Reliability and Clinical Outcomes of Preoperative Evaluations in Modern Total Hip Resurfacing and Total Hip Arthroplasty in Patients with Osteonecrosis of the Femoral Head

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Background: *Modern total hip resurfacing has been associated with excellent intermediate outcome in patients with osteonecrosis hip who are under 60 years. , Up to 30-50% necrosis area in X-ray and MRI are theoretically acceptable to perform total hip resurfacing. However, both of plain X-ray and MRI still are uncertain information to precisely support decision making for either hip resurfacing or hip arthroplasty.*
Objective: *Double setup operations (resurfacing or arthroplasty) were developed (i) to evaluate the reliability of preoperative evaluation based on plain X-ray and MRI comparing to the intra-operative finding after the completion of bone surface cut in hip resurfacing femoral procedure and (ii) to examine the early outcome for this double set up techniques.*
Material and Method: *Between September 2004 to December 2008, 45 osteonecrosis hips (40 patients) were managed with double setup in which was either total hip resurfacing or total hip arthroplasty. The final intra-operative decisions were performed and then the comparison of the reliability of pre-operative evaluation was done. Outcomes assessment was examined based on Harris Hip score, Oxford hip score, university of California Los Angeles (UCLA) activity score, Short form-12 score, complications, and radiographic alignment including radiolucencies.*
Results: *Twenty-five hips finally were performed with total hip resurfacing and the rest twenty hips were performed with total hip arthroplasty. Preoperative evaluation plans were unchanged from arthroplasty to resurfacing by intra-operative evaluation in 20 of 33 hips, representing the approximate reliability 61%. All 13 cases whose preoperative plans were changed had preoperative radiographic necrotic head involvement more than 50%, cystic change > 1.5 cm in size, superior head collapse more than 8 mm. The follow-up mean time was 28.6 months (5-50). All postoperative functional scores at the last follow-up (HHS, Oxford, UCLA, SF12) were significantly improved from preoperative functional score ($p < 0.001$). Pulmonary embolism was found in one patient with sickle cells induced osteonecrosis hip and no further complication after recovery. There was no postoperative infection, fracture neck of femur, DVT, nerve palsy, radiographic change.*
Conclusion: *Double setup operations were found efficacious to provide reliable information for the resurfacing surgeons to avoiding the too early total hip arthroplasty in the young patients. As a result, the patients can preserve their femoral heads at best.*

Keywords: *Osteonecrosis, Hip resurfacing, Arthroplasty, Avascular necroris, Surgical procedures*

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Osteonecrosis or avascular necrosis (AVN) of femoral head presents a challenging clinical hip problem in young active adults. It affects the quality of life and limits their physical and social life which finally burden to their family and community.

Wide arrays of treatments have been proposed for osteonecrosis of femoral head. Most osteonecrosis of femoral head cases were younger than 65 years old, usually around 25-45 years. Life expectancies in these patients were more than 20-30 years. There is currently

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no consensus regarding the treatment for various stages of osteonecrosis of the femoral head in adults. Many surgeons and authors have suggested the treatment depending upon stage of the osteonecrosis[1-5], the age of the patient[3,6], medical status[3], and/or symptoms[7] etc. Alternative bearing surfaces will lead to fewer revisions and less osteolysis. Total hip arthroplasty (THA) was frequently considered in older patients. In the past, however, this procedure was associated with poor results in this age group[8]. According to the rest of life expectancy, if THA was applied in very young active patients, the higher rates of hip revision would be encounter later. Patients with more revision hip usually show decreased bone stock rest with expected the worse outcomes and increased costs.

Modern joint preserving surgical procedure including alternative bearing surface is surface replacement arthroplasty (SRA), involving resurfacing of both the femoral head and acetabular cup. Many surgeons have considered SRA as an alternative to THA for the treatment of osteonecrosis, especially in younger active adults[9-12]. Hip resurfacing offers advantages in terms of preservation of femoral bone stock, providing complete pain relief and having a high postoperative activity level. Some studies have noted that patients treated with hip resurfacing generally can delay or postpone the need for THA to more than 10 years and may be more than 20 years[11,12]. The conversion of failed SRA procedures, then converted to conventional THAs, can be considered comparable procedures with similar outcome to primary THAs[13] However, this procedure can only be performed if the patient has sufficient healthy bone stock to support the resurfacing prosthetic[11,12].

