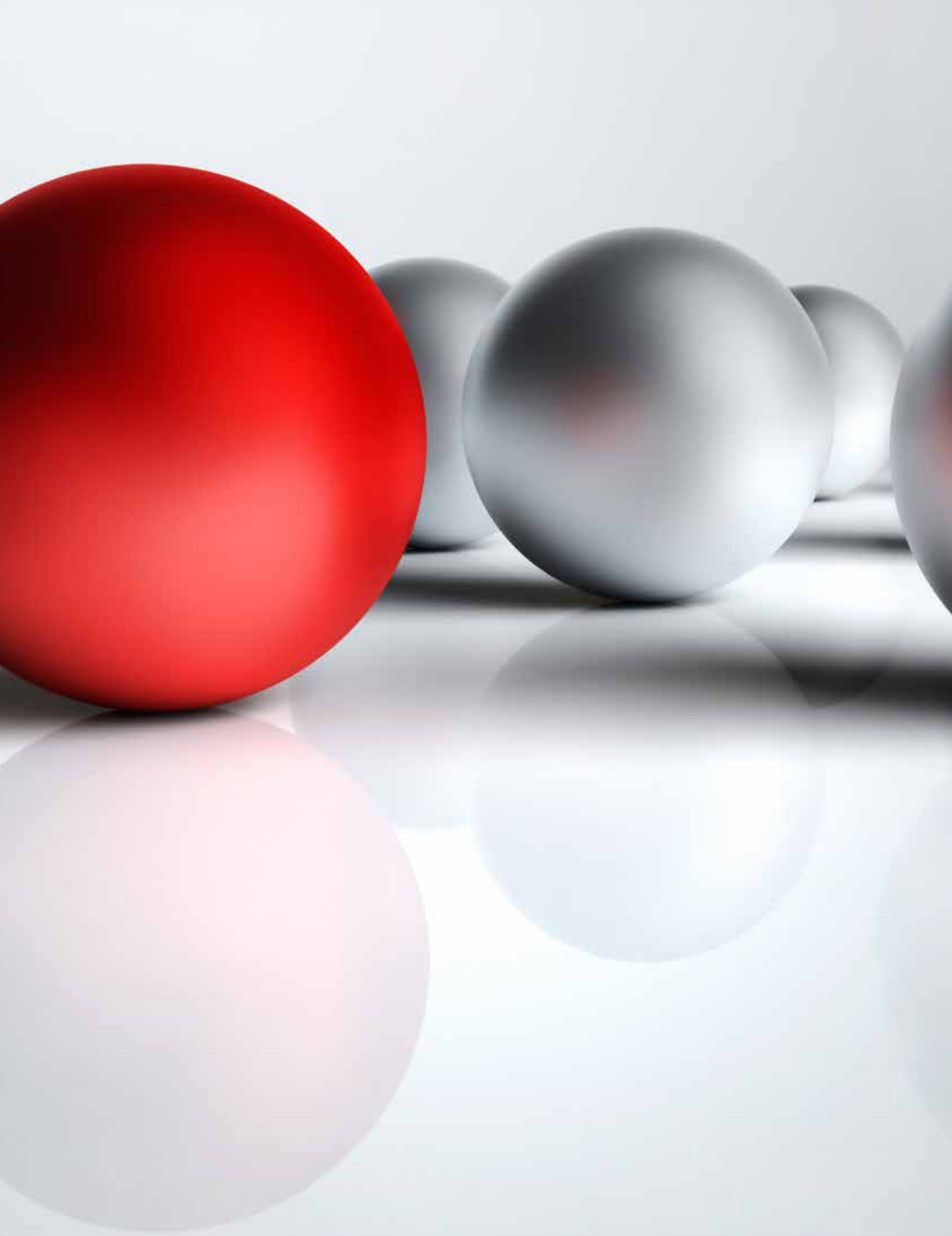

Radiostereometric Analysis in Orthopaedic Surgery

Paul Halfman, CST

The effectiveness of orthopaedic implants is dependent partly upon the maintenance of their anatomical position. Determining the relative position of implants to bony landmarks post operatively is difficult, if not impossible. Radiostereometric analysis (RSA) helps determine migration and wear of orthopaedic implants using radiopaque tantalum beads, which are inserted into the bone during the surgical procedure. The element tantalum (Ta), with the atomic number 73, is both radiopaque and chemically inert.

