INTRODUCTION

The proximal tibia represents the inferior articular surface of the knee, one of the most commonly operated on joints in the human body. In addition to its relation to the articular surface, it possesses a number of complex parameters which vary within a patient population. Aspects such as posterior slope, joint alignment axis, and metaphyseal width are just a few of the properties which make each individual tibia unique. Loss of native bony structure through fracture, tumor or degenerative joint disease can result in altered biomechanical function and lead to premature or accelerated deterioration of the knee joint. We evaluated a large number of left and right sided tibias as well as reconstructed the lower extremity in order to establish these values. This study defines averages and ranges of these parameters across a healthy population. In addition, the study compares these measured parameters with the mechanical axis of the lower extremity. The study reveals a number of relationships that the surgeon can use to reconstruct the native anatomy when dealing with the above listed processes.

Previous authors that have described tibial characteristics used either small numbers of cadaver samples or CT/MRI scans. However, we describe tibial characteristics using only the tibia (without any soft tissue) and used a much greater tibia sample from 90 disarticulated skeletons. Furthermore, we developed and utilized methods which acquired points from a three dimensional structure in space. Then, using vector analysis, we were able to calculate more complex parameters.

METHODS

We used the Hamman Todd Osteological Skeleton Collection at the Cleveland Museum of Natural History. From over 600 specimens within the age range, we randomly selected 22 black males, 21 white males, 24 black females, and 23 white females that were between the ages of 18 and 35. Specimens were without evidence of degenerative disease, fracture, or other pathologic condition. Other materials included a Microscope G2XL (Imersion), Rhinoceros software, and Matlab software. The Microscope is a three dimensional digitizer that allows acquisition of three dimensional coordinate points with a stylus. Rhinoceros was used to acquire the points, and MATLAB was used for data analysis.

We arranged each tibia on a flat surface secured in relative space to the digitizer. We then acquired multiple points from each tibia specimen.

For each tibia specimen, the following measurements were made. The tibia length was calculated using the scalar distance from the center point of the proximal articular surface and the distal articular surface. The proximal breadth was calculated using the scalar distance from the medial to lateral border of the proximal tibia. The lateral posterior slope angle (LPSA) and the medial posterior slope angle (MPSA) were found by calculating the angles between the tibial posterior slope vectors and the vector orthogonal to the tibial axis vector in the sagittal plane. The tibial axis vector was found by the line formed by the proximal articular surface point and the distal articular surface point (Figure 1).

RESULTS:

A large amount of data was obtained from this work. The most interesting are highlighted here. The lateral posterior slope was 8.9 ± 3.8°, the medial posterior slope was 10.8 ± 3.6°, the mean difference in posterior slope (MPSA – LPSA) was 1.9 ± 3.3°, and the mean absolute posterior slope difference was 3.1 ± 2.2°. These findings suggest that the posterior slope is, on average 1.9° steeper on the medial side, and that there is, on average, a 3.1 degree difference between the medial and lateral posterior slopes for any tibia. The medial posterior slope was correlated with the mechanical axis deviation (r = -0.41, p = 7.31E-5), tibia valgus/varus (r = -0.41, p = 6.34E-5), and M4 (r = 0.50, p = 4.82E-7). The lateral posterior slope was correlated with the mechanical axis deviation (r = 0.20, p = 0.0543), tibia valgus/varus (r = 0.41, p = 6.39E-7), and L3 (r = 0.42, p = 4.38E-5).

DISCUSSION:

This is the first study to use three dimensional vector analyses to examine the angular architecture of the tibia. Our data reveal that there in fact is a difference between medial and lateral posterior slope of the tibia. We suggest that there is a correlation between posterior slope of the tibia and axial alignment. Finally, we offer L3 and M4 as markers that can be used on AP plain films to predict the tibial slope.

REFERENCES:


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