Accuracy of cup positioning and achieving desired hip length and offset following robotic THA

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Introduction

- In total hip arthroplasty (THA), poor acetabular cup position can lead to instability, impingement, accelerated wear, and suboptimal hip mechanics.
- Similarly, leg length discrepancy after THA can contribute to poor hip function and patient dissatisfaction.
- Robotic THA has the potential to accurately place the cup, restore the center or rotation, and achieve the planned post-operative hip length and offset
- This study aims to determine the accuracy of the cup inclination, cup version, hip length and offset.

Material and methods

- Five surgeons performed THAs on 21 cadaveric hips using press-fit implant systems using one of three approaches (Table 1)
- A pre-operative CT of each hip was taken with 1mm slices of the full pelvis and proximal femur (to approximately 200mm below the lesser trochanter) and 5mm slices through the knee.
- Using the CT-based pre-op planning software, the surgeon then reviewed the cup and stem with options for stem type (standard or high-offset), head diameter, head length, and liner type (neutral or offset).
- At final reduction, the MAKO hip software displayed the final cup position, hip length and offset changes relative to both the pre-op native hip and contralateral hip.

Table 1. Methods

Surgeons=5	N=21
Approach	7 Posterior Lateral, 3 Anterior Lateral, 11 Direct Anterior
Pelvic Tracking	7 In-Wound, 14 Iliac Crest
Femoral Workflow	9 Express, 12 Enhanced

Methods

- Throughout the procedure implant positional values were recorded.
- At implantation, the MAKO hip software displayed the cup position, hip length, and offset changes relative to both the pre-op native hip and contralateral hip.
- Post-operative x-rays were performed, but accuracy measurements were measured on the CT scans.
- Post-operative CT scans were segmented into 3D models of the operative side pelvis, operative femur, contralateral femur, stem, and cup.
- Post-operative CT measurements were taken of the final cup position, hip length, and offset changes relative to both the pre-op native hip and contralateral hip.
- All of the post-op parameters were then compared with corresponding intra-operatively displayed and/or pre-operative planned values to determine the accuracy of the MAKO system.
- Absolute errors were calculated for each parameter.

Results

- Twenty-one robotic cadaver THAs were analyzed for cup position, hip length, and offset.
- Cup position vs. planned
  - M/L: 1.4±1.1mm
  - A/P: 1.3±1.1mm
  - S/I: 1.4±1.2mm.
- Cup orientation vs. intra-op plane:
  - Inclination: 2.7±2.2°
  - Version: 2.2±1.4°.
- Reduction results:
  - Hip length: 1.6±1.2mm
  - Combined offset: 1.3±0.8mm

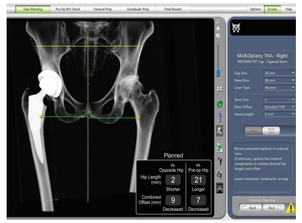

Fig. 1
MAKO preoperative simulated surgical plan (left)

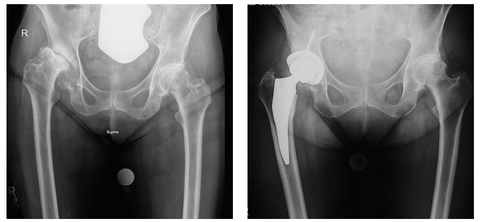

Fig. 2
AP Pelvis x-rays: preoperative radiograph (middle) and postoperative (right)

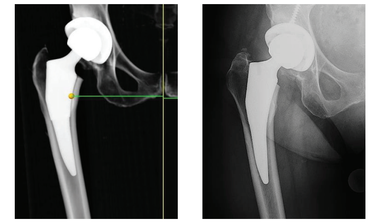

Fig. 3
Comparison of simulated pre-operative x-ray and post-operative x-ray

Conclusions

- Robotic THA provides excellent accuracy and precision with regard to planned cup position, hip length, and offset.

Reference:
Perets I, Walsh JP, Close MR, Mu B, Yuen L, Domb BG. Robotic-arm assisted total hip arthroplasty: clinical outcomes and complication rate. Int J Med Robotics Comput Assis Surg. 2018; 1-8.