Stress Distribution of the Femur after Insertion of Different Stem Length Proximal Fill Femoral Implants

INTRODUCTION:
The femoral stem of a traditional total hip arthroplasty is considered to be essential for fixation and stability. However, recent literature suggests that thigh pain due to distal canal fixation, micromotion, uneven stress patterns or cortex impingement by the femoral stem is directly correlated to increased stem length and often very disabling to a patient. To alleviate these issues, the Revelation femoral prosthesis (DJO Surgical Inc, Austin, TX), relies upon a proximal lateral expansion (Lateral Flare) to achieve stability. The stemmed portion, which is used only for alignment, is highly polished and finished with a three degree taper, thus discouraging osseous integration and load transfer. Use of the lateral flare configuration has been shown to relieve distal femur stress transfer and is inherently stable.

However, this prosthesis uses a traditional stem length, therefore some stress shielding may still exist. Short and ultra-short femoral components, such as the Mayo Conservative Hip and the Depuy Proxima hip have been purported to decrease the potential for stress shielding. However, to our knowledge, the load distribution in the short and ultra-short stems has not yet been demonstrated. In this study, we sought to determine if stemless, 1/3 stem length or 2/3 stem length Revelation lateral flare implants would result in more physiologic stress transfer and is inherently stable.

RESULTS:
Fringes formed in a similar pattern for all femurs, intact and with stems. The fringes first occurred medially and laterally in a proximal-distal direction and radiated outward, decreasing in fringe order, toward the neutral axis of bending (anterior and posterior). The magnitude of the fringe order, N, remained the same or increased in the proximal to distal direction. This became more prominent, particularly on the medial side, as the stem length increased, when there was a decrease in fringe order proximally and increase in fringe order distally compared to the intact femur (Figure 3). However, there was some variation in this pattern indicating that the exact stem position and the location of its interaction with the endosteal surface of bone was not the same in each femur.

DISCUSSION:
Prospective clinical evaluation of the traditional stem length Revelation lateral flare femoral implant demonstrated increased bone preservation in gruen zones one and seven without changes in femoral morphology. Additionally, excellent proximal stability and osseous integration of the component, without thigh pain or femoral fractures, were reported. Despite these excellent results, some distal load transfer can still occur, as shown by our study. To that end this study suggests that the stemless femoral component most closely replicates the strain distribution of the intact femur and may be a more promising alternative. However, more research regarding the stability of stemless hip implants are indicated prior to clinical trials. Given concerns about stem alignment, as well as stability, the 1/3 stem length implant design may present itself as an excellent option.