Direct Anterior Approach for Hip Resurfacing: Surgical Technique and Complications

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Abstract

Background The direct anterior approach (DAA) for hip resurfacing arthroplasty is a technically difficult approach but theoretically reduces the soft tissue trauma to the hip because it does not require muscle detachments from the bone. Furthermore, the patient is in the supine position facilitating fluoroscopy to control component placement. However, the complications associated with the learning curve and functional outcome scores are not well defined in the literature.

Questions/purposes We therefore asked how our first 57 operations using the anterior approach and special table extension compared with that in the literature with regard to (1) complication rate; (2) functional outcome scores; (3) component placement; and (4) length of stay.

Methods We retrospectively reviewed 51 patients who underwent 57 hip resurfacing procedures using a DAA. There were 45 men and six women with an average age of

51 years (range, 31–63 years) and a body mass index of 28.7 kg/m² (range, 19.7–42.0 kg/m²). The minimum followup was 0.3 months (mean, 8.7 months; range, 0.3–24.9 months).

Results There were three atraumatic (5%) and one post-traumatic (1.8%) femoral neck fractures. Average HOOS scores were equal to or better than averages reported for total hip arthroplasty. Average cup inclination was 36.5° (range, 25°–48°). The average length of stay was 2.11 days (range, 1–4 days).

Conclusions The surgical approach for anterior hip resurfacing is technically difficult but may have some clinical benefits. Surgeons interested in using the DAA for hip resurfacing should be very familiar with the DAA for total hip arthroplasty and with hip resurfacing.

Level of Evidence Level IV, retrospective study. See Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Hip resurfacing arthroplasty in properly selected patients provides functional scores comparable to conventional THA [11]. Patients reportedly return to higher levels of activity [19] and in one study of patients with bilateral hip procedures in which one hip was resurfaced and the other totally replaced, the authors reported no difference in ROM between hips [10]. Despite these reports, the benefits of resurfacing over conventional THA have been questioned [9]. Although bone-preserving, it is more traumatic to the soft tissue because it requires larger exposure [9]. Larger exposure may contribute to resorption of the femoral neck or avascular necrosis leading to femoral neck fracture or component loosening at long-term followup [2].

The direct anterior approach (DAA) through a single incision is a less invasive technique because it does not substantially affect any of the major muscle groups around the hip. The hip extensors, which are important for activities of daily living, and the abductors, critical for proper gait, remain intact during the DAA [14]. The main blood supply to the femoral neck comes from the major branch of the medial femoral circumflex artery from the posterior aspect of the hip, which is reportedly maintained with an anterior or anterior-lateral approach [2]. Although the anterior-lateral approach maintains the blood supply, the main disadvantage is the release of a substantial portion of the abductor muscle group, which may result in a postoperative Trendelenburg gait [13]. The posterior approach is advantageous in that it is familiar to most surgeons and the exposure of the femur is relatively simple. However, muscles that maintain coaptation and stability of the hip, the short external rotators [7], are released during this approach [15]. We found one study describing a surgeon's first 50 resurfacings using the DAA with an orthopaedic table and no femoral neck fractures were reported [4]. We published the surgical technique elsewhere [8] but did not explain the complications in detail or report any clinical outcome measures. We have also expanded on muscle release, maintaining blood supply to the femoral head, and protection of soft tissue structures.

We therefore asked how our first 57 operations using the anterior approach and special table extension compared with that in the literature with regard to (1) complication rate; (2) functional outcome scores; (3) component placement; and (4) length of stay.

Materials and Methods

We retrospectively reviewed data on 51 patients undergoing hip resurfacing between May 2007 and July 2009. All patients undergoing hip resurfacing during the study period were included. Six patients had bilateral resurfacings performed at different times during the study period for a total of 57 hips. Indications for hip resurfacing included young age (younger than 65 years for males and younger than 55 years for females), relatively active lifestyle, adequate femoral head bone stock, and sufficient bone on the acetabular side, which were qualitatively assessed on preoperative radiographs. Contraindications for resurfacing and thus indications for THA were large (> 1 cm) and multiple cysts (more than one) in the femoral head and head-neck junction, qualitatively assessed poor bone quality, poor kidney function as evidenced by elevated creatinine or blood urea nitrogen, and known metal sensitivity. All operations were performed by the same surgeon (SK). The surgeon learned hip resurfacing using the posterior approach and began using

