INTRODUCTION:

Femoral neck – shaft (FNS) angles, also known as caput-collum-diaphysial (CCD) angles, have been measured in past studies to help understand how much variation exists within the human population [1]. Orthopaedic manufacturers have been using data from various studies like these for decades to help develop new hip stem designs with a variety of neck angles that can be utilized to help restore the anatomic center of the hip. To date, very little research has been done to look for age related differences in adult humans FNS angles.

Tillman and Tondury [2] suggested that FNS angles start out at approximately 150 degrees during fetal development and decrease to approximately 125 degrees by the time of skeletal maturity. After reaching skeletal maturity, it is believed that this angle continues to decrease although no data was supplied to backup this statement.

The aim of this study was to compare young and old adult patient’s FNS angles and determine if a statistically significant difference exists between both age groups. Additional focus will be given to look at male and female groups within each age category to see if age related changes affect the two gender groups differently.

MATERIALS AND METHODS:

All FNS angle measurements were taken from a virtual bone database which is made up from more than 600 patient’s CT scanned femurs [3]. This database includes corresponding patient data for age, race, gender, weight and height. All patient data that was collected for this study was automatically output into an Excel table for further analysis. Any patient data that was found to be missing age and/or gender related data was excluded from this study. After excluding patients with missing age and gender data, 518 patients remained. Patients were then divided into groups to look at both male and female populations under 50 years old and over 50 years old.

RESULTS:

Out of the 518 patients in this study, 117 patients were under 50 years old and 401 patients were over 50 years old. There were 235 females and 283 males. For the under 50 age group, males accounted for 55 of the patients and females accounted for 62 of the patients. For the over 50 age group, males accounted for 228 of the patients and females accounted for 173 of the patients.

CONCLUSION:

The lower FNS values observed in the Over 50 age group indicate that femoral geometry does change significantly with age in skeletally mature adults. Assuming that the neck length of the femur remains the same, a decrease in the FNS angle should result in a higher femoral head offset value. With this thought in mind, the femoral head offset data from the same groups of patients was analyzed to determine the validity of this assumption. The results from this follow-up study confirmed that the average femoral head offset values do increase with patient age while the average FNS angles are decreasing with age.

The trend lines that were displayed in figure 3 indicate that the FNS angles are decreasing at a higher rate in the Over 50 populations of male and females. This change in the rate of decline for FNS angles may be a result of decreasing bone density. It was hypothesized early on in the development of this study that older female’s FNS angles may be decreasing at a faster rate than males of the same age due to the risk of post-menopausal osteoporosis [4]. No evidence in this analysis appears to support this theory about older women’s FNS angles.

The information from this study will be helpful for designing the next generation of femoral hip stem designs for total hip replacement. Currently, the majority of femoral hip stems that are produced for the orthopedic market are monolithic with fixed neck/shaft angles. In order to accommodate patients with a variety of FNS angles, multiple neck/shaft angles have been developed for each monolithic hip stem design which increases inventory significantly for manufacturers. The utilization of a hip stem with a modular neck design may be more effective for addressing the variety of FNS angles that exist in patient’s femurs which have been shown in this study to be changing with age.