PINNACLE™
ACETABULAR CUP SYSTEM

Surgical Technique

CERAMAX™
ULTAMET™
MARATHON™

FREEDOM TO

CHOOSE WITHOUT

COMPROMISE

DePuy
a Johnson & Johnson company

Contents

Introduction 3

Surgical Philosophy 4

Surgical Technique

- Templating and Pre-operative Planning 6
- Surgical Approach - Anterolateral 8
- Surgical Approach - Posterolateral 10
- Femoral Resection 12
- Acetabular Exposure 12
- Acetabular Reaming 13
- Acetabular Cup Trialing and Positioning 15
- Acetabular Trial Inserts 17
- Insert Configurations 18
- Implanting the Acetabular Cup 19
- Implanting the Acetabular Cup with Screw Fixation 20
- Implanting the Acetabular with Spikes 22
- Polyethylene Insert Insertion and Impaction 23
- Polyethylene Insert Extraction 25
- Ceramax™ Ceramic-on-Ceramic Insert Insertion 27
- Ceramax™ Ceramic-on-Ceramic Insert Extraction 29
- Ultamet™ Metal-on-Metal Insert Insertion 30
- Ultamet™ Metal-on-Metal Insert Extraction 32
- Functional Assessment 34
- Tight Exposure and Stability Tips 36
- Closure 37

The Pinnacle™ Acetabular Cup System was designed with the assistance of the following surgeons:

Dr William Barrett

Associate Clinical Professor, Department of Orthopaedics

University of Washington, Orthopaedic Consultants of Washington, Seattle, Washington, USA.

Dr Daniel Berry

Associate Professor of Orthopaedics, Mayo Medical School

Consultant in Orthopaedic Surgery

Mayo Clinic, Rochester, Minnesota, USA.

Dr Gregory Brick

Assistant Clinical Professor

Harvard Medical School

Orthopaedic Surgeon

Brigham and Women's Hospital, Boston, Massachusetts, USA.

Dr John Callaghan

Professor, Department of Orthopaedics

University of Iowa College of Medicine, Iowa City, Iowa, USA.

Dr Charles Engh

Clinical Associate Professor

University of Maryland School of Medicine, Baltimore, Maryland, USA.

Chairman of the Board/Staff Orthopaedic Surgeon

Anderson Orthopaedic Clinic, Alexandria, Virginia, USA.

Medical Director and Director of Hip Research

Anderson Orthopaedic Research Institute, Alexandria, Virginia, USA.

Dr Thomas Fehring

Co-Director, Charlotte Hip and Knee Centre

Charlotte Orthopaedic Specialists, Charlotte, North Carolina, USA.

Dr William Griffin

Co-Director, Charlotte Hip and Knee Centre

Charlotte Orthopaedic Specialists, Charlotte, North Carolina, USA.

Dr Thomas Schmalzried

Associate Director

Joint Replacement Institute at Orthopaedic Hospital, Assistant Professor of Orthopaedic Surgery

Chief of Joint Replacement

Harbor-UCLA Medical Centre, Los Angeles, California, USA.

Introduction

Hip reconstruction has become a successful answer for degenerative hip disease in a more demanding patient population. In addition, hip replacement provides mobility and pain relief to the younger patient with hip dysplasia or post-traumatic arthritis. Experience with total hip arthroplasty has resulted in a more comprehensive understanding of hip anatomy and biomechanics and advances in surgical technique. These advances have allowed the development of more efficient instrumentation and increasingly sophisticated implant designs that enhance clinical outcomes.

The Pinnacle™ Acetabular Cup System Primary Surgical Technique has been developed in consultation with an experienced surgeon design team and provides the surgeon with general guidance when implanting the Pinnacle™ Acetabular Cup System.

Surgical Philosophy

Pre-operative Planning

Pre-operative planning is essential for optimal prosthetic reconstruction of the hip joint. The Pinnacle™ Acetabular Cup System Templates enhance pre-operative planning by providing all cup profiles with the neutral and lateralised head centres identified.

Instrumentation

Executing the pre-operative plan requires exact surgical technique and precise surgical instrumentation. The Quickset™ Grater and Screw Instrumentation Systems, combined with the Pinnacle™ Acetabular Cup System Insertion and Trialing Instrumentation, are designed to function in concert for maximum efficiency and precision.

Fixation

Without initial and long-term component fixation, a surgeon's efforts to restore joint function are lost. With the Pinnacle™ Acetabular Cup System, fixation is achieved through 180 degrees of either Porocoat® Porous Coating or DuoFix™ Hydroxyapatite (HA) on Porocoat® Porous Coating. Unchanged in structure since its 1977 introduction, Porocoat® Porous Coating has established a clinical success record of more than 20 years.[1,2,3] DuoFix™ HA Coating has been in use for over 8 years.[4]

Restoration of Joint Biomechanics

Proper restoration of joint biomechanics positively impacts clinical outcomes, reduces wear and enhances function. Biomechanical restoration involves both the acetabular and femoral sides of joint reconstruction. The Pinnacle™ Acetabular Cup System Trials, Implants and Insert Alternatives, allow the surgeon maximum flexibility to work with virtually any DePuy femoral component and facilitate biomechanical restoration.

Modularity

Adding enhanced modularity, Pinnacle™ Acetabular Cup System incorporates the unique Variable Implant Prosthesis (VIP) taper which supports optimum performance for both ceramic and metal inserts, without compromising the dome loading that is critical to polyethylene inserts.

Wear Reduction

The Pinnacle™ Acetabular Cup System's microstability, congruency at the polyethylene insert/cup interface and bearing surface alternatives were developed to minimise wear.

The Pinnacle™ Acetabular Cup System combines optimal cup/polyethylene insert congruency to help minimise micromotion with standard polyethylene and Marathon™ Cross-Linked Polyethylene Inserts. With the improved wear resistance of Marathon™ Cross-Linked Polyethylene, larger head diameters up to 36 mm can be used to improve functional range of motion and reduce the risk of dislocation, while maintaining adequate thickness of the polyethylene insert.

The Pinnacle™ Acetabular Cup System's Ultamet™ Metal-on-Metal Insert is manufactured from forged high-carbon wrought alloy. Precision controlled manufacturing of the bearing surfaces results in specially engineered articular surface clearances. Sophisticated manufacturing and advanced grinding and polishing techniques enable Ultamet™ Metal-on-Metal Inserts to achieve a very low surface roughness. All of these factors help contribute to exceptionally low wear rates.

The ceramic material offered with the Pinnacle™ Acetabular Cup System is Ceramax™ Ceramic, a composite material with a unique combination of toughness and structural integrity. Through an exhaustive process of assessment and testing, Ceramax™ Ceramic has been developed to incorporate the best characteristics of ceramics as implant materials. The outcome is a material with improved mechanical properties when compared to alumina, with the wear behaviour and excellent biocompatibility associated with the latter, and the articulation performance of ceramic-on-ceramic joints.

Templating and Pre-operative Planning

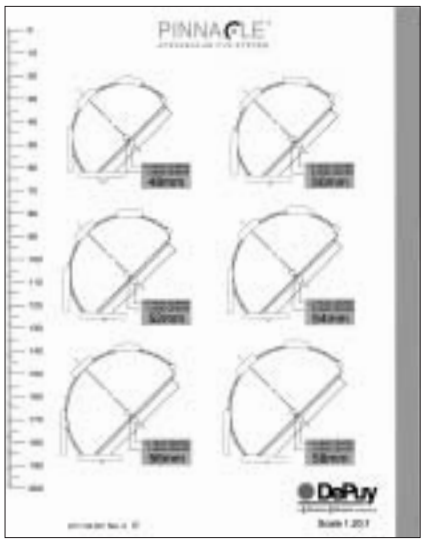

Figure 1a
Pinnacle™ Acetabular Cup System Template

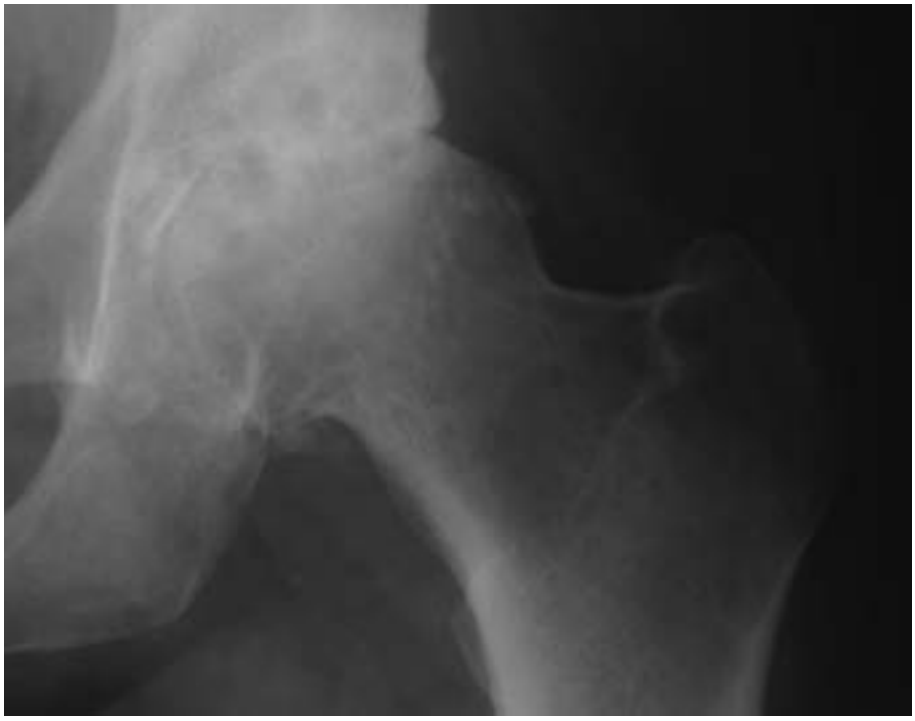

Figure 1b
Acetabulum with Good Lateral Coverage

The primary goal of total hip arthroplasty is the anatomic reconstruction of the hip joint, resulting in favourable prosthetic joint load and function. Mechanically, the goals are to create a stable articulation with an optimised range of motion, restore biomechanics for muscular efficiency and equalise limb lengths.

Meeting these goals begins with a thorough analysis of the hip with comparison to the contralateral side in anterior/posterior (A/P) and lateral projections. The desired magnification for all imaging should be 20 percent, which corresponds to the templates provided for the Pinnacle™ Acetabular Cup System (Figure 1a). Magnification markers taped to the patient's leg at the level of the trochanter will assist in determining actual magnification.

For the A/P projection, place both extremities in 15 degrees of internal rotation to position the head and neck parallel to the coronal plane.
Centre the beam on the symphysis pubis and ensure the proximal femoral shaft is included in the radiograph.
The radiographs should clearly demonstrate the acetabular configuration and the endosteal and periosteal contours of the femoral head, neck and proximal femur (Figure 1b).

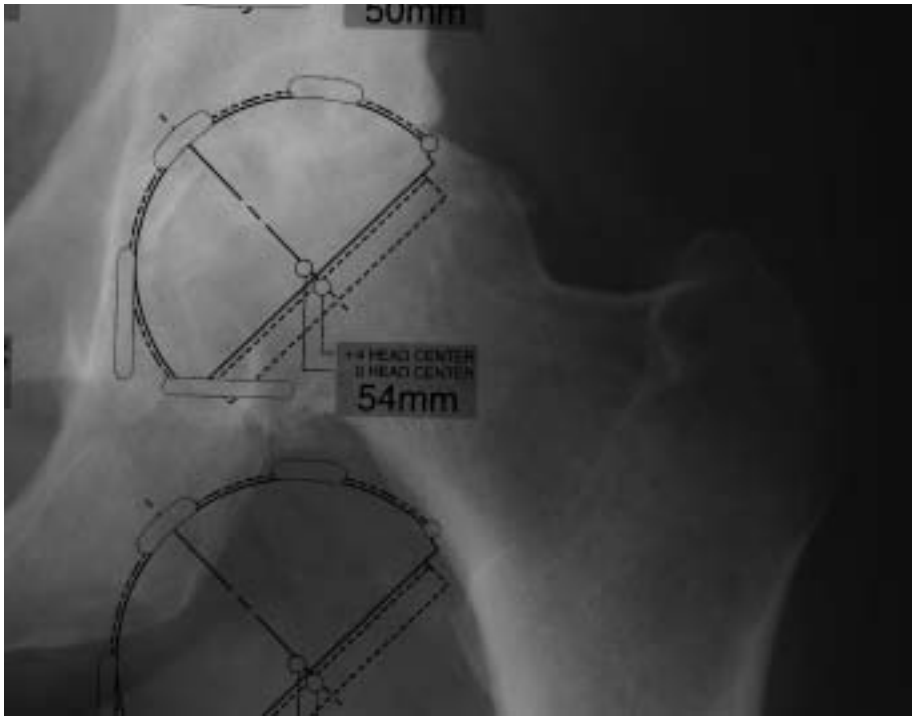

Figure 1c
Properly Positioned Acetabular Template

Frequently, the affected hip is fixed in external rotation, which leads one to underestimate the amount of offset present. In this situation it may be helpful to template the normal hip. Take into consideration any anatomical anomaly, dysplasia, previous fracture or leg length discrepancy.

The Pinnacle™ Acetabular Cup System Templates are oriented at 45 degrees and allow measurement of any hip that can be accommodated by the Pinnacle™ Acetabular Cup System Primary Components (48-66 mm).
Using the A/P radiograph, position the template 35-45 degrees to the inter-teardrop or interischial line so that the inferomedial aspect of the cup abuts the teardrop and the superior-lateral cup is not excessively uncovered (Figure 1c).

Anterolateral Surgical Approach

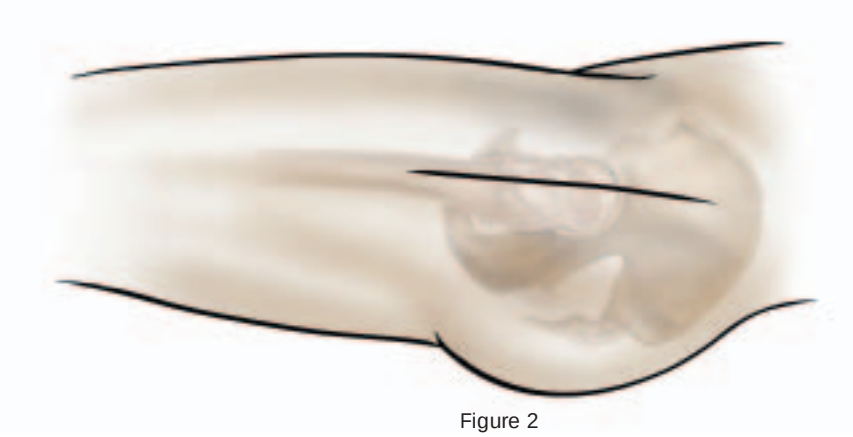

Figure 2
Skin Incision

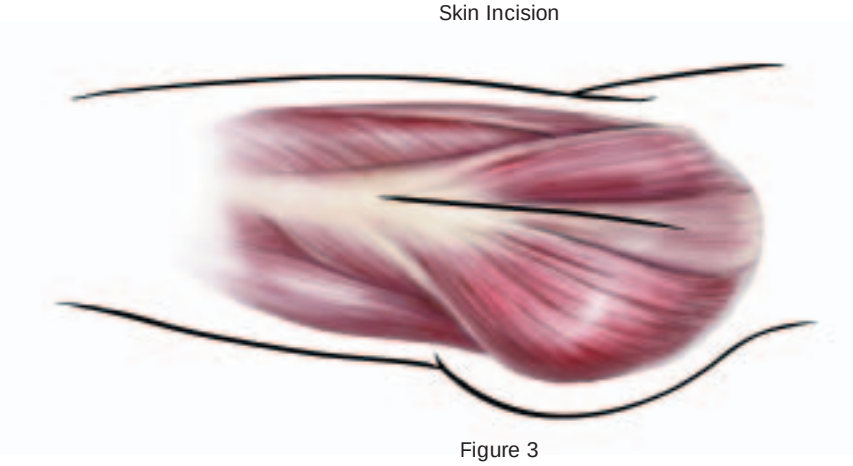

Figure 3
Fascial Incision

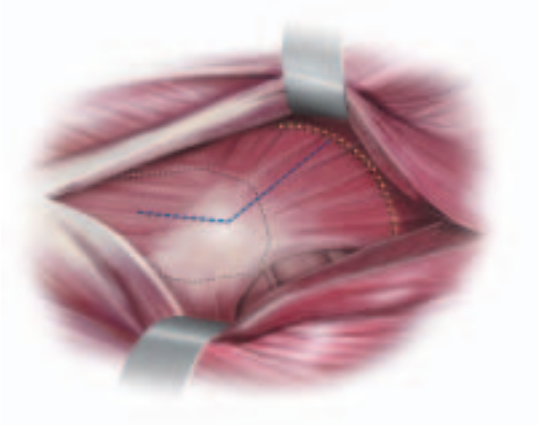

Figure 4
Gluteus Medius Split

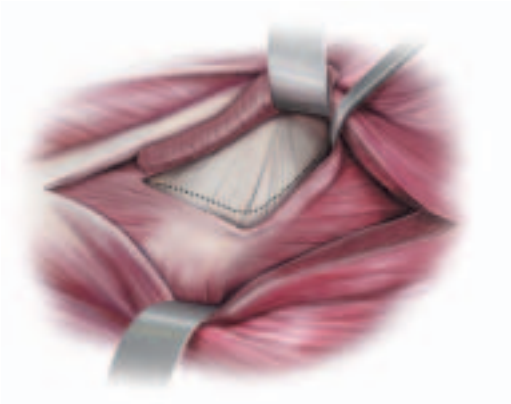

Figure 5
Capsulotomy/Capsulectomy

Use the approach with which you are most familiar and achieve the best surgical result. The Pinnacle™ Acetabular Cup System Instrumentation was designed to accommodate all surgical approaches. For the anterolateral approach, place the patient in the lateral decubitus position and execute a skin incision that extends from distal to proximal, centred over the anterior aspect of the femur, continuing over the greater trochanter tip (Figure 2).

