The Influence of Single radius design on flexion stability in TKA: An in-vitro biomechanical study

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INTRODUCTION
Single radius designs of the femoral component condyles were measured to show a decreased variation of motion of the flexion/extension axis compared to multiple radius designs. Measuring the instant finite helical axis (FHA), single radius designs concentrated at a single axis near to the medio-lateral axis of the femoral (1). This decreased variation of the FHA was supposed to offer a higher degree of functional stability after TKA especially in higher degrees of flexion (2). We hypothesized, that the higher degree of stability in flexion decreases the frontal long-leg varus/valgus deviation and the distances between the medial and lateral epicondyles, which was intended to be evaluated in this in-vitro biomechanical study.

METHODS
In seven left fresh-frozen human knee specimens a TKA-system with a single-radius design of the femoral component (Triathlon®, Stryker) and a fixed 9mm PE-Inlay was implanted under computer assisted navigation. Using the navigation system after implantation, movements and the alignment of the lower extremity were measured under constant varus-stress of 6Nm, while the knee was flexed passively from full extension to 90 degree flexion. The second cycle was performed with a 6Nm valgus stress. For this study the variation (difference) of the frontal overall long-leg axis (varus/valgus) and the distances between both epicondyles and the tibial bone cut between varus and valgus stress were evaluated. After measuring the single radius design the femoral component was changed to a multiple radius design (J-curve, Duracon®, Stryker), while the tibial component was left unchanged.

RESULTS
Following the implantation of a single radius design, varus-/valgus variation showed a maximum deviation of 2.4º (SD 1°) at 90º of knee flexion and was decreased up to 50% (p<0.05) relative to the multiple radius design (Fig. 1). With the single radius design the deviation of the distance of the medial epicondyle to the tibial bone cut was measured to be minimized at 45º knee flexion (0.2 mm, SD 0.5 mm) with a constant decrease of 45% (p<0.05) during nearly the entire range of motion compared to the multiple radius design (Fig. 2). On the lateral side the deviation was minimized at 30º knee flexion to 0.3 mm (SD 0.5 mm), representing a decrease of 70% (p<0.05) compared to the multiple radius design (Fig. 3).

DISCUSSION
This biomechanical in-vitro study showed a significant lower variation of the frontal long-leg axis during varus/valgus-stress especially in knee flexion. Additionally the variation of the medial and lateral joint line, represented by the distance of both epicondyles to the tibial bone cut, was significantly decreased, especially in the medial compartment. Therefore, the results of this biomechanical study offer a potential increase in knee stability after TKA with a single radius design especially in knee flexion. This improved stability was accompanied by a more balanced medial and lateral joint stability compared to multiple radius designs. This increased and balanced joint stability could offer a significant advantage for functional outcome of TKA:

REFERENCES
2. Wang et al., J Arthroplasty 2006

Figure 1: Deviation of frontal long-leg axis with varus/valgus stress of 6Nm (blue= multiple radius design of femoral component, red= single radius design of femoral component)

Figure 2: Deviation of distance between medial epicondyle and tibial bone cut with varus/valgus stress of 6Nm (blue= multiple radius design of femoral component, red= single radius design of femoral component)

Figure 3: Deviation of distance between lateral epicondyle and tibial bone cut with varus/valgus stress of 6Nm (blue= multiple radius design of femoral component, red= single radius design of femoral component)