the anterior approach after 14 hip resurfacings. All resurfacings have been done using the anterior approach since. If a patient would like a different approach, we recommend them to a surgeon experienced in their preferred approach. The ratio of hip resurfacing to THA at our institution during the study period was 1:6. There were 45 males and six females with an average age of 51 years (range, 31–63 years) and body mass index of 28.7 kg/m^2 (range, $19.7\text{--}42.0 \text{ kg/m}^2$) (Table 1). All 57 cases were performed through a DAA. Fifty-five hips were diagnosed with osteoarthritis and two had a diagnosis of avascular necrosis. The minimum followup was 0.3 months (mean, 8.7 months; range, 0.3–24.9 months). No patients were recalled specifically for this study; all data were obtained from medical records and radiographs.

The DAA was performed using the Arch table extension (Innovative Orthopedic Technologies, Houston, TX). Special instruments play an important role in anterior hip resurfacing such as standard goniometer and a special alignment device named Quadrafoil (Synvasive Technology Inc, Reno, NV) to ensure proper angle of pin placement, an image intensifier to ensure proper socket and pin placement, Mueller retractors, bent Hohmann and 90° Hohmann retractors, Aquamantus bipolar sealant to reduce blood loss (Salient Surgical Technologies, Portsmouth, NH), and a special operating room table setup (Fig. 1). After anesthesia, the patient was placed supine on a regular

Table 1. Patient demographics

Demographic information	Value
Age (years)	51 (range, 31–63; SD 7.4)
Male/female	45/6
Body mass index (kg/m^2)	28.7 (range, 19.7–42.0; SD 4.1)
Diagnosis	49 OA, 2 AVN

OA = osteoarthritis; AVN = avascular necrosis.

Fig. 1 The Arch Table Extension is a special table attachment that allows controlled movement of the extremity during preparation of the femur and acetabulum.

operating room table. All surgeries were performed by a single surgeon (SK). The table extension allows appropriate manipulation and positioning of the affected leg during surgery. In general, hip flexion facilitates posterior capsular releases and acetabular preparation, whereas extension, external rotation, and adduction facilitate femoral preparation. The capabilities of the table help facilitate surgery through this smaller and less invasive approach. A slightly curved incision between 10 and 14 cm was used starting 1 cm distal and lateral from the anterior–superior iliac spine curving distally and slightly posterior. The interval between the tensor fascia latae (TFL) (lateral) and the sartorius/rectus (medial) was developed. We rarely find the need to release the TFL at its origin. During the study period, we released the TFL three times. We placed a Cobra retractor along the superolateral hip capsule. At this time, a pocket was freed up between the medius and minimus muscle and the iliac wing to house the femoral head during acetabular preparation. We used electrocautery to incise the fascia over the rectus femoris to isolate the lateral femoral circumflex vessels, which were then ligated. A second Cobra retractor was then placed over the medial hip capsule. We performed an extensive capsulectomy by removing the majority of the anterior-lateral capsule. The remaining anterior medial capsule was tagged with a Number 5 Ethibond (Ethicon, Ciudad Juarez, Chihuahua, Mexico) suture and the distal portion of the capsule was released from the femur at the anterior intertrochanteric line down to the lesser trochanter avoiding the iliopsoas muscle. We then replaced the Cobra retractors inside the capsule exposing the femoral neck. Prominent anterior acetabular osteophytes and the anterior labrum were removed completely to allow the hip to be dislocated in an atraumatic fashion. A longitudinal anterior capsular release can also assist in the dislocation process. Once the proper releases and removal of acetabular osteophytes were completed, traction and external rotation were applied. We drilled a 4-mm shank pin (or threaded Steinmann pin) into the most proximal portion of the femoral head and with the assistance of the table extension dislocated the hip by applying external rotation with slight traction. Pulling on the fixation pin facilitated dislocation. In the case of a strong ligamentum teres in which it is not torn during the dislocation process, we release it at the foveal attachment after dislocation. We believe anterior osteophytes are more of an impediment to dislocation than the ligamentum teres. We also believe adequate posterior capsular releases are important and facilitated by flexing the leg up along the table extension to relax the quadriceps muscle complex. We try to leave a cuff of the capsule attached to the intertrochanteric area to maintain the retinacular vessels. We think it is important to protect the iliopsoas tendon and were careful to avoid its inadvertent release by clearly