A stereotype image is created by using simultaneous postoperative X-rays of the tantalum beads and the implants from two different directions. Using proprietary software developed by Leiden University, Halifax Biomedical constructs a 3D model. RSA allows physicians to determine the effectiveness of an implant and also could provide data for future implant design. Its application is not limited to use in total hip and knee arthroplasty, but may be utilized in other orthopaedic procedures in which implants are used including total ankle, shoulder and elbow arthroplasty, spinal fusion and fracture fixation. The beads can be placed in almost any bone for monitoring purposes.

For the purpose of this article, the focus of its use will be on the posteriorly approach of the total hip arthroplasty (THA). THA is usually recommended for patients with such disorders as osteoarthritis, rheumatoid arthritis and avascular necrosis.

LEARNING OBJECTIVES

- Identify which surgical procedures radiostereometric analysis benefits
- Outline the steps of inserting tantalum beads
- Review the procedure of a total hip arthroplasty
- Examine the replacement data regarding implants
- List the instruments and equipment needed for this procedure

REPLACEMENT DATA

Data on implant failure rates can be found in large registries such as the one complied by the Australian Orthopaedic Association. In its 2012 annual report on hip and knee replacement surgery, the Australian Orthopaedic Association's National Joint Replacement Registry analyzed the results of more than 713,000 primary and revision hip and knee replacements. Of the various types and combinations of hip implants observed, almost half of the 713,000 had a fewer than 5% revision rate for any reason after 10 years. In total knee arthroplasty, fewer than 5% of a quarter of the total had a revision rate after 10 years.

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The closest data base to a national registry in the United States is the American Joint Replacement Registry (AJRR), which is working to create a national center for data collection on primary and revision total joint replacements. The AJRR was incorporated in Illinois as a not-for-profit organization in 2009 and as of December 2012, it had enrolled 100 hospitals to participate in the program. According to the AJRR, more than 750,000 knee and hip replacements are performed annually and as many as 12% of those may need future revisions or replacements.

IMPLANTS

The surgical technologist must be able to assemble the implantation device on the sterile field and insert the bead cartridge/set. The bead inserter is a reusable, manual, orthopaedic instrument which inserts a 1mm diameter tantalum bead implant into the bone. It has five components, which are the piston, cap, main body, hub and the needle. The surgical technologist should visually inspect the device itself for damage and wear, check the needle for dullness or distortion and check the piston for deformation. Since this is a reusable device, the surgical technologist must ensure that all contaminants have been removed through steam sterilization. The sterilization container filter must be free of holes and moisture, and the indicator must display a positive reading for exposure to the sterilization process.

The most commonly observed damage due to normal wear with the bead inserter is a bent introducer. The surgical technologist needs to assemble the component parts without the bead cartridge and pass the piston through the needle to ensure functionality and that all component parts mate properly. The expiration date of the beads in the cartridge must be checked and serial numbers must be documented by the circulator.

TANTALUM BEADS

The tantalum beads are inserted into the bone prior to final articular implant positioning. There are 16 beads in each cartridge and they are inserted into the cancellous bone as close to cortical bone as possible. In an anterior/posterior radiograph, the radiopaque tantalum beads must not be obscured by the implant, and must be positioned at least 1.25 cm apart. The actual number and position of the tantalum beads is at the discretion of the surgeon.

CONSIDERATIONS

The surgical technologist may be required to inject the tantalum beads into the bone once the surgeon has positioned the implantation device. Positioning the device may require a mallet if the bone is very dense. In a total knee arthroplasty, the femur will typically receive 5 beads, the tibia 8 beads and the patella 3 beads. In a total hip arthroplasty, the femur and acetabulum will typically receive 8 beads each.

SURGICAL PROCEDURE

For this procedure, the patient typically is given a regional anesthetic, sedation and a urinary catheter. A time out is executed and the patient is placed in the appropriate lateral position with his or her arms extended on arm boards with pillows placed between his or her arms. A minimum of four staff members are required for the safe and correct positioning of the patient, during which the anesthesia care provider will control the patient's head and maintain his or her airway. The patient's skin is prepped after noting any possible allergies to the skin prep solution, followed by draping the patient.

