

Two Year Average Follow Up of Supercapsular Percutaneously Assisted Total Hip Arthroplasty; Zero Dislocations

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Abstract

BACKGROUND

Dislocation after primary total hip arthroplasty (THA) has an incidence of 2-3. Approximately 77% of dislocations occur within the first year after surgery. The SuperPATH technique is a minimally invasive approach for THA that preserves soft tissue attachments. The purpose of this study is to describe the dislocation rate at one year after SuperPATH primary THA.

METHODS

All elective primary THAs performed by the senior author using the SuperPATH approach. Exclusion criteria were acute femoral neck fracture, revision surgery, or malignancy. There were 214 of 279 eligible patients available for telephone interviews (76.7%). Medical records were reviewed for secondary outcomes including early and late complications, cup positioning, distance ambulated on postoperative day one, discharge destination, and blood transfusions.

RESULTS

Mean age at surgery was 64 ± 10.8 years and mean time to telephone follow up was 773 ± 269.7 days. There were 104 female and 110 male patients. There were zero dislocations reported. Blood transfusions were performed in 3.7% of patients, and 75.7% were discharged to home at an average of 2.3 ± 1.0 days. Cup position averaged $43.6 \pm 5.2^\circ$ abduction and $20.9 \pm 6.2^\circ$ anteversion, with an average leg length discrepancy of 3.6 ± 3.32 mm. Complications included three intraoperative calcar fractures, one periprosthetic femur fracture, one early femoral revision, three superficial infections, and one instance of wound necrosis.

CONCLUSION

SuperPATH approach is safe for use in primary THA resulting in a low dislocation rate.

Background

Dislocation is a serious complication of total hip arthroplasty (THA). Most studies report an incidence between 2–3% after primary THA, and it remains one of the most common reasons for revision surgery.[1, 2, 11, 3–10] Approximately 77% of dislocations occur within the first year, and up to 50% in the first three months.[11–13] The incidence of dislocation is affected by various factors including cup position, head size, soft tissue tension, spinopelvic disease and possibly surgical approach.[2, 3, 20–26, 5, 10, 14–19] While older studies demonstrated dislocation rates as high as 9–13% with the posterior approach, recent studies including a meta-analysis of 13,000 patients have demonstrated dislocation rates closer to that of other approaches.[1, 27–31]

Minimally invasive surgical (MIS) approaches for elective THA have become increasingly popular due to the potential for decreased muscular damage, pain, blood loss, and time to mobilization.[32–35] The supercapsular percutaneously-assisted total hip (SuperPATH®, MicroPort Orthopedics Inc., Arlington, TN, USA) is a MIS approach that shares some similarities to the traditional posterior approach.[36, 37] The hip is approached through the interval between the Gluteus Medius and Piriformis, as well as through a distal percutaneous portal. The short external rotator muscles and Iliotibial band are not violated, the hip is not dislocated, thus theoretically reducing the risk of postoperative dislocation.[38–40] The tissue-sparing nature of this approach may allow for decreased time to ambulation, length of stay, 30-day readmission rates, in-hospital costs, and blood loss.[41–43]

The purpose of the current study was to evaluate the incidence of dislocation at minimum one year follow up in a large series of patients undergoing primary, elective THA using the SuperPATH approach. Secondary outcomes included days to ambulation, distance ambulated on postoperative day one (POD1), surgical time from incision to dressing, estimated blood loss (EBL), hemoglobin decrease on POD1, perioperative blood transfusions, discharge disposition, radiographic outcomes, and complications.

Methods

IRB approval was obtained for a retrospective chart review and telephone interviews. All consecutive elective, primary SuperPATH THAs performed by the senior author at least one year prior to the study date were reviewed retrospectively, beginning with the surgeon's first case in practice on 11/21/2013 and ending on 12/5/2016. Exclusion criteria were a diagnosis of acute femoral neck fracture, revision surgery, other THA approach, metastatic disease, or surgery performed within one year of the study. The senior author was trained in the SuperPATH approach during fellowship, and uses it exclusively for elective primary THA, as well as for THA for femoral neck fractures. However, in contrast to the originally described technique, the treating surgeon in this study completely releases the piriformis tendon intraoperatively to gain better exposure.[37] The surgeon additionally uses a mechanical guide for acetabular alignment that is based off-of a preoperative CT scan(HipXpert®, Surgical Planning Associates, Inc., Boston, MA, USA). Postoperatively, there are no specific hip precautions. Patients worked with physical therapy (PT) starting on either the day of surgery or POD1.

Electronic medical records were reviewed to collect patient demographics and follow up information. Medical records and post-operative radiographs were reviewed to assess for dislocation and secondary outcomes. Standing radiographs taken in clinic 3 weeks post-operatively were reviewed and analyzed with commercially available templating software (Traumacad®, Brainlab, Munich, DE) to measure cup abduction, anteversion, and leg length discrepancy, a method that has been found to correlate well with CT-based measurements of implant position.[44–46] Number of dislocations were confirmed through telephone interviews with the patients one year or more after surgery. During telephone interviews, patients were also asked if the operative hip had experienced any dislocations, secondary surgery or any other complications in order to assess for any treatments that may have been rendered at outside institutions.