We learned from our pilot study that many patients had a tendency to treat with THA based on the information from plain X-ray and magnetic resonance imaging (MRI), however, when intra-operative evaluations after completely reaming femoral head were performed, most of them were appropriate for hip resurfacing. Therefore, all radiographic studies might be unreliable to evaluate the rest bone quality and quantity as comparing to after completely surface reaming. To compare preoperative and intra-operative evaluation, double setup operations were designed. Thus, the purposes of this study were to determine the reliability of the preoperative evaluation and to analyze the effectiveness of versatility and outcomes from all osteonecrosis patients using double setup procedures which provide the best chance for performing bone preserving procedure as SRA.

Material and Method

Patients with osteonecrosis of femoral heads undergoing double setup metal-on-metal (MoM) THA/RSA procedures between September 1, 2004 and December 31, 2008 were prospectively studied. Radiographic and clinical outcomes were assessed at preoperative and postoperative clinical visits. The study was approved by our institution review board, and all patients provided informed consent for the surgical procedure and for participation in this study.

A total of 45 consecutive hips (40 patients) were performed, consisting of 13 males and 27 females. All patients were followed for a mean of 28.6 months (5-55). The mean age at the time of surgery was 55 years (24-69). The mean body mass index (BMI) was 25.2 kg/m^2 (22.9-29.4). The mean height was 157.3 cm (149-175). The mean weight was 62.4 kg (51-87).

The most common causes of osteonecrosis of the femoral head were corticosteroid use (18 hips) and alcohol use (15 hips), which both together were about 73%. The remaining conditions associated with osteonecrosis were trauma (5 hips), idiopathic (6 hips) and sickle cell anemia (1 hip).

Two implant companies used in the present study were Birmingham Hip Resurfacing system (BHR, Smith & Nephew, Birmingham, United Kingdom) and DUROM hip resurfacing system (Zimmer, Warsaw, Indiana USA). In cases of MoM THA, Synergy (Smith & Nephew) or CLS (Zimmer) cementless stems were used.

Clinical evaluation

At preoperative and postoperative visits, we used the clinical outcomes were measured using the Oxford hip score (OHS), the Harris hip score (HHS) and the University of California Los Angeles (UCLA) activity scale to assess clinical outcomes. Patients also rated their pain level and overall satisfaction at follow-up visits using patient satisfaction SF12.

Preoperative evaluation (radiographic evaluation)

All patients with suspected osteonecrosis of the femoral head were examined using plain radiograph and MRI. Preoperative radiograph and MR images were characterized according to size (small, medium, large) and lesion stage according to the Ficat and Arlet classification modified for the hip. An anteroposterior (AP) radiograph of the pelvis was used to calculate the positioning of the implant as well as to identify the presence of heterotopic bone formation, as described by Brooker and colleagues[14]. The stem-shaft angle

and acetabular inclination were measured as described by Beaule and colleagues[15], which defines the stem-shaft angle as the angle between the stem and the anatomical axis of the femoral shaft, and the acetabular inclination angle as the angle between a line across the face of the acetabular component and the inter-teardrop line. Thinning of the femoral neck at the head neck junction was defined by post operative decreasing ratio of metal head-neck junction diameter and the distance from the superior margin of the lesser trochanter to inferior neck of metal head. If the calculation reduction is less than 10%, thinning is diagnosed[16].

Operative techniques and postoperative management

Preoperative radiographic both hip AP and lateral shoot through position include MRI were evaluated necrotic geographic and area by Kerboul method[17] then estimate the proper operation either for SRA or MoM THA. Radiographic template was used for estimating proper size both cup and head in case of and femoral stem size for THA. For SRA, mild valgus femoral stem orientation was planned. Cup planning was set to 40-45 degrees lateral opening. All patients underwent a standard pre- and post-operative regimen. With the patient in the lateral position and under spinal epidural anesthesia or spinal anesthesia, an extended posterior approach to the hip joint was incised as described by McMinn[11]. Tensor fascia lata, short external rotators and gluteus maximus was incised step by step. Complete circumferential capsulotomy was performed.