A longitudinal incision roughly a little longer than 10 cm in length is made with a #10 blade on a #3 handle proximal to the greater trochanter and continued distally along the proximal femoral shaft. The Weitlaner self-retaining retractor and the Hibbs retractor are employed as the fascia is incised and hemostasis is achieved with an electrocautery device and heavy tissue forceps. The muscle fibers are separated using blunt dissection, the Weitlander self-retaining retractor is removed and a Charnley retractor is positioned. The size of the blades of the Charnley retractor must be appropriate for the depth of the incision. The electrocautery tip is removed and replaced by the extended tip. The rotator muscles of the hip are divided, and if scar tissue is present, it is excised. The joint is then dislocated by adduction, traction and internal rotation.

Homan retractors are inserted on either side of the proximal femur. A power saw, typcially a sagittal, is used to osteomize the femoral head, which is freed with a three-quarter-inch osteotome, and excised with a Lewin clamp. After the femoral head is excised, the acetabulum is further exposed by removing the Homan retractors and inserting and anterior and posterior retractor. The labrum is excised using a Kocher clamp and electrocautery and the acetabulum is reamed with a power drill mounted with a reaming handle extension. The reaming heads create a cup shape in the acetabulum. Once the acetabulum bone is reamed to an acceptable size, the RSA tantalum beads are implanted into the acetabulum and a cup prosthesis is inserted on a handle with a mallet. Special care at this time is taken to make sure implanted tantalum beads are not obscured by implants. This prosthesis may be anchored with screws so the surgical technologist should be prepared with a power drill, drill bit attachment, depth gauge, ruler and an articulating hand driver. After the prosthesis is securely in place, a cup liner is inserted and secured with a liner tamp of the appropriate size and a mallet. The posterior and anterior retractors are removed and the femur is prepared to accept an implant.

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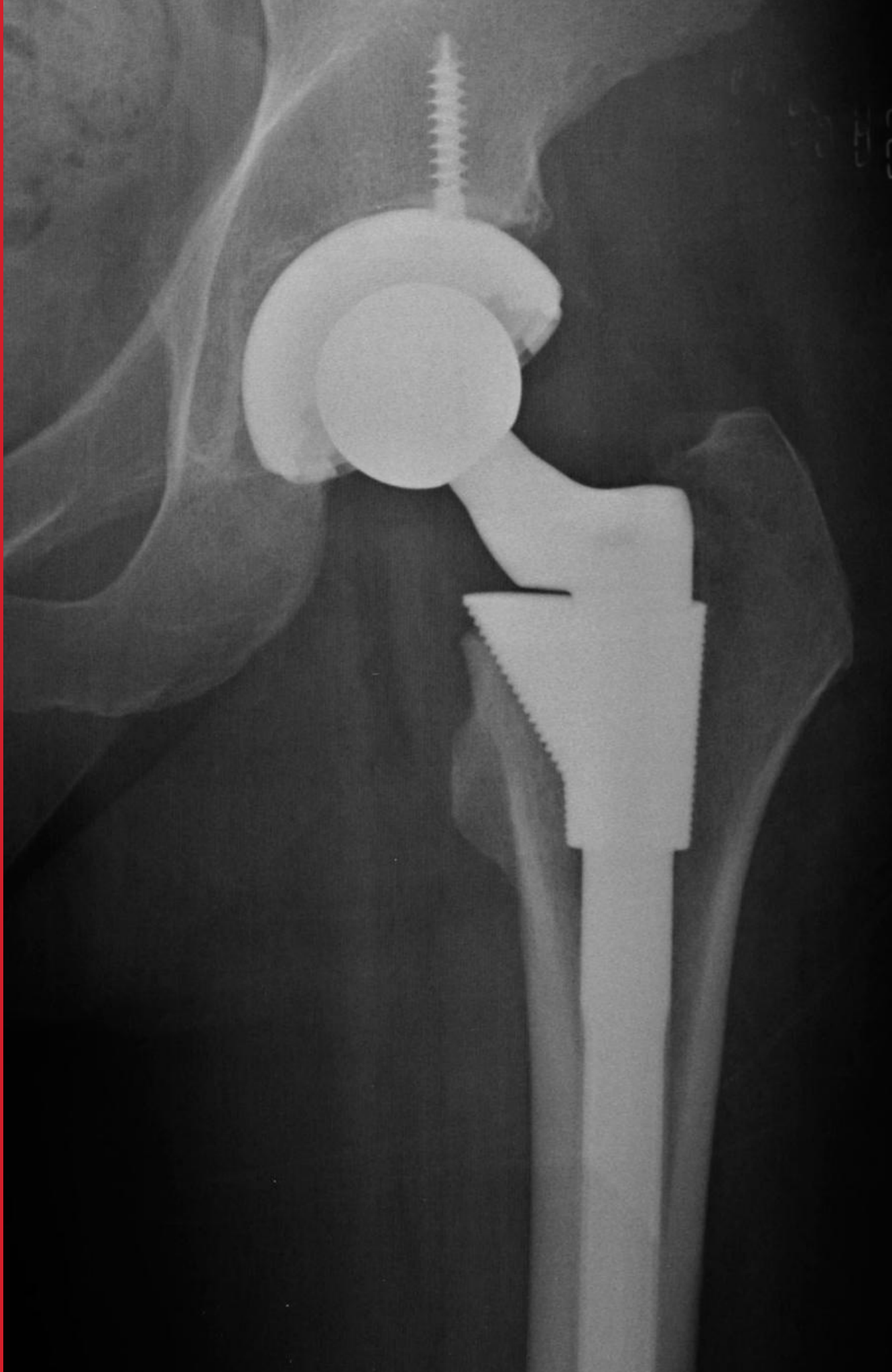
A femoral retractor is positioned medially and the proximal end of the femur is exposed. A Homan retractor also may be inserted to assist in retraction of tissue. A box osteotome and mallet are used to initiate the acceptance of the broaches and the femoral canal is found using a femoral canal finder on a T-handle. This is also known as a T-handle reamer. The surgeon then will begin compaction of the bone and create a pocket for the implant by inserting sequentially larger broaches, which are attached to a broach handle and driven with a mallet. The broaches are similar to the size and shape of the final implant that will be used. Once the appropriate size is reached, the broach handle is removed, a trial modular neck component is attached to the proximal end of the