Descriptive statistics were calculated for patient demographics, perioperative data, and follow-up data. Continuous variables were presented as mean (range) and categorical variables presented as whole integers with incidences. Component measurements were described as mean (standard deviation). Data was analyzed with Microsoft Excel software (Microsoft Corporation, Redmond, WA, USA).

Results

Patient Population

There were 279 primary THAs performed on 254 patients during the study period, of which 214 cases met inclusion criteria and were available for telephone follow-up (76.7%). The mean patient age was 64 ± 10.8 years (range 26-93). The mean time to telephone follow-up was 773 ± 269.7 days (range 368-1449). There were 104 female patients and 110 male patients. Ninety-two operations were left-sided and 122 right. Mean BMI was 29.5 ± 5.9 (range 17.3-55.7). Preoperative diagnosis was primary osteoarthritis in 172 patients, avascular necrosis in 18 patients, acetabular or proximal femoral dysplasia with degenerative changes in 14 patients, posttraumatic arthritis in 7 patients, rheumatoid arthritis in 2 patients, and femoral neck fracture nonunion in one patient.

Perioperative Measures

All but three patients were ambulatory on POD1, of whom one had experienced progressively declining ambulatory function prior to surgery secondary to a traumatic brain injury. Average distance ambulated on POD1 was 181 ± 152.5 feet (range 0-800). Surgical time averaged 136 ± 40.5 minutes (range 77-475). The first 20 cases averaged 176 minutes, and the last 20 averaged 111 minutes. EBL averaged 321 ± 230 cc (range 50-1700). Hemoglobin dropped by an average 1.6 ± 1.0 g/dL during surgery (range 0.2-5.9). Intraoperative Cell Saver blood salvage was initially used, but abandoned midway through the study period due to lack of perceived benefit by the treating surgeon. A total of eight patients (3.7%) needed blood transfusions in the perioperative period. 162 patients (75.7%) were discharged to home, four to home with home health, 44 to inpatient rehabilitation, and four to skilled nursing facilities. Time to discharge averaged 2.3 ± 1.0 days (range 1-8), with 72.4% discharged on POD1.

Components and Positioning

Most implants were non-modular Microport stems, cups, and polyethylene liner. One Link revision stem was used after an intramedullary nail removal. One patient received a modular DePuy S-ROM® implant due to proximal femoral dysplasia. The majority of components were press-fit except for two patients who received cemented femoral component due to intraoperative calcar fractures. Cup position averaged $43.6 \pm 5.2^\circ$ of abduction (range 29.0-66.0) and $20.9 \pm 6.2^\circ$ of anteversion (range 5.0-53.0). Leg length discrepancy averaged 3.6 ± 3.3 mm (range 0.0-16.0).

Complications

There were zero dislocations throughout the study period. Intraoperatively, there were three calcar fractures (1.4%), and one patient needed an immediate return to the operating room (OR) from post-anesthesia care unit (PACU) after a postoperative radiograph revealed a loose piece of bone interposed in between the prosthetic head and polyethylene liner. There were two operations to revise components. One patient sustained a periprosthetic femur fracture 21 days after the index surgery and underwent revision of the femoral component. Another underwent femoral component revision 19 months after the index procedure for aseptic loosening. There was one irrigation and debridement of a superficial abscess, three suture reactions treated conservatively, and one wound revision performed in the office for skin necrosis. Femoral stem subsidence of 2mm was noted on one patient at the initial postoperative visit, but thereafter remained stable and no further treatment was necessary. There were no deep infections.

Table 1
demographics of the study population

Mean Age, yrs (range)	64 ± 10.8 (26-93)
<i>Female</i>	110 (51.4%)
<i>Male</i>	104 (48.6%)
Laterality, n (%)	
<i>Right</i>	122 (57.0%)
<i>Left</i>	92 (43.0%)
Mean BMI, kg/m² (range)	29.5 ± 5.9 (17.3-55.7)
Diagnoses, n (%)	
<i>Primary OA</i>	172 (80.4%)
<i>AVN</i>	18 (8.4%)
<i>Dysplasia</i>	14 (6.5%)
<i>Post-traumatic arthritis</i>	7 (3.3%)
<i>Rheumatoid arthritis</i>	2 (0.9%)
<i>Femoral neck nonunion</i>	1 (0.5%)
<i>Abbreviations- BMI = Body mass index; OA = Osteoarthritis, AVN = Avascular necrosis</i>	

