RadioStereometric Analysis (RSA) enables accurate three-dimensional measurements from radiographs. The three-dimensional kinematics of skeletal or implant movements can be determined between repeated examinations. RSA has a large field of applications – orthopaedics, pediatrics, odontology, plastic surgery, oncology, rheumatology, neuro surgery and hand surgery.

1. Marker Insertion
To obtain skeletal markers, spherical-markers made of tantalum are installed (0.5, 0.8, 1.0 mm). The material is biocompatible, i.e. it is well tolerated by the body and is readily observed as a distinct point in the radiograph. The UmRSA® Injector™ is used for insertion of tantalum markers during surgery. The markers are inserted into the anatomic structure in question, usually the skeleton.

Marking of the prostheses is preferable done by the manufacturer as a part of the manufacturing process.

2. Radiographic Examination
Two x-ray tubes, fixed or mobile, are used for simultaneous exposure of the patient together with the UmRSA® calibration cage. The calibration cage enables calculation of the 3D-positions of the tantalum markers.

3. Measurement
The markers are automatically identified and their positions are measured with high precision using UmRSA® Digital Measure. Advanced mathematical algorithms are used to obtain the two-dimensional position of the marker centre with high precision, even in case with low contrast and/or disturbance by nearby metal objects.

Attaching tantalum markers to prostheses may sometimes be difficult. Therefore we have developed a method for marker free measurement of prostheses, e.g. hemi-spheric cups.

4. Analysis
The UmRSA® analysis software is used to reconstruct the 3D-positions of the markers. Using 3D-positions from different examinations the 3D-motions of different segment, skeleton or prostheses, are calculated.

5. Conclusion
The high precision of the method facilitates early conclusions even in small studies with a short-term follow ups and a small sample of patients. This makes the studies very cost-effective.
Some applications in orthopaedics

Prosthetic fixation
Migration of hip orthoplasties or of other artificial joints exceeding 0.05–0.2 mm can be detected by RSA.

Growth problems
Child growth problems of the skeleton can be studied in detail for optimal treatment.

Determination of joint stability
The extent and direction of the instability is measured in order to determine its nature. RSA opens up new possibilities for judging the accuracy of various operations in order to stabilize a damaged joint.

Determination of joint kinematics
Detailed recordings of the three-dimensional joint movements may be performed. The influence of ligament injury or the kinematics of artificial joints may be studied.

Fracture healing
Fracture movements during the healing period may be studied. An evaluation of different treatment methods may be performed.

Prosthetic PE wear
Prosthetic PE wear during a period may be clinically investigated and analysed.

Ethical considerations

The insertion of tantalum markers is a considered, established and recognized method for many purposes. More than 10,000 patients have been studied during a period of 30 years without any complications. No adverse reaction after implantation of tantalum markers has occurred. Nevertheless, the potential risk of tissue damage during the insertion as well as infection and radiation doses have to be considered.

The tantalum markers are radio-opaque, so only a low x-ray dosage is required on each radiographic examination. For example, the x-ray dose from the two machines combined amounts to about one-fifteenth of a standard pelvic x-ray dose.