The femoral neck was measured to two nearest head sizes which available for 2-4 acetabular sizes would be chosen later. The femoral head was then dislocated to anterio-superior and the acetabulum reamed sequentially. The 1 mm larger acetabular implant was then inserted. Circumferential acetabular osteophytectomy was done until 1 mm rest. Short arm jig type of Birmingham instrumentation was used to align K-wire in the centre of neck with mild valgus orientation and avoid superior notching.

The proper thickness blue stopper was used to protect unexpected subsequence cervicotrochanteric fracture. The head was then reamed to matching with the acetabular component. The rest of cancellous bone include size of bone cyst was evaluated. If trabecular bone was too soft or bone cyst greater than 1 cm especially at weight bearing area, femoral head was cut and then MoM THA was proceeded. If SRA was selected, the lesser trochanter suction tip was inserted. Macro cement locking drills were done at many points in cancellous bone surface on femoral head. The femoral implant was positioned and secured with Simplex (Howmedica International, Limerick, Ireland) low-viscosity cement at within one and a half minutes. If MoM THA was selected, broaching, rasping was done step by step until proper size for femoral stem was reached. Cementless femoral stem was inserted. Ligament balancing by using proper neck length was done. Big metal head was then inserted. The hip was reduced and posterior capsule, the short external rotators, gluteus maximus tendon, tensor fascia lata were then repaired step by step. Ambulation and mobilization was allowed on the second post-operative day with immediate full weight-bearing with axillaries crutches or walker gait aids as tolerated. Patients were discharged home when they were able to mobilize independently.

Patients were reviewed postoperatively at approximately six weeks, three, six, twelve months when a further AP radiograph of the pelvis was obtained and annually afterwards.

Data analyses

Reliability was reported as percentage of number of patients whose preoperative evaluation plans were unchanged from arthroplasty to resurfacing by intra-operative evaluation to total patients.

For statistical analyses, the changes in the preoperative and the last follow-up hip scores were compared for statistical significance using the pair t-test. A p-value < 0.05 was considered statistical significant. The results were expressed as mean and range.

Results

Demographic data was shown in Table 1. According to modified Ficat & Arlet classification, one hip was in stage IIB, 14 were in stage III and 25 hips were in stage IV (Table 2). Four patients had simultaneous bilateral THA. The overall survival rate was 100% at a mean follow-up of 28.6 months (5-50). None of the patients underwent implant revision over the study period or developed complications which an implant revision was indicated.

Preoperative radiographs demonstrated that 33 hips were severe head involvement and highly intended to be performed with MoM THA. Twenty-two hips had more than of 8 mm collapse in the superior portion of the femoral head in combination with of more than 30-50% sclerotic lesion and of more than 1 cm in size cystic change. According double setup technique

Table 1. Demographics data

Parameters	Values (mean)
Patient	40
Male : Female	13:27
Hips	45
Age (mean)	55 years (24-69)
Height (mean)	157.3 cm (149-175)
Weight (mean)	62.4 kg (51-87)
BMI (mean)	25.2 kg/m^2 (22.9 -29.4)

Table 2. Osteonecrosis stage

Stage	Amount (hips)
IIB	1
III	14
IV	25

Table 3. Summary results

Parameters	Values (mean)
Follow-up	28.6 months (5-50)
Cup angle	41.8 degrees (38-48)
Stem-shaft angle	139.1 degrees (132-145)
Hematocrit (before)	34.5 % (34.8-42.5)
Hematocrit (1 Day after)	29 % (23.5-33)
Operative time	148 min (110-170)
Radiographic osteolysis	0
Radiographic polar gap cup	0
Radiographic neck thinning	0
Revision or plan to revision	0
Complications	
Clincial DVT	0
PE	1 (2.2%)
Death	0
Nerve injury	0
Infection	0
Neck fracture[#]	0
Dislocation	0

which evaluated intra-operative finding after complete head reaming, if cancellous bone quality by forceps pinching were good, no necrotic bone and/or cystic that were more than 1 cm in size hip resurfacing would be proceeded.