The iliotibial band is split under the skin incision, extending proximally into the gluteus maximus or in between the maximus and the tensor fascia lata muscles (Figure 3).

Palpate the anterior and posterior borders of the gluteus medius.

The gluteus medius is split from the trochanter, parallel to its fibres, releasing the anterior $^{1}/_{2}$ to $^{1}/_{3}$ of the muscle (Figure 4).

The gluteus medius should not be split more than 4 cm from the tip of the greater trochanter. Care must be taken to ensure the inferior branch of the superior gluteal nerve is not damaged. The gluteus minimus is exposed and released either with or separate from the gluteus medius (Figure 5).

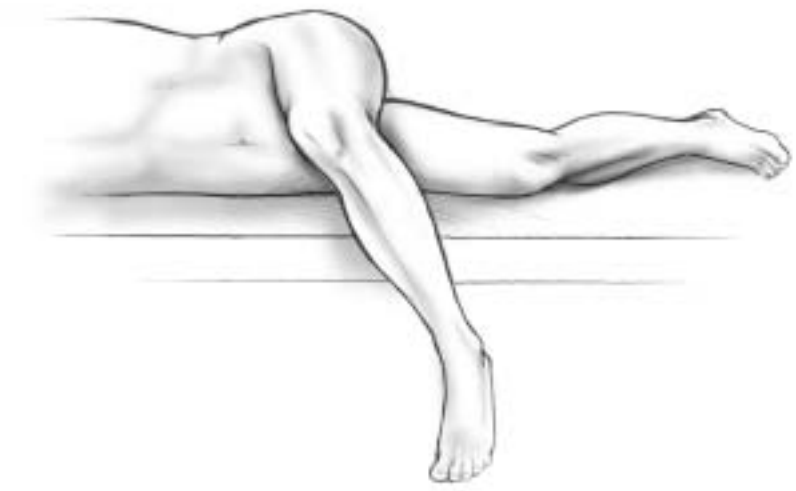

Figure 6
Hip Dislocation

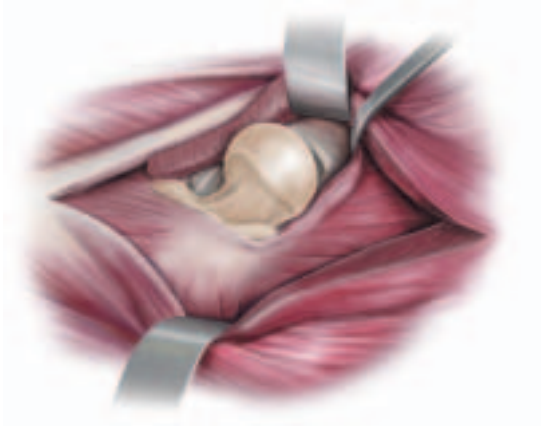

Figure 7
Femoral Neck Osteotomy

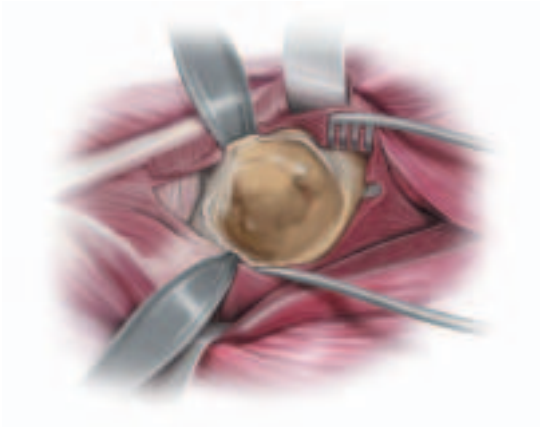

Figure 8
Acetabular Exposure

Flexion and external rotation of the leg facilitates exposure of the hip capsule, which is incised or excised depending on surgeon preference. Dislocate the hip with gentle adduction, external rotation and flexion (Figure 6).
The patient's leg is now across the contralateral leg and the foot is placed in a sterile pouch. If dislocation is difficult, additional inferior capsule may be released.

Perform a femoral neck osteotomy based upon the protocol for the selected femoral prosthesis. Exposure of the acetabulum is accomplished by placing the leg back on the table in slight flexion and external rotation. Use a self-retaining retractor to spread the medius and minimus anteriorly and the hip capsule posteriorly (Figure 7).

Carefully place another retractor over the anterior inferior wall of the acetabulum. The final retractor is placed in the acetabular notch beneath the transverse ligament and pulls the femur posteriorly (Figure 8).

Posterolateral Surgical Approach

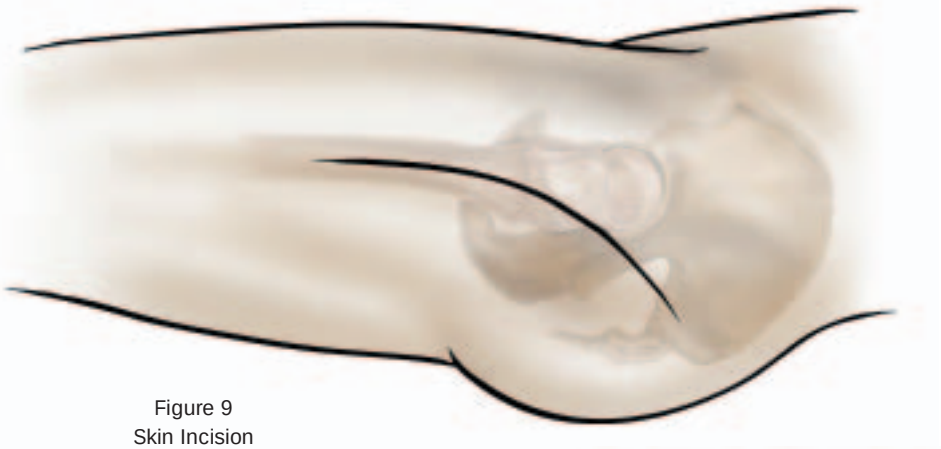

Figure 9
Skin Incision

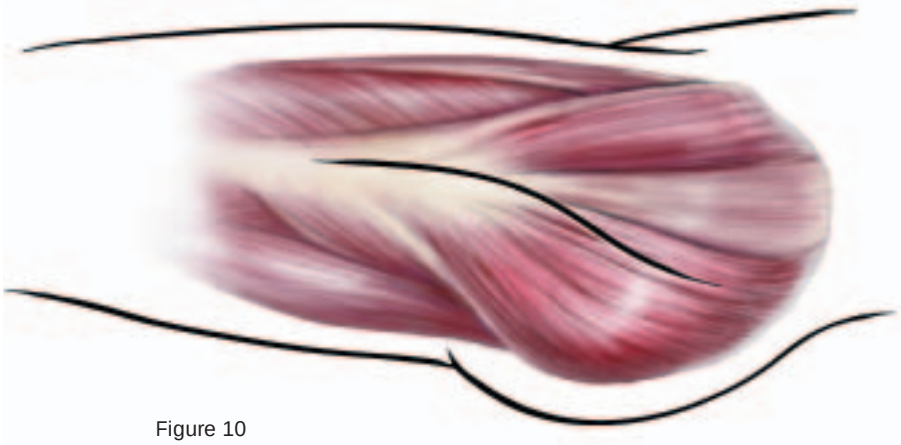

Figure 10
Fascial Incision

Use the approach with which you are most familiar and achieve the best surgical result.

The Pinnacle™ Acetabular Cup System Instrumentation was designed to accommodate all surgical approaches. For the posterolateral approach, place the patient in the lateral decubitus position. Ensure that the operating table is parallel to the floor and that the patient is adequately secured to the table to improve accuracy of the external alignment guides.

Centre the skin incision over the greater trochanter, carrying it distally over the femoral shaft for about 15 cm and proximally in a gently curving posterior arc of about 30 degrees for about the same distance (Figure 9).

Fascial Incision

Incise the iliotibial tract distally following the skin incision. Develop the incision proximally by blunt dissection of the gluteus maximus along the direction of its fibres (Figure 10).

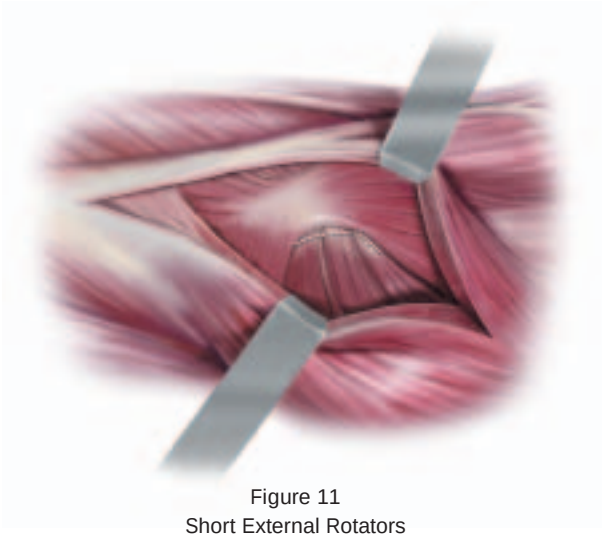

Figure 11
Short External Rotators

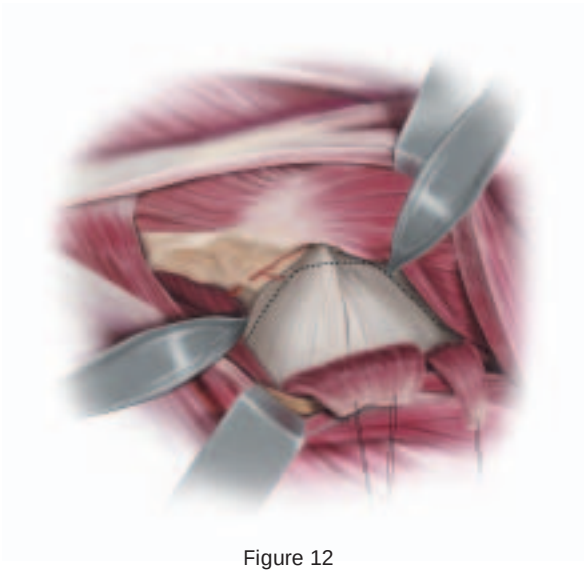

Figure 12
Posterior Capsulotomy

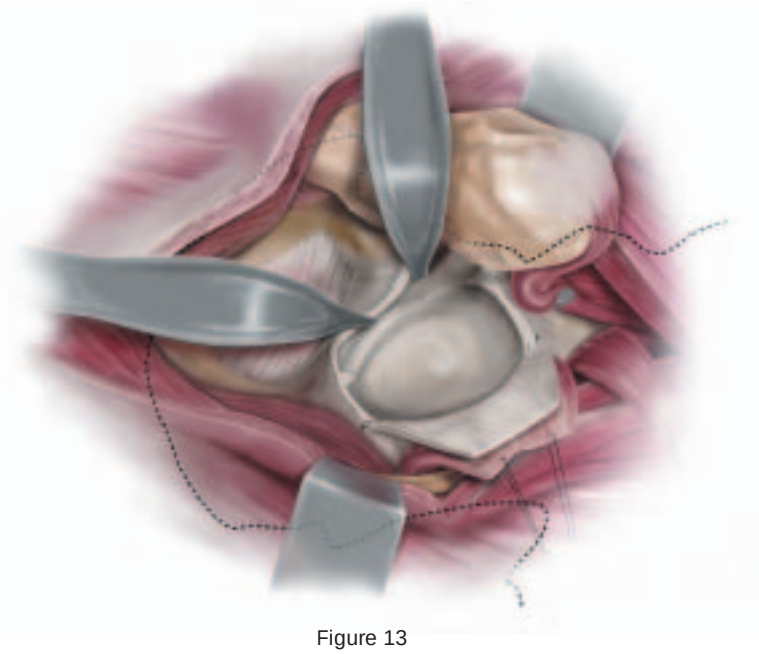

Figure 13
Posterior Capsulotomy

Initial Exposure

Place the leg in extension and internal rotation. Utilise self-retaining retractors to facilitate the exposure. Gently sweep loose tissue posteriorly, exposing the underlying short external rotators and quadratus femoris. Identify the posterior margin of the gluteus medius muscle proximally and the tendon of the gluteus maximus distally (Figure 11). *Use caution to protect the sciatic nerve.* Incise the quadratus femoris, leaving a cuff of tissue for later repair (Figure 12). This exposes the terminal branch of the medial circumflex artery, which lies deep to the proximal third of the quadratus femoris. Identify the piriformis tendon, the obturator internus tendon (conjoint with the gemelli tendons) and the tendon of the obturator externus, and free them from their insertions at the greater trochanter. The piriformis and the conjoint tendon may be tagged for subsequent reapproximation.

Posterior Capsulotomy

Retract the short rotator muscles posteromedially together with the gluteus maximus (with consideration to the proximity of the sciatic nerve), thus exposing the posterior capsule (refer to figure 12). Place cobra retractors anteriorly and inferiorly (Figure 13). Open the capsule posteriorly starting at the acetabular margin at about 12 o'clock and heading to the base of the neck, around the base of the neck inferiorly and back to the inferior acetabulum, creating a posteriorly based flap for subsequent repair. Excise additional anteriorsuperior capsule to enhance dislocation of the hip. Alternatively the capsule can be excised.

Femoral Resection Acetabular Exposure

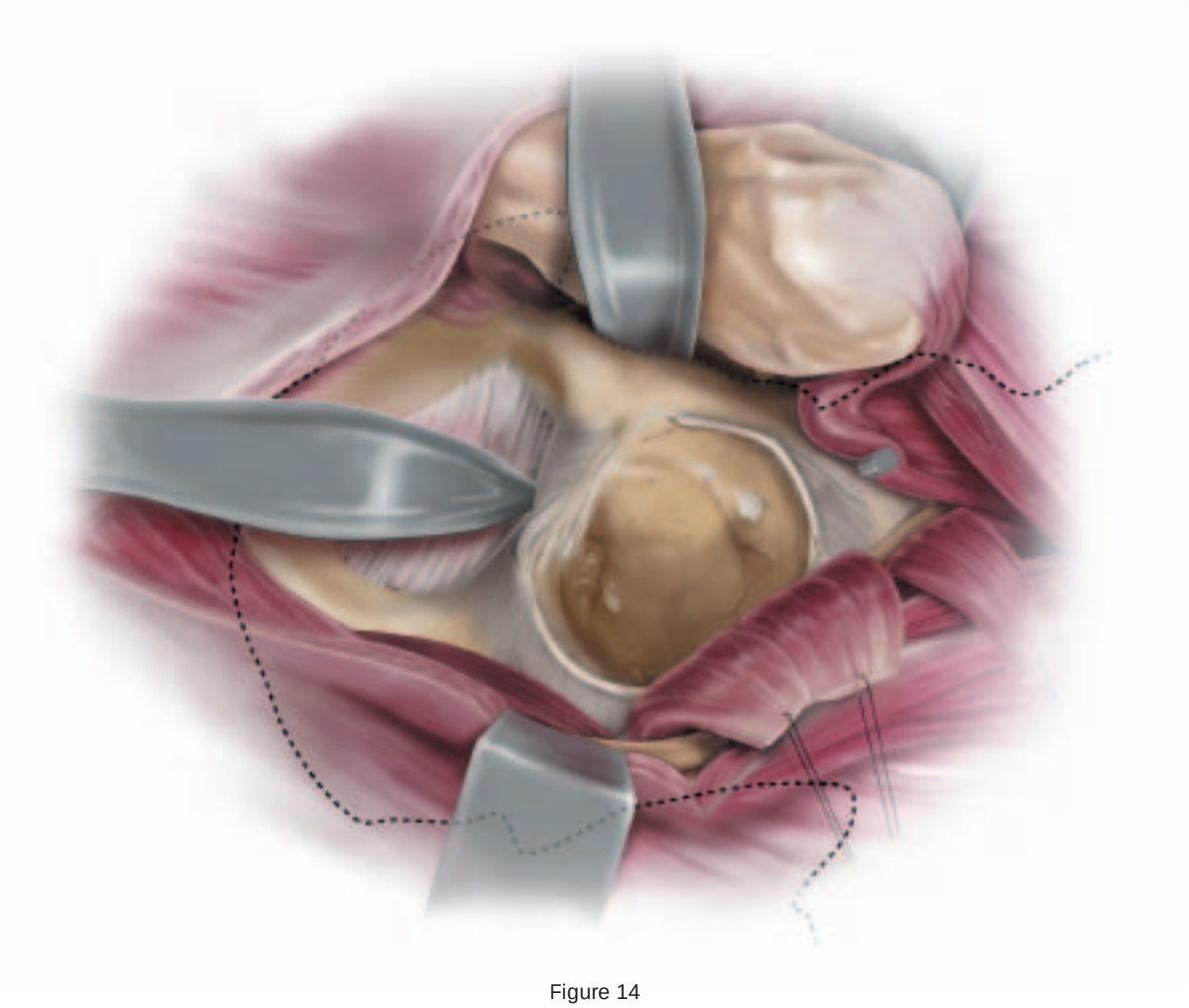

Figure 14
Acetabular Exposure

Place a superior pin or retractor in the ilium at approximately the 12 o'clock position. The pin placement is approximately 2 cm superior to the acetabular margin. Caution should be taken not to penetrate the medial wall of the ilium. Measure leg length and dislocate the hip through a combination of flexion, adduction and internal rotation. Osteotomise the femoral neck in accordance with the protocol of the femoral component you have selected. One key to proper acetabular component positioning is adequate surgical exposure.

Following femoral neck resection, pass a curved retractor, which straddles the pubis, or a blunt cobra over the anterior column to displace the femur anteriorly (Figure 14).
Position a second retractor at the acetabular notch, inferior to the transverse acetabular ligament. An additional retractor may be positioned posteriorly to retract the capsule or short external rotators.

Care should be taken to position retractors to avoid injury to the sciatic nerve. Obtain an unobstructed view of the acetabulum. Excise the entire labrum and remove osteophytes to identify the true anterior and posterior acetabular margins. Release or resect the transverse ligament, together with any accompanying osteophytes.
A branch of the obturator artery is often encountered. Clear all soft tissue from the fovea to define the true medial wall.

Acetabular Reaming

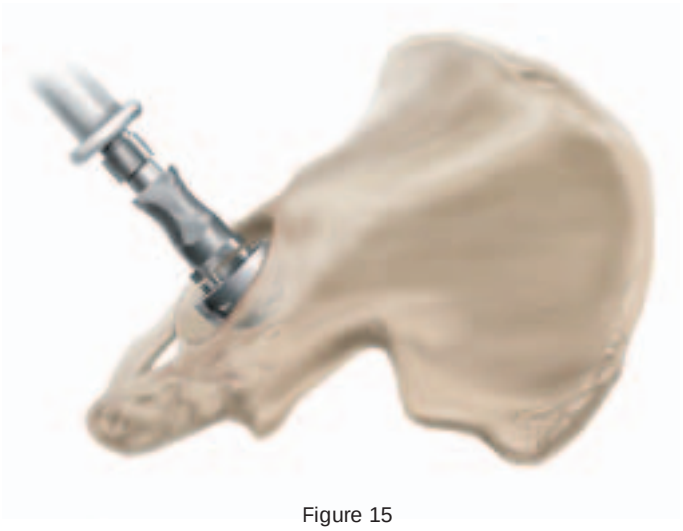

Figure 15
Acetabular Reaming

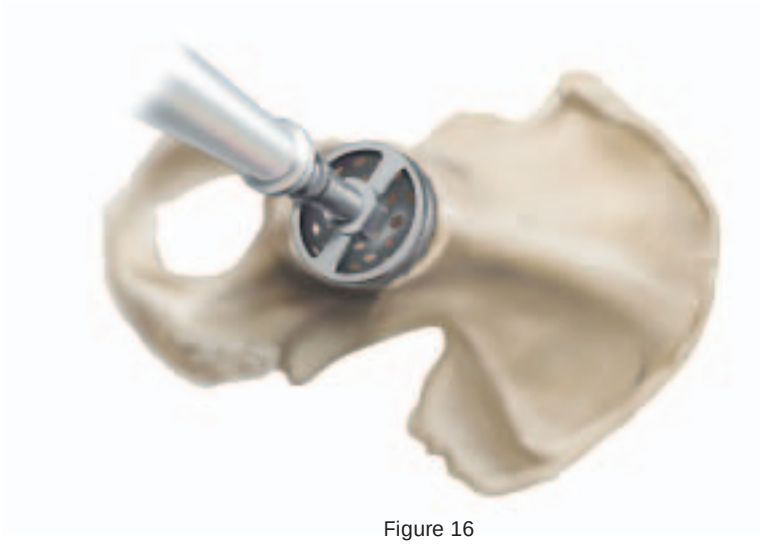

Figure 16
Acetabular Reaming

A 54 mm Quickset™ Grater reams a 54 mm cavity.

A 54 mm trial cup is 54 mm in diameter.

A 54 mm Pinnacle™ Acetabular Cup is 54 mm in diameter as measured over the Porocoat® Porous Coating.

Figure 17

The goal of acetabular reaming is to restore the centre of the original acetabulum. Initially employ a grater 6-8 mm smaller than the anticipated acetabular component size to deepen the acetabulum to the level determined by pre-operative templating (Figures 15 and 16). Subsequent reaming should proceed in 1-2 mm increments. Centre the reamers in the acetabulum until the deepened socket becomes a true hemisphere. Use a curette to free all cysts of fibrous tissue. Pack any defects densely with cancellous bone.

It is important to understand that all Pinnacle™ Acetabular Cup System Instrumentation is marked with true dimensions. The graters, cup trials and actual Pinnacle™ Acetabular Cups are all 180 degrees (Figure 17).

Under-reaming of the acetabulum is dependent on bone quality and the size of the acetabular component. A 1 mm under-ream is usually sufficient in smaller sockets, while a larger socket may require 1-2 mm under-ream. Likewise, soft bone will more readily accommodate a greater press-fit of the acetabular component than sclerotic bone.

Acetabular Cup Trialing and Positioning

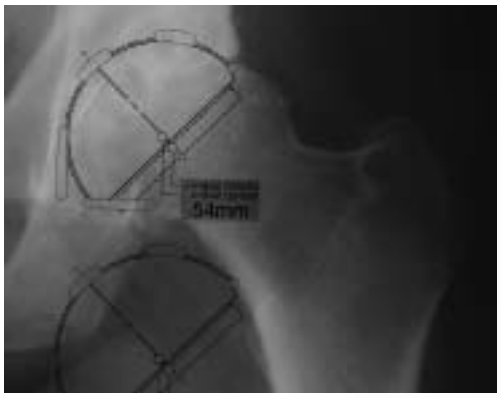

Figure 18
Pre-operative Determination of Abduction Angle

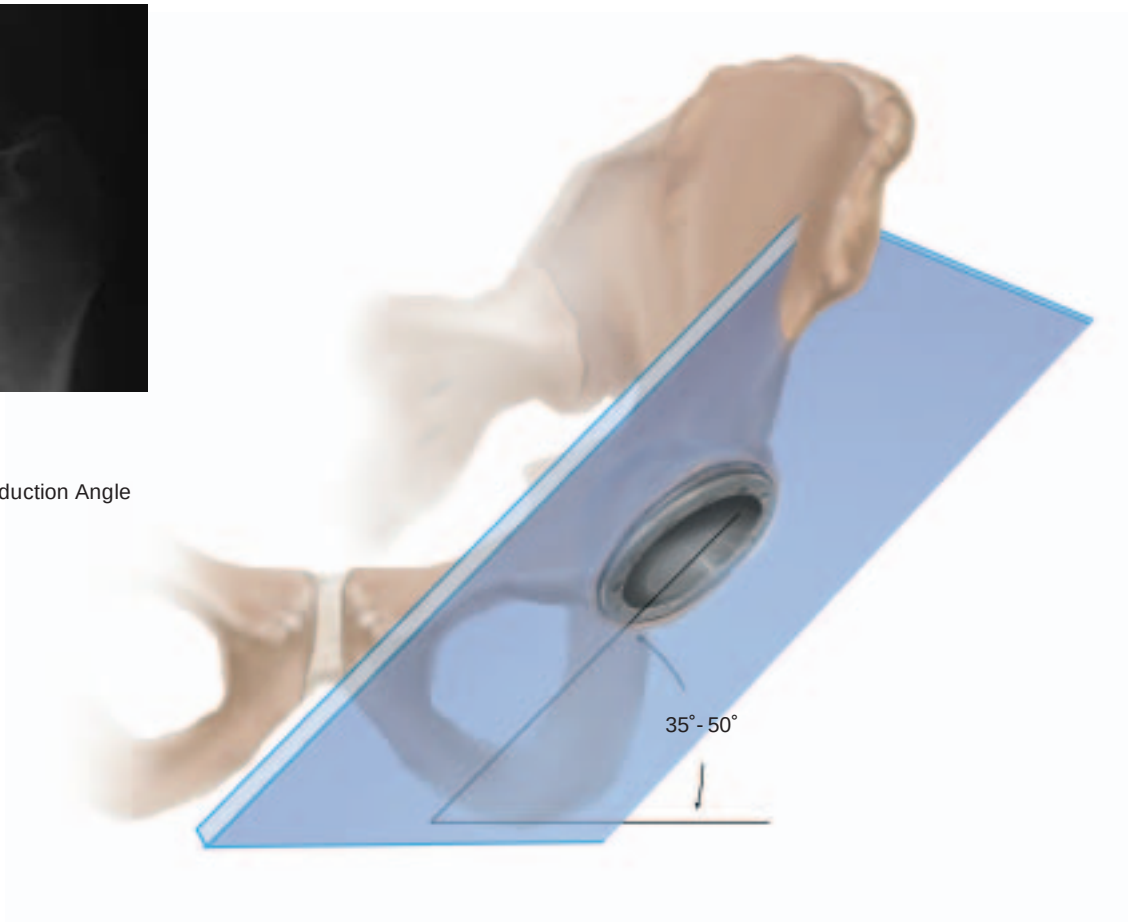

Figure 19
Cup abduction is typically 35˚ - 50˚.

Determining The Abduction Angle

The pre-operative A/P X-ray can help determine the ideal abduction angle (Figure 18).

The lateral ilium is a useful landmark as an intra-operative guide to a proper abduction angle. In a normal acetabulum with good lateral coverage, if the implanted socket lies flush with a normal lateral pillar, the abduction angle is usually correct (Figure 19).

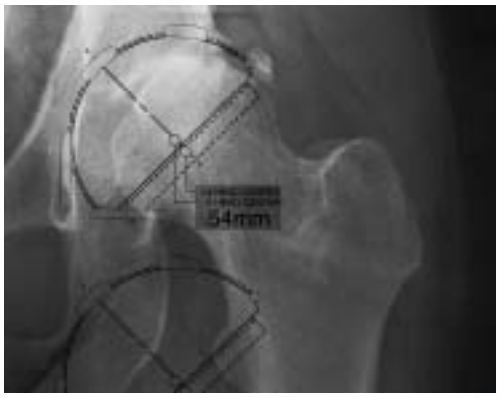

Figure 20
Pre-operative Assessment
of Coverage of the Acetabulum

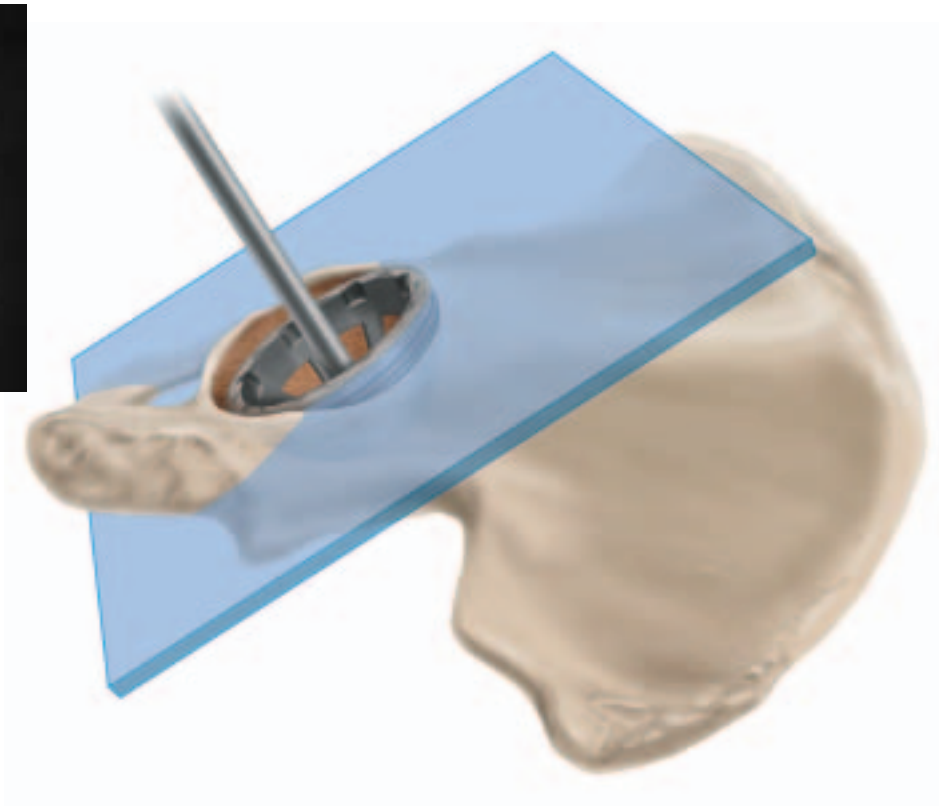

Figure 21
Cup anteversion is typically 15° - 20°.

However, degenerative sockets often have deficient lateral covering. The pre-operative A/P X-ray can be helpful in determining how much of the acetabular component should be left uncovered to provide the proper implant abduction angle (Figure 20).

Determining Proper Anteversion

The most reliable method for determining proper anteversion is the use of the bony landmark. Other methods are subject to error through a change in patient position during the procedure. Defining the bony landmarks of the ischium and pubis during exposure greatly facilitates proper acetabular component position.

The plane created by the pubis and the ischium can serve as a guide for proper acetabular cup orientation. The cup should be slightly more anteverted than the pubis/ischial plane. This relationship should remain constant regardless of the depth of reaming (Figure 21).

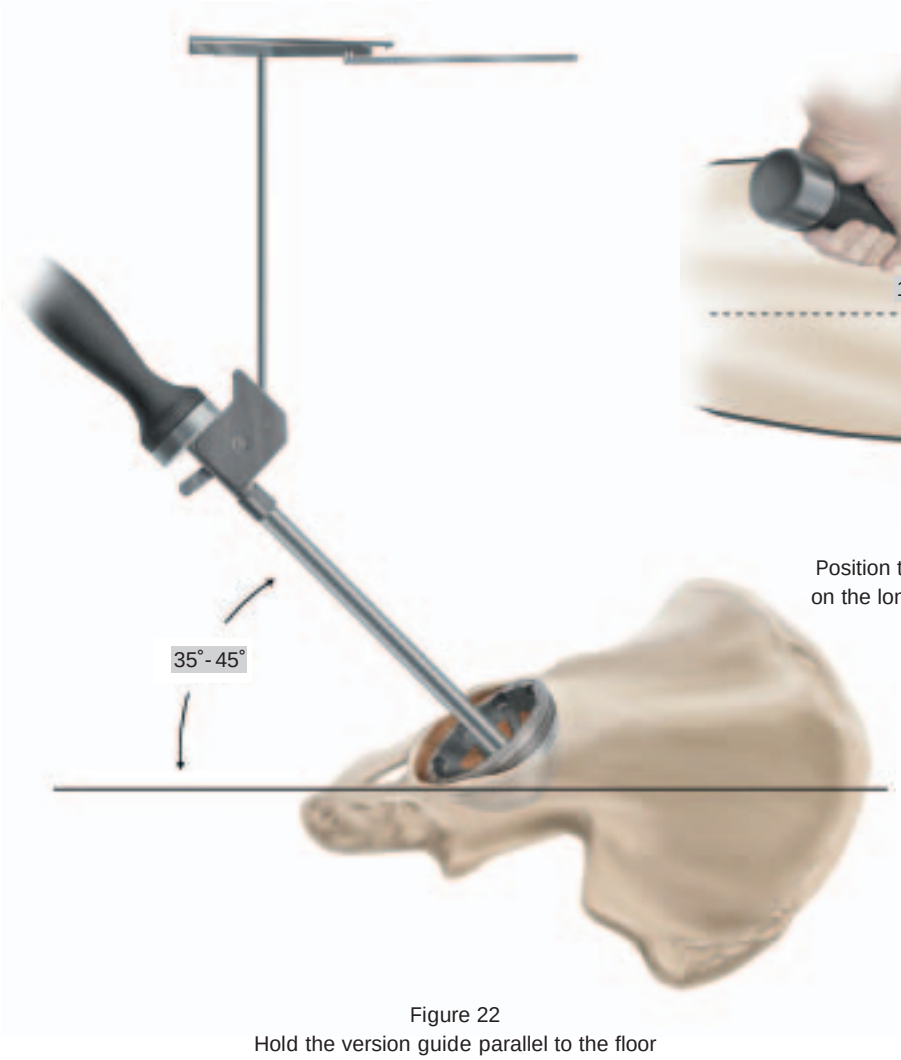

Figure 22
Hold the version guide parallel to the floor
and select the abduction angle.

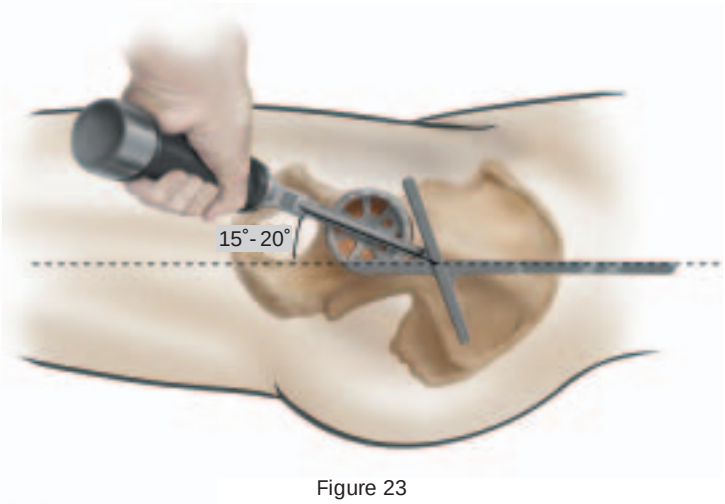

Figure 23
Position the extended arm of the version guide
on the long body axis to determine anteversion.

Cup trials in 1 mm incremental sizes are available to assess cup fit and orientation. Contingent on the quality of the prepared bone, select the acetabular trial equal to or 1 mm larger in diameter than the final grater size. The size of the cup trial is as marked on the trial cup (54 mm measures 54 mm). Peripheral rim ridges on the cup trial enhance the stability of the trial cup through trial reduction. Even insert trials fit both odd and even cup trials. For example, a 54 mm polyethylene insert trial fits both the 54 mm and the 53 mm cup trials. Using cup and insert trials in conjunction with the femoral component trials aids in ensuring optimum position of the components.

Place the cup trial in an anatomic orientation with an abduction 35-45 degrees to the transverse plane (refer to Figure 19) and 15-20 degrees anteversion. Confirm complete cup trial seating by sighting through the holes and cutouts in the acetabular cup trial. The screw hole pattern in the trial cup replicates the Pinnacle™ Sector Cup Implant Screw Hole Pattern to assist with screw targeting. *Do not use the cup trial to prepare screw holes. Prepare screw holes only through the final implant.*
Appropriate trial cup orientation can be verified with external alignment guides in addition to bony landmarks.

With the patient in the lateral decubitus position and the version guide parallel to the floor (Figure 22) the cup will be in the amount of abduction selected on the handle. Available options are 35 and 45 degrees.
When the extended arm of the version guide, which corresponds to the affected hip, follows the long axis of the patient's body, the trial cup is in 15-20 degrees of anteversion (Figure 23). The external alignment guide will not be accurate if the pelvis is tilted or if the patient has rolled forward or backward.

Acetabular Trial Inserts

Figure 24
Insert Trial Colour Guide

Following positioning and seating of the acetabular cup trial, place a insert trial into the trial cup. Secure the insert trial to the cup trial through the apical hole screw using a standard hex head screwdriver. There are four alternative insert configurations for 28 and 32 mm inner diameter (ID) polyethylene inserts and three configurations for 36 mm inner diameter polyethylene inserts. Dedicated trials for alternative bearings exist that help ensure the correct restoration of biomechanics. The 28 mm alternative bearing trials are yellow and the 36 mm alternative bearing trials are purple (Figure 24).

With the femoral component trials in position, assess stability and range of motion. Couple the insert trial with the cup trial in the desired position. For insert alternatives other than neutral, there is an orientation reference etch mark on the insert trial and insert implant.

Cup Trial and Insert Trial Chart

Cup Trial and Insert Trial Sizes	
Cup Trial Size (mm)	**Insert Trial Size** (mm)
47, 48	48
49, 50	50
51, 52	52
53, 54	54
55, 56	56
57, 58	58
59, 60	60
61, 62	62
63, 64	64
65, 66	66

Insert Configurations

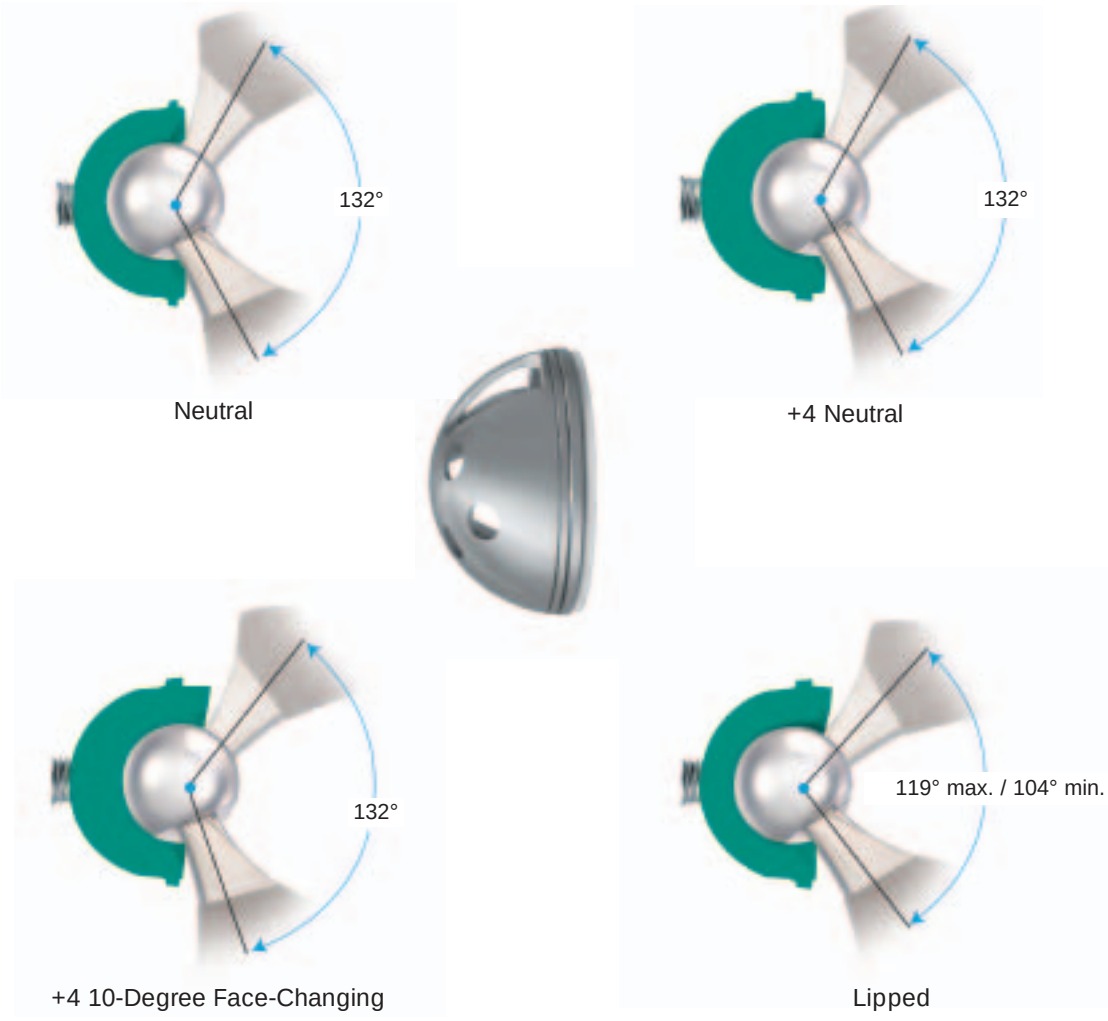

Figure 25
Insert Alternatives — 28 mm Inner Diameter (ID) with Summit™ 12/14 Taper Stem

In the Pinnacle™ Acetabular Cup System, a variety of polyethylene insert designs are available. Each design has specific benefits. It is important for the surgeon to understand the geometry of the various insert alternatives and their impact on joint biomechanics and range of motion (Figure 25 and Insert ROM Chart).

Neutral Insert

The neutral insert provides 180 degrees of head coverage. The wide face chamfer is optimised for range of motion. The range of motion measured is 132 degrees with a Summit™ 12/14 Taper Stem and a 28 mm head. The femoral head's centre of rotation is concentric with the outer diameter of the cup.

+4 Neutral Insert

Like the neutral insert, the +4 mm neutral insert provides 180 degrees of head coverage. The wide face chamfer is optimised for range of motion. The range of motion measured is 132 degrees with a Summit™ 12/14 Taper Stem and a 28 mm head. This insert provides a 4 mm lateralisation of the femoral head's centre of rotation. This 4 mm offset both increases soft tissue tensioning and provides 4 mm of increased polyethylene thickness in the cup's dome region. This lateralised insert can be used as an alternative to a longer neck and may enable the surgeon to avoid using a skirted head. A +4 mm lateralised insert will result in about 3 mm of leg length and about 3 mm of offset if the cup is inserted at a 45 degree abduction angle.

+4 10 Degree Face-Changing Insert

Like the other inserts, the +4 10 degree insert provides 180 degrees of head coverage and the wide chamfer is optimised for range of motion is 132 degrees with a Summit™ 12/14 Taper Stem and a 28 mm head. This insert lateralises the femoral head 4 mm and a 10 degree face change alters inclination/version dependent upon placement of the insert.

Lipped Insert

This insert provides 180 degrees of head coverage, plus a 4 mm vertical wall to enhance stability. The range of

Implanting the Acetabular Cup

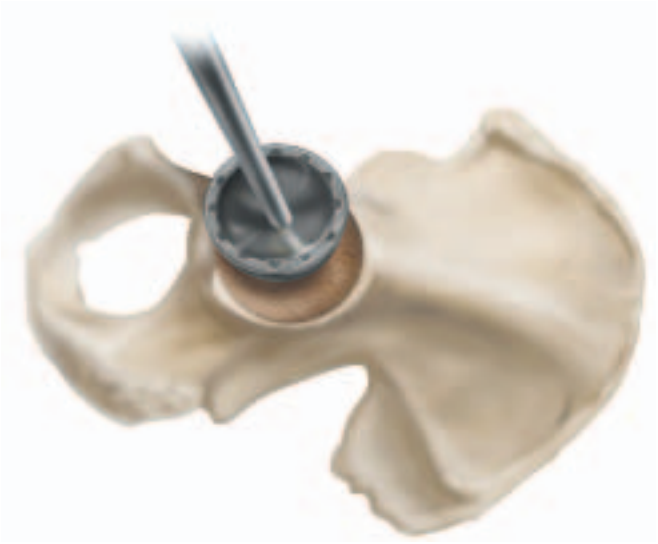

Figure 26
Securely thread the acetabular cup onto the acetabular cup positioner.

Figure 27
Confirm acetabular cup alignment.

Insert ROM Chart

		Neutral	+4 Neutral	+4 10-Degree Face-Changing	Lipped
Polyethylene	28 mm	132°	132°	132°	119°/104°
Polyethylene	32 mm	139°	139°	139°	130°/113°
Polyethylene	36 mm	140°	140°	140°	N/A
Metal	28 mm	146°	N/A	N/A	N/A
Metal	36 mm	151°	N/A	N/A	N/A
Ceramic	28 mm	135°	N/A	N/A	N/A
Ceramic	36 mm	153°	N/A	N/A	N/A

Range Of Motion (ROM) tested with 12/14 Taper Summit™ Stem.

motion is measured at 119 degrees maximum/104 degrees minimum with a Summit™ 12/14 Taper Stem. The lip on this insert can provide additional stability; however, the impact on range of motion and early impingement must be understood.

Cup Insertion

Each Pinnacle™ Acetabular Cup Style is implanted using the same basic surgical technique; however, some cup styles have technique-specific tips that help facilitate implantation. This technique demonstrates the insertion of a Pinnacle™ 100 Series (No-Hole) Cup. The following sections also examine techniques for Pinnacle™ Sector (Three-Hole) and Pinnacle™ 300 (Tri-Spike) Series Cups. Before implanting the real prosthesis, take the hip through a full range of motion and stability assessment with all trial components in position. Securely thread the permanent acetabular cup prosthesis onto the acetabular cup positioner (Figure 26). Use the acetabular alignment rod, with optional positions of 35 and 45 degrees of abduction, to assist in component orientation (refer to Figure 23). Anteversion is typically set at 15-20 degrees. Establish this orientation through visual confirmation that the acetabular component is directed fully into the acetabulum. The external alignment guide should be used in conjunction with appropriate bony landmarks and the position of the acetabular trial to determine the best position for the acetabular component (refer to Figure 22). After confirming alignment (Figure 27), impact the prosthesis into position. Given the nature of a hemispherical acetabular component, rim contact will occur before dome seating occurs. This may require additional impaction to ensure seating. Confirm seating by sighting through the apical hole or, if present, screw holes. An apical hole eliminator may be inserted with a standard hex head screwdriver following cup impaction. Following final component seating, if adjustments to the cup orientation are necessary, thread the impactor handle back into the apical hole to adjust the cup position. *Avoid using a punch in the taper region to adjust cup position.*

Implanting the Acetabular Cup with Screw Fixation

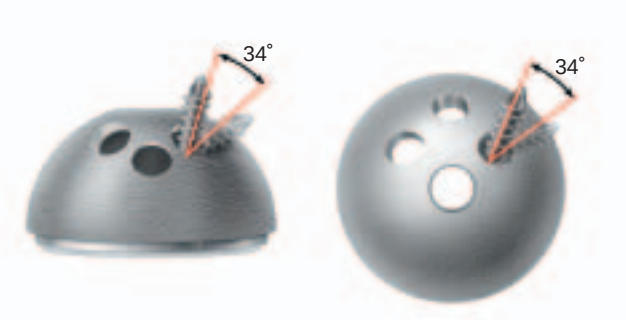

Figure 29
Screw Angulation

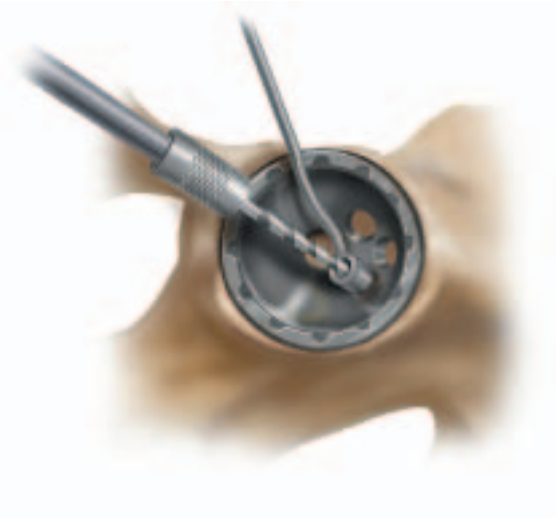

Figure 28
Drill Guide

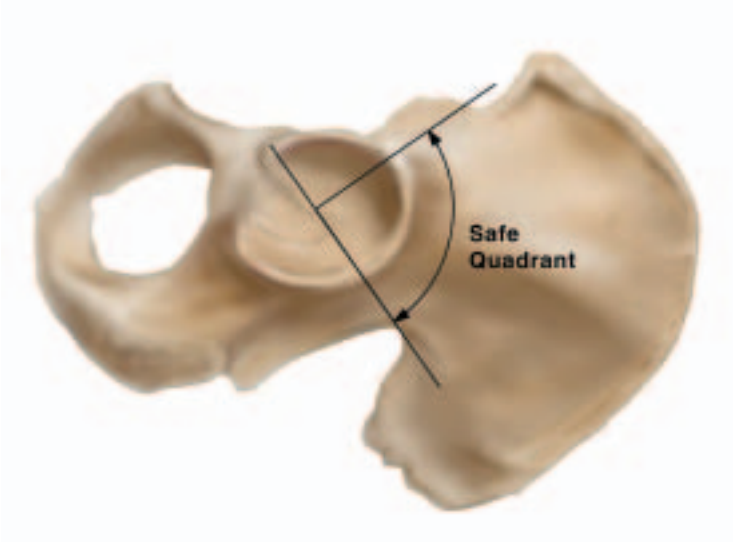

Figure 30
Screw Hole Selection

Screw Insertion

The Pinnacle™ Sector Cup has three screw holes and is designed for insertion with screws. Quickset™ Acetabular Screw Instruments are recommended for screw insertion. Two medial hole alternatives are placed to enable screw placement up the posterior column in either the right or left hip. The single lateral screw provides additional access to the ilium.

The drill bit is controlled by the drill guide as it passes through selected holes into the acetabulum (Figure 28). The screw angle may vary by as much as 34 degrees (Figure 29). The effective lengths of the four drill bits available are for 25, 35, 45 and 70 mm. By seating the drill bit completely into the guide, holes corresponding to the effective length of the drill bit will be created.

Select holes where the prosthesis is to be anchored with cancellous screws so that the screws lie within a safe quadrant. The safe quadrant is defined by two lines from the anterior-inferior iliac spine through the centre of the acetabulum and posterior by a line from the sciatic notch to the centre of the acetabulum (Figure 30).

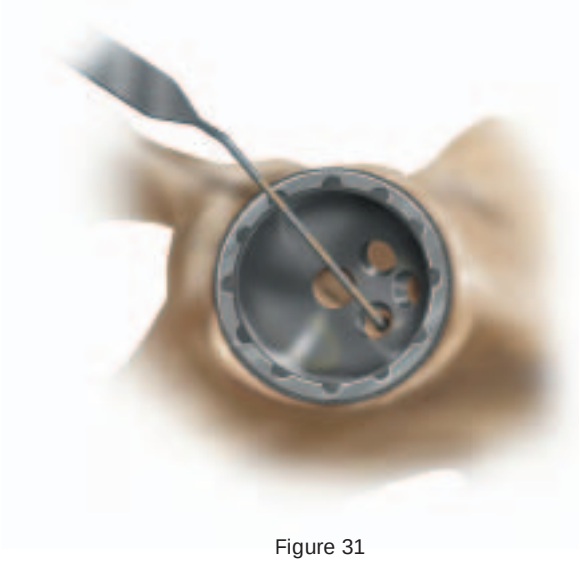

Figure 31
Depth Gauge

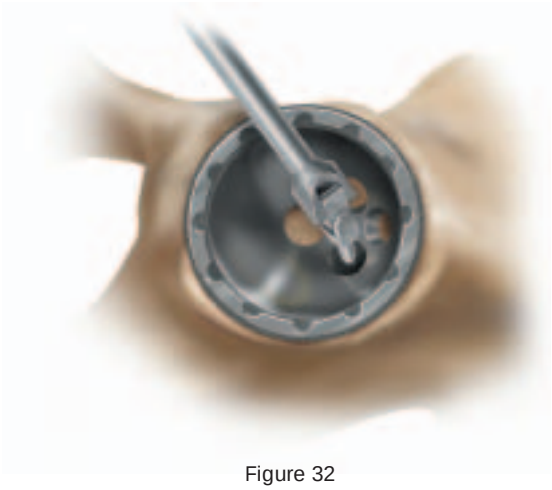

Figure 32
Screw Insertion

Verify hole depth using the Quickset™ Depth Gauge. Alternating colours on the depth gauge represent 10 mm increments (Figure 31).

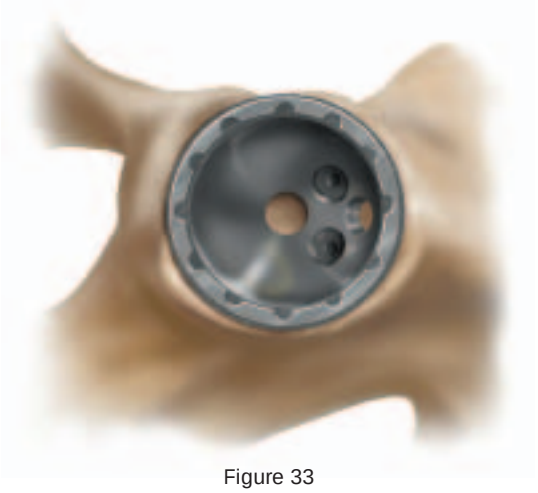

Figure 33
Screw Insertion

Figure 34
Screw Tip

Insert 6.5 mm Pinnacle™ Acetabular Cup System Cancellous Bone Screws using a hex head screwdriver (Figures 32 and 33).

The 6.5 mm self-tapping screws have four-point cutting flutes with a blunt tip to reduce the risk of neurovascular injury (Figure 34).

Implanting the Acetabular Cup with Spikes

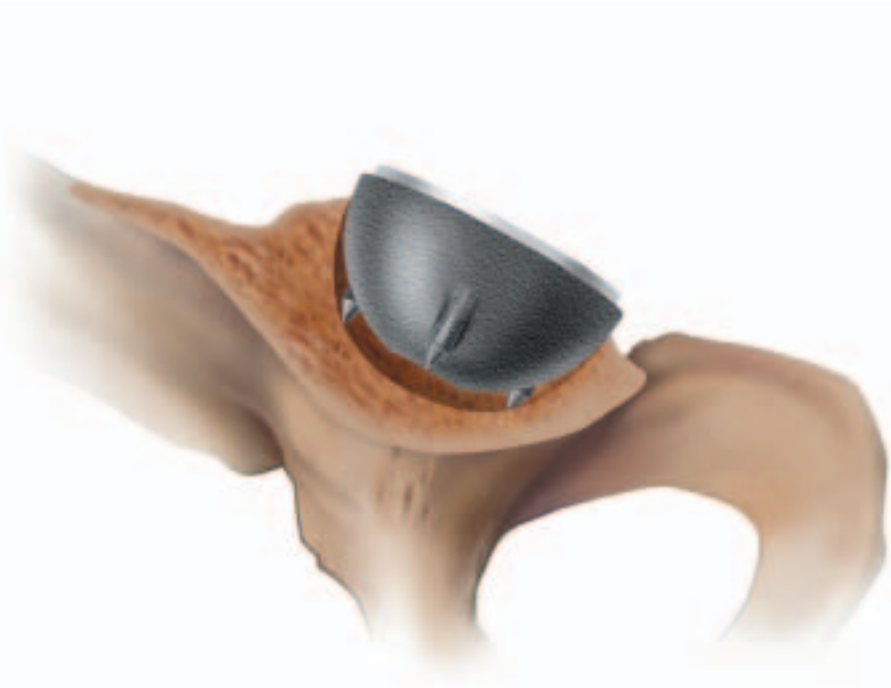

Figure 35
Prior to cup impaction, spikes and rim engage simultaneously when the cup is centred and aligned.

Spike Orientation

Spike Length

Figure 36

Pinnacle™ 300 Series Cup Insertion

Spike placement along the radius of the Pinnacle™ 300 Series Cup is the same as the clinically established Duraloc® 300 Series Acetabular Cup (Figures 35 and 36). The spikes are coated for additional fixation but have been reduced in length by 1.5 mm in height compared to the Duraloc® Acetabular Cup. This reduction in spike height does not alter fixation but ensures that the spike contacts bone on insertion at the same point that the cup contacts the rim of the prepared acetabulum. This gives the surgeon greater control when inserting the Pinnacle™ 300 Series Cup and ensures the cup bottoms out in the dome of the acetabulum.

The recommended acetabular reaming technique for the Pinnacle™ 300 Acetabular Cup is either 1 mm under or line-to-line dependent on bone quality.

It is important that the cup is well centred in the prepared acetabular cavity in the predetermined alignment indicated by the trial before being impacted.

Polyethylene Insert Insertion and Impaction

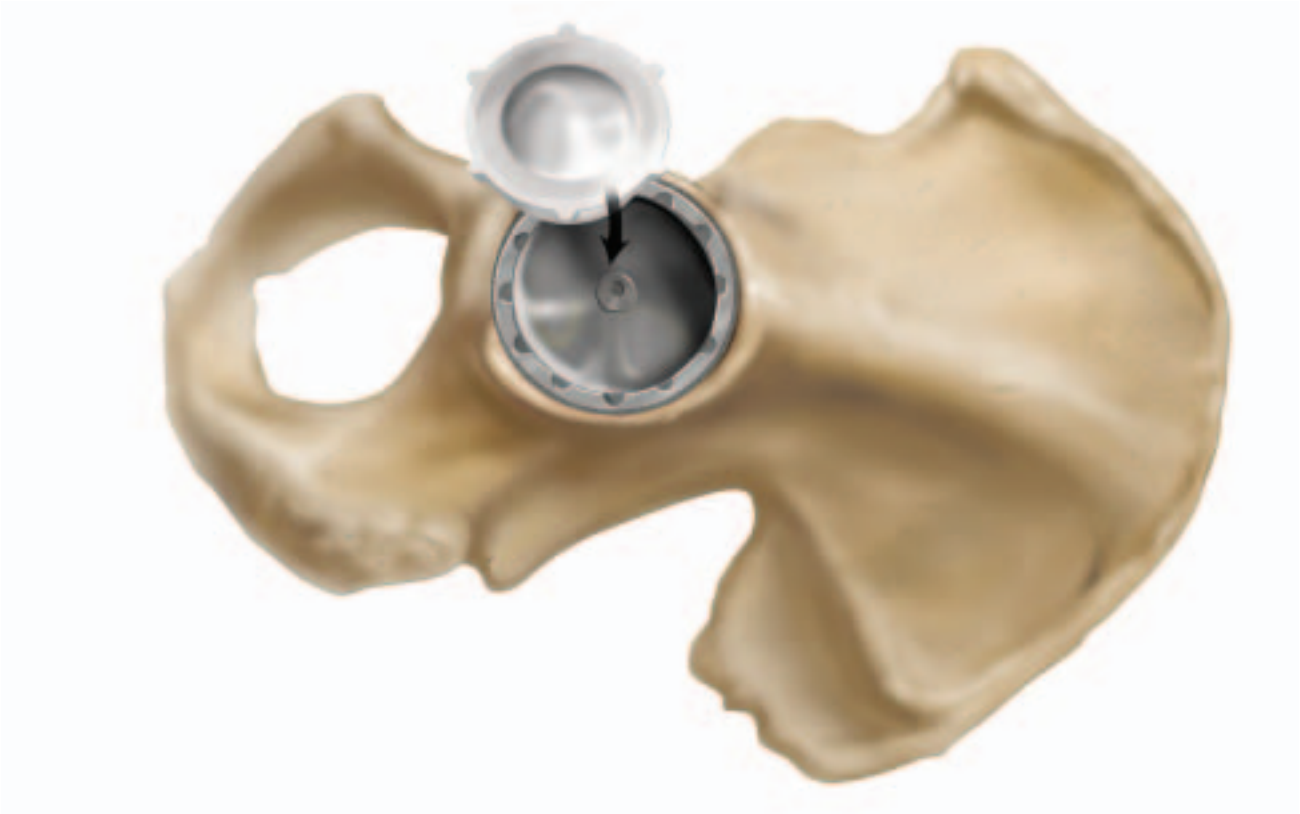

Figure 37
Insert Placement

Following insertion of the final acetabular cup and femoral component, the trial inserts can be used in the cup to confirm insert selection and evaluate joint stability and range of motion.

Prior to inserting the final acetabular insert, thoroughly irrigate and clean the cup. It is important to check the cup/insert locking groove is free from debris.
Remove all soft tissue from the face of the cup so as not to impede insert seating (Figure 37). An apex hole plug may be used prior to insert insertion.

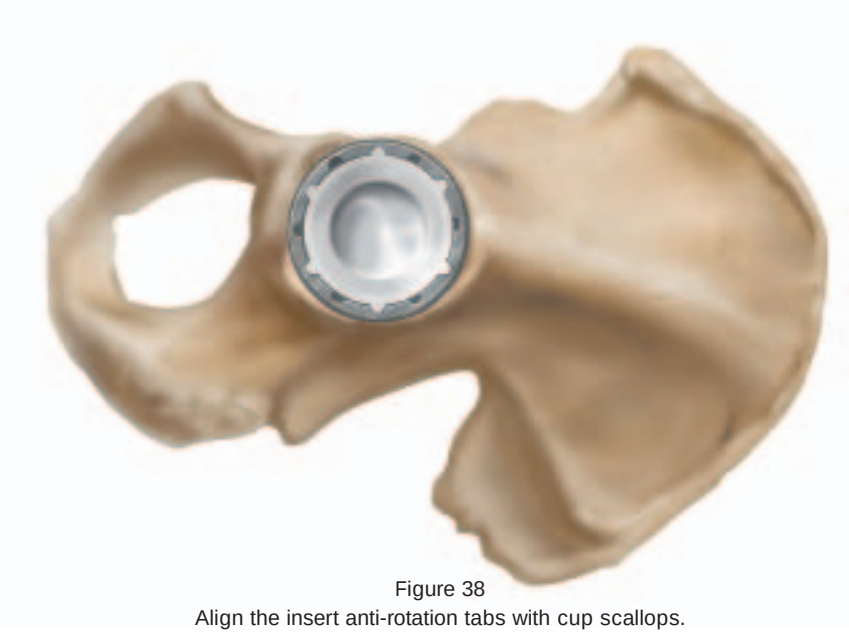

Figure 38
Align the insert anti-rotation tabs with cup scallops.

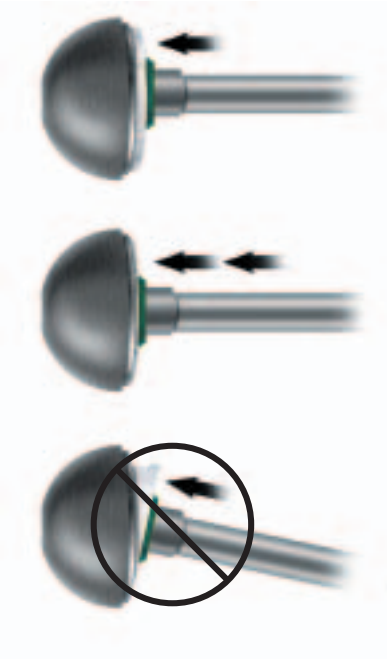

Figure 39
Insert Impaction

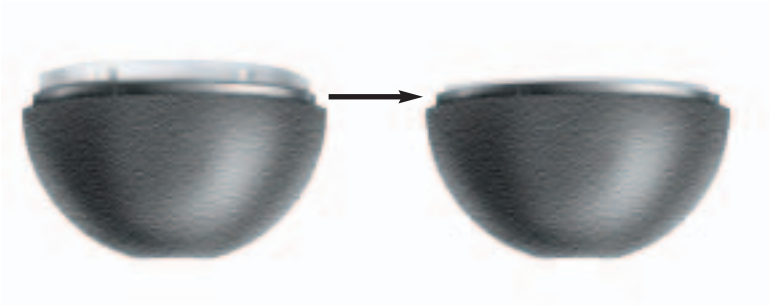

Figure 40
Insert Seating Height

Align the insert anti-rotational device (ARD) tabs with the ARD scallops on the cup (Figure 38). There are six ARD tabs on the inserts and 12 ARD scallops in the cup. This allows the insert to be rotated in 30-degree increments. Seat the insert using the ID insert impactor that corresponds to the selected implant. Because the locking mechanism is tapered, it is important to impact the insert directly into the cup with multiple medium blows (Figure 39). Impacting the insert in a tilted position may prevent complete seating.

Seating is visually confirmed when the insert ARDs are flush with the face of the acetabular cup; however, the insert face will remain proud in relation to the cup face by approximately 1 mm (Figure 40).

Polyethylene Insert Extraction

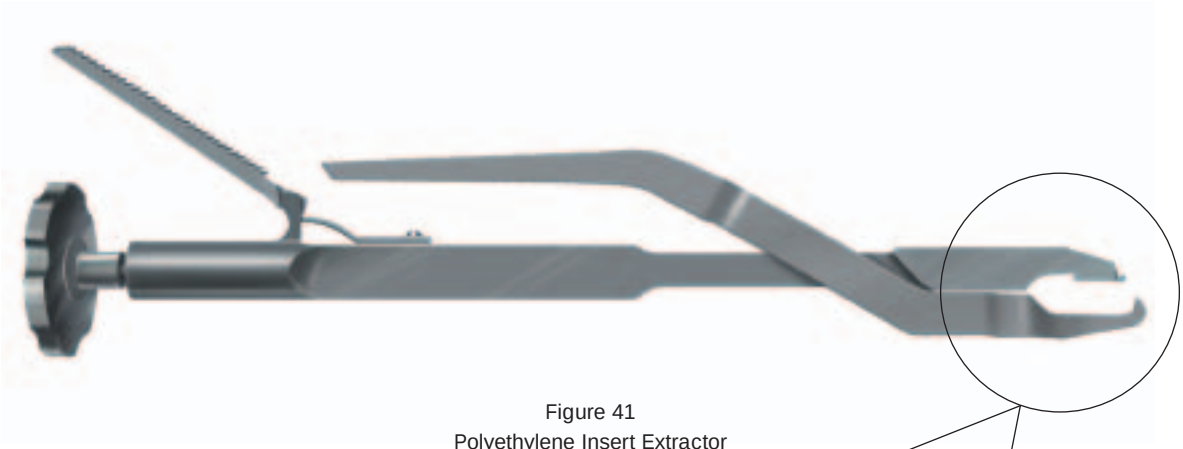

Figure 41
Polyethylene Insert Extractor

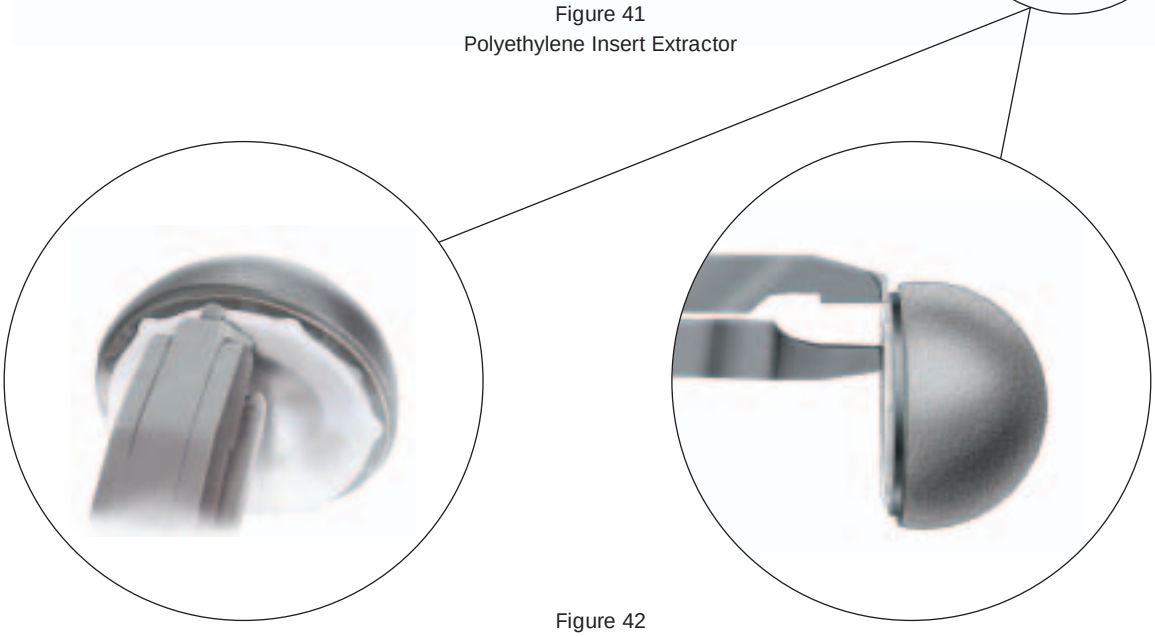

Figure 42
Extractor Placement

A polyethylene insert extractor is available to aid in polyethylene insert extraction and to help ensure the Pinnacle™ Acetabular Cup is not damaged during polyethylene insert extraction (Figure 41).

Open the extractor jaws and extend the ARD pin from the extractor tip. Place the ARD pin into an empty ARD and tightly close the jaws of the extractor (Figure 42). The teeth of the extractor should dig into the inner diameter of the polyethylene.

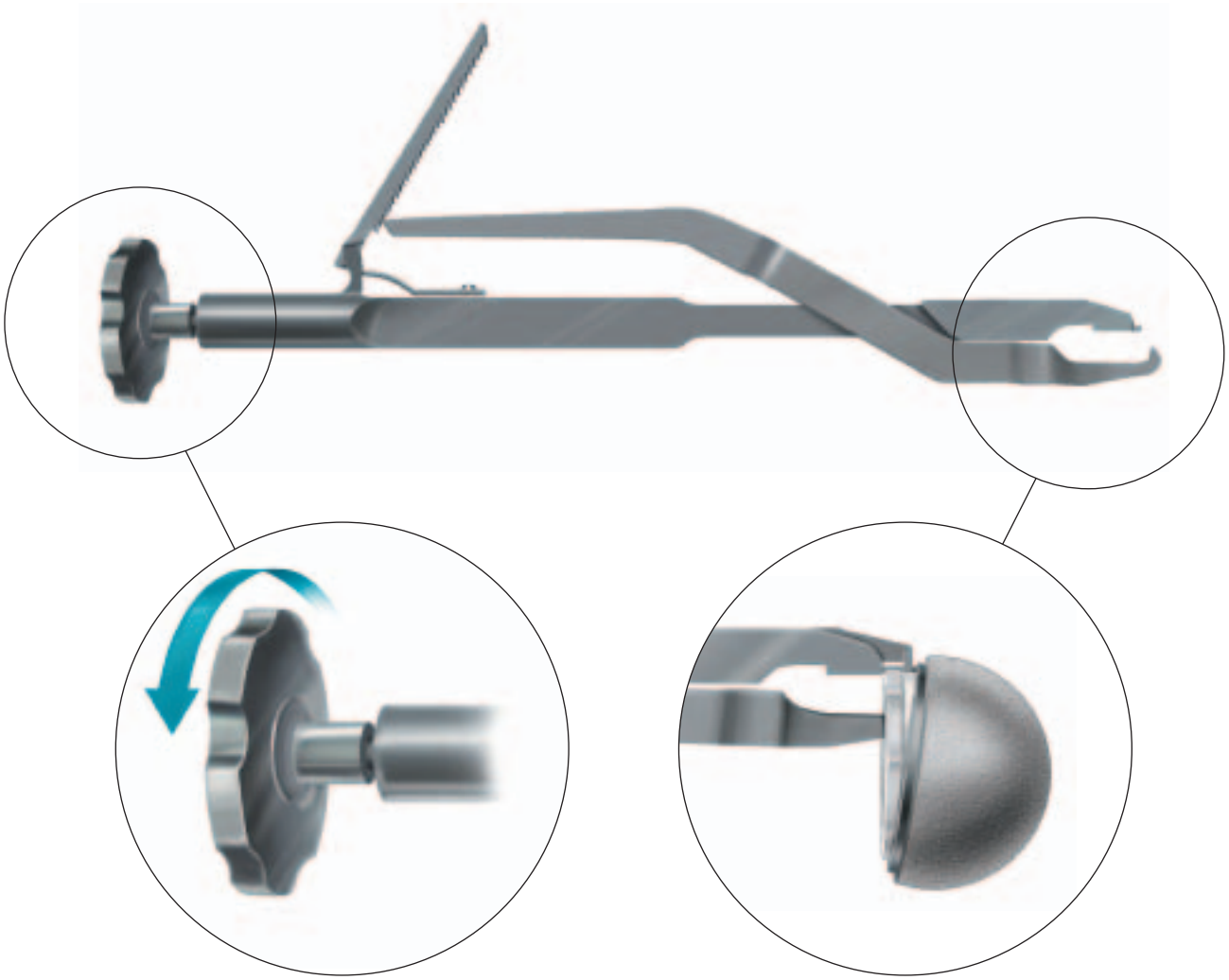

Figure 43
Rotation of Extraction Knob

Figure 44
Polyethylene Insert Removal

Once the ARD tip and teeth are secure on the polyethylene, advance the extraction knob clockwise until the polyethylene is removed (Figures 43 and 44).

It is important to note that an extracted polyethylene insert cannot be reused.

Ceramax™ Ceramic-on-Ceramic Insert Insertion

28 mm Alternative Bearing Trial

36 mm Alternative Bearing Trial

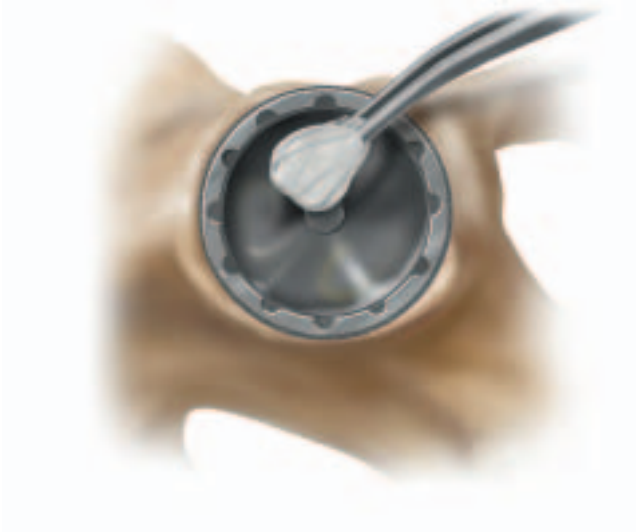

Figure 45
Ensure all taper mating surfaces are clean and free of debris.

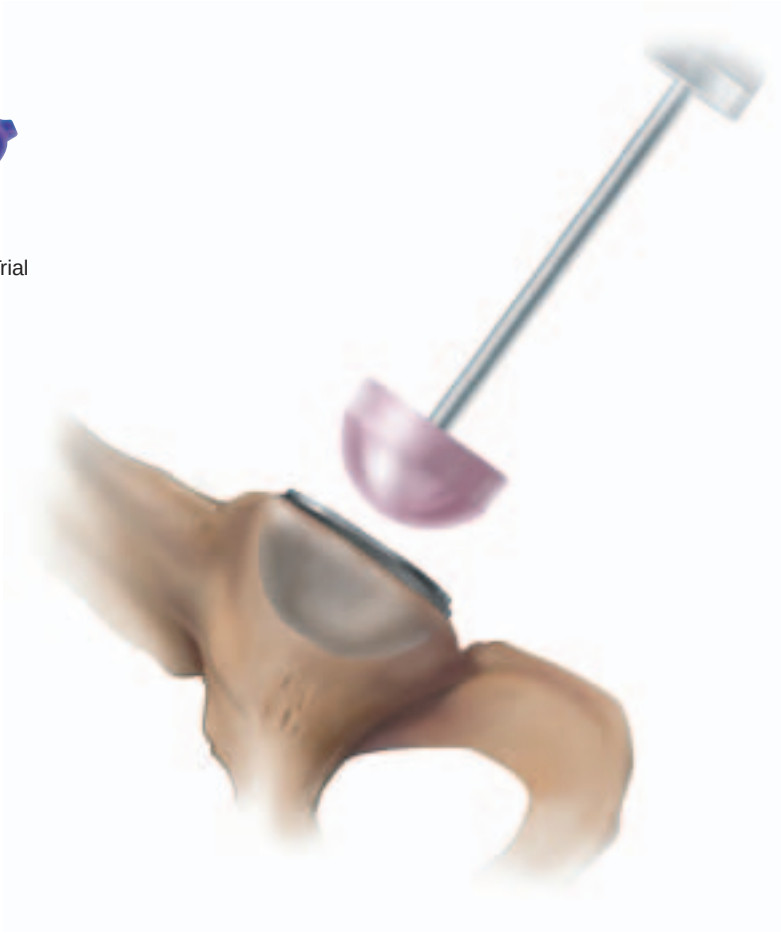

Figure 46
Confirm proper taper alignment of the ceramic insert.

To ensure optimal component placement with Ceramax™ Ceramic-on-Ceramic Inserts, trialing is critical. Dedicated trials for Ceramax™ Ceramic-on-Ceramic Inserts help ensure the correct restoration of biomechanics. The 28 mm insert trials are yellow; the 36 mm insert trials are purple.
If correct joint biomechanics, free of mechanical impingement, cannot be obtained with the alternative bearing trials, perform a trial reduction using the Pinnacle™ Acetabular Cup System Polyethylene Insert Trials. Then use the Pinnacle™ Acetabular Cup System Polyethylene Insert that results in joint stability.

Before placing the Ceramax™ Ceramic-on-Ceramic Insert into the Pinnacle™ Acetabular Cup, ensure all mating surfaces are clean and free of debris (Figure 45). Handle the Ceramax™ Ceramic-on-Ceramic Insert carefully to avoid damage that could compromise the mechanical integrity of the insert taper locking mechanism. Attach the suction cup inserter to the Ceramax™ Ceramic-on-Ceramic Insert Inner Diameter. Cautiously advance the insert to ensure circumferential alignment of the taper mechanism (Figure 46).

Palpate the insert to confirm proper taper alignment and seating in the cup. The insert should sit flush relative to the face of the cup. If the view is obscured a check can be made by running a finger around the outside of the insert to ensure it is correctly seated. Apply finger pressure to ensure initial locking of the taper mechanism. Do not attempt to fully engage the taper locking mechanism by striking the end of the suction cup inserter.

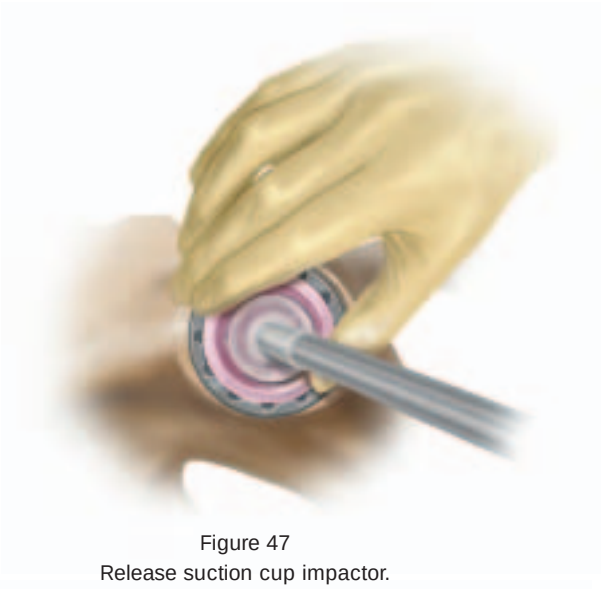

Figure 47
Release suction cup impactor.

Figure 48
Verify insert alignment.

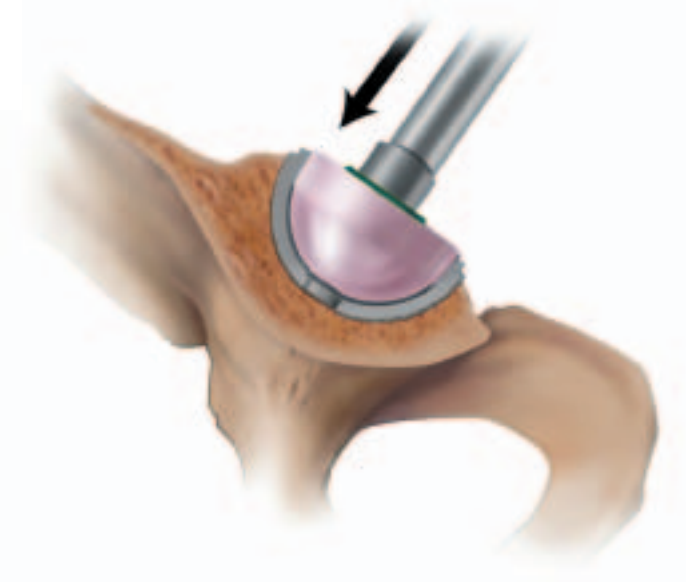

Figure 49
Impact Ceramax™ Ceramic-on-Ceramic Insert.