Table 2
perioperative outcomes

Perioperative Outcomes	
<i>Mean ΔHgb, g/dL (range)</i>	1.6 ± 1.0 (0.2-5.9)
<i>Mean Surgical time, min (range)</i>	136 ± 40.5 (77-475)
<i>Mean EBL, mL (range)</i>	321 ± 230 (50-1700)
<i>Transfusion, n (%)</i>	8 (3.7)
<i>Mean Ambulation POD1, ft (range)</i>	181 ± 152.5 (0-800)
<i>Mean Hospital LOS, days (range)</i>	2.3 ± 1.0 (1-8)
<i>Discharge destination, n (%)</i>	
<i>Home</i>	162 (75.7)
<i>Home w/ home health</i>	4 (1.9)
<i>IPR</i>	44 (20.6)
<i>SNF</i>	4 (1.9)
<i>Abbreviations- Hgb = Hemoglobin; EBL = Estimated blood loss; POD = Post-operative day; LOS = Length of stay; IPR = Inpatient Rehab; SNF = Skilled nursing facility</i>	

Discussion

This series demonstrates the successful use of the SuperPath approach for THA and most notably, zero dislocations 214 patients one year after surgery. Prosthetic hip dislocation is one of the most common early complications after primary THA, and may be influenced by factors including surgical approach and cup position.[18, 19, 54–58, 20, 47–53] The present study shows that the SuperPath approach may present an opportunity for the surgeon to further reduce dislocation incidence below the reported rates of 2–3%.[1, 2, 11, 3–10] Additionally, the present study demonstrates the ability of CT-assisted navigation to achieve adequate cup position within the classic safe zone as described by Lewinnek et al., despite the decreased visualization that accompanies a smaller incision.[18] It should be noted that dislocation rates have decreased in recent years due to factors such as the increased popularity of larger femoral heads, capsular repair, and increased offset stems, and the impact of surgical approach remains controversial. [59–65]

EBL was 321 cc. Although intraoperative surgeon EBL is often underestimated[66], patients overall experienced small decreases in hemoglobin after surgery (1.6 g/dL), as well as a low rate of intraoperative and postoperative blood transfusions (3.7%). A recent analysis of the Nationwide Inpatient

Sample of 2,087,423 THAs found that the rate of allogenic blood transfusion increased from 11.8% in 2000 to 19.0% in 2009.[67] A prospective study of 92 patients randomized to either SuperPATH or the posterior approach THA demonstrated a decreased rate of transfusions with SuperPATH, although the results were not statistically significant.[68] Allogenic blood transfusions have been associated with increased risk of infection after total joint arthroplasty, and the SuperPATH approach may help reduce this risk by reducing blood loss.[69]

Rapid time to ambulation is a theoretical advantage of MIS THA approaches. The vast majority of patients in the present series were ambulatory on POD1, and most (75.7%) were discharged home without home health. Multiple studies have demonstrated similar recovery at home as compared to rehabilitation or skilled nursing facilities after TJA, with or without another person living in the home.[70–76] Bozic et al. reported that post discharge payments account for 36% of total Medicare payments for total joint arthroplasty, of which 70% is consumed by the 49% of patients who are discharged to post acute care facilities.[77] By allowing the majority of patients to discharge home, the SuperPATH approach may enable significant cost savings, findings that were supported by a recent economic analysis by Chow and Finch.[42]

Overall operative time averaged 136 minutes from skin incision to dressing application, but decreased 65 minutes from the first 20 cases to the last 20, which may represent the effect of the initial learning curve. Rasuli and Gofton found that operative time continued to significantly decrease with the SuperPATH approach even at the 50th case, implying a longer learning curve that may require extensive experience to become proficient.[78] A recent retrospective analysis of the National Surgical Quality Improvement Program database reported an average operative time of 94 minutes in 103,000 THAs, which is shorter than reported in the present series.[79] However, operative times did not translate into an unacceptably high rate of infection nor complications in this series.

Adequate visualization is an inherent challenge in MIS THA. There is some evidence that the risk of intraoperative periprosthetic fracture is elevated with MIS approaches for elective THA.[80, 81] However, the present study demonstrated an incidence of 1.4%, which is lower than the 2.95–10.6% reported in other large series.[82–85] The three intraoperative fractures in the present series were all treated successfully using cerclage cables inserted through a smaller secondary incision without compromising the short external rotators. The only other complication attributable to decreased visualization was a return to the OR from PACU after a postoperative radiograph demonstrated a previously unrecognized piece of bone interposed between the prosthetic head and cup.

The present study is limited by several factors. Most notably, the retrospective data comes from a single surgeon who routinely uses the SuperPATH approach at a single institution. Without a control group undergoing a different approach, it is difficult to isolate the effect of the approach itself. Additionally, the number of total patients was relatively small, and prior analysis has shown that a sample size of 3720 patients would be needed to detect a 2% difference in dislocation rates of two different methods of THA with 80% power, leaving our study underpowered.[86] Thus, outcomes may not be generalizable to the

broader patient population. Furthermore, telephone follow up was 76.7%, and although the medical records were examined for dislocations or other complications, it is possible that some patients lost to follow up experienced a dislocation that was treated at an outside facility. Larger, prospective studies with a comparison group are warranted to confirm our findings.

