OPTIMAL TIBIAL COMPONENT SIZE IN TOTAL KNEE REPLACEMENT - ANALYSIS WITH COMPUTED TOMOGRAPHY AND INTRAOPERATIVE MEASUREMENT -

Introduction

With a high success rate of total knee replacement (TKR), increasing number of operations are currently performed in Asian countries. It has been postulated that a smaller stature in Asian population requires a different size variation. There has however been a paucity of date regarding the optimum component size. The aim of this study is to evaluate the morphology of the proximal tibia in Japanese elderly populations and to determine the optimal tibial component size variation.

Materials and Methods

The study group consisted of 83 knees in 70 patients undergoing TKR (55 females, 15 males. Average age: 70.3 years old). The mean height was 148.9 cm in females and 160.3 cm in males. The anterior-posterior (AP) and medial-lateral (ML) length of the proximal tibia was analysed using preoperative computed tomography (CT) and intraoperative measurement. CT measurements: CT scan images were obtained to visualize the epicondylar axis of the femur and the resection level of the proximal tibia. Briefly the scans were made in the plane perpendicular to the mechanical axis of the tibia in the frontal plane with 3 degrees of posterior tilt. CT images of 3 mm and 1 mm thickness were obtained at two areas namely the epicondyles of the femur and the proximal tibia. The slice traversed the optimum osteotomy line in the proximal tibia (usually 6 – 8 mm below the lateral tibial plateau) was selected. For the chosen tibia slice, a line parallel to epicondylar axis and traversing the longest distance on the tibia was drawn and its length was regarded as the ML size of the tibia. A line was drawn to be perpendicular and through the midpoint of this line and the length was regarded as the AP size of the tibia.

Intraoperative measurement: The proximal tibia resection was made using extramedullary alignment technique to be perpendicular to its long axis in frontal plane with 3 degrees of posterior tilt. Then the osteophytes were removed and varus-valgus balance was checked with a spacer-block. The contour of the resection surface was traced on a transparent plastic sheet. The medial and lateral margins of the tibial tuberosity were marked on the sheet to determine the orientation. The ML and AP length were measured on the retrieved sheets while the direction of the measurement being adjusted with reference to the tibial tuberosity (patella tendon) and contour of the tibia on CT images.

Results

The result in CT measurement was shown in Figure 1. There was a tendency to overestimate the ML length when compared to intraoperative measurement because of the presence of the medial osteophyte.

The results in intraoperative measurement together with size distributions of three widely used prostheses were plotted in Figure 2. It was shown that small size component was not necessarily required for the population examined. It was also suggested that the ratio of ML and AP length as well as their increment among the sizes were not in complete accordance with the real resection surface.

Discussion

For the maximum tibial coverage, it is essential to evaluate the morphology of the proximal tibia at the resection level. CT images were inaccurate in the estimation of the ML length but essential to accurately determine the transepicondylar line and thus in determining the optimum rotational direction of the measurement. In contrast, the size of the proximal tibia at the resection level could be accurately evaluated intraoperatively but the rotational direction could not be determined when the measurement was attempted on the plastic sheets retrieved. Thus accurate and reproducible measurement was possible only when the CT and intraoperative measurement was combined. In practice, the measurement direction of the retrieved sheet was determined with reference to the tibial tuberosity and the contour of the antero-lateral quarter of the proximal tibia where little arthritic changes occurred in varus knees.

Asian populations are known to have a smaller build and stature as compared with their Western counterpart. There has long been a belief among Asian-Pacific arthroplasty surgeons that the prosthetic components currently available on the market do not fulfill the requirements of the population. There have been, however, no quantitative data on the actual size of the proximal tibia at resection level. From the viewpoint of the number of patients who requires TKR, Asian country is an important market. This study has demonstrated that special smaller size variation is not necessary even for the short stature patients. Instead, more attention should be paid to make more size variation with in a ML length of 65-75mm.

In conclusion these data provided a basis for the design of the knee prostheses with maximum tibial coverage in Asian population which probably the most important market in the 21 century.

Figure 1. CT measurement results

Figure 2. Intraoperative measurement results