Evaluation of minimally invasive versus conventional total hip replacement

Ahmad Khairy Mahmoud Awad [a,*], Hamdy Tammam[a], Elsayed Said[a], Hesham Hamed Refae[b]

[a]Department of Orthopaedics, Faculty of Medicine, South Valley University, Qena,83523, Qena Governorate, Egypt

[b]Department of Orthopaedics, Faculty of Medicine, Aswan University, Aswan City, Aswan Governorate, Egypt

Abstract

Background: Total hip replacement (THR) is considered a low-risk and efficient procedure, to improve pain and disability not exposing patients to significant risk burden. Minimally invasive (MIS) approaches of THR are not only desired to add more benefits but also shouldn`t compromise the already accomplished long-term results**.**

Objectives: The purpose of our study was to evaluate the surgical outcome of minimally invasive versus conventional approach total hip arthroplasty.

Patients and methods: This study was performed through a prospective; study comparing two patient groups containing 30 patients who had1^{ry} hip replacement (THA) during the period from March 2018 to May 2020 at Qena University Hospital, fifteen of them undergone 1^{ry} THA utilizing conventional approach and the other fifteen patients undergone 1^{ry} THA utilizing mini-invasive approaches.

Results: In Conventional THA group (group-A) nine males and six females were included with a mean age (± SD) of 57.2 ± 4.3 years; ranging (50-65 years). Preoperative HHS in-group-A patients ranged 20.3 – 37.1 (mean 26.8 ± 4.7). In Minimally invasive THA group (group-B) eight males and seven females were included with a mean age (± SD) of 57.7 ± 5.1 years; ranging (49-66 years).Preoperative HHS in group-B patients ranged 20.5 – 48.8 (mean 31.1 ± 8.0).The post-operative HHS were 89.56 ±6.11 and 91.94 ±1.91 in the group-A and group-B respectively, no statistically significant variation regarding the mean values was discovered between the two groups. The mean time to resume work in the group-A was 6.87 ±2.23 weeks compared to 5.67 ±1.39 weeks in the group-B with a significant statistical increase regarding group-A.

Conclusion: MIS approaches are advantageous in the terms of hospitalization and time to return to work.

Key Words*:* arthroplasty, MIS, minimally invasive, approaches

Introduction

Total hip replacement (THR) is considered a low-risk and efficient procedure, to improve pain and disability not exposing patients to significant risk burden. Minimally invasive (MIS) approaches of THR are not only desired to add more benefits but also shouldn`t compromise the already accomplished long-term results.**(Pipino and Keller, 2006)**

Starting in the 1990s, the conventional THR approaches were adjusted to decrease the extent of soft-tissue injury and limit damage to surrounding healthy structures **(Kennon et al., 2003)**. Prior to questioning the benefits of these techniques, it is crucial to agree on the definition: THR is considered MIS only if the procedure is carried out without soft issue compromises, and no bony resection beyond pathologic tissues. This definition considers both bone and soft tissues. **(Devadasan, 2013; Woolson et al., 2004)**

Nevertheless, reaching a satisfactory definition of a MIS-THR is not as easy job as the literal meaning of those words. Some considers a MIS-THR definition based solely on the incision length, agreeing that an incision less than ten centimetres can be considered as MIS-THR. However, one can interpret the MIS as less trauma to soft tissue or less bony trauma while performing the THR.**(Swanson, 2005)**

During the evolution of the learning curve regarding the MIS-THR, the incision usually decreases its size as the experiences accumulated. Surgeons need to familiarize with the anatomy and different approaches for THR in order to establish an experience with the MIS-THR techniques. **(Archibeck and White, 2004)**

Materials and Methods

This study was performed through a prospective study comparing two groups containing total of 30 patients who underwent primary THA during the period from March 2018 to May 2020 at Qena University Hospital, fifteen of them undergone1^{ry} THA utilizing conventional approach and the other fifteen patients undergone1^{ry}THA using mini-invasive approaches. Patients in both groups received Clinical examination and assessment using *Harris hip Score* (HHS). The study was approved by the "Ethics Committee" of our institute. Inclusion criteria were; 1^{ry}THA, cases of hip osteoarthritis, and average body weight. While exclusion criteria were revision THA, severe ankylosed hip joint, severe protrosio acetabuli, acetabular dysplasia and, body mass index (BMI) > 40.

