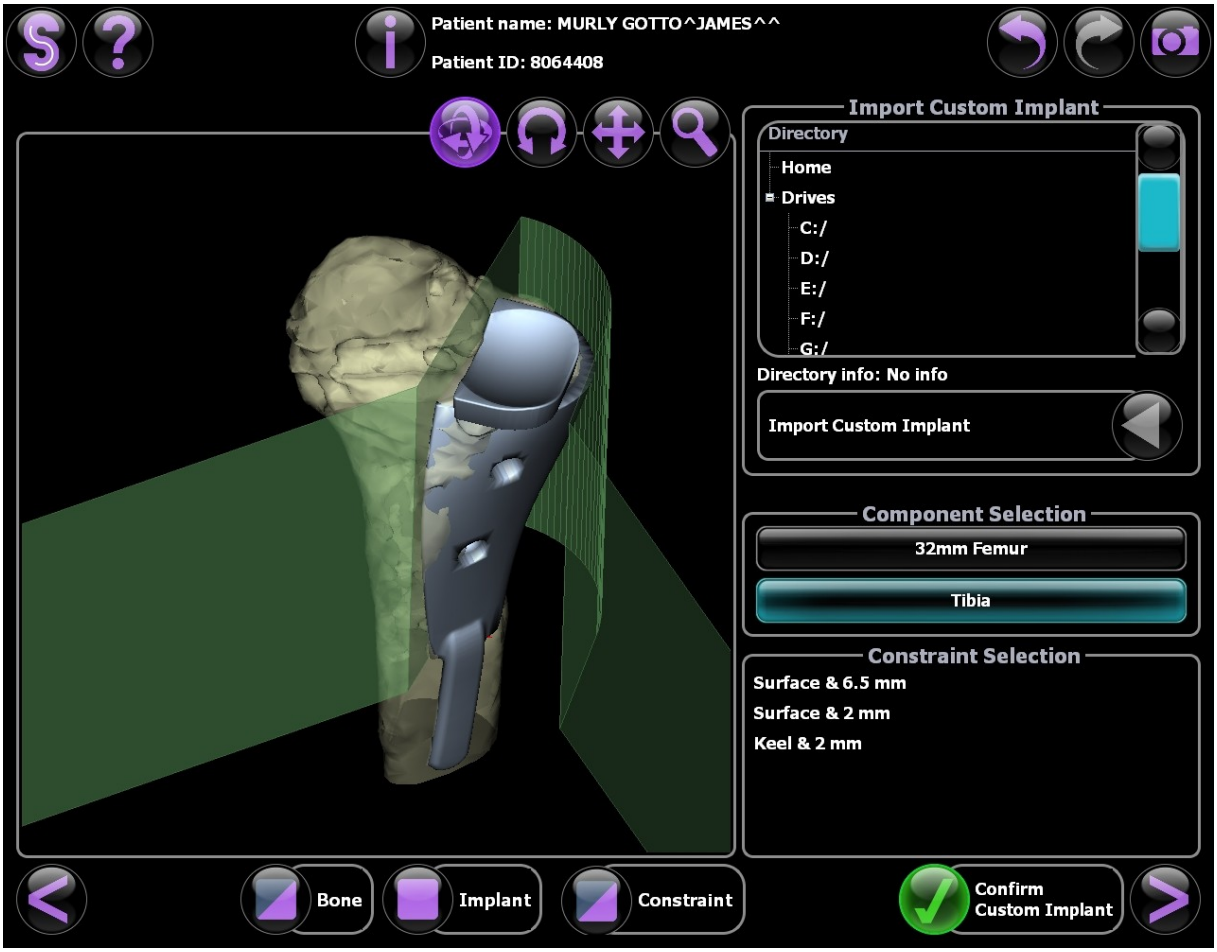
Robot-assisted, custom-made massive medial unicondylar knee arthroplasty for traumatic bone and joint loss

ANDREWS BL[1], SUNMUGAM S[2], FLOYD D[3], AQIL A[1], COBB JP[1]

[1]*MSK Lab, Charing Cross Hospital, Imperial Healthcare NHS Trust, London, UK*
[2]*Stanmore Implants Worldwide, Elstree, UK*
[3]*Royal Free Hospital, London, UK*

barrylandrews@me.com

Background: A 26 year-old soldier, serving in Afghanistan, sustained a high-velocity gunshot wound to his right knee. After debridement and external fixation of his open fracture in the field, he was repatriated to the UK. He underwent open reduction and internal fixation of the femur prior to the application of a circular frame to the tibia. The frame was removed after 14 months, when the bone was judged to have united and stable soft-tissue coverage was obtained. However, massive intra-articular bone loss of the medial femoral and tibial condyles resulted in chronic pain, instability and difficulty walking. 18 months following his injury, he still had an antalgic gait, correctable varus and a 10° flexion deformity due to soft-tissue contractures. He was unable to walk without two crutches. His patella and trochlea were undamaged and his lateral compartment was clinically acceptable. The cruciate ligaments were difficult to assess.



Methods: A massive unicondylar prosthesis, including tunnels for ACL and PCL grafts, was planned and made from 3D-CT reconstruction. The aim was to restore the medial tibia and femur with minimal

bone removal, based upon the capabilities of the Sculptor robot (Stanmore Implants Worldwide, UK). The implant was contoured to fill the bony defects of medial tibia and femur and to restore the joint line. A fixed UHMWPE bearing was selected, with variable inserts to optimize alignment. A combined orthopaedic and plastic surgical team performed the operation. Intra-operatively, the free flap was reflected posteriorly, and all existing femoral metalwork was removed. The limb was connected to the tracking arm of the robot by bone pins. The bone was prepared using a high-speed burr under robotic control, to match the curved surfaces of the implant. Preparation of the tibia preceded that of the femur. Progress was determined visually by the "painting" of an image displayed on a monitor. The image included active-constraint boundaries. The implant was fixed using screws and hydroxyapatite coating. The knee was determined to be stable in both coronal and sagittal planes following insertion of the chosen bearing, and ligament reconstruction was deemed unnecessary. Soft-tissue coverage was achieved. A post-operative regime of protected early weight-bearing was followed.

Early Results: Six weeks post-operatively, the patient is walking with crutches, without instability or significant pain, and has regained flexion to 90°. Soft-tissues remain viable. Radiographs show satisfactory component position with a tibio-femoral angle of 180°

Conclusion: Robot-assisted reconstruction of massive osteoarticular defects using patient-specific tibial and femoral implants has not previously been reported. The technology enables the surgeon to address irregularly-shaped osteochondral bony defects and reconstruct them, while preserving normal tissues. This technique offers the prospect of a higher-performing and more conservative option in limb reconstruction for injured servicemen.

References

1. Cobb J, Henckel J, Gomes P, Harris S, Jakopec M, Rodriguez F, et al. Hands-on robotic unicompartmental knee replacement: a prospective, randomised controlled study of the acrobot system. J Bone Joint Surg Br. 2006 Feb.;88(2):188–197.
2. Rose B, Bartlett W, Blunn G, Briggs T, Cannon S. Custom-made lateral femoral condyle replacement for traumatic bone loss: a case report. Knee. 2010 Dec.;17(6):417–420.