identifying its insertion on the lesser trochanter because it is in close proximity during inferior medial capsular release. With the leg placed in 30° to 45° of extension, 90° to 110° of external rotation, and 20° of adduction, we placed two narrow bent Hohmann retractors or a Mueller (double-prong) retractor between the medius-minimus complex to allow release of the lateral-superior capsule. This allowed the femur to be translated laterally (away from the acetabulum) and superiorly (elevated to the ceiling). After 25 cases (three of four femoral neck fractures were in the first 25 cases), we placed a Ranawat retractor medially pressing on the posterior proximal femoral area distal to the intertrochanteric line and a Mueller retractor over the tip of the greater trochanter just inside the medius/minimus insertion. Previously we placed a Mueller retractor on the posterior femoral neck, which may have gouged the femoral neck, later resulting in femoral neck fracture. Early in the learning curve, substantial force was needed to expose the femoral head as a result of inadequate capsular release, which was later improved once circumferential capsular releases were adequate. As mentioned earlier, we leave a cuff of capsule in an effort to maintain the retinacular vessels [24]. This was the most critical step to allow accurate femoral preparation.

Several techniques can be used for guide pin placement, a critical step in hip resurfacing. We believe the incorporation of the image intensifier is essential to ensure proper placement of the guide pin. We used a sterile goniometer to determine the neck angle based on preoperative templating or the Quadrafoil, which allowed the dialing in of each angle separately and allows for multiple entry holes for a 3.0-mm guide pin (Fig. 2). The jig has nine parallel holes and was designed by the primary author. If the varus/valgus

Fig. 2 A new alignment jig named Quadrafoil (Synvasive Technology Inc, Reno, NV) is currently used that allows the dialing in of each angle separately and allows for multiple entry holes for the guide pin.

and version angles were correct but the pin was not centered, the alignment jig was turned approximately 180°, placed over the existing pin, and one of the remaining eight holes was used to redirect a second pin. If the varus/valgus and/or version angle were not acceptable, we had to start over. Once the guide pin was aligned in adequate position, it was replaced with a thinner 1.6-mm Kirschner wire. To avoid losing the Kirschner wire in the previously drilled hole, the tip was bent 90° (Fig. 3). We then used an image intensifier to check AP and lateral planes. Once adequate placement of the guide pin was achieved, the appropriately-sized barrel cutter was advanced over the guide rod to make the initial head cut. Once the final size was reached, the guide pin was removed and the top head guide was positioned. Depending on implant size, the top 6 mm to 10 mm of the head was then resected with an oscillating saw. The guide pin was reinserted and the top head cutter created a surface perpendicular to the neck axis. The appropriate head chamfer cutter was then used to create the bevel.

Preparation of the acetabulum was facilitated by careful placement of retractors, removal of the labrum and osteophytes, and careful guidance with the image intensifier. Countertraction of the femoral head and slight flexion of the leg to approximately 20° facilitated acetabular exposure. We could then place retractors across the transverse acetabular ligament and over the anterior rim of the acetabulum. Routine thin-shaft, straight reamers are easier to use than offset reamers. Acetabular cup insertion was facilitated with a rigid or offset handle inserter (if available) that reduces pressure on the distal wound and avoids placing the component too vertical. To ensure accuracy of

the component position, we used image intensification to verify the abduction angle and anteversion as the prosthesis was sequentially seated. Our target value for cup inclination was 35° to 45°. Proper component placement was confirmed with an intraoperative AP pelvis or with the use of an image intensifier. We repositioned the femur into the preparation position. The trial component was removed and the final component inserted using a routine cementing technique inserting the femoral head at approximately 1 minute. The entire surgical area except the femoral head was covered with a green surgical towel to avoid cement spreading into the soft tissue (Fig. 4). We used the image

Fig. 4 The entire surgical area except the femoral head is covered with a green surgical towel to avoid cement spreading into the soft tissue and the femoral head is inserted at 1 minute.

