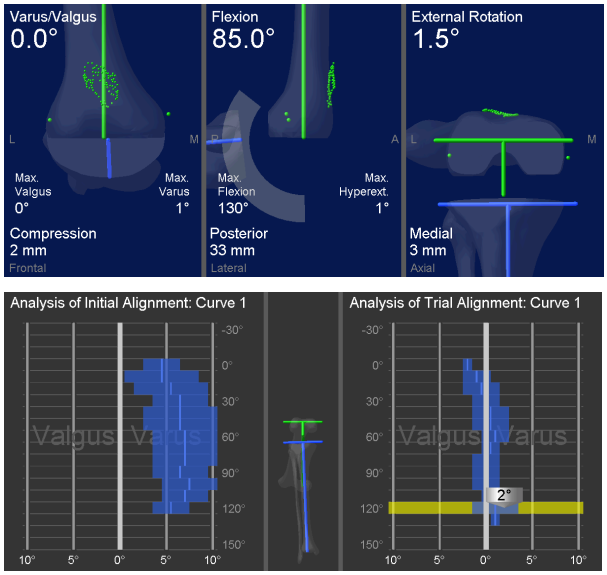
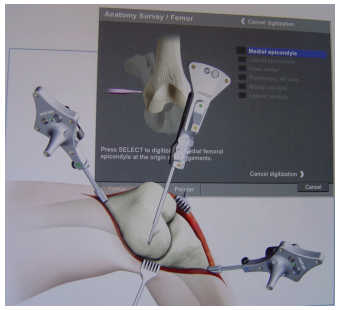
Computer Navigated Knee Replacement Surgery

The use of computers and image guided techniques is the latest revolution in orthopaedic surgery. The technology is most developed for replacement of arthritic knee joints.

