SuperPATH[®] Minimally Invasive Total Hip Arthroplasty - An Australian Experience

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Abstract

Introduction: SuperPATH[®] is a new minimally invasive technique for hip replacement surgery that was introduced in Australia in 2013. The aim of this study was to assess short-term patient outcomes and surgical results of SuperPATH hip replacements in Australia.

Methods: A retrospective cohort analysis of the first 100 SuperPATH hip replacements by a single surgeon was performed. Surgical outcomes were reviewed with a minimum follow-up of 1 year post operation. A functional and patient satisfaction questionnaire was administered at a minimum of 6 weeks post operation.

Results: There were 3 major complications with 1 revision operation in this series. There were no dislocations. By 2 weeks post operation, 86% of patients were ambulant without walking aids, 84% of patients were able to dress themselves independently and 91% of patients did not need opioid analgesia. 81% of patients were driving within 4 weeks of surgery. Of patients who were working full-time prior to surgery, 33% of them were back at work or functional baseline within 1 week post surgery, and 52% by 2 weeks. 100% of patients were extremely satisfied with the operation.

Conclusion: We conclude that SuperPATH is a safe technique of hip arthroplasty with excellent functional recovery and patient satisfaction.

Keywords: arthroplasty, replacement, hip; minimally invasive surgical procedures; patient outcome assessment; learning curve; complications

Level of Evidence: AAOS Therapeutic Level IV

Introduction

Total Hip Arthroplasty (THA) has been a successful operation for treatment of end-stage degenerative disease of the hip. [1] Although excellent results are usually obtained in terms of mobility and analgesic effects, patients often have to modify their activity to accommodate hip dislocation precautions for variable time durations according to individual rehabilitation protocols. This can involve several weeks of avoiding driving [2], time off work and modi-

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fication of daily activities. [3,4]

With today's patients living longer and leading more active lifestyles, newer minimally invasive, muscle sparing operative techniques are being pursued. This aims to take advantage of progressive technology and allow better short-term results, early return to function and avoidance of conventional hip precautions. One such technique garnering increased focus is the Supercapsular Percutaneously Assisted Total Hip (SuperPATH®) Arthroplasty which has yielded excellent technical results by the pioneer of the technique in the United States. [5]

The aim of this study was to measure surgical and functional outcomes in the short term of a single surgeon series using the SuperPATH technique in Australian Practice.

Method

The first 100 patients (including initial learning-curve) who underwent total hip arthroplasty using the SuperPATH technique [5] by a single surgeon, were interviewed at six weeks post operation. The surgeries were performed between June 2013 and February 2015 across six different hospitals. Un-cemented prostheses (MicroPort Orthopedics Inc., Arlington, TN, USA; Dynasty Acetabular component, Profemur L Classic monoblock femoral component) were used with metal on polyethylene or ceramic on polyethylene bearing surfaces. All patients were treated with the same operative technique, perioperative care and rehabilitation protocol. Interviews were conducted over the phone by the same interviewer.

Patient Selection

All patients who underwent THA using the SuperPATH technique were included in the analysis. Patients who had their surgery with the traditional posterior approach were excluded from the study. Patients whose operations began as a minimally invasive technique but had to be converted into the traditional posterior approach intra-operatively for any reason were excluded from the functional outcome study but not from reporting of complications. No patients were excluded from the operative technique and the study on

the basis of their age, Body Mass Index (BMI), hip pathology or medical comorbidities.

Operative Technique

Standard anterior-posterior pelvic and lateral hip hard copy radiographs obtained pre-operatively were used to template for sizing implants. After induction of general anaesthesia an indwelling urinary catheter was inserted. The patients were positioned lateral decubitus and secured on a pegboard with radiolucent pegs. A mayo stand was utilised to rest the patients' foot and facilitate manoeuvring of the hip (similar to positioning for a traditional posterior approach). Intravenous antibiotic therapy thirty minutes prior to, and tranexamic acid infusion (15mg/kg) at time of, skin incision were routinely used. Patients received two further doses of intravenous antibiotics and tranexamic acid at eight and 16 hours post surgery.

The operative procedure was based on the recommended SuperPATH technique. [6] A skin incision was made proximal to the greater trochanter in line with the medullary axis of the femoral shaft. Electrocautery dissection was then performed through subcutaneous tissue and gluteus maximus fascia with no extension of dissection into the ilio-tibial band. Finger dissection of the gluteus maximus fibres was followed by retraction of the underlying gluteus medius and minimus through the interval between these muscles (Figure 1). The piriformis tendon was tagged at this stage but not routinely released, while none of the other short external rotator tendons were released. Retractors were placed between the piriformis tendon posteriorly and gluteus minimus anteriorly to expose the capsule. The capsule was tagged and incised in line with the skin incision. The piriformis fossa was then visualised and femoral preparation commenced.