Conclusions

The present study demonstrates a non-existent dislocation rate for THA performed through the SuperPATH approach by a single surgeon in the early stages of his career. Despite the soft tissue sparing approach utilizing a small incision, complication rates were low and good cup position was achieved. Though the present study describes the outcomes of a surgeon at the beginning of their career, the senior author was trained in the SuperPATH approach during fellowship and these results may not be representative of the early experience of surgeons who are already facile with alternative approaches. Future prospective research to compare outcomes to other approaches is needed.

Abbreviations

THA (Total Hip Arthroplasty), SuperPATH (Percutaneously Assisted Total Hip Arthroplasty), PACU (Post Anesthesia Care Unit), OR (Operating Room), MIS (Minimally Invasive Surgery), TJA (Total Joint Arthroplasty), EBL (Estimated Blood Loss), CT (Computed Tomography), PT (Physical Therapy)

Declarations

Ethics Approval and consent to Participate:

IRB approval was obtained and all patients consented to participate in the study along with any publications

Consent for publication:

All authors consent to publication

Availability of data and material:

All data and material are available for editorial review

Competing interests:

Dan Le MD is a paid consultant for Microport Inc, all other authors have no financial disclosures

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Authors' contributions:

AK: Data collection, manuscript preparation

DK: Manuscript preparation

VH: Data collection, manuscript preparation

MP: Data collection, table and figure creation

DL: Senior author, performed all surgeries, manuscript editing

All authors have read and approved this manuscript

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References

1. Masonis JL, Bourne RB. Surgical approach, abductor function, and total hip arthroplasty dislocation. *Clin Orthop Relat Res* 2002;46–53.
2. McCollum DE, Gray WJ. Dislocation after total hip arthroplasty. Causes and prevention. *Clin Orthop Relat Res* 1990;159–70.
3. Morrey BF. Instability after total hip arthroplasty. *Orthop Clin North Am.* 1992;23:237–48.
4. Turner RS. Postoperative total hip prosthetic femoral head dislocations. Incidence, etiologic factors, and management. *Clin Orthop Relat Res* 1994;196–204.
5. Yuan L, Shih C. Dislocation after total hip arthroplasty. *Arch Orthop Trauma Surg.* 1999;119:263–6.
6. Fackler CD, Poss R. Dislocation in total hip arthroplasties. *Clin Orthop Relat Res* 1980;169–78.
7. Dorr LD, Wan Z. Causes of and treatment protocol for instability of total hip replacement. *Clin Orthop Relat Res* 1998;144–51.
8. Morrey BF. Difficult complications after hip joint replacement. Dislocation. *Clin Orthop Relat Res* 1997;179–87.
9. Qurashi S, Chinnappa J, Lord SJ, Nazha A, Gordon J, Chow J. Driving After Microinvasive Total Hip Arthroplasty. *J Arthroplasty.* 2017;32:1525–9. <https://doi.org/10.1016/j.arth.2016.11.052>.

10. Ali Khan MA, Brakenbury PH, Reynolds IS. Dislocation following total hip replacement. *J Bone Joint Surg Br.* 1981;63-B:214–8.
11. Woo RY, Morrey BF. Dislocations after total hip arthroplasty. vol. 64. 1982.
12. Phillips CB, Barrett JA, Losina E, Mahomed NN, Lingard EA, Guadagnoli E, et al. Incidence rates of dislocation, pulmonary embolism, and deep infection during the first six months after elective total hip replacement. *J Bone Jt Surg Am.* 2003;85-A:20–6. <https://doi.org/10.2106/00004623-200301000-00004>.
13. Meek RMD, Allan DB, McPhillips G, Kerr L, Howie CR. Epidemiology of dislocation after total hip arthroplasty. *Clin Orthop Relat Res*, 2006, 9–18. <https://doi.org/10.1097/01.blo.0000218754.12311.4a>.
14. Kristiansen B, Jørgensen L, Hölmich P. Dislocation following total hip arthroplasty. *Arch Orthop Trauma Surgery.* 1985;103:375–7.
15. Ritter MA. Dislocation and subluxation of the total hip replacement. *Clin Orthop Relat Res* 1976:92–4.
16. Coventry MB, Beckenbaugh RD, Nolan DR, Ilstrup DM. 2,012 total hip arthroplasties. A study of postoperative course and early complications. *J Bone Joint Surg Am.* 1974;56:273–84.
17. Kohn D, Rühmann O, Wirth CJ. [Dislocation of total hip endoprosthesis with special reference to various techniques]. *Z Orthop Ihre Grenzgeb.* 1997;135:40–4. <https://doi.org/10.1055/s-2008-1039553>.
18. Lewinnek GE, Lewis JL, Tarr R, Compere CL, Zimmerman JR. Dislocations after total hip-replacement arthroplasties. *J Bone Joint Surg Am.* 1978;60:217–20.
19. Biedermann R, Tonin A, Krismer M, Rachbauer F, Eibl G, Stöckl B. Reducing the risk of dislocation after total hip arthroplasty: the effect of orientation of the acetabular component. *J Bone Joint Surg Br.* 2005;87:762–9. <https://doi.org/10.1302/0301-620X.87B6.14745>.
20. Hailer NP, Weiss RJ, Stark A, Kärrholm J. The risk of revision due to dislocation after total hip arthroplasty depends on surgical approach, femoral head size, sex, and primary diagnosis. An analysis of 78,098 operations in the Swedish Hip Arthroplasty Register. *Acta Orthop.* 2012;83:442–8. <https://doi.org/10.3109/17453674.2012.733919>.
21. Furnes O, Lie SA, Espehaug B, Vollset SE, Engesaeter LB, Havelin LI. Hip disease and the prognosis of total hip replacements. A review of 53,698 primary total hip replacements reported to the Norwegian Arthroplasty Register 1987-99. *J Bone Joint Surg Br.* 2001;83:579–86.
22. Byström S, Espehaug B, Furnes O, Havelin LI. Femoral head size is a risk factor for total hip luxation: A study of 42,987 primary hip arthroplasties from the Norwegian Arthroplasty Register. *Acta Orthop Scand.* 2003;74:514–24. <https://doi.org/10.1080/00016470310017893>.
23. Berry DJ, Von Knoch M, Schleck CD, Harmsen WS. Effect of femoral head diameter and operative approach on risk of dislocation after primary total hip arthroplasty. *J Bone Jt Surg - Ser A.* 2005;87:2456–63. <https://doi.org/10.2106/JBJS.D.02860>.