Socio-Demographic data were collected, such as age, gender, affected side, presenting symptoms, details of the associated comorbid conditions. Preoperative evaluation included clinical history, patient Examination including general assessment, musculoskeletal examination, anthropometrics (BMI), and Range of Motion (ROM). Radiographic assessment done preoperatively, first day postoperatively, 6 months postoperatively and at last visit. Serial antero-posterior and lateral radiographs of the involved joint were reviewed in detail.

Surgical technique:

Administration of prophylactic antibiotics was done half an hour prior to skin incision. The exception to this is vancomycin, which was administered 1 hour prior to incision owing to its long infusion time. All patients had a spinal anaesthetic of intrathecal 0.5% bupivacaine.

Group (A) Direct Lateral Approach (DLA) - Conventional:

The patient is positioned in the lateral decubitus position in lateral decubitus position. The incision is initiated 2–4 cm proximal to the anterior-middle part of greater trochanter (GT) and distally extended in line with the femoral shaft 4-6 cm distal to GT**[Figure 1]**. The skin and subcutaneous fat are incised to the fascia lata and ITB. The fascia is then incised longitudinally just anterior to the most lateral prominence of GT, starting approximately three cm proximal to GT and extending distally. The anterior portion of the fascial sleeve is retracted with a retractor and the posterior portion is retracted with a retractor placed posterior to GT. This exposes gluteus medius and vastus lateralis. After identifying borders of gluteus medius muscle, dissection is kept blunt,and used to split in line with muscle fibers at the junction of the anterior-middle thirds. The split is started at GT and its proximal extension should be limited to 3–5 cm. A blunt Hohman can then be placed extracapsular and posterior to the femoral neck to protect the posterior portion of gluteus medius while the hip capsule is incised sharply in line with the blunt muscular division. Vastus lateralis should be exposed next and split longitudinally just distal to vastus ridge,

followed by placement of a Hohman anterior to the femur to retract the vastus lateralis. The split in vastus lateralis is then extended proximally into and through the tendinous insertion of gluteus medius until the muscular split of medius is reached. The anterior one third of medius, majority of minimus, the anterior part of the hip capsule, and anterior portion of vastus lateralis can then be elevated subperiosteally as one flap off the anterior femur. A cuff of medius tendon should remain on the anterior border of GT to allow for later repair. The dissection is facilitated by tensioning the tissue to be elevated through gentle gradual externally rotating and adducting the hip. Once the labrum is incised and the inferior femoral neck becomes visible, the hip is dislocated with traction, external rotation, and adduction. If dislocation is difficult, a bone hook can be placed anteriorly around the femoral neck to assist through anterolaterally directed traction. After trialling and final component placement, the anterior flap (gluteus medius, gluteus minimus, anterior capsule, and anterior vastus lateralis) is repaired to its anatomic position and closed as one layer with a combination of interrupted and running sutures. If the repair appears tenuous, transosseous suture tunnels can be utilized. The fascia lata, ITB, and gluteus maximus are then closed with either interrupted or running sutures followed by routine closure of the subcutaneous tissues and skin.

