RADIOSTEREOMETRIC ANALYSIS

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Radiostereometric analysis (RSA) is an accurate computer-assisted technique for establishing the position of markers in 3D space after implantation, calculating accurate relative positions in space between the implanted markers rather than absolute position using two 'stereo' radiographs. The technique requires the use of modified implants containing tantalum markers (usually referred to as 'beads') which are attached in groups of at least three to each component of the implant to allow the position of each 'segment' to be located within 3D space.

Orthopaedic applications for the system are many and RSA is commonly used in joint arthroplasty to establish features such as wear,[1] component subsidence (as a surrogate for fixation)[2] and even to establish relative motion of fracture fragments.[3] In this edition of *360* we report on the use of RSA to establish the quality fixation in thumb arthroplasty.

The technique can trace its roots back to London in 1898 when Davidson first used Roentgen beams to localise an object in space.[4] Much like the free body diagrams most orthopaedic surgeons are familiar with, the model makes a number of assumptions, including that of rigid bodies (that there is no deformation under load) which are designated as segments. The assumption of rigid bodies is essential as it allows displacement of the markers to be interpreted as translation or rotation. When combined with markers implanted into the surrounding bone or neighbouring component, extremely precise measurements can be made.

Tantalum markers in common use vary in size between 0.6 mm and 1.0 mm, with the smaller sizes offering increased accuracy but impaired visualisation when covered with a soft-tissue envelope. Larger markers are commonly used in the hip and pelvis and smaller markers in the knee and elbow.

The technology behind RSA is developing continuously and more modern systems do not always require separate markers, using the femoral head or acetabulum as surrogate markers. RSA is currently the gold standard technique for localising component (or rather, 'segment') positions and is able to detect migrations of around 0.2 mm[5], as compared with plain films which are limited to 5 mm and EBRA (Ein-Bild-Roentgen-Analyse) achieving accuracy of around 1.5 mm.[6] The use of RSA technology has allowed more accurate early evaluation of a prosthesis and is likely to prove useful in identifying a failing prosthesis prior to clinical failure. Given the increased sensitivity of RSA over plain radiographic studies, journals will often accept results at shorter (often two years) follow-up.

The benefits of RSA technology are not limited to the research environment, forming the basis for the 3D tracking technology used in navigated arthroplasty. In this case two stereo-optical images are used to map the position of markers in 3D space, a remarkably similar technique.

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