Preoperative radiographic necrotic area in the THR group and in the MoM THA group was 45.3% (35-60) and 73.2% (55-85), respectively. Changes of the preoperative planning from MoM THA to SRA was found in 13 of 33 hips (39.3%), resulting in a 61% reliability.

Post-operation, the average hematocrit value dropped from 34.5 (34.8-42.5) to 29 (23.5-33). The mean total operative time (the time completion of anesthetic induction until the patient was returned to a supine position after the procedure) was 148 minutes (110 to 170). The length of stay was 8 days in average (5-14). Surgical blood loss were 733 cc (400-1000).

According to double setup technique, 45 hips were operated with 25 hips underwent SRA and 21 hips underwent BHR. DUROM were implanted in 4 hips. The others were MoM THA.

The mean preoperative OHS, UCLA activity score and HHS were 45.3 $\pm$ SD (37-56), 2.9 $\pm$ SD (range, 2 to 4) and 30 $\pm$ SD (range, 20-47), respectively. At the last follow-up, the patients presented significant improvement in clinical outcomes, with an average OHS of 13.9 $\pm$ SD (12-16), UCLA activity score of 8.3 $\pm$ SD (range, 7 to 10) and HHS of 94.6 $\pm$ SD (range, 93 to 98) (all p-value < 0.001). The preoperative mean SF12 was 19.2 $\pm$ SD (14-25) and at last follow-up was 60.7 $\pm$ SD (range, 57 to 64) ($p < 0.001$).

Patients performed with THR had a mean femoral stem-shaft angle of 139.1° (range, 132° to 145°), with a mean acetabular inclination angle of 41.8° (range, 38° to 48°). There were no fractures of femoral neck, radiographic loosening or component change position. No thinning of the femoral neck was addressed. Heterotopic ossification was none. No deep vein thrombosis, dislocation, nerve palsy, limb length discrepancy more than 5 mm was observed in the present study.

One non-fatal pulmonary embolism was found in 25-year-old Arabian. This patient developed secondary osteonecrosis from sickle cell anemia. The final diagnosis confirmed with laboratory for dyspnea was pulmonary embolism.

Discussion

Modern MoM bearing is presently well-accepted as indicated by the large number of procedures that take place throughout the world. This new bearing can overcome the limitation of metal-on-polyethelene wear that eventually leads to revision, because of early implant loosening due to osteolysis brought about by wear particles, particularly in young active patients. The failure of previous generation of the hip resurfacing has evolved over the past year with new femoral head component design, metallurgy and surgical techniques. Stem added to head

component makes it secure fixation and much better load distribution at entire femoral head and calcar area. RSA is the combined concepts of total hip resurfacing and MoM bearing.

The most important and major dominant advantage over other new bearing THA, *e.g.* ceramic-on-ceramic, ceramic-on-metal, metal-on-crosslink, is femoral head and neck bone preservation. Femoral canal is untouched that allows an easy conversion of RSA to THA in the future[13]. Mont et al[18] recommended that the indications for hip resurfacing included post-collapse radiographic disease, lesions with a combined necrotic angle > 200° or > 30% head involvement and femoral head with > 2 mm of head depression. Amstutz et al[19] stated that the bone mineral density preserved in patients who undergo hemiresurfacing may be of relevance in this setting.

The most common revision of RSA is femoral neck fracture which can be simply removed the head and conversed to THA that cup has no need to revise except only in case of cup loosening, metal allergy, and chronic renal failure. It has been suggested that blood loss volume and complications revision surgery are similar to the primary THA[13]. According to bone preserving procedure concept, it has been suggested that RSA procedure should be performed in all patient especially younger than 35 years[12]. Therefore, the outcomes of RSA in osteonecrosis hips can be expected as good or excellent outcomes at 93% for at least 5 years[9]. Revell et al[20] suggested that patients with osteonecrosis of the femoral head who had early femoral failure from hip resurfacing procedure remained a relatively rare event.