Figure 1. A: Interval between gluteus minimus and piriformis (tagged with suture) B: Capsulotomy with anterior capsular leaf lifted by Cobb elevator (right) and piriformis (left) tagged with suture. C: Femoral broach in canal with neck in-situ

The femoral canal was reamed and broached to a stable fitting trial stem, with the femoral neck left intact and head in-situ during this process (Figure 1). The in-situ broach was then used as an intramedullary guide to neck osteotomy, followed by extraction of the femoral head using Schanz pins in a piecemeal fashion. An acetabular guide (similar to a trial cup) was then inserted to allow a guided stab incision and passage of blunt trocar and cannula posterior to the femoral shaft. This allowed access of instrumentation for acetabular preparation. Following line to line reaming of the acetabulum under direct vision, the definitive acetabular component and liner were inserted. Adjunct acetabular screws were used as a routine practice despite rim capture. Trial femoral components were then reduced and tested for stability and tissue tension. Once satisfied, the definitive head and femoral stem were inserted. Local anaesthetic infiltrate with ropivacaine 1% was administered to the soft tissues surrounding the exposure and hip joint. After closure of the capsule and gluteus maximus fascia, the skin was closed with a running absorbable suture. Steristrips and a waterproof dressing were applied, and a mobile AP radiograph of the pelvis obtained in recovery.

Post-operative rehabilitation

Patients were given either oral analgesia (regular paracetamol and meloxicam with as required oxycodone), or patient controlled analgesia (intravenous morphine or fentanyl) for the first 18 hours post operation, after which time all patients were put on the aforementioned oral analgesic regime. Patients on chronic pain medication were continued on their regular medications in addition to the oral analgesics mentioned above.

Patients were mobilised 15-20 metres around the ward by the physiotherapists post operation on the day of surgery. All patients were encouraged to mobilise independently when confident and comfortable, and no hip precautions were recommended post surgery. Patients were discharged from hospital once cleared from a mobility point of view by the physiotherapist. Most patients received outpatient physiotherapy with a focus on muscle strengthening and mobility (including deep squats and crossing legs to reach shoes, socks and toenails). No patients were referred to inpatient rehabilitation from a mobility point of view. Patients were encouraged to speak to their insurers and employers and were not given specific instructions regarding fitness to work or drive.

Follow-up

All patients were followed up at two weeks and six weeks post operation with repeat radiographs. Patients

were then followed up with repeat radiographs at 6 months, 18 months and 2 yearly check ups thereafter. No patients were lost to follow-up.

Functional and Patient Satisfaction questionnaire

Patients were contacted by phone at six weeks post surgery and asked about the time-frame post surgery to achieving independent aid-free mobility, cessation of narcotic analgesia, return to work or day to day function and return to driving. These questions comprised on the functional component of the Harris Hip Scores [7] and were based on a similar study investigating functional recovery following a direct anterior approach. [8] Patients were also asked about their satisfaction with the procedure by means of their opinion on the surgery using a Likert scale (Excellent, Very Good, Good, Fair, Poor) and their likelihood in choosing this method of surgery again (Yes, No, Maybe).

Ethics Approval

Ethics approval for this study was obtained from the Hunter New England Ethics Committee (Reference 15/03/18/5.01).

Statistical Analysis

Normally distributed data are presented as means with standard deviations (SD) and 95% confidence intervals, while non-normally distributed data is presented as medians with inter-quartile ranges (IQR). Categorical data is presented as proportions.

Results

A total of 100 SuperPATH technique patients were included in this study with minimum follow-up of 1 year post-operation. Four patients were excluded from this study after beginning as SuperPATH approaches but being converted intra-operatively to traditional posterior approaches (three due to difficult exposure, one to assess suspected peri-prosthetic calcar fracture). 23 patients were excluded having undergone a planned traditional posterior approach due to equipment unavailability (n=11) or lack of consent (n = 12; nine booked on waitlist prior to surgeon commencing SuperPATH, three waitlist reduction patients of other surgeons). Included patient pre-operative baseline characteristics are provided in Table 1.

There were a total of four surgical complications and one medical complication within the included series of patients, with one patient requiring revision arthroplasty surgery. There was one surgical complication in the excluded patient group.

