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What causes the decreased dislocation rate of larger femoral heads in total hip arthroplasty? Range of Motion, Jump Distance or Stability due to atmospheric pressure? An experimental study.

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INTRODUCTION: Although there is so far no evidence, the use of larger femoral heads in total hip arthroplasty (THA) seems to significantly reduce the risk of dislocation. In the literature this is attributed to increased Range of Motion before impingement and to increased Jump Distance of the femoral head till dislocation. Our earlier experimental studies showed however a significant rise in the joint stability due to atmospheric pressure proportional to the second power of the diameter of femoral head.
OBJECTIVES: The aim of this study was to measure both the technical ROM (tROM) as the stability of 6 different hip joint models with 22 to 44 mm diameter and to discuss the main reason of reduced dislocation risk of larger femoral heads in THA.
METHODS: Joint models with 22 (a), 28 (b), 32 (c), 36 (d), 40 (e) and 44mm (f) ball diameter were investigated. The tROM was measured till impingement (tROM-A) and till dislocation (tROM-B). The maximum movement angles were analysed with special software. The tROM-A- and tROM-B-Values were compared with those of the 28mm joint model. Later on the 6 joint models were sealed hermetically with capsules, exhausted from air, filled with defined amount of water and exposed to an increasing traction force till dislocation occurred (traction experiment). The applied force and resulting dislocation were continuously measured with sensors. In another experimental set-up the 6 joint models were levered out till dislocation, while the applied torque and the resulting dislocation were continuously measured too (lever experiment). More than 20 experiments were performed for each joint model. The maximum values of required forces and torques for dislocation were detected.
RESULTS: The required traction forces for dislocation of the different joint models were 65.6N (a), 92.8N (b), 109.3N (c), 133.6N (d), 172.2N (e) and 192.7N (f). This corresponds to70.7% (a), 117.8% (c), 144% (d), 185.6% (e) and 207.6% (f) relative to the 28mm joint model. The maximum values of torque in the lever experiment were 1.08Nm (a), 1.94Nm (b), 2.59Nm (c), 3.27Nm (d), 4.45Nm (e) and 4.73Nm (f). This corresponds to 55.7% (a), 133.5% (c), 168.6% (d), 229.4% (e) and 243.8% (f) in relation to the 28mm joint model.
The tROM-A values were 113.4° (a), 122.6° (b), 131.2° (c), 134.6° (d), 141.8 (e) and 145° (f). This corresponds to92.5% (a), 107% (c), 109.8% (d), 115.7% (e) and 118.3% (f) relative to the 28mm joint model. The tROM-B values were 212.6° (a), 218.8° (b), 226° (c), 248.4° (d), 246.2° (e) and 248.2° (f). This corresponds to97.2% (a), 103.3% (c), 113.5% (d), 112.5% (e) and 113.4% (f) in relation to the 28mm joint model.
CONCLUSION: Comparing the joint models of 28 and 44mm diameter we found an moderate increase in tROM-A by 18,3% and in tROM-B by 13,4%. In contrast, we identified a sharp increase in the stability by 107.6% (traction experiment) and by 143,8% (lever experiment). The high absolute values of the tROM-B and the small differences in the jump distance must be considered too. The enormous increase in the stability due to atmospheric pressure suggests, that this parameter plays an important - perhaps the decisive - role in reducing the risk of dislocation using larger femoral heads in THA. This could be very important for the further development of THA.

Disclosure of Interest: None Declared

Keywords: atmospheric pressure, ball diameter, dislocations, jump distance, Range of Motion, stability, THA