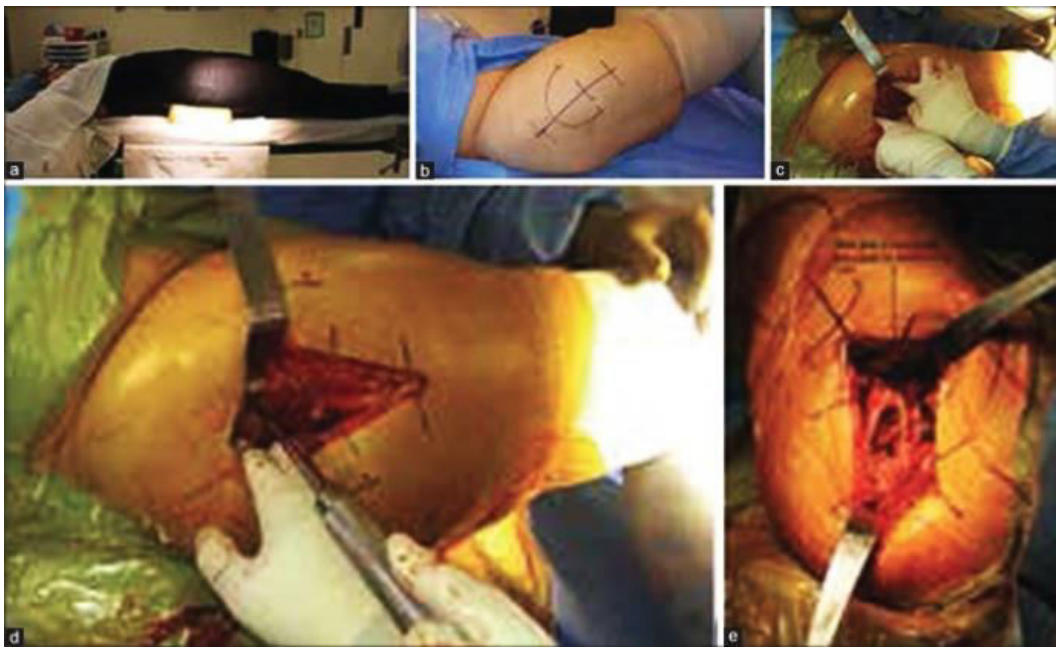

Figure 1: Intraoperative photographs showing (a) A bump is placed under the pelvis at the level of the anterior superior iliac spine. (b) The incision is started 2–4 cm proximal to the anterior-middle third of GT and extended distally in line with the femur to a point 4–6 cm distal to GT. (c) The anterior and posterior border of gluteus medius are identified. (d) Blunt dissection is used to split the muscle in line with its fibers. (e) The leg is placed in extreme adduction and external rotation to allow the surgeon excellent visualization of femoral version

Group (B) Minimally invasive Anterolateral Approach:

The patient is held in place by two cushions in lateral decubitus, at neutral position. The incision starts at the anterior tubercule and extends 7-9 cm towards the ASIS**[Figure 2]**. It is always important that the proximal two cm of this incision lie over the trochanter. Up to 10 cm, incision is sometimes needed for an obese patient. To locate the intermuscular interval between them the tensor fascia lata and gluteal muscles (minimus and medius), we used finger palpation. At first,incision in the fascia lata is made close to the GT. Thus exposing the fat pad, using it as a guide to the intermuscular interval. Blunt dissection is made to the joint capsule. Using Hohmann retractor,the gluteal muscles are retracted. Using an electrocautery knife, we undermine the tendon of the gluteus minimus. To exposes the femoral neck an anterior capsulotomy is performed.

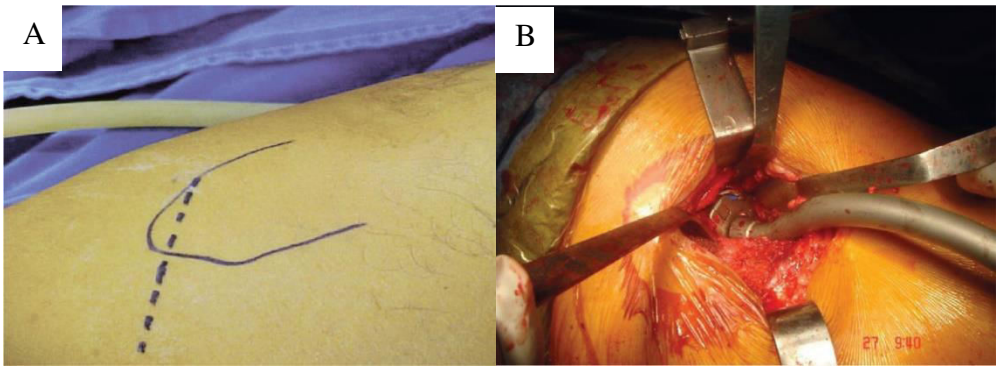

Figure 2: Intraoperative photographs showing (a)The incision 3cm posterior and 1cm superior to the most prominent part of the GT, at a 45^{o} angle to the femoral diaphysis (b) Acetabular component positioning.

