THE ACCURACY OF A ROBOTICALLY-CONTROLLED FREEHAND SCULPTING TOOL FOR UNICONDYLAR KNEE ARTHROPLASTY

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Abstract

Knee osteoarthritis results in pain and functional limitations. In cases where the arthritis is limited to one compartment of the knee joint then a unicondylar knee arthroplasty (UKA) is successful, bone preserving option. UKA have been shown to result in superior clinical and functional outcomes compared to TKA patients. However, utilisation of this procedure has been limited due primarily to the high revision rates reported in joint registers. Robotic assisted devices have recently been introduced to the market for use in UKA. They have limited follow up periods but have reported good implant accuracy when compared to the pre-operative planned implant placement.

UKA was completed on 25 cadaver specimens (hip to toe) using an image-free approach with infrared optical navigation system with a hand held robotically assisted cutting tool. Therefore, no CT scan or MRI was required. The surface of the condylar was mapped intra operatively using a probe to record the 3 dimensional surface of the area of the knee joint to be resurfaced. Based on this data the size and orientation of the implant was planned. The user was able to rotate and translate the implant in all three planes. The system also displays the predicted gap balance graph through flexion as well as the predicted contact points on the femoral and tibial component through flexion. The required bone was removed using a bur. The depth of the cut was controlled by the robotically controlled freehand sculpting tool.

Four users (3 consultant orthopaedic surgeon and a post-doctoral research associate) who had been trained on the system prior to the cadaveric study carried out the procedures. The aim of this study was to quantify the differences between the 'planned' and 'achieved' cuts. A 3D image of the 'actual' implant position was overlaid on the 'planned' implant image. The errors between the 'actual' and the 'planned' implant placement were calculated in three planes and the three rotations. The maximum femoral RMS angular error was 2.34°. The maximum femoral RMS translational error across all directions was up to 1.61mm. The maximum tibial RMS angular error was 2.60°. The maximum tibial RMS translational error across all directions was up to 1.67mm.

In conclusion, the results of this cadaver study reported low RMS errors in implant position placement compared to the plan. The results were comparable with those published from clinical studies investigating other robotic orthopaedic devices. Therefore, the freehand sculpting tool was shown to be a reliable tool for cutting bone in UKA and the system allows the surgeon to plan the placement of the implant intra operatively and then execute the plan successfully.