captured by the software (Tarsós[β] 2.0, Div. of Biomechanics), namely in steps of 3°. The immobile system was the tibia, the mobile one the forefoot. Three different data sets were taken for each leg.

ANALYSIS: The coordinate system used was: x pointing anteriorly, y cranially, and z to the right. After having printed the finite helical axes in the xy- and xz-planes, the angle ("axis angle") between the finite helical axes (of the different stages of movement) and the reference co-ordinate system was measured. A deviation from the horizontal base line indicates compulsory motion. The results were evaluated for the first 3° of the movement, so as to unveil discrepancies in the axes' positions. The plantar/dorsiflexion occurred about the z-axis, the ab/adduction about the y-axis, and the pro/supination about the x-axis. The relative parts of the single motions with respect to the total motion was calculated in the following way:

α = angle between finite helical axis and z-axis in the xz-plane

β = angle between finite helical axis and z-axis in the yz-plane

plantarflexion : supination or pronation : adduction or abduction =

$$1/(1+\tan\alpha+\tan\beta) : \tan\alpha/(1+\tan\alpha+\tan\beta) : \tan\beta/(1+\tan\alpha+\tan\beta) \tag{1}$$

(as parts of 1, or percentage if $\times 100$)

RESULTS: The first 10° of motion are not solely a plantar extension, as compulsory motion simultaneously arises. In the initial phase of motion a combined adduction/supination occurs, which decreases in the course of further motion. However, following insufficiency of the tibialis posterior muscle, an abduction/pronation combination arises at the beginning of the motion (Table 1).

Table 1 — Main motions as parts of total motion

motions (in %)	normal foot (n=25)	muscle insufficiency (n=5)
plantarflexion	68.21±4.87	63.69±5.02
supination (+), pronation (−)	+14.86±5.59	−10.15±6.77
adduction (+), abduction (−)	+16.93±8.97	−26.16±10.34

DISCUSSION: The reason for the pronation motion due to tibialis posterior insufficiency can be explained by 2 facts: 1) following tibialis posterior insufficiency a pes valgus develops which diminishes the supination moment of the triceps surae muscle, and can even cause a pronation moment in severe cases. 2) The missing tibialis posterior function causes an overweight of the peronei muscles, leading to increased pronation. The reason for the abduction motion can be explained by 3 facts: 1) pronation is usually combined with abduction. The abduction relative to pronation is, however, higher than adduction relative to supination (ratio of pronation : abduction = 1 : 2.58, ratio of supination : adduction = 1 : 1.14; Table 1). 2) The missing tibialis posterior function causes an overweight of the peronei muscles, leading to increased abduction. 3) The forefoot - hindfoot junction is chronically hypermobile in tibialis posterior dysfunction.

CONCLUSIONS: The clinical significance of ankle joint axiometry lies in the possibility of objectively documenting the kinematic implications of muscle function disorders (muscle injuries, paralysis following nerve lesion) and joint injuries. Application possibilities are: additional method for the diagnosis of muscular disorders, handicap detection for expert opinions in liability suits, decision aid in therapy strategies (this study showed that the tibialis posterior is indispensable and that insufficiency or even rupture thereof must be treated immediately or a muscle replacement be executed), success assessment after surgery and during rehabilitation.

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