Postoperative Protocol

Postoperatively, most of the patients were allowed to walk &weight bearing is permitted as tolerated. Hip precautions, included: flexion limitation to 90°, leg crossing avoided, and a high chair and elevated toilet seat are instructed for six to twelve weeks, were instituted. All study patients were supervised during the 30 feet walk, the day of surgery assisted with walker.

Clinical outcome

Postoperative compared to preoperative mobility status, hip range of movements at last follow-up, incidence of complications: namely re-fracture; non-union and failure of metalwork were assessed for all patients. HHS performed by independent physician preoperative and postoperative with a maximum score = 100 (the best possible outcome).

Statistical analysis

Univariable logistic regression was used. Data were recorded and analysed in Excel spreadsheets. Direct comparison between patients included was notattempted, owing to their different preoperative situations, different types of implants and their management.

Results

In Group-A (Conventional THA) nine males and six females were included with a mean age (± SD) of 57.2 ± 4.3 years, ranging (50-65 years). Most of the cases involved in the study occurred to have primary osteoarthritis of the hip (8 patients) and least were rheumatoid patients; who developed secondary osteoarthritis of the hip joint (3 patients). Four patients had undergone right THA while 11 had undergone left THA **[Table 1]**. Preoperative HHS in-group-A patients ranged 20.3 – 37.1 (mean 26.8 ± 4.7).

Table 1: Socio-demographic data among patients:

Variables		*Group-A*	*Group-B*
Age (years)		57.2 ± 4.3 *	57.7 ± 5.1 *
Gender	***Female***	6	8
	Male	9	7

* Mean ± SD

In Group-B (Minimally invasive THA), eight males and seven females [Table 1] were included with a mean age (± SD) of 57.7 ± 5.1 years, ranging (49-66 years). Most of the cases involved in the study occurred to have primary osteoarthritis of the hip (11 patients) and least were sequela of AVN of the femoral head; who developed secondary osteoarthritis of the hip joint (4 patients). Eight patients had undergone right THA while seven had undergone left THA. Preoperative HHS in group-B patients ranged 20.5 – 48.8 (mean 31.1 ± 8.0).

The mean preoperative blood haemoglobin level of the group-A was 12.1 ± 0.57 and postoperative was 11.13 ± 0.78 while in the group-B preoperative was 12.14 ± 0.79 and postoperative was 11.21 ± 0.75 with no significant difference between the two groups (P-value > 0.38). The mean intraoperative loss of blood in the group-A was 426.7 ± 84.23 ml compared to 310.33 ± 78.38 ml in group-B. Statistically significant (P-value 0.00036) increase in the mean intraoperative loss of blood in the conventional group compared to the MIS approach group.

The mean surgical time in the group-A accomplished 96.93 ± 6.25 min compared to 88.87 ± 3.16 in the group-B with a statistical significance (P-value 0.00018). Five cases in the conventional approach group received intraoperative blood transfusion representing 3.3% compared to one of the MIS group representing 0.6%.

The mean length of incision in the group-A was 20.29 ± 0.778 cm compared to 10.27 ± 0.571 cm in the group-B with a high significant difference (P-value < 0.0001).

The post-operative HHS were 89.56 ±6.11 and 91.94 ±1.91 in the group-A and group-B respectively, with statistically non-significant disparity in the mean values (P-value 0.0602) between both groups. The mean of time to resume work in the group-A was 6.87 ±2.23 weeks compared to 5.67 ±1.39 weeks in the group-B showing a statistically significant increase (P-value 0.0286) in the group-A.