24. Lachiewicz PF, Soileau ES. Dislocation of primary total hip arthroplasty with 36 and 40-mm femoral heads. *Clin Orthop Relat Res*. 2006; 153–5. <https://doi.org/10.1097/01.blo.0000238851.31368.e7>.
25. Enocson A, Pettersson H, Ponzer S, Törnkvist H, Dalén N, Tidermark J. Quality of life after dislocation of hip arthroplasty: A prospective cohort study on 319 patients with femoral neck fractures with a one-year follow-up. *Qual Life Res*. 2009;18:1177–84. <https://doi.org/10.1007/s11136-009-9531-x>.
26. Sariali E, Lazennec JY, Khiami F, Catonné Y. Mathematical evaluation of jumping distance in total hip arthroplasty: Influence of abduction angle, femoral head offset, and head diameter. *Acta Orthop*. 2009;80:277–82. <https://doi.org/10.3109/17453670902988378>.
27. Abram SGF, Murray JB. Outcomes of 807 Thompson hip hemiarthroplasty procedures and the effect of surgical approach on dislocation rates. *Injury*. 2015;46:1013–7. <https://doi.org/10.1016/j.injury.2014.12.016>.
28. Enocson A, Tidermark J, Törnkvist H, Lapidus LJ. Dislocation of hemiarthroplasty after femoral neck fracture: Better outcome after the anterolateral approach in a prospective cohort study on 739 consecutive hips. *Acta Orthop*. 2008;79:211–7. <https://doi.org/10.1080/17453670710014996>.
29. Enocson A, Hedbeck C-J, Tidermark J, Pettersson H, Ponzer S, Lapidus LJ. Dislocation of total hip replacement in patients with fractures of the femoral neck. *Acta Orthop*. 2009;80:184–9. <https://doi.org/10.3109/17453670902930024>.
30. Sköldenberg O, Ekman A, Salemyr M, Bodén H. Reduced dislocation rate after hip arthroplasty for femoral neck fractures when changing from posterolateral to anterolateral approach: A prospective study of 372 hips. *Acta Orthop*. 2010;81:583–7. <https://doi.org/10.3109/17453674.2010.519170>.
31. Biber R, Brem M, Singler K, Moellers M, Sieber C, Bail HJ. Dorsal versus transgluteal approach for hip hemiarthroplasty: An analysis of early complications in seven hundred and four consecutive cases. *Int Orthop*. 2012;36:2219–23. <https://doi.org/10.1007/s00264-012-1624-4>.
32. Meneghini RM, Pagnano MW, Trousdale RT, Hozack WJ. Muscle Damage During MIS Total Hip Arthroplasty. *Clin Orthop Relat Res*. 2006;453:293–8. <https://doi.org/10.1097/01.blo.0000238859.46615.34>.
33. Vavken P, Kotz R, Dorotka R. Der minimalinvasive Hüftersatz - eine Metaanalyse. *Z Orthop Unfall*. 2007;145:152–6. <https://doi.org/10.1055/s-2007-965170>.
34. Restrepo C, Parvizi J, Pour AE, Hozack WJ. Prospective Randomized Study of Two Surgical Approaches for Total Hip Arthroplasty. *J Arthroplasty*. 2010;25:671–9.e1. <https://doi.org/10.1016/j.arth.2010.02.002>.
35. Dorr LD, Maheshwari AV, Long WT, Wan Z, Sirianni LE. Early Pain Relief and Function After Posterior Minimally Invasive and Conventional Total Hip Arthroplasty A Prospective, Randomized, Blinded Study. *J Bone Jt Surg*. 2007;89:1153–60. <https://doi.org/10.2106/JBJS.F.00940>.
36. <https://doi.org/10.1007/s12178-011-9090-y>.
37. Della Torre PK, Fitch DA, Chow JC. Supercapsular percutaneously-assisted total hip arthroplasty: radiographic outcomes and surgical technique. *Ann Transl Med*. 2015;3:180. <https://doi.org/10.3978/j.issn.2305-5839.2015.08.04>.