There are some concern about subsequence progressive osteonecrosis after hip resurfacing, metal allergy (ALVAL), toxic or carcinogenic risk from blood metal ion level[21-24]. McMahon and colleagues[25] demonstrated the survival of 100% after 2 years THR by this posterior approach. However, two studies[21-22] also showed the progressive osteonecrosis of the retrieval analysis from the femoral neck fracture samples. Shimmin and co-workers[26] analyzed data obtained from the Australian National Registry and concluded that the cause of 1.46% fractures in RSA were not at all from subsequence osteonecrosis but it was believed that it might be affected from the combination of surgeon experience, surgical technique, implant design, and postoperative component position.

Although the operations were used posterior approach, which has been criticized for potentially further compromising the blood supply to the femoral head, the survival results for these patients were comparable with those for young patients with osteoarthritis[9,27,28]. Campbell et al[29] studied the isolated hemiresurfacing of the femoral head and reported that in twenty-five resurfaced femoral heads histologically up to twelve years postoperatively, the osteonecrosis was not induced by posterior approach. McMahon[25] stated that blood supply may came from intra-osseous (Fig. 1). Although posterior approach may disturb blood supply to femoral head, this picture was taken before application of suction tube at lesser trochanter, the osteonecrosis femoral head showed well intra-osseous blood supply after resurfacing of the femoral head.

Revell et al[20] recommended that the intra-operative evaluation were less than 35% of femoral head was necrotic, the integrity of the head-neck junction was preserved and good bone stock was remained. We also evaluated size and location of bone cyst which should be less than 1 cm and should not locate at head-neck junction or weight bearing area. Bone quality after femoral preparation (complete all steps reaming) were tested by forceps pinching.

However hemiresurfacing is not provided the best outcomes for osteonecrosis either Ficat & Arlet stage IIB or III. Mont et al[18] compared the outcomes of hemiresurfacing to that of THA for hips with late-stage disease. At a mean follow-up time of 7 years for the hemiresurfacing group and 8 years for the THA group, they found that 20% of patients with hemiresurfacing had groin pain compared to 6% of THA. Beaule et al[30] reported the overall survival of hemiresurfacing was 79% at five years, 59% at ten

Fig. 1 Well intra-osseous blood supply after resurfacing of the femoral head

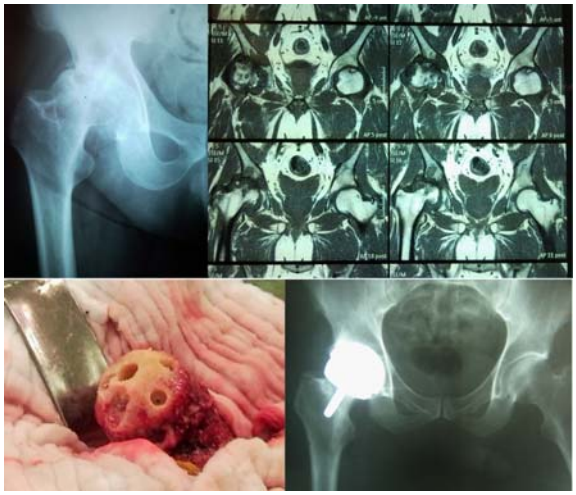

Fig. 2 A 49-year-old police man suffered from osteonecrosis stage IV for many years. Cystic and sclerotic changee upper half of femoral head included at middle centre. MRI showed very extensive osteonecrotic bone. Intra-operative showed good bone quality and less than 1 cm^3 cyst was rest after completely reaming. Bone punctures around chamfer cup were done allow macro locking with cement and skip this cystic area. RSA was performed in this case. All periphery necrotic bone and most of cystic area were removed after reaming. Plain X-ray showed over imaging necrotic area because Silhouette phenomenon with peripheral posterior necrotic (cystic and sclerotic) bone

years, and 45 at fifteen years. Beaule et al[31] compared the outcomes for 56 hips treated with a MoM THA with the outcomes of 28 hips treated with hemiresurfacing arthroplasty. It showed that at a mean of 44 months follow-up, MoM THA group had better UCLA and SF-12 scores than hemiresurfacing arthroplasty group ($p < 0.05$).