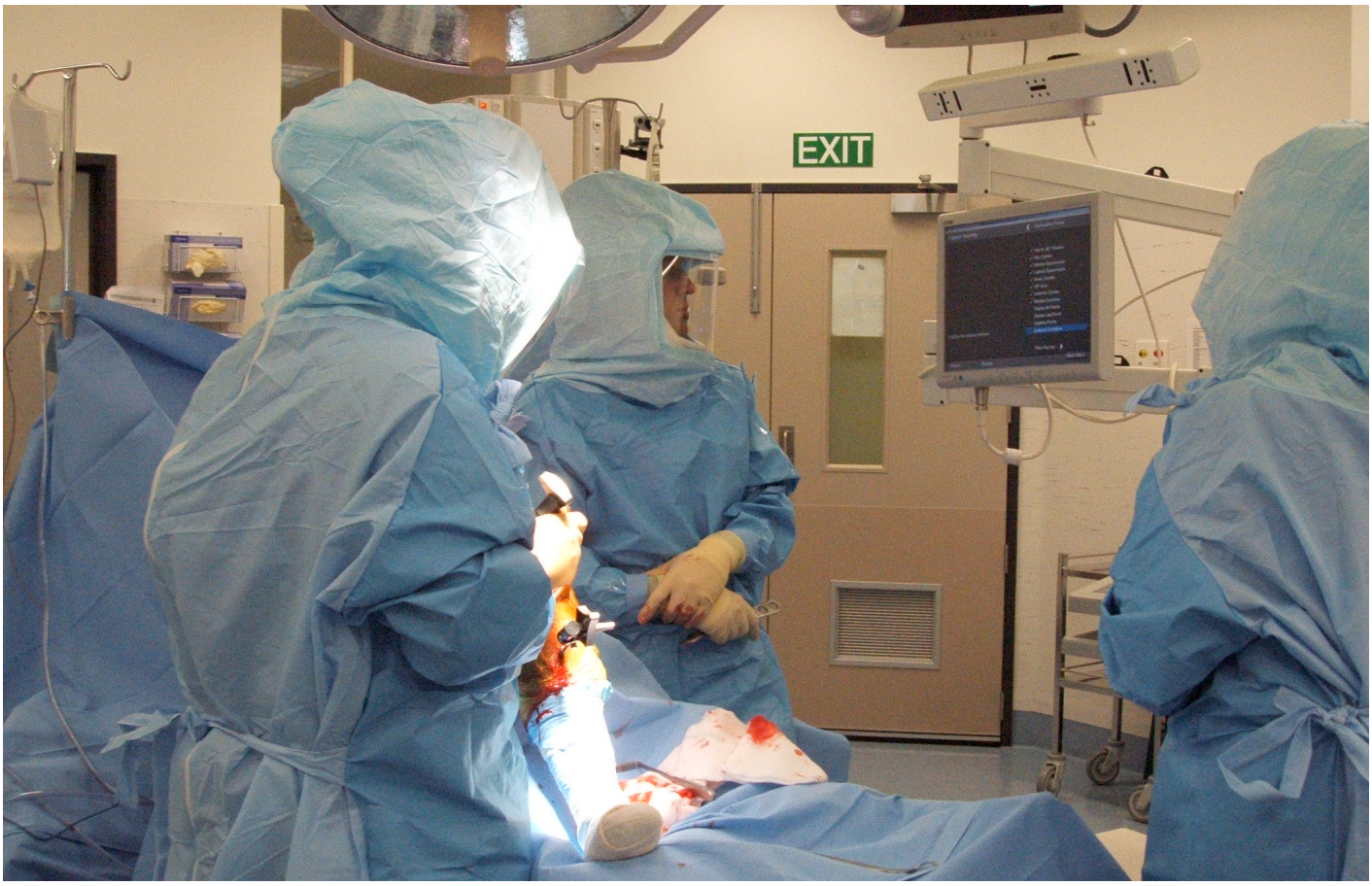


Rob Sharp is a UK trained orthopaedic surgeon specialising in hip and knee joint replacement surgery. He is in public practice at North Shore Hospital and private practice on Auckland's North Shore. He has been involved in use and development of computer navigated orthopaedic surgery since early 2004.

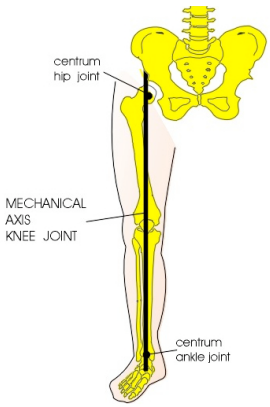
Modern knee replacements have been implanted since the early 1970s with designs modified and improved over time. Knee replacement is now more commonplace than total hip replacement. The operation involves making cuts in the bone to allow metal components to fit on to the end of the femur and top of the tibia. A polyethylene bearing between the components completes the joint. Sometimes it is necessary to resurface the underside of the kneecap with a plastic 'button'. It is also important for the surgeon to balance the ligament tension of the new knee and to ensure that the gaps between the femur and the tibia are equal in flexion and extension. Correct alignment of the component ensures that the polyethylene bearing is loaded equally to prolong the life of the replacement. Knees have traditionally been aligned using jigs either loosely clamped on to the outside of the leg or referenced from rods placed in the middle of the bones. The majority of knees can be implanted in a satisfactory position using this older technology. However, a proportion of components may be mal-aligned, potentially leading to poorer function and earlier failure. Placement of large rods in the middle of the tibia and femur can also have detrimental physiological effects including respiratory difficulties and post operative confusion.



Computer navigation surgery requires small pins to be placed into the femur and tibia



allowing attachment of infra-red ‘trackers’. A hand-held pointer is then used to identify the joint surface and various anatomical landmarks around the knee. The centre of the hip is calculated and the midpoint of the ankle defined. The computer is then able to work out the weight bearing axis of the limb and build up a three dimensional model of the knee and it’s movement characteristics. The same trackers are used to position cutting jigs to allow the surgeon to make accurate bone cuts for placement of the components in the correct alignment and orientation. Knee movement data can be recorded for trial components and minor adjustments made. Once the new knee has been implanted it’s movement characteristics can be saved digitally. Our understanding of knee replacement positioning and function will improve with analysis of this information. In the future there are likely to be ‘smart’ implants which will be able to transmit data about loading, number of cycles and any loosening or change in position of the components.



From a patient’s perspective, the components are identical to those implanted conventionally, however, the alignment of the limb should be more accurate and together with soft tissue balancing, the new knee is likely to be more stable. Navigation may require extra small incisions in the tibia for placement of the tibial pins. The pins in both the femur and tibia are associated with a very low risk of fracture and infection. Surgical time is slightly longer with navigation depending on the surgeon’s familiarity with the technology, although the differences are getting less.

Computer assisted orthopaedic surgery is a very exciting development. Navigation systems are being used for hip replacement surgery, fracture fixation and spinal surgery. As in all other aspects of modern life, the influence of computer technology is likely to proceed at a rapid pace over the next few years.

Rob Sharp