One patient sustained an undisplaced peri-prosthetic fracture (Vancouver B2) with stem subsidence at eight to ten weeks post surgery. This occurred after a twisting injury whilst coming down stairs. The patient was treated conservatively protected weight bearing for four weeks. The same patient sustained a Vancouver C peri-prosthetic frac-

Table 1: Baseline patient characteristics (n=100)

Characteristics	Mean	(SD)	Range
Age (years)	64	(11)	25 – 88
	Median		Range
BMI	28.0		20- 41
ASA	2		1-3
	n	(%)	
Sex			
Male	60	(60)	
Female	40	(40)	
Side of operation			
Left	44	(44)	
Right	56	(56)	
Pre-operative Hip Pathology			
Osteoarthritis	92	(92)	
Avascular necrosis	5	(5)	
Post-septic arthritis	1	(1)	
Ankylosing Spondylitis	1	(1)	
DDH [†]	1	(1)	

[†]Developmental Dysplasia of the Hip

ture after being hit by a motor vehicle twelve weeks post surgery. He was treated with surgical fixation by a plate construct, which later failed due to non-union and plate breakage. This was subsequently revised with a long stem revision implant with the primary stem noted to be well ingrown intra-operatively. At time of writing, there have been no other re-operations needed for any reason.

There were two incidences of early implant migration. One patient had subsidence of the femoral component after falling at home two weeks post surgery. She was placed partial weight-bearing for four weeks and gradually allowed to increase weight-bearing after progress imaging showed stable component position. A second patient was found to have acetabular component loss of position during routine imaging at the two-week post-operative review. As she was asymptomatic and clinically stable, she was placed

partial weight-bearing for four weeks, and then allowed to fully weight-bear after repeat radiographs showed stable component position. Both patients remained asymptomatic at one year follow-up.

Other surgical complications in the SuperPATH[®] patient group were one psoas tendon avulsion post surgery treated conservatively and one instance of symptomatic leg length discrepancy (LLD; 1.5cm long on the operative side) treated with a contralateral 0.8cm heel-raise. One patient had a myocardial infarct day one post-operation and recovered well with medical therapy. Of the four excluded (converted to posterior approach) patients, there was one complication with a symptomatic leg length discrepancy of 1.5cm. There were no neurovascular injuries, dislocations, infections (superficial or deep), venous thrombo-embolic events or intra-operative peri-prosthetic fractures in any of the patients.

A fellowship trained musculoskeletal specialist radiologist independently reviewed all THA postoperative radiographs and reported all acetabular prostheses to be well seated and anteverted. The inclination of the acetabular components had a mean of 34.4 (SD 7.38) degrees with a range of 15 to 56 degrees.

Overall median hospital length of stay post surgery in this series was 3 days. Median hospital LOS post surgery was 2 days at public hospitals (mean 2.3, range 1-10, SD 1.89) and 4 days at private hospitals (mean 3.7, range 1-10, SD 1.92). No patients needed to attend inpatient rehabilitation to achieve their mobility goals prior to discharge. No patients in the public system attended inpatient rehabilitation. Some patients in the private system had pre-booked inpatient rehabilitation (patient's discretion) via their insurance and proceeded to attend this despite achieving physiotherapy discharge goals.

Functional questionnaire cumulative percentage results are provided in Figure 2. One patient used walking aids for non-arthritis related reasons, 55 patients were retired

Figure 2. Cumulative percentage of participants who regained function or ceased using opiate analgesics over time

or did not work and 10 patients did not drive and so their responses were excluded from the relevant sections of the functional questionnaire analysis.

100% of patients were extremely satisfied with the SuperPATH operative experience, with a summary of their opinions on this method of surgery provided in Table 2.

Table 2: Patient Satisfaction

	n	(%)	95% CI
Patient opinion of operation			
Excellent	90	(90)	83 – 95
Very good	10	(10)	5 – 17
Good	0	(0)	-
Fair	0	(0)	-
Poor	0	(0)	-
Would the patient have the operation again?			
Yes	99	(99)	97 – 100
Maybe	1	(1)	0 – 3
No	0	(0)	-

Discussion

A variety of minimally invasive and muscle-sparing approaches to THA have been gaining interest amongst patients and orthopaedic surgeons. Studies have shown both successes [8] and complications [9] of other muscle sparing techniques. SuperPATH offers the comfort of ability to easily extend the approach into a traditional posterior approach to the hip when required. The effectiveness of the SuperPATH approach has been demonstrated overseas by its pioneer. [5] SuperPATH has also been shown to be cost-effective when compared with the lateral approach. [10] The purpose of this study was to describe the initial clinical results of this method in Australian practice, its reproducibility as a safe and reliable technique, as well as its effectiveness regarding patients' functional outcomes. With no patients lost to follow-up, we feel this study is an accurate reflection on initial SuperPATH THA outcomes.

