INTRODUCTION

The rotational alignment of the tibia is an unresolved issue in knee replacement. A poor functional outcome may be due to malrotation of the tibial component. Our aim, therefore, was to identify local landmarks in the knee which could be used in both health and disease to describe the sagittal axis of the tibia to define its rotational alignment.

METHOD

Computed tomography (CT) scans of 21 knees from 21 patients (11 males and 10 females) were analysed. They had been obtained using the Imperial Protocol (1) from patients who have given their consent for use of the datasets in research. Eleven of these patients had undergone unilateral knee surgery, so the contralateral knees were studied. For each of the other five patients, one of the two knees was analysed. The mean age was 54 years. Customised software was created and used for analysis of the CT datasets.

The tibia was orientated by aligning the line joining the center of the talus and proximal tibial center vertically and rotating 90° along a horizontal axis to get a craniocaudal view of the tibial plateau. More than six data points were placed on the surface of the tubercle at the level of its most anterior point. The center of the best-fit circle formed using these points was termed the tibial tubercle center.

An axial plane was identified 20 mm below the tibial spines. The center of each tibial condyle was calculated from ten points taken round the condylar cortex.

Three different sagittal axes were then created (Fig1). The posterior condylar axis (APC) was defined as the perpendicular to the posterior condylar line at its midpoint. The sagittal tubercle axis (AST) was generated joining the lateral tibial spine and the tibial tubercle center. The anatomical tibial axis (ATA) was described as the perpendicular at the mid-point of the line joining the medial and the lateral condylar centers. Intra-observer repeatability was measured by repeating the data collection after one week. Two more independent observers repeated the entire process and the reproducibility of this method was then calculated by using Bland-Altman analysis for interobserver agreement.

RESULTS

The derived points were identified by three observers with errors of 0.6 mm to 1 mm. The medial and lateral tibial centers were constant features (radius 24 mm (SD 3), and 22 mm (SD 3), respectively). An anatomical axis was created perpendicular to the line joining these two points. The tubercle center was found to be 20 mm (SD 7) lateral to the center of the medial tibial condyle. Compared with this axis, an axis perpendicular to the posterior condylar axis was internally rotated by 6° (SD 3). An axis based on the tibial tubercle and the tibial spines was also internally rotated by 5° (SD 10).

Using the ATA and the longitudinal anatomical axis of the tibia to adjust rotation in the axial and sagittal planes, respectively, a frame of reference could be defined with the x-axis being mediolateral, the y-axis superoinferior, and the z-axis anteroposterior.

A morphometric analysis of the proximal tibia was then performed. The mean medial tibial condyle radius was 24 mm (SD 3) and the mean lateral tibial condyle radius 22 mm (SD 3). The mean distance between the medial and lateral condylar centers was 26 mm (SD 6). The mean anterior distance from the line joining the two condylar centers to the tibial tubercle center was 23 mm (SD 5). The tibial tubercle center was located 20 mm (SD 7) lateral to the medial condylar center. The tibial tubercle is the feature which varies more than any other in the proximal tibia. (Fig2)

DISCUSSION

We conclude that alignment of the knee when based on this ‘anatomic’ axis is more reliable than either of the posterior surfaces. It is also more reliable than any axis involving the tubercle, which is the least reliable feature in the region. The ‘anatomic’ axis can be used in pre operative planning and navigated knee arthroplasty for referencing the rotational alignment of the tibial component.

Fig 1

Fig 2: six of the tibias used, showing the differing proportions, and the variable position of the tibial tubercle relative to the tibial spines.

References: