Minimally Invasive System for Total Hip Arthroplasty

Surgical Technique
INTRODUCTION

The DePuy MI System was created by an International team of surgeons whose first priority was to achieve patient gain through minimally invasive surgery using established surgical techniques. Their collaboration with DePuy Synthes' engineers and scientists constitutes the essence of an accomplished and complete minimally invasive system where all aspects of THR are considered. Besides specially designed instrumentation, our complete system includes a very comprehensive and individualised educational programme as well as a unique portfolio of successful and established implants.

The focus of the DePuy MI System is to make orthopaedic surgery a less traumatic experience and we strongly believe that we are uniquely positioned for such a mission.

The DePuy MI System is designed to accommodate any DePuy Synthes cementless acetabular and femoral implants. In this surgical technique, DURALOC® cups and CORAIL® stems are used as an example.

If you are using other DePuy Synthes implants, please also refer to the appropriate surgical technique.
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Patient selection

Minimally invasive THR is not recommended in the following cases.

- Obese patients with BMI > 30 - especially in conjunction with large upper thigh circumference
- Large gluteus medius muscle mass
- Revision hip surgery
- Patients with previous surgery to the hip
- Patients with scarring to or in the region of the hip joint
- Patients with abnormal anatomy e.g. severe DDH, severe anteversion of the femoral head

Pre-operative planning

The contralateral side is compared in anterior/posterior (A/P) and lateral projections. The desired magnification for all imaging should correspond to the templates provided. Magnification markers taped to the patient’s leg at the level of the trochanter will assist in determining actual magnification.

Both extremities are placed in 15 degrees of internal rotation to position the head and neck parallel to the coronal plane in the A/P projection. The beam is centred on the symphysis pubis to 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.

Frequently, the affected hip is fixed in external rotation, which leads to an underestimation of 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.

**Acetabular templating**

DURALOC templates allow assessment of the most likely size of the cup to be implanted. The acetabular component should be placed on structurally sound bone to optimise the opportunity for bone ingrowth. The cup should be placed so that the head centre is as near to the anatomical position as possible and the most inferior part of the cup should normally be at the level of the bottom of the teardrop (Figure 1A).

**Femoral templating**

The CORAIL Hip System provides a comprehensive pre-operative range of femoral templates, at 20% magnification. These are placed over the A/P and lateral X-rays to determine offset, implant size and neck length in order to restore the patient’s natural anatomy. Particular attention should be paid to achieving optimum metaphyseal filling.

As the CORAIL stem is a self-locking design, there should be apparent contact between the stem and the bone at the calcar level on the medial side and below the flare of the implant on the lateral side. Distally, there should be a gap of 1 mm between the stem and the cortex. Templating will also indicate the level of neck resection. This should be at an angle of 45°, usually 1 cm above the lesser trochanter (Figure 1B).
PATIENT POSITIONING

The patient is placed on the operating table in the lateral decubitus position. The pelvis must be supported so that it remains perpendicular to the table throughout the procedure.

The unaffected leg is fixed in approximately 90° of flexion at the knee (Figure 3).
An initial skin incision is made over the tip of the greater trochanter. The incision is extended approximately 2.5 cm distally, in line with the leg, and 5 cm proximally, following a gentle curve (convex anteriorly) (Figure 4).

The fatty layer is divided in line with the skin incision. The skin is lifted and the fatty layer is undermined, allowing the skin opening to be moved above the fascia lata. A deep, forked retractor may be introduced at this stage to open the window (Figure 5).
EXPOSURE

Pass through the fascia lata following the line of the incision, dividing the layer, both distally and proximally under the initial incision. Exposure is continued down through gluteus maximus (Figure 6).

The forked retractors can now be repositioned to retract gluteus medius. With the leg in internal rotation, the sciatic nerve is located by placing the foot onto a Mayo table, but it is not exposed at the base of the wound. The layer of fat, which is below the tip of the greater trochanter, is swept back and away using a swab to expose the short rotator muscles (Figure 7).
The gluteus medius retractor is placed behind the trochanter and gluteus medius is retracted to improve visualisation of the rotator muscles.

The piriformis tendon is identified, close to the femur. Blunt scissors are passed under the short rotator muscles, including the piriformis muscle, to allow a single suture to be passed through the entire group (Figure 8).

The suture is tied and the muscles are detached close to the femur. Tension on the suture will allow any adhesions between the rotator muscles and the capsule to be identified and released (Figure 9).
The released rotator muscles will now provide protection for the sciatic nerve. The gluteus medius retractor is removed and a second forked retractor introduced to open the wound.

The quadratus femoris muscle may limit access to the capsule. If the muscle is to be divided, care should be taken to limit bleeding from the vessels of the circumflex femoral artery which passes along the femur, close to the attachment of the rotator muscles (Figure 10).

At this point, the leg can be rotated to help identify the femoral head and establish good visualisation of the acetabular anatomy.

The capsule is incised using a single curved incision that starts above the superior border of the acetabulum, extending over the rim of the acetabulum. The incision continues close along the intertrochanteric line of the femur until the level of the lesser trochanter is reached (Figure 11).
A single suture is passed through the capsule. Tension is applied and the flap of capsular tissue is distracted. The forked retractor (shown in Figure 7) can now be repositioned to retract the capsule and expose the hip joint (Figure 12).

With the leg internally rotated, the knee is brought into adduction and the hip is dislocated. It may be necessary to make a further release of the tight capsular fibres in the orbicular zone, close to the femoral neck, to facilitate dislocation without force. This will also improve access to the femoral neck and release of the anterior capsule.

The superior capsular retractor is placed under the femoral neck and the gluteous medius retractor is placed under the greater trochanter. This should provide a clear view of the femoral neck (Figure 13).
**FEMORAL NECK RESECTION AND ACETABULAR PREPARATION**

**Femoral neck resection**

A trial stem or broach of the size determined during pre-operative templating is laid above and along the mid line of the femur, so that its tip points to the centre of the knee. The neck resection will be made at the level determined during templating and at the angle set by the shoulder of the stem (Figure 14).

A corkscrew instrument may be used to ease extraction of the head from the wound, allowing any remaining attachments to be released.

**Acetabular preparation**

Access to the acetabulum is now improved by displacing the femur anteriorly. A two centimetre incision may be made in the anterior capsule, just before it joins the femur. With the tip of the gluteus medius retractor inserted through the incision, so that its blade is centred over the femoral neck, the leg is then rotated back into neutral position on the table (Figure 15).

With a clear view past the femur, the full circumference of the acetabulum is presented into the wound. Any remaining soft tissues are cleared from the rim of the acetabulum.

The entire labrum is excised and any osteophytes are removed to ensure that the anterior and posterior margins of the acetabulum are identified, and the true floor of the acetabulum is established.
ACETABULAR REAMING

Acetabular reaming

The aim of acetabular reaming is to restore the original centre. Using the smallest reamer attached to the 45° driver, introduced perpendicular to the table, ream the acetabulum, holding close to the transverse ligament (Figure 16).

Once the acetabulum has been deepened to the level determined during pre-operative templating, the reamer size is sequentially increased in 1 – 2 mm increments. Reaming stops when the socket has become a true hemisphere and when the reamer makes contact with the anterior and posterior walls of the acetabulum. Any cysts of fibrous tissue should be removed with a curette. Pack any defects densely with cancellous bone.
Either the standard or bantam threaded connector is selected (depending on the cup to be implanted). The rotation locking catch is disengaged and the release button is inserted into the acetabular inserter body.

The shaft assembly is inserted into the acetabular inserter body, holding down the release button to allow the shaft to fully engage into the body.

The selected threaded connector is inserted into the acetabular inserter body and the hex socket is engaged into the shaft. Releasing the button will lock the acetabular inserter in position. Rotating the shaft handle should now rotate the threaded connector (Figure 17).
ACETABULAR CUP TRIAL AND POSITION

Following preparation of the acetabulum, a trial cup of 1 to 2 mm larger in diameter than the last reamer is inserted to assess the coverage of the acetabular component and to gauge the seating depth of the actual cup. The rim fit of the fully seated trial should be tight enough to make it difficult to alter its position.