Fig. 3A–B Once the guide pin is aligned in adequate position, it is replaced with a thinner 1.6-mm Kirschner wire. To avoid losing the Kirschner wire in the previously drilled hole, the tip was bent 90°. An image intensifier is then used to check AP (A) and lateral planes (B).

intensifier to confirm the position of the final implants. After a copious amount of irrigation, the fascia over the TFL was closed with a running suture followed by subcutaneous skin closure. A pain cocktail consisting of 400 mg ropivacaine, 30 mg Toradol, 5 mg epimorphine, and 0.6 mL epinephrine (1:1000) in normal saline and a deep drain were placed before closure. All operations were done under general anesthesia. The average operative time was 105.7 minutes (range, 73–151 minutes; SD 15.2) and the average blood loss was 505.5 mL (range, 200–1500 mL; SD 270.1). One patient received a transfusion during the study period. Fifty patients received a Cormet Hip Resurfacing implant (Stryker, Kalamazoo, MI) and seven patients received a Birmingham Hip Resurfacing implant (Smith and Nephew, Memphis, TN).

All patients followed the same postoperative pain management protocol, were allowed to weightbear as tolerated, and all patients were discharged home. Physical therapy was ordered for stiffness, trochanteric bursitis, persistence of antalgic gait, or by patient request. We ordered ROM and strengthening exercises for stiffness, iliotibial band stretching for trochanteric bursitis, gait analysis and gait training for abnormal gait pattern, and a general strengthening program if the patient requested. A total of 12 patients were ordered physical therapy.

We followed patients at 10 days, 6 weeks, 3 months, 6 months, and yearly. Clinical examinations at followup included a brief history, evaluation of the incision, and hip ROM. AP pelvis radiographs as well as AP and lateral radiographs of the hip were taken at 10 days, annually, and if indicated for complications. Pre- and postoperative Hip disability and Osteoarthritis Outcome Scores (HOOS), an extension of the WOMAC, were collected and compared with normalized THA scores from 90 patients (41 females, 49 males) with an average age of 71.5 years (range, 49–85 years) [21]. From the medical records we extracted the length of hospital stay.

A single investigator (KL) analyzed the postoperative radiographs using TraumaCad software (TraumaCad 2.2;

Voyant Health, Columbia, MD) for cup inclination, neck angle, angle of the prosthesis, and varus/valgus angle of the prosthesis relative to the neck angle. The inferior rim of the obturator foramen was used as the reference point when measuring cup inclination.

Results

There were three postoperative (5%) femoral neck fractures and one posttraumatic femoral neck fracture (1.8%) for a total of four (7%) femoral neck fractures. The atraumatic femoral neck fractures occurred at 9 days, 10 weeks, and 4 months postoperatively. The posttraumatic femoral neck fracture occurred 4 months after surgery. Three were converted to THAs using an anterior approach. One of them sustained a hematoma 3 weeks postoperatively, which was irrigated and débrided 7 weeks before femoral neck fracture. This patient was converted to THA by an outside surgeon also using an anterior approach. There was one transient peroneal nerve palsy that completely resolved in 3 weeks and one incomplete seating of an acetabular component, which has since filled in (Fig. 5). There was also one incomplete seating of a femoral component, which has not been of any consequence so far. We have also had one infection that occurred 8 months postoperatively requiring irrigation and débridement and one draining wound in a patient with a large pannus that required reoperation 6 weeks after primary surgery, but in both cases, the initial resurfacing implants were able to be retained (Table 2).

The average HOOS scores for our resurfacing patients were pain 92.3 (range, 60–100; SD 10.9), symptoms 90.3 (range, 60–100; SD 11.4), activities of daily living (ADL) 93.1 (range, 65–100; SD 9.7), sport 86.9 (range, 50–100; SD 14.7), and quality of life (QOL) 80.6 (range, 19–100; SD 20.6) (Fig. 6). The average cup inclination angle was 36.5° (range, 25°–48°; SD 5.25) (Table 3) and the average length of stay was 2.1 days (range, 1–4 days; SD 0.41).

Fig. 5A–B Incomplete seating of the acetabular cup (A) that eventually filled in (B). The patient was asymptomatic.