38. Prigent F. Incidence of capsular closure and piriformis preservation on the prevention of dislocation after total hip arthroplasty through the minimal posterior approach: comparative series of 196 patients. *Eur J Orthop Surg Traumatol*. 2008;18:333–7. <https://doi.org/10.1007/s00590-008-0295-8>.
39. Moussallem CD, Hoyek FA, Lahoud JCF. Incidence of piriformis tendon preservation on the dislocation rate of total hip replacement following the posterior approach: a series of 226 cases. *J Med Liban*. 2012;60:19–23.
40. Khan RJK, Maor D, Hofmann M, Haebich S. A comparison of a less invasive piriformis-sparing approach versus the standard posterior approach to the hip: A randomised controlled trial. *J Bone Joint Surg Br*. 2012;94:43–50. <https://doi.org/10.1302/0301-620X.94B1.27001>.
41. Gofton W, Chow J, Olsen KD, Fitch DA. Thirty-day readmission rate and discharge status following total hip arthroplasty using the supercapsular percutaneously-assisted total hip surgical technique. *Int Orthop*. 2015;39:847–51. <https://doi.org/10.1007/s00264-014-2587-4>.
42. Chow J, Fitch DA. In-hospital costs for total hip replacement performed using the supercapsular percutaneously-assisted total hip replacement surgical technique. *Int Orthop*. 2017;41:1119–23. <https://doi.org/10.1007/s00264-016-3327-8>.
43. Gofton W, Fitch DA. In-hospital cost comparison between the standard lateral and supercapsular percutaneously-assisted total hip surgical techniques for total hip replacement. *Int Orthop*. 2016;40:481–5. <https://doi.org/10.1007/s00264-015-2878-4>.
44. Anil Kumar PG, Kirmani SJ, Humberg H, Kavarthapu V, Li P. Reproducibility and Accuracy of Templating Uncemented THA with Digital Radiographic and Digital Traumacad Templating Software. *Orthopedics*. 2009;32:815. <https://doi.org/10.3928/01477447-20090922-08>.
45. Derbyshire B, Diggle PJ, Ingham CJ, Macnair R, Wimhurst J, Jones HW. A New Technique for Radiographic Measurement of Acetabular Cup Orientation. *J Arthroplasty*. 2014;29:369–72. <https://doi.org/10.1016/J.ARTH.2013.06.024>.
46. Westacott DJ, McArthur J, King RJ, Foguet P. Assessment of cup orientation in hip resurfacing: A comparison of TraumaCad and computed tomography. *J Orthop Surg Res* 2013;8. <https://doi.org/10.1186/1749-799X-8-8>.
47. Ranawat CS, Rao RR, Rodriguez JA, Bhende HS. Correction of limb-length inequality during total hip arthroplasty. *J Arthroplasty*. 2001;16:715–20. <https://doi.org/10.1054/arth.2001.24442>.
48. Sikes C, Van, Lai LP, Schreiber M, Mont MA, Jinnah RH, Seyler TM. Instability After Total Hip Arthroplasty. Treatment with Large Femoral Heads vs Constrained Liners. *J Arthroplasty*. 2008;23:59–63. <https://doi.org/10.1016/j.arth.2008.06.032>.
49. Moskal JT, Capps SG. Acetabular Component Positioning in Total Hip Arthroplasty: An Evidence-Based Analysis. *J Arthroplasty*. 2011;26:1432–7. <https://doi.org/10.1016/j.arth.2010.11.011>.
50. Amstutz HC, Le Duff MJ, Beaulé PE. Prevention and treatment of dislocation after total hip replacement using large diameter balls. *Clin Orthop Relat Res*, 2004, 108–16. <https://doi.org/10.1097/01.blo.0000150310.25603.26>.