The inferior rim of the trial liner should be level with the bottom of the teardrop and its position should match the templated position (Figure 18). Using cup and trial liners in conjunction with the femoral component trials is essential to assure optimum position of the implants.

The cup trial is screwed onto the threaded connector of the acetabular inserter until locked. The trial cup should not be over tightened.

The alignment guide is attached to the acetabular inserter, and the trial is introduced to the acetabulum. 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 the cup will be at 45 degrees. (Figure 19).
When the extended rod of the version guide, corresponding the affected hip, follows the long axis of the patient’s body, the trial cup is in 30 degrees of antversion (Figure 20).

The external alignment guide will not be accurate if the pelvis is tilted or if the patient has rolled forward or backward. The transverse ligament is used as a natural landmark to further verify the alignment.

Figure 20
POLYETHYLENE LINER TRIAL

The locking catch is placed in the unlocked position and the handle rotated counter clockwise to release the threaded connector from the trial. The inserter is then removed. (Figure 21).

Polyethylene liner trial

The liner trial is secured to the cup trial through the apical hole screw using a hex head screwdriver (Figure 22).
To preserve bone stock, improve stability and offer optimal conditions for bone ongrowth, the femoral preparation for the CORAIL stem removes as little cancellous bone from the metaphysis as possible. An impactor is used to compact the cancellous bone prior to broaching of the metaphysis (Figure 23).

The broaches are then used to tamp down the cancellous bone and to produce a femoral cavity.

To avoid undersizing, varus positioning and to permit in-line broaching, it is sometimes necessary to remove a small piece of cortex from the greater trochanter with a chisel or the CORAIL osteotome, to ensure an adequately lateral starting point.

Beginning with the smallest broach attached to the broach handle, progressively enlarge the medullary cavity until the level of the neck resection is reached, and no further. The anteversion is automatically set during broaching.

Broaching should continue until complete stability is achieved (Figure 24).

The size of each broach is the same as the corresponding implant without HA coating. The last broach is left in place.
The calcar mill is placed into the medial hole in the broach and the femoral neck is milled to produce a flat surface (Figure 25).

**Trial reduction**

With the broach in situ, the appropriate trial neck and head are attached (Figure 26). The hip is reduced and adjustments, if any, are made to ensure joint stability through a full range of motion. Leg length may be adjusted by varying the trial neck and head length if necessary. Leg length may be reduced with a second neck osteotomy and further broaching to prepare the femoral canal. After trial reduction, carefully remove the broach from the femur with the broach handle to avoid enlarging the prepared femoral canal.

To preserve the surface of the compacted cancellous bone, and to promote bone ongrowth, irrigation and drying of the femur is not recommended.
ACETABULAR CUP TRIAL REMOVAL & CUP IMPLANTATION

Acetabular cup trial removal

The inserter handle is rotated to secure the threaded connector into the trial. The inserter handle is pulled back to extract the trial (Figure 27).

Acetabular cup implantation

Securely thread the acetabular cup prosthesis onto the threaded connector.

Rotate the cup with the alignment handle to position any sector holes. Engage the locking catch when the correct alignment is achieved. Introduce the cup into the acetabulum, using the external alignment guide as before. With correct cup positioning achieved, impact the cup in place (Figure 28).
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 (Figure 29). An apical hole eliminator may be inserted with a hex head screwdriver following cup impaction. If adjustments to the cup orientation are necessary, thread the inserter back into the apical hole to adjust the cup position. Unlocking and rotating the alignment handle allows the removal of the acetabular inserter from the cup.

**Polyethylene liner insertion**

Prior to inserting the final acetabular liner, thoroughly irrigate and clean the cup. It is important to check the cup/liner locking groove for the removal of all debris. Remove all soft tissue from the face of the cup so as not to impede liner seating (Figure 30).

The liner anti-rotational device (ARD) tabs are aligned with the ARD scallops on the cup. The correct sized liner inserter head is selected and attached to the acetabular inserter. The liner is seated using firm hand pressure only. Final impaction into the cup is completed using the acetabular inserter and the correctly sized liner inserter head.

Figure 29

Figure 30
FEMORAL COMPONENT INSERTION & PROXIMAL BONE IMPACTION

Femoral component insertion

The definitive prosthesis is the same size as the last broach used. With the taper still protected by the cover, the implant is introduced and impacted into the canal using the femoral component impactor, aligned in the central axis of the femur, to the level of the HA coating (Figure 31). With the prosthesis in situ, the silicone cover is removed and the trial head added to carry out a trial reduction. The prosthesis is irrigated and cleaned, ensuring the taper is free of debris.

Proximal bone impaction

When the definitive stem is fully seated, cancellous bone graft from the femoral head is packed around the proximal part of the prosthesis. A tamp is provided for this purpose (Figure 32). This procedure encourages bone ongrowth and allows a complete seal to form between the proximal femur and the implant.
FEMORAL HEAD IMPACTION & CLOSURE

Femoral head impaction

The appropriate femoral head is placed onto the taper and lightly tapped home using the head impactor (Figure 33). The hip is reduced and a final stability check is performed.

Closure

The flap of capsular tissue retained by suture is returned to its natural position over the joint and sutured to the opposing remnant of the capsule over the acetabulum. Three stitches are used to reattach the flap of the capsule (Figure 34).
The tendonous attachments of the short rotator muscles are passed and stitched to the tendon of the gluteous medius (Figure 35).

Gluteus medius will then close naturally over the wound. If the fascia lata is visible or can be felt distally below the muscle, a single stitch is used to close the layer at this point.

Closure is completed in the normal way.
ORDERING INFORMATION

DePuy MI System Core Set Instruments

- 9200-10-023 Bantam Connector Shaft
- 9200-10-024 Impactor Tip 22.225 mm
- 9200-10-025 Impactor Tip 26 mm
- 9200-10-026 Impactor Tip 28 mm
- 9200-10-027 Impactor Tip 32 mm
- 9200-10-028 Impactor Tip 36 mm
- 9200-10-029 Angled Acetabular Inserter
- 9200-10-031 Angled Reamer Driver
- 2217-50-044 Version Guide
- 9200-10-017 Primary Acetabular Case Complete
- 2598-07-110 MI Gluteus Medius Retractor
- 2598-07-625 MI Inferior Posterior Retractor Right
- 2598-07-626 MI Inferior Posterior Retractor Left

DePuy MI System Additional Instruments

- 2598-07-120 MI Blunt Right Angle Posterior Capsular Retractor
- 2598-07-130 MI Cobra Retractor with Armrest
- 2598-07-140 MI Superior Capsular Retractor
- 2598-07-150 MI Sciatic Nerve Retractor
- 2598-07-180 MI Right Angle Posterior Capsular Retractor
- 2598-07-650 MI XL Femoral Neck Elevator
- 2598-07-500 Retractor Case Complete
ORDERING INFORMATION

DePuy MI System Additional Instruments

530300  Zimmer to Hudson Adaptor
9622-56-000  CHARNLEY® Initial Incision Retractor
9622-95-000  CHARNLEY Initial Incision Retractor Arm
9620-02-000  CHARNLEY Horizontal Retractor
9620-03-000  CHARNLEY Vertical Retractor
9620-04-000  CHARNLEY Pin Retractor & Handle

2440-00-536  QUICKSET™ Grater Head 36
2440-00-537  QUICKSET Grater Head 37
2440-00-538  QUICKSET Grater Head 38
2440-00-539  QUICKSET Grater Head 39
2440-00-540  QUICKSET Grater Head 40
2440-00-541  QUICKSET Grater Head 41
2440-00-542  QUICKSET Grater Head 42
2440-00-543  QUICKSET Grater Head 43
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2440-00-568  QUICKSET Grater Head 68
2440-00-569  Grater Case Complete

Educational Material

9200-10-086  DePuy MI System Product Rationale
9200-10-090  Interactive CD-ROM
DePuy MI System includes a comprehensive and tailored educational programme offering cadaver workshops and visits with our design surgeons.

Talk to your DePuy Synthes Account Manager to organise your individual education plan.