ANKLE JOINT DORSIFLEXION: ASSESSMENT OF THE TRUE VALUES

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INTRODUCTION

The amount of ankle joint dorsiflexion required for human ambulation is claimed to be 10 degrees [1,2,3,4,5]. Motion of a reduced quantity has been referred to in the literature as "equinus" and the widely accepted theory is that when equinus is present abnormal foot function occurs. Clinical experience suggests that the majority of patients evaluated, display an amount of ankle joint dorsiflexion during stance, which falls short of this figure. However, patients presenting within the clinical environment normally complain of some discomfort and therefore may not be a good representation of the normal population. One of the main purposes of this study is to determine how and when this arbitrary figure of 10 degrees became established and accepted as the norm and is it in fact a correct figure.

METHODOLOGY

Fifteen subjects consisting of 8 men and 7 women, aged 19-49 years (mean 27.07), with a body mass ranging between 51.5-126 kg (mean 71.96), height ranging between 161-189 cm (mean 173) and no known gait abnormalities were recruited from a population of university students. All subjects reported to have a passive ankle joint motion of between 12.2 and 25.6 degrees. Ethical approval was sought and received from the university ethics committee. As a result of the prescribed exclusion criteria, one male subject was eliminated from the study (ankle surgery due to fracture). All subjects were supplied with a written explanation of the study and gave a written consent.

A three dimensional opto electronic motion analysis system consisting of five infra-red cameras, sampling at a rate of 60 Hz was employed for data collection and analysis (Motion Analysis Corp, Santa Rosa, CA). Reflective skin markers were placed on predetermined anatomical landmarks. Once the markers were placed on the subject, they were asked to stand on a dynastat weight bearing goniometer (Dynastat, Stafford, UK), with their ankle joint maintained at 90 degrees, whilst their subtalar joint was placed in neutral position [6]. The positioning of the subject in neutral was performed by the same researcher (JW). Two trials of data were taken for each subject whilst they were in this position. The information from this data was later used as a zero reference point to correct the walking data for subtalar neutral position during data analysis. The markers were used to define a segment coordinate system for each limb segment, 3 markers per segment i.e. foot, shank, thigh. This set up allowed for analysis of motion between the foot and leg for each subject. While the data was collected for several trials, three trials were chosen at random for each subject to measure the dorsiflexion values. The 3D co-ordinates were be smoothed using a Butterworth filter (Fc = 7Hz) and all foot angles were expressed relative to the subtalar neutral position. Data were subjected to analysis for similarities using the co-efficient of multiple correlation (CMC) [7].

RESULTS AND DISCUSSION

Results (Table 1) show ankle joint dorsiflexion values of between 12 degrees and 22 degrees dorsiflexion with a wide variation between subjects. Data from a particular subject was discarded due to errors in analysis.

Table 1: Maximum values for ankle joint dorsiflexion/ plantarflexion

	Max Dorsiflexion (degrees)		Max Plantarflexion (degrees)		
Subject No:	Mean	St.Dev	Mean	St.Dev	Typical CMC Values
1	14.07	*0.25*	-12.33	*1.10*	0.983
2	14.70	*0.11*	-3.79	*1.11*	0.755
3	12.43	*1.18*	-12.24	*2.11*	0.732
4	17.31	*2.07*	-6.03	*3.69*	0.823
5	17.85	*0.34*	-4.02	*2.15*	0.989
6	18.93	*0.52*	-3.68	*1.03*	0.955
7	21.97	*1.36*	-1.48	*1.19*	0.914
8	16.97	*0.34*	-7.61	*2.59*	0.989
9	13.77	*0.15*	-3.77	*0.66*	0.992
10	17.67	*0.38*	0.58	*3.83*	0.917
11	13.37	*0.26*	-6.11	*0.50*	0.757
12	20.39	*0.82*	3.69	*1.76*	0.773
13	22.53	*0.29*	0.44	*1.51*	0.941

The results appear to show ankle joint dorsiflexion in normal subjects is greater than the value traditionally espoused by clinicians for walking. This may have clinical implications. More research is needed to determine the effect of terrain, footwear and muscle length on the measurements.

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