51. Amuwa C, Dorr LD. The Combined Anteverision Technique for Acetabular Component Anteverision. *J Arthroplasty*. 2008;23:1068–70. <https://doi.org/10.1016/j.arth.2008.04.025>.
52. Fukunishi S, Fukui T, Nishio S, Fujihara Y, Okahisa S, Yoshiya S. Combined anteverision of the total hip arthroplasty implanted with image-free cup navigation and without stem navigation. *Orthop Rev (Pavia)*. 2012;4:e33. <https://doi.org/10.4081/or.2012.e33>.
53. Meftah M, Yadav A, Wong AC, Ranawat AS, Ranawat CS. A novel method for accurate and reproducible functional cup positioning in total hip arthroplasty. *J Arthroplasty*. 2013;28:1200–5. <https://doi.org/10.1016/j.arth.2012.09.018>.
54. Queally JM, Abdulkarim a, Mulhall KJ. Total hip replacement in patients with neurological conditions. *J Bone Joint Surg Br*. 2009;91:1267–73. <https://doi.org/10.1302/0301-620X.91B10.22934>.
55. Peters CL, McPherson E, Jackson JD, Erickson JA. Reduction in Early Dislocation Rate With Large-Diameter Femoral Heads in Primary Total Hip Arthroplasty. *J Arthroplasty*. 2007;22:140–4. <https://doi.org/10.1016/j.arth.2007.04.019>.
56. Rodriguez JA, Rathod PA. Large diameter heads: is bigger always better? *J Bone Joint Surg Br*. 2012;94:52–4. <https://doi.org/10.1302/0301-620X.94B11.30508>.
57. Archbold HAP, Mockford B, Molloy D, McConway J, Ogonda L, Beverland D. *Orthopaedic proceedings*. vol. 90-B. Orthopaedic Proceedings; 2008.
58. Garbuz DS, Masri BA, Duncan CP, Greidanus NV, Bohm ER, Petrak MJ, et al. The Frank Stinchfield award: Dislocation in revision THA: Do large heads (36 and 40 mm) result in reduced dislocation rates in a randomized clinical trial? *Clin. Orthop Relat Res*. 2012;470:351–6. <https://doi.org/10.1007/s11999-011-2146-x>.
59. Ho KWK, Whitwell GS, Young SK. Reducing the rate of early primary hip dislocation by combining a change in surgical technique and an increase in femoral head diameter to 36 mm. *Arch Orthop Trauma Surg*. 2012;132:1031–6. <https://doi.org/10.1007/s00402-012-1508-5>.
60. Bistolfi A, Crova M, Rosso F, Titolo P, Ventura S, Massazza G. Dislocation rate after hip arthroplasty within the first postoperative year: 36 mm versus 28 mm femoral heads. *HIP Int*. 2011;21:559–64. <https://doi.org/10.5301/HIP.2011.8647>.
61. Amlie E, Høvik Ø, Reikerås O. Dislocation after total hip arthroplasty with 28 and 32-mm femoral head. *J Orthop Traumatol*. 2010;11:111–5. <https://doi.org/10.1007/s10195-010-0097-8>.
62. 10.1097/00003086-199810000-00023
Pellicci PM, Bostrom M, Poss R. Posterior approach to total hip replacement using enhanced posterior soft tissue repair. *Clin. Orthop. Relat. Res.*, Lippincott Williams and Wilkins; 1998, p. 224–8. <https://doi.org/10.1097/00003086-199810000-00023>.
63. 10.1007/s11999-011-2113-6
Browne JA, Pagnano MW. Surgical technique: A simple soft-tissue-only repair of the capsule and external rotators in posterior-approach THA. *Clin. Orthop. Relat. Res.*, vol. 470, Springer New York LLC; 2012, p. 511–5. <https://doi.org/10.1007/s11999-011-2113-6>.

64. Tsukada S, Wakui M. Lower Dislocation Rate Following Total Hip Arthroplasty via Direct Anterior Approach than via Posterior Approach: Five-Year-Average Follow-Up Results. *Open Orthop J*. 2015;9:157–62. <https://doi.org/10.2174/1874325001509010157>.
65. Maratt JD, Gagnier JJ, Butler PD, Hallstrom BR, Urquhart AG, Roberts KC. No Difference in Dislocation Seen in Anterior Vs Posterior Approach Total Hip Arthroplasty. *J Arthroplasty*. 2016;31:127–30. <https://doi.org/10.1016/j.arth.2016.02.071>.
66. Ram GG, Suresh P, Vijayaraghavan PV. Surgeons often underestimate the amount of blood loss in replacement surgeries. *Chinese J Traumatol*. 2014;17:225–8. <https://doi.org/10.3760/CMA.J.ISSN.1008-1275.2014.04.008>.
67. Saleh A, Small T, Chandran Pillai ALP, Schiltz NK, Klika AK, Barsoum WK. Allogenic blood transfusion following total hip arthroplasty: results from the nationwide inpatient sample, 2000 to 2009. *J Bone Joint Surg Am*. 2014;96:e155. <https://doi.org/10.2106/JBJS.M.00825>.
68. Xie J, Zhang H, Wang L, Yao X, Pan Z, Jiang Q. Comparison of supercapsular percutaneously assisted approach total hip versus conventional posterior approach for total hip arthroplasty: a prospective, randomized controlled trial. *J Orthop Surg Res*. 2017;12:138. <https://doi.org/10.1186/s13018-017-0636-6>.
69. Pulido L, Ghanem E, Joshi A, Purtill JJ, Parvizi J. Periprosthetic Joint Infection: The Incidence, Timing, and Predisposing Factors. *Clin Orthop Relat Res*. 2008;466:1710–5. <https://doi.org/10.1007/s11999-008-0209-4>.
70. K MH, Kelly RMA, Ackerman MH. RM. Total joint arthroplasty: a comparison of postacute settings on patient functional outcomes. *Orthop Nurs*. 1999;18:75–84.
71. Mahomed NN, Davis AM, Hawker G, Badley E, Davey JR, Syed KA, et al. Inpatient compared with home-based rehabilitation following primary unilateral total hip or knee replacement: a randomized controlled trial. *J Bone Joint Surg Am*. 2008;90:1673–80. <https://doi.org/10.2106/JBJS.G.01108>.
72. López-Liria R, Padilla-Góngora D, Catalan-Matamoros D, Rocamora-Pérez P, Pérez-De La Cruz S, Fernández-Sánchez M. Home-based versus hospital-based rehabilitation program after total knee replacement. *Biomed Res Int* 2015;2015. <https://doi.org/10.1155/2015/450421>.
73. Shepperd S, Harwood D, Jenkinson C, Gray A, Vessey M, Morgan P. Randomised controlled trial comparing hospital at home care with inpatient hospital care. I: three month follow up of health outcomes. *BMJ*. 1998;316:1786–91. <https://doi.org/10.1136/bmj.316.7147.1786>.
74. Chimenti CE, Ingersoll G. Comparison of home health care physical therapy outcomes following total knee replacement with and without subacute rehabilitation. *J Geriatr Phys Ther*. 2007;30:102–8.
75. Buhagiar MA, Naylor JM, Harris IA, Xuan W, Kohler F, Wright R, et al. Effect of inpatient rehabilitation vs a monitored home-based program on mobility in patients with total knee arthroplasty the HIHO randomized clinical trial. *JAMA - J Am Med Assoc*. 2017;317:1037–46. <https://doi.org/10.1001/jama.2017.1224>.
76. Fleischman AN, Austin MS, Purtill JJ, Parvizi J, Hozack WJ. Patients Living Alone Can Be Safely Discharged Directly Home After Total Joint Arthroplasty. *J Bone Jt Surg*. 2018;100:99–106.