Treacy et al[28] reported that survival rate of RSA was at 93.2%, with a mean of 6.1 years. To avoid complication from groin pain or loosening which leads to lower successful in hemiresurfacing, in our study, THR procedure was performed only in patients with osteoncrosis of the femoral head stage III-IV, based on Ficat & Artlet classification. In very young patients (< 35 years), Amstrutz[12] recommend that THR was worth more than MoM THA and should be considered even the cyst size less than 2 cm which was double size we used in this study.

We also analyzed the cause of intra-operation judge changing in 13 hips (39%) from MoM THA to RSA. Necrotic area was mostly located in peripheral head instead of at the middle core. If this necrotic area far extend from superior to anterior or posterior, in AP plain radiographic will show as cystic or sclerotic at the middle of femoral head, actually the centre and core of femoral head were good health from well nourished with intra-osseous blood supply. This Silhouette phenomenon usually leads surgeon to misinterpretation as Fig. 2. We also found that femoral reaming can remove peripheral bone about 35%, and may up to 40% if use smaller head. However, in mid year 2009, we plan to use new Birmingham Mid Head Resection (BMHR) design instead of using MoM THA.[11]

Finally, our finding and outcomes are limited by small patient group and follow up period. We still be closely following up these patient groups and will report the later results.

Conclusion

MoM resurfacing of the hip can be considered a safe, effective, reliable and provide a promising outcomes for the patients with osteonecrosis of the femoral head. Preoperative evaluation was 61% reliable and by double setup technique, surgeon can decide the proper implants much better and accurate than preoperative radiographic evaluation with excellent short term outcomes. Moreover, patient will not lose their opportunity to preserve their femoral head.

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ความน่าเชื่อและผลลัพธ์ทางคลินิกของวิธีการประเมินก่อนผ่าตัด ระหว่างการผ่าตัดเปลี่ยนผิวสะโพกเทียมกับการผ่าตัดเปลี่ยนข้อสะโพกเทียมในผู้ป่วยที่เป็นข้อสะโพกขาดเลือด

วิโรจน์ ลาภไพบูลย์พงศ์, ธนา ธุระเจน, จตุพล คงถาวรสกุล, ถาวร ศิษยนเรนทร์

ภูมิหลัง: *การผ่าตัดเปลี่ยนผิวข้อสะโพกสมัยใหม่ได้รับการยอมรับว่า ให้ผลการรักษาที่ดีโดยเฉพาะในผู้ป่วยข้อสะโพกขาดเลือดที่มีอายุน้อยกว่า 60 ปี เมื่ออิงตามทฤษฎีจะเห็นว่า เนื้อที่หัวสะโพกที่ตายมากถึงร้อยละ 30-50 ซึ่งเห็นได้จากภาพถ่ายทางรังสีและการวินิจฉัยโรคด้วยรังสีแม่เหล็ก (magnetic resonance imaging, MRI) สามารถทำผ่าตัดเปลี่ยนผิวสะโพกเทียมได้ ผู้วิจัยตั้งข้อสังเกตว่า ข้อมูลที่ได้จากภาพถ่ายทางรังสีและ MRI อาจจะไม่สามารถกำหนดวิธีการผ่าตัดได้แม่นยำเพียงพอระหว่างการผ่าตัดเปลี่ยนข้อสะโพก และผ่าตัดเปลี่ยนผิวสะโพก ดังนั้นจึงได้ออกแบบการเตรียมผ่าตัดแบบคู่ขนานขึ้น โดยใช้เกณฑ์การตัดสินของสภาพหัวสะโพกหลังการกรอหัวในห้องผ่าตัดเป็นการตัดสินใจขั้นสุดท้าย*

วัตถุประสงค์: *เพื่อที่จะประเมินความน่าเชื่อถือของการตัดสินใจเลือกการผ่าตัด โดยอิงภาพถ่ายทางรังสี และ MRI แล้วเปรียบเทียบผลการตัดสินใจขั้นสุดท้ายในห้องผ่าตัดหลังจากที่ทดลองกรอหัวสะโพกแล้ว และติดตามประเมินผลการรักษาของการเตรียมผ่าตัดแบบคู่ขนาน*

