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A Detailed Analysis of Time taken in Robotic Surgery for Total Hip Replacement Arthroplasty and Comparison with Computer Assisted Navigation in Total Hip Replacement Arthroplasty

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Abstract

The accuracy of implantation using navigation and robotic hip replacement (THR) has been proven and accepted. Time taken for the use of technology, has been one of the major factors quoted by many surgeons for not using it. Aim was to analyse the time taken during different steps of the procedure and identify which part needs further improvement. Secondary aim was to compare the time with computer navigation technology. 20 total joint replacements were carried out with MAKO robotic system using extended software version, which includes both acetabular and femoral guidance. The times of different surgical steps were noted. After the incision was made, and joint exposed the trackers for the pelvis and femur were then inserted, tightened and verification pins inserted. Femoral registration matching was started at 15 minutes (SD5.4 Range7-22). Femoral Neck Cut level was made at 22.5 minutes (SD4.5 Range15-29). It took mean 7.5 minutes to match the femoral anatomy to preop CT scan anatomy. Pelvic registration matching was done at 42.4 minutes (SD5.9 Range33-50). It took average 8.4 minutes to match pelvic anatomy. Bone reaming was with robotic arm at 50.8minutes (SD5.5 Range40-57). The cup was impacted at 56.2 minutes (SD5.2 Range45-60). Cementing stem added 14 minutes. The navigation hip replacement surgery took mean 60 minutes in uncemented and 72minutes for cemented stems. Robotic technique took 10 minutes longer. There is room for improvement in two main modifiable steps. Total registration matching time which took 16 minutes and using a uncemented stem. Should time constraint supersede accuracy achievable with technology?

Introduction: The accuracy of implantation using computer assisted navigation (1,2,3) and robotic (4,5,6) total hip replacement arthroplasty (THR) has been proven and accepted. The time taken for the use of technology during surgery, has been one of the major factors quoted by many surgeons for not using and accepting the technology in the procedure. Aim of the present study was to analyse the time taken during different steps of the procedure of THR, one by one and identify which part needs further improvement. Secondary aim was to compare the time take for use of robotic technology compared to the computer navigation technology. Methods: 20 total joint replacements were carried out with MAKO robotic system. MAKO offers the choice of either using an acetabular only software version or an extended software version, which includes both acetabular as well as femoral tracker insertion and preparation with the robotic guidance. We used the extended software for both the cup and femoral preparation. We analysed both the cemented and uncemented stems. The cup was uncemented for all the patients. All patients had a CT scan preoperatively to plan the surgery. The times of different surgical steps were noted by a person who did not leave the theatre at any time during the procedure and paid attention to the different steps involved to record accurately. We also looked at the total time taken for using an imageless computer navigation technique for doing the THR. Results and Discussion: Anaesthesia is usually given in a prep room and then the patient is brought into the operating room. Patient in operating room to Incision time was 12.7 minutes (SD 4.6 Range 9-22). This time includes preparing the patient and draping along with a surgical pause. During this time the surgeon is scrubbing and getting ready as well. A posterior mini approach was used with posterior L shaped capsulotomy and stay sutures for the capsule. After the incision was made, and joint exposed, the trackers for the pelvis and femur were then inserted, tightened and verification pins inserted. Femoral registration matching was started at 15 minutes (SD 5.4 Range 7-22) post incision. Femoral Neck Cut level was guided by the robot and was made at 22.5 Minutes (SD 4.5 Range 15-29) post incision. It took 7.5 minutes on an average to match the femoral anatomy to the pre op CT scan anatomy. Once the matching was accepted to required accuracy and neck cut was made, the femoral broaching done at 25.2 minutes (SD 6.62 Range 15-33) post incision. The broaching step only took an average of three minutes. This part of the procedure is surgeon performed and the final broach position is recorded with the robot. Next step was then taken to prepare the acetabulum. The acetabulum was prepared with taking off the labrum and cleaning the fossa fat from floor and removing any soft tissues that can come in the way for the cup preparation and seating. Pericapsular tissues optimised for taking the points for matching. Pelvic registration matching was done at 42.4 minutes (SD 5.9 Range 33-50) post incision. It took on an average 8.4 minutes to do the registration matching. Bone reaming was with robotic arm at 50.8 minutes (SD 5.5 Range 40-57) post incision. The cup was impacted at 56.2 minutes (SD 5.2 Range 45-60) post incision. It only took 5.5 minutes to bring in the prepared robotic arm to the table, adjust and lock the position of the robotic arm, do the verification check of the robotic arm and pelvis, make sure the soft tissues are not in the way, ream with one to two reamers, prepare the cup for final seating and changing the reamer handle to the cup insertion handle at the robotic arm, screwing the cup to the cup insertion handle and impacting the cup to the acetabulum. Although one can use only one reamer but with hard bone especially, we prefer to use one undersized reamer first before the final reamer. Once the cup was seated and stable, liner was inserted, and a good fit was ensured. The femoral stem was then inserted in already prepared femoral canal, if it was uncemented. If it was cemented the preparation of the femur was done for cementing, cement restrictor inserted, and final stem seated. Cementing was done at 65.6 minutes (SD 4 Range 62-70) post incision. Then the trial reduction was done, clinical tests done for stability, leg length, range of movements, telescoping and final neck size determined. A definitive head inserted onto the stem. Hip joint was then reduced, and washout was done. Final parameters were checked, and the surgical wound was closed in layers with drill holes in bone to stay sutures for capsule. Skin wound was closed by 75.2 minutes (SD 9.7 Range 60-90) post incision on an average. For uncemented stems

wound was closed by 69.2 minutes (SD 7.3 Range 60-78) of the start. For the cemented stems wound was closed by 83.3 minutes (SD 5.7 Range 80-90). Cementing of the stem added 14 minutes to the procedure. The computer navigation hip replacement surgery took 60 minutes on an average for uncemented stems and 72 minutes for the cemented stems. Compared to navigated hip replacements the robotic technique took approximately 10 minutes longer. While looking at different stages of the procedure there is room for improvement in various steps. The familiarity of all the staff involved with the system should undoubtedly increase the speed and efficiency of the procedure at all the steps. As these were part of the early implantations for MAKO robotic THR, learning curve for time might improve these. There were two main steps, which took time and could be modified. One is registration matching time which took 16 minutes for the bone anatomy matching procedure including femoral and acetabular matching. The other is using a uncemented stem which will cut down about 14 minutes, but there are constraints of the cost involved, suitability of the bone bed and training and preference of the surgeons for a suitable stem. At final conclusion the robotic procedure of THR takes longer than the navigated techniques. There are various parts of the step which can be modified to make it faster. However, the question is, how much time you can spend Vs the gain in accuracy of the implantation. Of course, the answer of the patient and the surgeon may be different, although it should not be.

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