<https://doi.org/10.2106/JBJS.17.00067>.

77. Bozic KJ, Ward L, Vail TP, Maze M. Bundled payments in total joint arthroplasty: targeting opportunities for quality improvement and cost reduction. *Clin Orthop Relat Res*. 2014;472:188–93. <https://doi.org/10.1007/s11999-013-3034-3>.
78. Rasuli KJ, Gofton W. Percutaneously assisted total hip (PATH) and Supercapsular percutaneously assisted total hip (SuperPATH) arthroplasty: learning curves and early outcomes. *Ann Transl Med*. 2015;3:179. <https://doi.org/10.3978/j.issn.2305-5839.2015.08.02>.
79. Wills BW, Sheppard ED, Smith WR, Staggers JR, Li P, Shah A, et al. Impact of operative time on early joint infection and deep vein thrombosis in primary total hip arthroplasty. *Orthop Traumatol Surg Res*. 2018. <https://doi.org/10.1016/j.otsr.2018.02.008>.
80. Anterior Total Hip Arthroplasty Collaborative Investigators. Bhandari M, Matta JM, Dodgin D, Clark C, Kregor P, et al. Outcomes Following the Single-Incision Anterior Approach to Total Hip Arthroplasty: A Multicenter Observational Study. *Orthop Clin North Am* 2009;40:329–42. <https://doi.org/10.1016/j.ocl.2009.03.001>.
81. Alexandrov T, Ahlmann ER, Menendez LR. Early Clinical and Radiographic Results of Minimally Invasive Anterior Approach Hip Arthroplasty. *Adv Orthop*. 2014;2014:1–7. <https://doi.org/10.1155/2014/954208>.
82. Intraoperative femoral fractures. Prevention is better than cure. *Bone Joint Res*. 2018. <https://doi.org/10.1302/2046-3758.71.BJR-2017-0318.R1>.
83. Li M, Hu Y, Xie J. Analysis of the complications of the collum femoris preserving (CFP) prostheses. *Acta Orthop Traumatol Turc*. 2014. <https://doi.org/10.3944/AOTT.2014.13.0060>.
84. Ponzio DY, Shahi A, Park AG, Purtill JJ. Intraoperative Proximal Femoral Fracture in Primary Cementless Total Hip Arthroplasty. *J Arthroplasty*. 2015;30:1418–22. <https://doi.org/10.1016/j.arth.2015.02.043>.
85. Liu B, Ma W, Li H, Wu T, Huo J, Han Y. Incidence, Classification, and Risk Factors for Intraoperative Periprosthetic Femoral Fractures in Patients Undergoing Total Hip Arthroplasty With a Single Stem: A Retrospective Study. *J Arthroplasty*. 2019;34:1400–11. <https://doi.org/10.1016/j.arth.2019.03.031>.
86. Bartz RL, Noble PC, Kadakia NR, Tullos HS. The effect of femoral component head size on posterior dislocation of the artificial hip joint. *J Bone Jt Surg - Ser A*. 2000. <https://doi.org/10.2106/00004623-200009000-00010>.

Figures



Figure 1

Pre op x-rays from one of our patients



Figure 2

Post op x-rays from one of our patients For a live surgical demonstration please see the following link;
<https://www.vumedi.com/video/superpath-the-direct-superior-portal-assisted-total-hip-approach-live-surgery/>