It is important to cautiously release the suction cup insertion instrument from the Ceramax™ Ceramic-on-Ceramic Insert so the insert does not disengage from the cup. It is recommended that the Ceramax™ Ceramic-on-Ceramic Insert be secured with a thumb and forefinger placed superiorly and inferiorly, while the suction cup instrument is disengaged from the insert (Figure 47).

Prior to final impaction, examine the insert to ensure it is seated evenly relative to the cup face (Figure 48). Use an impactor with a 28 mm impactor tip for final seating of the Ceramax™ Ceramic-on-Ceramic Insert. Final seating requires two to four moderate blows (Figure 49).

In the event that the Ceramax™ Ceramic-on-Ceramic Insert is impacted and does not seat properly in the cup, it must be removed as shown in the removal technique.
After removal of a Ceramax™ Ceramic-on-Ceramic Insert that has been impacted, only a polyethylene or metal insert may be used in the cup due to potential damage to the cup taper.
An insert that has been placed as shown in Figures 47, 48 and 49 may be removed and re-inserted prior to impaction.

Ceramax™ Ceramic-on-Ceramic Insert Extraction

Figure 50
Alternative Bearing Extractor

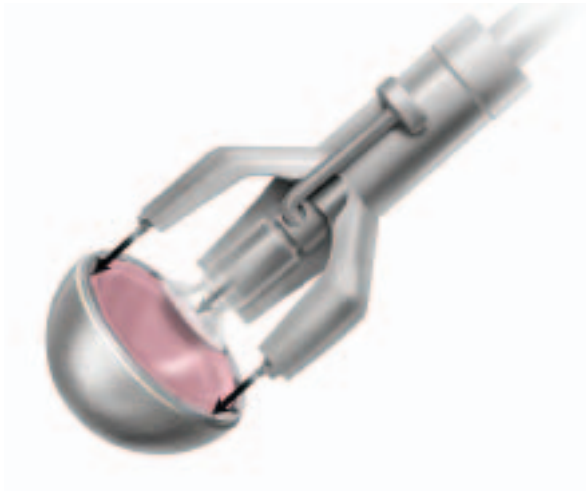

Figure 51
Placement of Alternative Bearing Extractor

Figure 52
Engage the suction cup by pushing down on the lever.

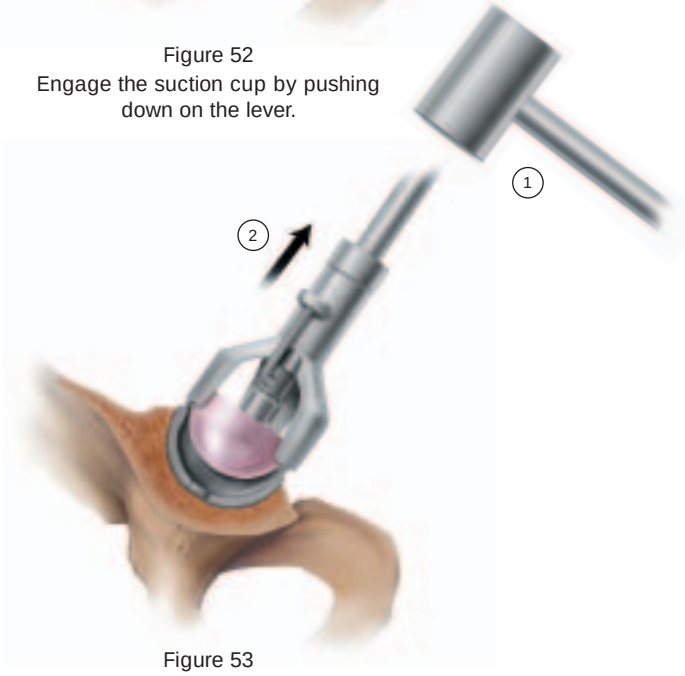

Figure 53
Impact the extractor handle lightly and lift the insert.

If it is necessary to remove a Ceramax™ Ceramic-on-Ceramic Insert from a Pinnacle™ Acetabular Cup, thread the extractor handle onto the appropriate size alternative bearing extractor (Figure 50). Each cup size has a specific extractor, e.g., 48 mm cup uses a 48 mm extractor. Place the three tips of the AB extractor into any three scallops on the face of the Pinnacle™ Acetabular Cup (Figure 51).

Push the attached lever down with thumb pressure to engage the suction cup to the inner diameter of the Ceramax™ Ceramic-on-Ceramic Insert (Figure 52).

To remove the Ceramax™ Ceramic-on-Ceramic Insert from the cup, tap the extractor handle lightly one to two times with a mallet. The resulting vibration will release the taper lock between the Ceramax™ Ceramic-on-Ceramic Insert and the Pinnacle™ Acetabular Cup.

Lift the insert out of the cup with the suction cup mechanism (Figure 53).

Ultamet™ Metal-on-Metal Insert Insertion

28 mm Alternative Bearing Trial

36 mm Alternative Bearing Trial

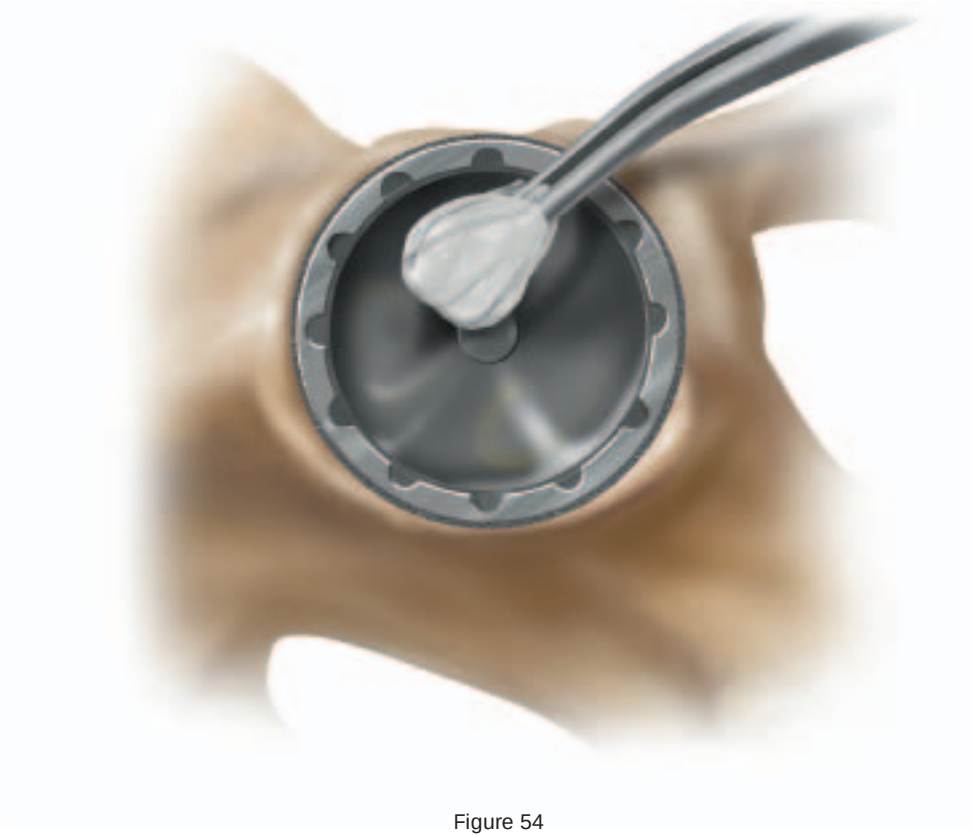

Figure 54
Ensure all taper mating surfaces are clean and free of debris.

To ensure optimal component placement when using alternative bearings, trialing is critical. Dedicated trials for alternative bearings exist that help ensure the correct restoration of biomechanics. The 28 mm alternative bearing trials are yellow and the 36 mm alternative bearing trials are purple.

If correct joint biomechanics, free of mechanical impingement, cannot be obtained with the alternative bearing trials, perform a trial reduction using the Pinnacle™ Acetabular Cup System Polyethylene Insert Trials. Then, use the Pinnacle™ Acetabular Cup System Polyethylene Insert that results in joint stability.

Before placing the Ultamet™ Metal-on-Metal Insert into the Pinnacle™ Acetabular Cup, ensure all mating surfaces are clean and free of debris (Figure 54).

Handle the Ultamet™ Metal-on-Metal Insert carefully to avoid damage that could compromise the mechanical integrity of the insert taper locking mechanism.

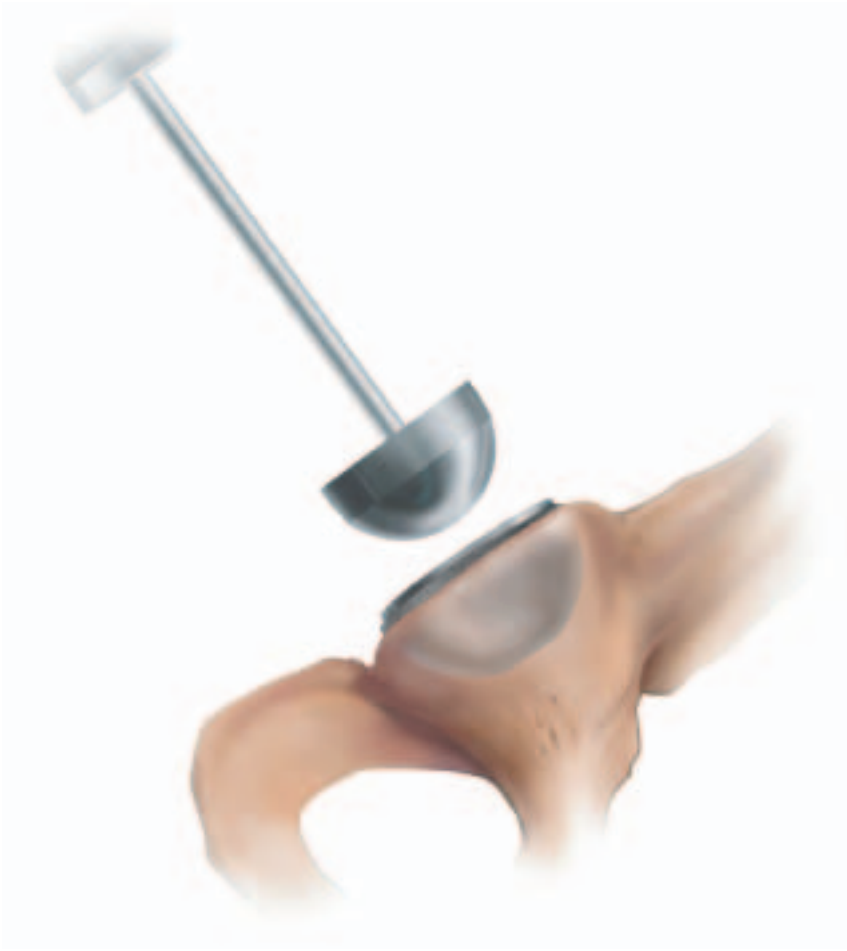

Figure 55
Confirm proper taper alignment of metal insert.

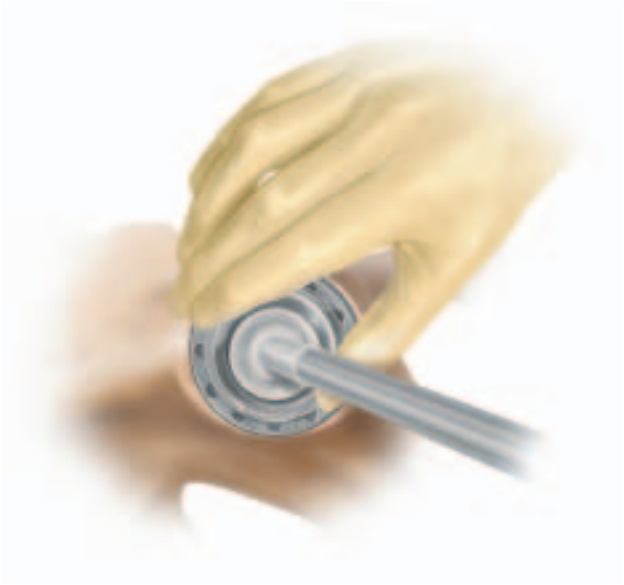

Figure 56
Release suction cup inserter.

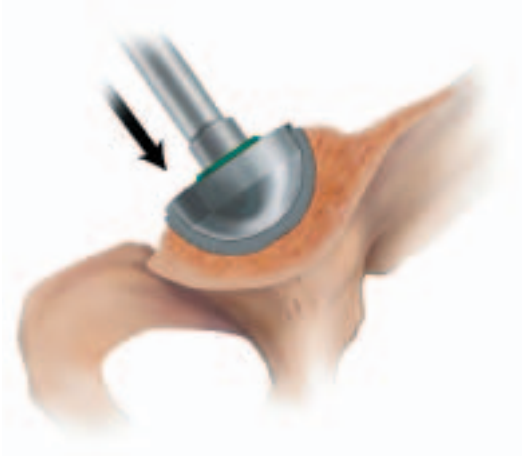

Figure 57
Verify insert alignment and impact insert.

Attach the suction cup inserter to the metal insert ID in any angle that facilitates introduction of the insert into the acetabular cup. Cautiously advance the metal insert to ensure circumferential alignment of the taper mechanism (Figure 55).

Palpate the metal insert to confirm proper taper alignment and seating in the cup. The insert should fit flush relative to the face of the cup.

If the view is obscured a check can be made by running a finger around the outside of the insert to ensure it is correctly seated.

Apply finger pressure to ensure initial locking of the taper mechanism. Do not attempt to fully engage the taper locking mechanism by striking the end of the suction cup inserter.

It is important to cautiously release the suction cup insertion instrument from the Ultamet™ Metal-on-Metal Insert so the insert does not disengage from the cup. It is recommended that the Ultamet™ Metal-on-Metal Insert be secured with a thumb and forefinger placed superiorly and inferiorly while the suction cup instrument is disengaged from the insert (Figure 56).

Prior to final impaction, examine the insert to ensure it is seated evenly relative to the cup face. Use an impactor with the appropriate head size for final seating of the metal insert. Final seating requires two to four sharp blows (Figure 57).

Use only the femoral heads with the Ultamet™ Metal-on-Metal Insert listed in the Ultamet™ Femoral Head Chart (page 30).

Use of femoral heads other than those recommended is contraindicated and will compromise performance.

Ultamet™ Metal-on-Metal Insert Extraction

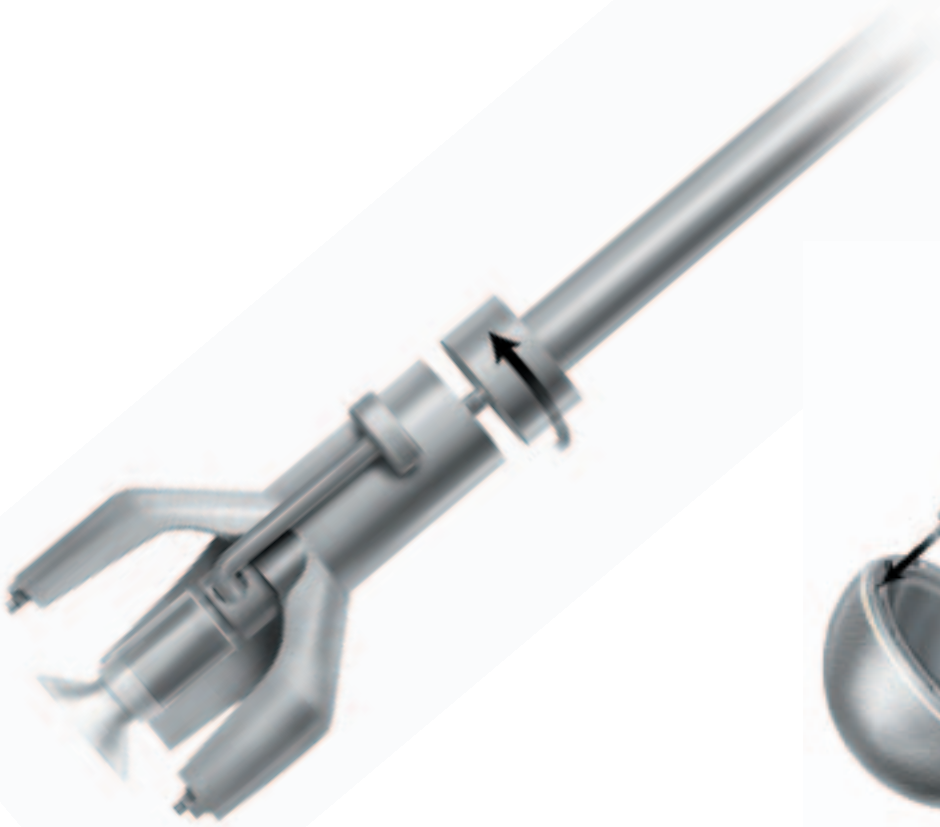

Figure 58
Alternative Bearing Extractor

Figure 59
Placement of Alternative Bearing Extractor

If it is necessary to remove an Ultamet™ Metal-on-Metal Insert from a Pinnacle™ Acetabular Cup, thread the extractor handle onto the appropriate size alternative bearing (AB) extractor (Figure 58). Each cup size has a specific extractor, e.g., 48 mm cup uses a 48 mm extractor.