One case of the total number of the group-A presented with postoperative dislocation representing 6.67% and 2 cases presented with early postoperative surgical site infection required frequent dressing and parenteral antibiotic for one week. In

the group-B one patient had an intraoperative periprosthetic fracture during stem insertion treated using cerclage wiring.

Table 2: Overall comparison between both groups

	Group A		Group-B	p-value
Side	**Rt. : Lt.**4:11		8:7	
Gender	**Male : Female**7:8		9:6	
Age	57.2 ± 4.3		57.7 ± 5.1	
Postoperative HB	**Preop:**	12.1 ± 0.57	12.14 ± 0.79	0.3750
	Postop:	11.13 ± 0.78	11.21 ± 0.75	
Operative Time "minutes"	96.93 ± 6.25		88.87 ± 3.16	0.00017
Blood Loss "mL."	426.7 ± 84.23		310.33 ± 78.38	0.00036
Incision Length	20.29 ± 0.778		10.27 ± 0.571	< 0.0001
Last HHS	89.56 ± 6.11		91.94 ± 1.91	0.0602
Return to work "weeks"	6.87 ± 2.23		5.67 ± 1.39	0.0286
Complications	3		1	

Discussion

MIS exposures have been tested in efforts to decrease complications and Fasten recovery time. The supposed advantages regarding MIS is to decrease soft tissue damage in order to reduce bleeding, better control of postoperative pain, limit hospital stay, and allow for early rehabilitation. Our work was a prospective comparative analytical study to evaluate the surgical outcome of minimally invasive versus conventional total hip replacement.

In our study, the mean intraoperative loss of blood in the group-A was 426.7 ± 84.23 ml compared to 310.33 ± 78.38 ml in group-B. Statistically significant (P-value 0.00036) increase in the mean intraoperative loss of blood in the conventional group compared to the MIS approach group.; in agreement with **(Wang et al., 2021; Migliorini et al., 2019; Hu et al., 2021;Xu et al., 2013)**. While there was no statistically significant decrease in intraoperative blood loss in the MIS posterior approach group in **(Fink et al., 2010; Wright et al., 2004; Pavone, 2001)**.

The mean surgical time in the group-A accomplished 96.93 ± 6.25 min compared to 88.87 ± 3.16 in the group-B with a statistical significant variance (P-value 0.00018). in agreement with **(Moskal and Capps, 2013; Sculco et al., 2004;Nakamura et al., 2004)**, in contrast to **(Woolson et al., 2004; Chung et al., 2004; Goldstein et al., 2003;Fink et al., 2010)**; who all showed non-significant variance between the conventional and MIS approaches.

The mean length of incision in the conventional approach was 20.29 ± 0.778 cm on the other hand; to 10.27 ± 0.571 cm in the MIS group with a high significant difference (P < 0.0001). **(Nakamura et al., 2004)**showed the mean incision length in the conventional approach was 18 cm and 10.3 cm in the MIS.**(Lin et al., 2007)** reported the mean incision length in the conventional group was about 20 cm

compared to about 9.2 cm in the MIS. **(Migliorini et al., 2019)**, showed the mean length of incision in the conventional group was 15 cm compared to 8.5 cm in the MIS approach.

The improved cosmetic appearance of the MIS approaches is questioned by **(Woolson et al., 2004)**. Showing that, complications were higher in the MIS than in the conventional approach. They came to a conclusion that, there was no evidence to support that the MIS technique resulted in lower bleeding rates or minimize soft tissues trauma, factors that would have resulted in a faster recovery and a decrease hospital stay, than did the conventionalapproach. **(Taunton et al., 2018)**.

The mean of time to resume work in the group-A was 6.87 ±2.23 weeks compared to 5.67 ±1.39 weeks in the group-B showing a statistically significant increase (P-value 0.0286) in the group-A. Thus, denoting early good functional outcomes after MIS-THA; in accordance with **(Sculco et al., 2004; Chung et al., 2004; Chimento et al., 2005;Fink et al., 2010; Laffosse et al., 2007;DiGioia et al., 2003)**. However, these results are in contrast to **(Woolson et al., 2004; Nakamura et al., 2004;Bennett et al., 2006)**, they did find no advantage to the MIS posterior approach regarding early functional results.

The post-operative HHS were 89.56 ±6.11 and 91.94 ±1.91 in the group-A and group-B respectively, with statistically non-significant disparity in the mean values (P-value 0.0602) between both groups. Showing no significant superiority to the MIS regarding long-term functional and clinical results, which was also showed by;**(Chung et al., 2004; Chimento et al., 2005; Fink et al., 2010; Laffosse et al., 2007;DiGioia et al., 2003)**.Who all showed faster recovery, better earlier outcomes and lower prevalence of limping but those became equal at six months follow-up similar to our results.Also, those results are in accordance with **(Woolson et al., 2004;Ogonda et al., 2005; Nakamura et al., 2004;Bennett et al., 2006)**, all showed no advantage to the MIS posterior approach regarding late clinical results, for the early results they showed again no significant advantage in contrast to our results.**(Duwelius et al., 2007)** performed a comparison of the two-incision MIS technique and the MIS-posterior approach for THA. Patients within a two-incision group had uniformly better function with no more complications than in the MIS-posterior group

Conclusion

The preference of any approach used to perform a THA remains controversial issue. The well agreed primary aim of THA is to provide pain relief, restoration of activities of daily living, and implant durability through a safe and repeatable approach with lower complication rate. MIS approaches are promising regarding lower hospitalization periods, and early return to daily activities. Despite the fact that, recent research is confirming that component positioning, in MIS, surgery is safe and reliable, no long-term results have yet been published to support this view.

References

Archibeck MJ, White RE(2004). Learning curve for the two-incision total hip replacement. Clinical Orthopaedics and Related Research,429:232–238.

Bennett D, Ogonda L, Elliott D, Humphreys L, Beverland DE(2006). Comparison of gait kinematics in patients receiving minimally invasive and traditional hip replacement surgery: A prospective blinded study. Gait Posture, 23:374–382.

Berger RA, Jacobs JJ, Meneghini RM,Della Valle C, Paprosky W, Rosenberg AG(2004). Rapid rehabilitation and recovery with minimally invasive total hip arthroplasty. Clinical Orthopaedics and Related Research,429: 239–247.

Chimento GF, Pavone V, Sharrock N, Kahn B, Cahill J, Sculco TP(2005). Minimally invasive total hip arthroplasty: A prospective randomized study. Journal of Arthroplasty, 20: 139–144.

Chung WK, Liu D, Foo LS(2004). Mini-incision total hip replacement-surgical technique and early results. Journal of Orthopaedic Surgery-Hong Kong, 12: 19–24.

Devadasan B(2013). Minimally Invasive Lateral Approach in Total Hip Replacement. Orthopaedic Procedures, 95(B): 54-54.

DiGioia AM, Plakseychuk AY, Levison TJ, Jaramaz B(2003). Mini-incision technique for total hip arthroplasty with navigation. Journal of Arthroplasty, 18: 123–128.

Duwelius PJ, Burkhart RL, Hayhurst JO, Moller H, Butler JB(2007). Comparison of the 2-incision and mini-incision posterior total hip arthroplasty technique: a retrospective match-pair controlled study. Journal of Arthroplasty, 22: 48–56.

Fink B, Mittelstaedt A, Schulz MS, Sebena P, Singer J(2010). Comparison of a minimally invasive posterior approach and the standard posterior approach for total hip arthroplasty a prospective and comparative study. Journal of Orthopaedic Surgery and Research, 5: 46-46.

Goldstein WM, Branson JJ, Berland KA, Gordon AC(2003). Minimal-incision total hip arthroplasty. Journal of Bone and Joint Surgery,85(4):33-38.

Hu Y, Wang MC, Wang T, Meng Y, Chao XM, Zhu HF, et al.(2021). Less blood loss in supercapsular percutaneously assisted versus posterolateral total hip arthroplasty. Journal of Orthopaedic Surgery and Research, 16: 217-217.

Kennon RE, Keggi JM, Wetmore RS, Zatorski LE, Huo MH, Keggi KJ(2003). Total hip arthroplasty through a minimally invasive anterior surgical approach. Journal of Bone and Joint Surgery, 85-A (4): 39–48.

Laffosse JM, Chiron P, Molinier F, Bensafi H, Puget J(2007). Prospective and comparative study of the anterolateral mini-invasive approach versus minimally invasive posterior approach for primary total hip replacement: Early results. International Orthopaedics,31(5): 597–603.

Lin Y, Chen C, Huang H, Su J(2007). Minimally Invasive Total Hip Arthroplasty Using a Posterolateral Approach: Technique and Preliminary Results. The Kaohsiung

Journal of Medical Sciences, 23 (12): 611–617.

Meneghini RM, Smits SA, Swinford RR, Bahamonde RE(2008). A randomized, prospective study of 3 minimally invasive surgical approaches in total hip arthroplasty: comprehensive gait analysis. Journal of Arthroplasty, 23 (6): 68–73.

Migliorini F, Biagini M, Rath B, Meisen N, Tingart M, Eschweiler J(2019). Total hip arthroplasty: minimally invasive surgery or not? Meta-analysis of clinical trials. International Orthopaedics, 43(7): 1573-1582.

Moskal JT, Capps SG(2013). Is limited incision better than standard total hip arthroplasty? A meta-analysis hip. Clinical Orthopaedics and Related Research, 471(4): 1283–1294.

Nakamura S, Matsuda K, Arai N, Wakimoto N, Matsushita T(2004). Mini-incision posterior approach for total hip arthroplasty. International Orthopaedics, 28: 214–217.

Ogonda L, Wilson R, Archbold P, Lawlor M, Humphreys P, O'Brien S, et al. (2005). A minimal-incision technique in total hip arthroplasty does not improve early postoperative outcomes: A prospective, randomized, controlled trial. Journal of Bone and Joint Surgery, 87 (A): 701–710.

Pavone V(2001). The role of incision length in total hip arthroplasty. Journal of Bone and Joint Surgery, 83 (B): 213-213.

Pipino F, Keller A(2006). Tissue-sparing surgery: 25 years' experience with femoral neck preserving hip arthroplasty. Journal of Orthopaedics and Traumatology 7: 36–41.

Sculco TP, Jordan LC, Walter WL(2004). Minimally invasive total hip arthroplasty: The Hospital for Special Surgery experience. Orthopaedic Clinics North America, 35(2):137-142.

Swanson TV(2005). Early results of 1000 consecutive, posterior, single-incision minimally invasive surgery total hip arthroplasties. Journal of Arthroplasty,20 (7): 26-32.

Taunton MJ, Trousdale RT, Sierra RJ, Kaufman K, Pagnano MW(2018). John Charnley Award: Randomized Clinical Trial of Direct Anterior and Miniposterior Approach THA: Which Provides Better Functional Recovery? Clinical Orthopaedicsand Related Research, 476: 216–229.

Wang T, Zhou Y, Li X, Gao S, Yang Q(2021). Comparison of postoperative effectiveness of less invasive short external rotator sparing approach versus standard posterior approach for total hip arthroplasty. Journal of Orthopaedic Surgery and Research,16: 46-46.

Woolson ST, Mow CS, Syquia JF, Lannin JV, Schurman DJ(2004). Comparison of primary total hip replacements performed with a standard incision or a mini-incision. Journal of Bone and Joint Surgery, 86(A): 1353–1358.

Wright JM, Crockett HC, Delgado S, Lyman S, Madsen M, Sculco TP(2004). Mini-incision for total hip arthroplasty: A prospective, controlled investigation with 5-year follow-up evaluation. Journal of Arthroplasty, 19: 538–545.

Xu CP, Li X, Song JQ, Cui Z, Yu B(2013). Mini-incision versus standard incision THA regarding surgical outcomes: A systematic review and meta-analysis. PLOS ONE, 8 (11): 821-822.