วัสดุและวิธีการ: *ช่วงกันยายน พ.ศ. 2547 ถึง ธันวาคม พ.ศ. 2551 มีผู้ป่วย 40 ราย ได้รับการผ่าตัดเปลี่ยนข้อสะโพกขาดเลือดจำนวน 45 ข้อสะโพก โดยใช้ผ่าตัดรักษาแบบวิธีคู่ขนาน ระหว่างการเปลี่ยนผิวข้อสะโพกเทียมและการเปลี่ยนข้อสะโพก โดยใช้การตัดสินใจในห้องผ่าตัดเป็นขั้นสุดท้ายแล้วเปรียบเทียบค่าน่าเชื่อถือของการประเมินก่อนการผ่าตัดด้วยภาพถ่ายทางรังสีและ MRI ผู้วิจัยติดตามประเมินแฮริสฮิบสกอร์ อ๊อกฟอร์ดสกอร์ ยูซีแอลเอสกอร์ แบบสอบถามความพึงพอใจแบบสั้น ผลแทรกซ้อนหลังการรักษาและติดตามความเปลี่ยนแปลงในภาพถ่ายทางรังสี*

ผลการศึกษา: *หลังจากการตัดสินใจขั้นสุดท้าย มีการผ่าตัดแบบเปลี่ยนผิวสะโพกเทียมจำนวน 25 ข้อ และการผ่าตัดเปลี่ยนข้อสะโพก 20 ข้อ โดยหลังจากการประเมินในห้องผ่าตัดพบว่ามีการเปลี่ยนแผนการผ่าตัด จากการผ่าตัดเปลี่ยนข้อสะโพกมาเป็นการผ่าตัดเปลี่ยนผิวสะโพกในข้อสะโพกจำนวน 13 ข้อจาก 33 ข้อสะโพก (ร้อยละ 39) ทั้งนี้ข้อสะโพกทั้งหมด 13 ข้อ ได้รับการประเมินให้ทำการผ่าตัดเปลี่ยนข้อสะโพกเทียม เพราะมีพื้นที่กระดูกตายมากกว่าร้อยละ 50 หรือ มีซิสขนาดใหญ่กว่า 1.5 ซม. หรือ มีหัวสะโพกทรุดตัวมากกว่า 8 มม. ผู้ป่วยได้รับการติดตามผลการรักษานาน 28.6 เดือน (5-50) การประเมินผลทางคลินิกหลังการผ่าตัด ด้วยคะแนนหลังการผ่าตัด (แฮริสฮิบสกอร์ อ๊อกฟอร์ดสกอร์ ยูซีแอลเอสกอร์ แบบสอบถามความพึงพอใจแบบสั้น) พบว่าคะแนนหลังการผ่าตัดดีขึ้นกว่าก่อนการผ่าตัดอย่างมีนัยสำคัญ ($p < 0.001$) ผู้ป่วยจำนวน 1 ราย เกิดภาวะแทรกซ้อนลิ่มเลือดอุดตันที่ปอด ซึ่งเกิดขึ้นเนื่องจากผู้ป่วยเป็นโรคเลือดชิกเกิลเซลที่มีข้อสะโพกขาดเลือด ทั้งนี้ผู้ป่วยฟื้นตัวเป็นปกติหลังการรักษา การศึกษาครั้งนี้ไม่พบว่ามีผู้ป่วยรายใดเกิดการติดเชื้อ หรือ มีกระดูกคอสะโพกหักหลังผ่าตัดเปลี่ยนผิวข้อสะโพก หรือมีการบาดเจ็บของเส้นประสาท และภาพถ่ายทางรังสีที่ผิดปกติ*

สรุป: *ความน่าเชื่อถือของการประเมินก่อนการผ่าตัดอยู่ที่ร้อยละ 61 การผ่าตัดแบบคู่ขนานมีประสิทธิภาพดี ช่วยให้ศัลยแพทย์ หลีกเลี่ยงการผ่าตัดเปลี่ยนข้อสะโพกในอายุน้อย ผู้ป่วยจึงมีโอกาสดีที่สุดในการเก็บหัวสะโพกไว้*