We feel this exposure is applicable to all primary elective hip replacement situations, although there were not many patients with DDH or inflammatory arthritis in this series and further cases may be needed to support this. Similarly, none of the cases were performed in the trauma setting and conclusions regarding SuperPATH THA for intracapsular neck of femur fractures cannot be made. The cases were spread out across different hospital with different assistants and nursing staff at each site without any

identifiable difference in surgical outcomes. Furthermore no patients were excluded from this technique on the basis of their medical comorbidities, BMI or hip pathology. The four cases excluded due to conversion to traditional posterior approach all had BMI less than 25 and primary osteoarthritic hips. These patients were also spread out throughout the case series, without any identifiable learning curve correlation.

Complication rates were minimal in this series of the first 100 patients performed using the SuperPATH technique. Our finding of all post-operative radiographs showing appropriately positioned prosthetic components is similar to another study concerning SuperPATH THA in North America. [11] There were no dislocations in this series, even with no patient having to comply with any post-operative restrictions immediately post surgery. This included most patients performing movements such as deep squats and crossing legs to get to shoes, socks and toenails in the early post operative period. No approaches have reported a zero percent dislocation rate [12–14] and dislocation was the second most common reason for revision surgery in the Australian Joint Replacement Registry. [15] The LLD rate in this series is lower than other reported incidences of LLD following THA [16,17] whilst there were no known intra-operative fractures, venous thromboembolic events or infections in this series.

Of the two early implant migrations, the femoral one occurred following a fall. Whilst no clear cause of the acetabular loss of position was identified, this may have been a result of an unidentified (not seen on high resolution artefact reduced computed tomography scan) intra-operative acetabular fracture. Both these cases have responded well to conservative treatment. Only one patient in this series required re-operation and revision arthroplasty surgery that was related to a traumatic periprosthetic fracture. Additionally, the complications in this series were evenly distributed and not biased towards the beginning or “learning curve”.

The high rate of patients achieving early independent mobility, independent dressing including shoes and socks, and cessation of narcotics in our study lends credence to the benefit of the soft tissue preservation aspect of SuperPATH. Most patients were independent with their mobility the day after surgery. Although social circumstances often contributed to increased LOS, a few specific factors may be responsible for the variation in the median length of stay between public and private hospital patients. Some patients had pre-booked rehabilitation beds, whilst some private insurance company's different rates of remuneration / case payment conditions linked based on minimum LOS may also have contributed.

A large portion of patients in our study felt comfortable and confident driving within a month of surgery. No instructions were given to patients beyond checking with their insurer and being off narcotics before driving. Although no legal guidelines dictate not driving period post THA [18–20], current recommendations [21] suggest no driving for a minimum of six weeks post THA. These are based on literature for traditional THA approaches. [2] Due to the nature of SuperPATH, we feel these recommendations may not be applicable as a result of the different degree of soft tissue trauma and altered musculoskeletal mechanics involved. Study into driving after SuperPATH THA is required to further investigate this area.

Patients who were not retired or unemployed were asked about duration of time post surgery to return to work. As many of them had pre-booked 6 weeks of sick leave and did not want to return to work prior, they were also alternatively asked about time to reach their baseline day to day function. With over 50% of patients returning to work/function within two weeks of surgery, SuperPATH offers an excellent option for motivated patients to minimise time off work after their joint replacements. Our study is limited in that actual work duties were not detailed so no specific recommendations can be made to patients beyond being guided by their comfort and employer.

Patients in this study were also extremely satisfied with the SuperPATH operative experience. The only non-positive feedback was one patient (1%) who was undecided on whether they would choose this method of operation again, although they did still rate the operative experience overall as “Very Good”.

Limitations of this study include recall bias due to the retrospective nature of the patients’ questionnaires, and the absence of validated functional hip scores. As most of the patients had not completed pre-operative functional hip score questionnaires, there was no baseline comparison to interpret post-operative scores. A final limitation of this study is that longest patient follow-up in this series is two and a half years to date and long-term survivorship and patient outcomes (although these may not be influenced by surgical technique) cannot be concluded at this stage. However, the short-term results to date suggest a promising future for SuperPATH THA in Australia.

Conclusion

The results of this study show that SuperPATH is a reproducible technique of performing THA with minimal complications, quick functional recovery and excellent patient satisfaction.

Disclosure

The authors declare that there is no conflict of interest regarding the publication of this paper. For full disclosures refer to last page of this journal.

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