The cup liner of a hip prosthesis shown on a X-ray

Courtesy KimvdLinde

prosthesis and a trial ball component is then attached to the neck. All retractors except for the Charnley are removed, and the relocation is performed. The surgeon then checks the range of motion along with leg length relative to the non-operative leg. Once these perimeters meet the surgeon's approval, the leg is dislocated, retractors are reinserted and the trial prosthesis is removed. At this point, the femur will receive the RSA implants as described earlier. After this is completed, the permanent femoral implants are inserted in a similar manner, the leg is relocated and all retractors are removed. A count is executed by the surgical technologist and the circulator and the wound is closed in layers. A 1-0 polyglatcin 910 on a pop-off cutting needle in the fascia, a 3-0 polyglatcin 910 on a pop-off cutting needle in the subcutaneous layer and staples on the skin may be used. The dressing may consist of an adaptic cover, a sponge, one to three abdominal pads and foam tape.

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POST-OPERATIVE PROCEDURE

After the dressings are applied, the drapes will be removed and the bed will be brought into the OR suite. The patient will be in the lateral position so the bed is locked into position at the posterior side. The transfer from the OR table to the bed requires a minimum of four staff members as the patient will be rolled onto his or her back and slid onto the bed. It is important to maintain the patient's leg position and not rotate the leg as this may cause dislocation. To prevent this from occurring, an abduction pillow can be positioned between the patient's legs prior to transfer from the OR table to their bed. Post-operative simultaneous angle views X-rays are taken and the patient is then transported to the recovery area. Once the surgeon deems the surgery successful by verifying from the post-operative X-rays and the patient has recovered from the procedure, the RSA imaging can begin.

RSA imaging protocols are different than standard imaging protocols in that the tantalum beads and the implants are the areas of interest and not the tissues. Post-operative images are taken periodically to track implant loosening or wear.

AUTHOR BIO

Paul Halfman, CST, works on the orthopaedic surgical team at Cadence Health Central Dupage Hospital in Winfield, Illinois. He is a member of the Perioperative Services Shared Governance Committee for Best Practice and has been elected to the official Preceptor Program. He received his bachelor's of science degree from Loyola University Chicago in chemistry and his associate degree from Robert Morris University Chicago in surgical technology.

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