Note: The AB extractor can be used with 28 or 36 mm ID inserts.

Place the three tips of the AB extractor into any three scallops on the face of the Pinnacle™ Acetabular Cup (Figure 59).

Ultamet™ Femoral Head Chart

Articul/eze® Metal Head, 28 mm (12/14 Taper)	
Cat. No.	Neck Length
1365-11-500	+1.5
1365-12-500	+5
1365-13-500	+8.5

S-ROM® Metal Head, 28 mm (11/13 S-ROM® Taper)	
Cat. No.	Neck Length
1365-16-500	+0
1365-17-500	+3
1365-18-500	+6

Articul/eze® Metal Head, 36 mm (12/14 Taper)	
Cat. No.	Neck Length
1365-50-000	-2
1365-51-000	+1.5
1365-52-000	+5
1365-53-000	+8.5
1365-54-000	+12

S-ROM® Metal Head, 36 mm (11/13 S-ROM® Taper)	
Cat. No.	Neck Length
1365-31-000	+0
1365-32-000	+3
1365-33-000	+6
1365-34-000	+9

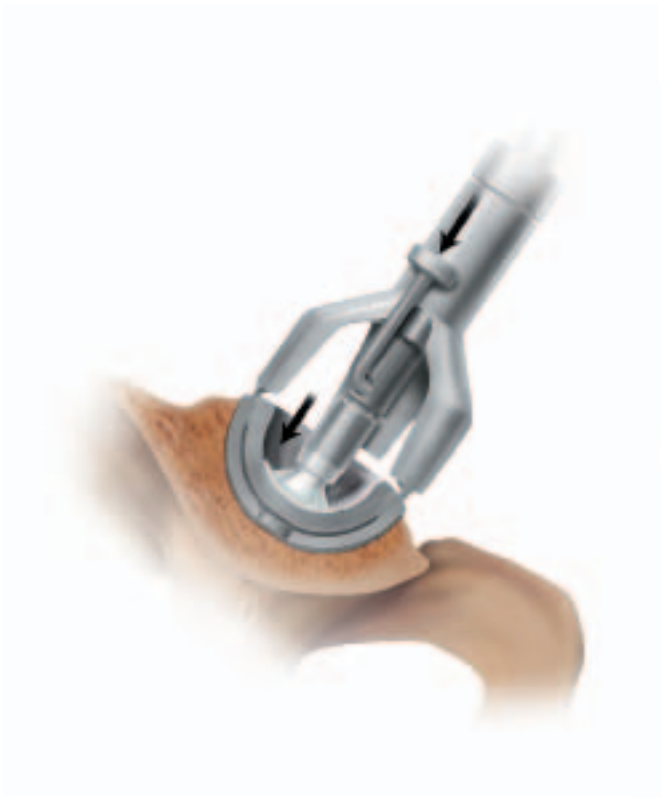

Figure 60
Engage the suction cup by pushing down on the lever.

Figure 61
Impact the extractor handle lightly and lift the insert.

Ultamet™ Femoral Head Chart

Elite™ Metal Head, 28 mm	(9/10 Taper)
Cat. No.	Neck Length
9627-00-100	-3
9627-01-100	+0
9627-02-100	+3
9627-03-100	+6

Elite™ Metal Head, 36 mm	(9/10 Taper)
Cat. No.	Neck Length
9627-10-000	-3
9627-11-000	+0
9627-12-000	+3
9627-13-000	+6

Push down the attached lever with thumb pressure to engage the suction cup to the inner diameter of the Ultamet™ Metal-on-Metal Insert (Figure 60).

To remove the Ultamet™ Metal-on-Metal Insert from the cup, impact the extraction handle lightly one to two times. The resulting vibration will release the taper lock between the Ultamet™ Metal-on-Metal Insert and the Pinnacle™ Acetabular Cup. The insert will be lifted out of the cup by the suction cup mechanism (Figure 61).

Functional Assessment

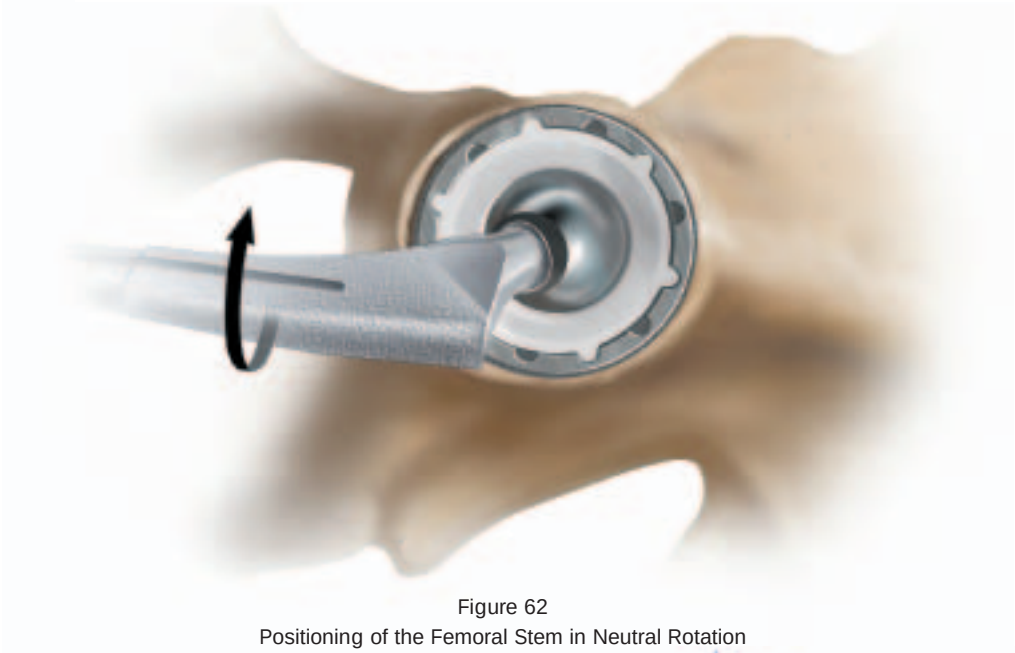

Figure 62
Positioning of the Femoral Stem in Neutral Rotation

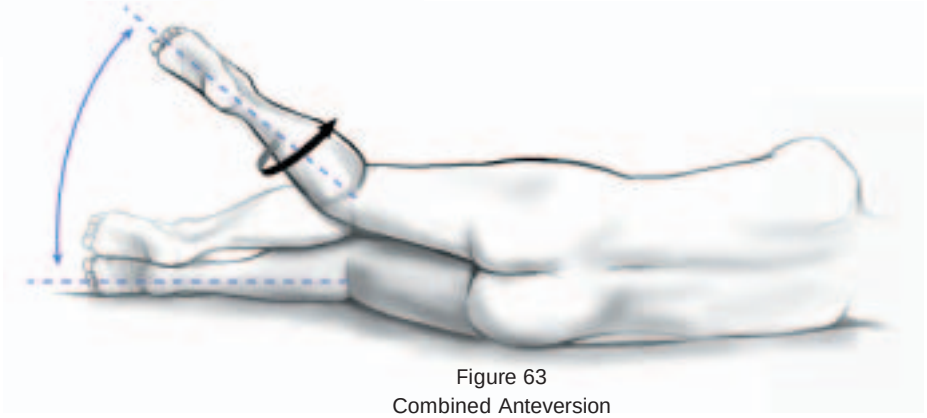

Figure 63
Combined Anteversion

Correct component placement is critical for the longevity of the hip reconstruction. Component placement is even more critical when alternative bearings are used in the reconstruction.

The following illustration depicts the position of the femoral component neck with relation to the opening of the acetabular component with the reconstructed hip in neutral rotation (Figure 62).

To assess the combined anteversion of the femoral stem and acetabular component, place the patient in the lateral decubitus position with the operative hip gently flexed and internally rotated (Figure 63) until the circumference of the femoral head becomes coplanar with the opening of the acetabular insert (i.e. the axis of the femoral neck is perpendicular to the insert face).

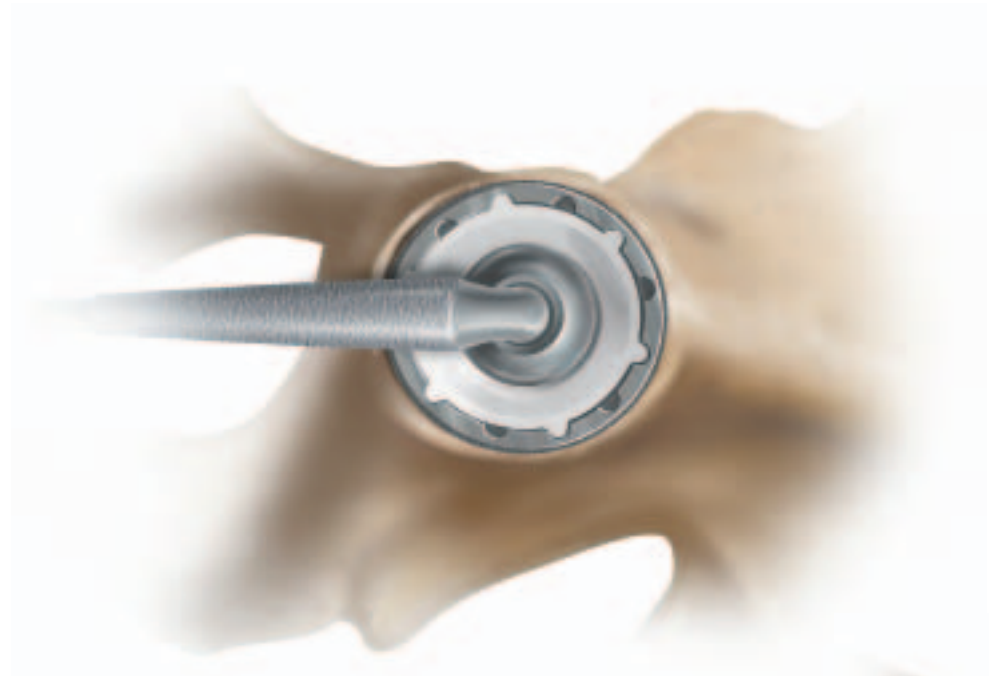

Figure 64
Frontal View of Coplanar Position of Head and Insert
and Perpendicular Position of Stem

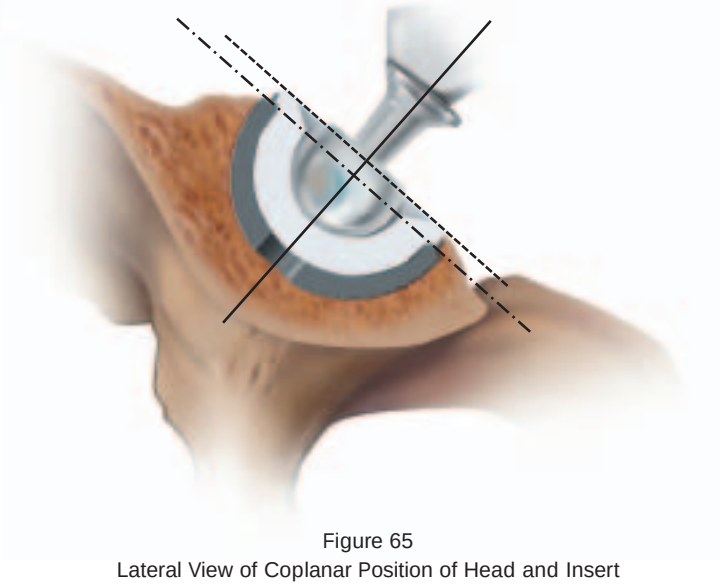

Figure 65
Lateral View of Coplanar Position of Head and Insert
and Perpendicular Position of Stem

This position is depicted through a frontal view (Figure 64) and through a lateral view (Figure 65).

The angle between horizontal and the internally rotated operative leg provides an estimate of combined anteversion of the acetabular component and the femoral stem. Combined anteversion at 30-40 degrees is generally acceptable.

Tight Exposure and Stability Tips

Tight Exposure

If the exposure is tight, completely incise the anterior capsule, perform a partial or complete release of the gluteus maximus tendon and release the reflected head of the rectus femoris.

Stability Assessment

Posterior Instability

With the trial implants in place, place the hip in 90 degrees of flexion, neutral abduction and internally rotate until subluxation. If there is less than 60 degrees of internal rotation, determine the cause of instability.

Prosthetic Impingement

Problem
- Femoral implant neck levers on the component rim.

Solutions
- Trial with a face-changing insert and re-evaluate impingement.
- Reposition cup to correct version/abduction.
- Increase head size and evaluate.
- Increase anteversion of the stem.

Bony Impingement

Problems
- Prosthetic neck levers on anterior acetabular osteophyte.
- Greater trochanter impinging on ilium.

Solutions
- Remove anterior osteophytes from the acetabulum.
- Increase stem offset to move trochanter away from the ilium.
- Remove anterior trochanteric bone.
- Trial with a lateralised insert.

Soft Tissue Impingement

Problem
- Redundant anterior capsule causes head to lever out of socket.

Solutions
- Resect redundant anterior capsule.
- Trial with a lateralised insert.

Soft Tissue Laxity

Problem
- Lax soft tissue leading to multidirectional instability.

Solutions
- Increase the neck length.
- Trial with a lateralised acetabular insert.
- Advance the trochanter.

Anterior Instability

With the implant trial in place, place the hip in extension and maximally externally rotate; subluxation should not occur. If subluxation occurs, assess the following:

Prosthetic Impingement

Problem
- Prosthetic neck impinges on the acetabular cup.

Solutions
- If lipped or face-changing trial insert is in, convert the insert to a neutral insert.
- Reposition acetabular component to decrease anteversion.
- Decrease anteversion of the femoral stem.
- Increase the head size and re-evaluate.

Bony Impingement

Problem
- Femur impinges on the ischium.

Solutions
- Increase femoral offset.
- Decrease acetabular or stem anteversion.
- Trial with a lateralised insert.

The keys to managing stability are:

1. Ensure the appropriate anteversion/abduction of the acetabular and femoral components.
2. Avoid the routine use of lipped inserts and skirted heads as these decrease range of motion prior to mechanical impingement.
3. Restore correct leg length and femoral offset.
4. Repair the posterior capsule and rotators.
5. Work with the patient to ensure appropriate post-operative precautions are followed.

Closure

Closure is based on the surgeon's preference and the individual case. If the capsule is retained it is closed separately. The gluteus minimus and gluteus medius can be closed separately or as a single unit. At least one stitch is passed through bone. Tension is relieved during the repair with slight internal rotation. The repair should be tested throughout the hip range of motion.

References:

1. Bobyn J et al. The Optimum Pore Size for the Fixation of Porous-Surfaced Metal Implants by the Ingrowth of Bone. Clinical Orthopaedics and Related Research, 150, 1980.

2. Bobyn J, Engh C. Human Histology of the Bone-Porous Metal Implant Interface. Orthopaedics, July, 1984.

3. Engh C et al. Evaluation of Bone Ingrowth in Proximally and Extensively Porous Coated Anatomic Medullary Locking Protheses Retrieved at Autopsy. Journal of Bone and Joint Surgery, 903, June, 1995.

4. Frayssinet P et al. Natural History of Bone Response to Hydroxyapatite-Coated Hip Prostheses Implanted in Humans. Cells and Materials, February, 1995.

Cat No: 9068-80-050

DePuy
a Johnson & Johnson company

DePuy International Ltd
St Anthony's Road
Leeds LS11 8DT
England
Tel: +44 (113) 270 0461
Fax: +44 (113) 272 4191