Three-dimensional morphological study of the Thai proximal femoral geometry: Relevance to trochanteric nail

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Introduction

Concerning the proximal femoral nails that are widely used for fixation of trochanteric fractures, most of the designs are based on western anthropometry. Although there have been a design for Asia-Pacific population (Gamma AP) this design still has some problems of miss-matching to serve most of the Thai and ASEAN populations. To our knowledge, no investigation has directly developed from the three-dimensional morphology anatomical data with computer technique and no any data have been investigated from Thai or ASEAN proximal femoral anatomical data.

The purpose of this study is to present the new method of modern technologies of computerized tomographic image combine with the reverse engineering technique for computer-aided design (CAD) to analyze the three-dimensional geometrical data of the proximal femur both for the outer surface and the shape of the femoral canal. This will provide more precise and accurate anatomical data than that of the conventional two-dimensional method of analysis. This study was performed on Thai cadaveric bones that will be relevant to the development of design for trochanteric nail for Thai patients and also can be expect to match for that of the ASEAN populations.

Methods

One hundred and eight femora were obtained from the Thai donors in Siriraj Hospital, Mahidol University. The donors were 26 males, 22 females and 12 unknown genders with an age range of 22-83 years, with a mean of 48.5 years at the time of death. Nine femora were scanned as a group (Fig.1) with Philips spiral CT scanner (Tomoscan AV). Three-dimensional models were extracted from the computerized tomographic images and built with the reverse engineering techniques related to the trochanteric nail.

Fig. 1 The positioning of the femur drybones for CT scanning

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The following parameters were calculated for each femur: (1) Femoral head, it is calculated from the used of least square method to fit a sphere to the three-dimensional data of head portion. The femoral head diameter and the position of femoral head center could be measured later. (2) Femoral neck axis: Firstly the assumed femoral neck axis was created from the point cloud data and then determined the isthmus of femoral neck was determined with the use of least square method to fit a circle in the cross-sectional plane, which was perpendicular to the assumed neck axis. Secondly, the true femoral neck axis was then created as a lined from the femoral head center passing through the center of the isthmus of femoral neck. (3) Femoral shaft axis: Firstly calculated from the isthmus of femoral shaft with the use of least square method to fit a circle of each cross-sectional at the femoral shaft region. The femoral shaft isthmus can be measured and the least square method of fitting a line was then used to create the femoral shaft axis from the femoral shaft isthmus level and extended to the proximal and distal region. (4) Anteversion angle, the amount of this angle was determined by the angle that was formed by the line of projection of the true femoral neck axis to that of the transverse plane. (5) Neck-shaft angle, this angle was measured from the angle between the tangent plane of the femoral neck axis and femoral shaft axis.

![Fig. 2 All of the Parameters of the proximal femur modeling](image)

**Results**

From this method of investigation for Thai cadaveric proximal femora, it was found that the femoral head averaged 44 mm and the neck isthmus averaged 29 mm. The average of isthmus intramedullary diameter was 10 millimeters. The average of isthmus level starting from the lesser trochanter was 113 millimeters. The average anteversion angle was found to be extremely variable within the high range of 0 to 35 degrees and averaged 11 degrees. The neck-shaft angle averaged was 128 degrees, but was less variable than the anteversion angle.

**Conclusions**

This study has demonstrated a new method of measurement for the proximal femoral morphology by the use of three-dimensional reverse engineering technique. The present data can represent the geometrical data of Thai population, which was smaller than that of the European size. The results can also be extended to use for that of ASEAN population. This data can facilitate the proper design for the proximal femoral nail for Thai patients and also may extend to serve the ASEAN population. The nail design should be smaller size and smaller valgus angulation of the proximal part and greater anteversion angle for lag screw insertion.
References

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