Table 2. Complications

Number	Type of complication
4	Femoral neck fracture
1	Peroneal nerve palsy
1	Incomplete seating of acetabular component
1	Incomplete seating of femoral component
1	Hematoma
1	Infection
1	Draining wound

Fig. 6 Graph shows the Hip disability and Osteoarthritis Outcome Score (HOOS) for our patients undergoing anterior hip resurfacing as compared with patients undergoing normalizing (Norm) THA from a reference group published by Nilsdotter et al. [21]. ADL = activities of daily living; QOL = quality of life.

Table 3. Radiographic measurements

Measurement	Value
Cup inclination	36.5° (range, 25°–48°; SD 5.25)
Neck angle	137.0° (range, 125°–154°; SD 6.65)
Angle of prosthesis	140.8° (range, 129°–157°; SD 6.70)
Valgus(+)/varus(–)	3.8° (range, –3° to +16°; SD 3.73)

Discussion

Currently, other approaches for hip resurfacing include posterior or anterior-lateral approaches, which have their respective advantages and disadvantages. The advantage of the posterior approach is familiarity to most surgeons and the ease of exposure of the femur. The main disadvantages include devitalizing the femoral neck [2], the need for extensive exposure [16], and releasing the short external rotators, which act to stabilize the hip [7]. The anterior-lateral approach has certain benefits such as maintaining the blood supply and improved hip stability but has the disadvantage of releasing the abductors off the greater trochanter, which may result in a permanent limp in up to

20% of cases [13]. In an attempt to resolve this issue, a modified Watson-Jones approach that avoids the release of the abductors has been described [5]. The anterior approach has the advantage of maintaining the blood supply to the femoral neck because it preserves the attachment of the obturator externus tendon [2]. In cases of circumferential capsular release we recommend leaving a cuff of capsule to preserve femoral vasculature. This is based on an oxygenation study of the femoral head comparing a capsule-saving technique with a standard technique [24]. The approach also maintains muscle attachments but is technically difficult and therefore not commonly used [14]. Subsequently, there is a limited amount of literature published for its use in a challenging surgery such as hip resurfacing. We therefore examined our first 57 operations using this approach to determine the (1) complication rate; (2) functional outcome scores; (3) component placement; and (4) length of stay.

Our study is associated with limitations. First, this is a retrospective study with no control group. Second, we adapted our surgical technique during the collection period. Although this changed the study design, it was important to implement so as to reduce the incidence of femoral neck fractures. Third, the followup period was short. We believe it is important to report our early complications because there is a limited amount of literature pertaining to the DAA in hip resurfacing and its complications. With a growing popularity in hip resurfacing, it is possible more surgeons will be interested in using the DAA. They should have some knowledge of the early complications. Fourth, one of the authors has a financial interest as an owner of Innovative Orthopedic Technologies, the manufacturer of the Arch table.

The overall incidence of femoral neck fracture ranges from 0% to 4% (Table 4) [1, 3, 4, 6, 12, 17, 18, 22, 23, 25] but can be much higher during the learning curve [12]. We believe the fractures that did occur in our study were not related as a result of varus placement of the femoral component, notching of the femur, or incomplete seating of the femoral implant but the result of the use of a sharp Mueller retractor to obtain exposure of the femoral head, which may have inadvertently gouged the femoral neck. The transient peroneal nerve palsy completely resolved in 3 weeks and was the result of aggressive traction on the extremity during the dislocation step. To avoid this complication, we now use a shank screw or threaded Steinmann pin in the femoral head, assure proper removal of anterior acetabular osteophytes and labrum, and adequate anterior capsular release to facilitate the dislocation process. We suspect the incomplete seating of the cup was the result of a large overhanging osteophyte inferiorly. We are now more diligent in removing these. The incomplete seating of the femoral implant was the result of omitting the use of the

Table 4. Comparison of complications

Study	Approach	Number of hips/followup	Complications	Ratio [†]
Amstutz et al. [1]	Posterior	400/41 months	3-Fx, 2-Inf	1:80
Beaule et al. [3]	Posterior	94/36 months	1-Fx, 1-Inf	1:47
Treacy et al. [25]	Posterior	144/60 months	1-Fx, 2-Inf	1:48
Shimmin and Back [23]	Posterior	3497*	50-Fx	1:70
Gross [6]	Posterior	100/50.4 months	1-Fx	1:100
Gross [6]	MIS posterior	100/40.8 months	2-Fx	1:50
Marker et al. [12]	Anterolateral	550/44 months	14-Fx, 4-Inf	1:34
Mont et al. [17]	Anterolateral	54/40 months	1-Fx	1:54
Sandri et al. [22]	Anterolateral	26/28 months	1-NP	1:26
Mont et al. [18]	Various	1016/33 months	27-Fx, 28-NP	1:18
Benoit et al. [4]	Anterior	50/6 months	1-Inf	1:50
Kreuzer et al. (current study)	Anterior	57/8.7 months	4-Fx, 1-NP, 1-Inf, 1-DW	1:8

* Did not report average followup; [†]ratio of complications to number of hips; MIS = minimally invasive surgery; Fx = fracture; Inf = infection; NP = nerve palsy; DW = draining wound; MIS = minimally invasive surgery; followup is reported as average.

neck chamfer drill. One patient underwent irrigation and débridement 8 months after primary surgery on the left hip for an acute infection. We had one draining wound in a patient with a body mass index of 42 kg/m² who smoked requiring irrigation and débridement 6 weeks postoperatively. All cultures were negative and the patient's wound healed without further complications.

The five HOOS subscale averages were all greater than those of normalized THAs. The average scores for the normalized THA patients were pain 82.3 (SD 18.3), symptoms 73.9 (SD 16.7), ADL 75.5 (SD 17.9), sport 56.3 (SD 26.2), and QOL 66.2 (SD 23.2). The differences in scores may have been affected by the low body mass index of our patients (28.7 kg/m²) and the lower preoperative scores for all subgroups in the THA group. Also, our patients had an average age of 51 years compared with the average age of the patients undergoing THA, which was 71.5 years. The sport and QOL scores were the two lowest scores for both groups. Our scores are consistent with Lingard et al. who compared 132 patients undergoing hip resurfacing with 214 patients undergoing THA [11]. They reported that patients with 1-year followup after undergoing hip resurfacing had comparable WOMAC scores with better pain scores compared with patients undergoing THA.

The average cup inclination of our cohort was 36.5° ranging from 25° to 48°. Benoit et al. [4] also looked at this variable and had 19 cups with an inclination between 45° and 55°. In our study, we had three cups with an inclination angle between 45° and 55° with maximum angle equal to 48°. Other reports of hip resurfacing cup angles in the literature average between 38° and 43° (Table 5) [3, 17, 18, 22]. With the anterior approach we averaged a more horizontal cup position.

Table 5. Comparison of component placement

Study	Approach	Number of hips	Stem angle	Cup angle
Amstutz et al. [1]	Posterior	400	131.1° and 137.8°	NA
Beaule et al. [3]	Posterior	94	138.2°	41.8°
Mont et al. [17]	Anterolateral	54	140°	38°
Sandri et al. [22]	Anterolateral	26	136°	43°
Mont et al. [18]	Various	1016	138.7°	42.9°
Kreuzer (current study)	Anterior	57	140.8°	36.5°

NA = not available.

Table 6. Comparison of hospital length of stay

Study	Approach	Number of hips	Length of stay*
Mont et al. [17]	Anterolateral	54	3
Sandri et al. [22]	Anterolateral	26	8
Gross [6]	MIS posterior	100	2.3
Gross [6]	Posterior	100	2.3
Benoit et al. [4]	Anterior	50	2.98
Kreuzer (current study)	Anterior	57	2.11

* Reported as average of days; MIS = minimally invasive surgery.

The average length of stay for our patients was 2.1 days. Reports of this variable in the literature range from 2.98 to 8 (Table 6) [4, 6, 17, 22]. In a comparison to the posterior approach for THA, the DAA resulted in more rapid recovery of hip function and gait [20]. Although this comparison was of THAs, it demonstrates the inherent benefits of the anterior approach in that the posterior stabilizers are left intact allowing for reasonable recovery

time. With the anterior approach, we have a comparable length of stay as that in the literature.

We believe DAA is an option for performing hip resurfacing provided our complication rate decreases with more experience. Because our complication rate is greater than that published in the literature, we must caution anyone attempting to use this approach. Although a more challenging approach, our data suggest it results in comparable outcome scores to other approaches, allows for more horizontal positioning of the acetabular component, and requires a relatively short length of hospital stay. Anyone attempting this approach should be experienced with hip resurfacing and with the DAA for primary hip arthroplasty.

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