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Original Article

Driving After Microinvasive Total Hip Arthroplasty

Suleman Qurashi, MBBS, FRACS (Orth) [a, b, *], Jason Chinnappa, MBBS, MS (Ortho) [a], Sarah J. Lord, MBBS, MS [c], Alan Nazha, MBBS, FANZCA [d], Jonathan Gordon, MBBS [b], James Chow, MD [e]

[a] Department of Orthopaedic Surgery, The Canterbury Hospital, Canterbury, NSW, Australia
[b] Harbour City Orthopaedics, Sydney, NSW, Australia
[c] School of Medicine, The University of Notre Dame Australia, Darlinghurst, NSW, Australia
[d] Department of Anaesthesia and Pain Management, Norwest Private Hospital, Bella Vista, NSW, Australia
[e] Hedley Orthopaedic Institute, Phoenix, Arizona

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A B S T R A C T

Background: Patients undergoing total hip arthroplasty (THA) are often advised to avoid driving for 6 weeks postoperation. This is based on patients having to maintain postoperative hip precautions and studies investigating brake reaction time (BRT) following THA using conventional techniques. The aim of this study was to assess patients' ability to drive in the early postoperative period following microinvasive THA by assessing BRT.

Methods: Hundred consecutive patients undergoing SuperPATH® THA in 2015 who drove automobiles preoperatively were included in this prospective cohort study. BRT was measured preoperatively and at day 1 or 2 postoperation using a driving simulator. A subset of 25 consecutive patients had repeat BRT testing at 2 weeks postoperation. Five BRT measures were taken at each time point. Differences in the patient's mean and best BRT at each time point were assessed using the paired t-test.

Results: The study cohort included 50 men and 50 women with mean age 63 years (range 25-86). The mean preoperative BRT was 0.63 s (range 0.43-1.44), with a mean difference of −0.1 s (range −0.57 to 0.33, $P < .0001$) at day 1 or 2 postoperation. The 2-week mean and best BRTs were also better than paired preoperative readings with a mean improvement of 0.15 s (range −0.78 to −0.004, $P < .0001$).

Conclusion: BRT reaches preoperative values by day 2 following microinvasive THA. Patients may be suitable to drive earlier than the previously recommended 6 weeks postoperation.

Total hip arthroplasty (THA) is a widely performed procedure that has excellent results in alleviating pain and recovering function [1,2]. Patients' functional recovery includes returning to work and sports over a period of months postsurgery [3,4]. Newer minimally invasive methods of THA hold the potential to accelerate this recovery period and allow patients to return to desired activities in shorter time frames. Driving is one of the most important aspects of daily life that patients are eager to return to postoperatively. The treating physician or surgeon is often looked to for guidance on appropriateness to get behind the wheel by both patients [5,6] and driving authorities [7]. Recent reviews consistently highlight the lack of clear clinical and legal guidelines on the appropriate time to return to driving after THA [5,6,8]. Current recommendations include advising patients against driving for up to 6 weeks post all THAs [9] or right-sided THA [10]. These recommendations are based on traditional approaches of THA that require patients to maintain hip precautions for up to 6 weeks to avoid dislocation, and studies reporting time to normalization of brake reaction times (BRTs) following these traditional approaches [11-14]. A more recent study showed that BRTs normalize by 2 weeks post right-sided THA using a muscle sparing approach [15]. The authors are not aware of any other studies investigating the time to return to driving after minimally invasive THA. The purpose of this study was to assess the ability to drive in relation to BRT in the early postoperative period following microinvasive THA using the novel SuperPATH® technique [16,17].

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* Reprint requests: Suleman Qurashi, MBBS, FRACS (Orth), Harbour City Orthopaedics, PO Box 573, Kingsford, NSW 2032, Australia.

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Materials and Methods

Patients and Setting

All patients undergoing SuperPATH THA by a single surgeon across 2 hospitals in Sydney, Australia in 2015 were eligible to participate in this prospective cohort study. No patients eligible for THA were excluded from the operative technique or the study on the basis of their age, body mass index (BMI), hip pathology, or medical comorbidities. Nondrivers and patients who had their THA performed using the traditional posterior approach were excluded from the study.

All patients were treated with the same operative technique, perioperative care, and rehabilitation protocol (with no hip precautions required).

Surgical Procedure

All operations were performed using the recommended SuperPATH technique [16,17]. Uncemented acetabular and femoral components with metal or ceramic on polyethylene bearing surfaces were implanted.

Study Variables and Measurement

Baseline patient characteristics including age, sex, BMI, hip pathology, and operative side were recorded. The primary study endpoint was difference in mean BRT preoperation vs day 1 or 2 postoperation.

BRT was measured using simulation software connected to a steering wheel and accelerator/brake pedals (Vericom Stationary Reaction Timer, Rogers, MN). Patients were given time to get used to simulator with practice runs. Once they felt adequately prepared, 5 sequential simulations requiring a hard brake (75%-100% brake pedal depression) were performed. Braking stimuli were randomly delayed between 1 and 10 s from starting with car speed at braking stimuli varied between 5 and 80 miles/h (8-129 km/h). Preoperative BRT was measured on the day of surgery. Postoperative BRT was measured once on either day 1 or day 2 postoperatively. Patients' best and mean of 5 results were recorded at each time point. The mean BRT value was chosen as the primary endpoint to reduce intraindividual variation as a source of random error. Difference in the best brake time recorded at each time point was assessed as a secondary endpoint.

A subset of consecutive patients had their BRT measurements repeated at the 2-week postoperative checkup using the same protocol. A further analysis was performed in this subset to compare differences in brake time before surgery, day 1 or 2 postoperation, and 2 weeks postoperation.

Statistical Analyses

Paired t-tests were used to compare preoperative and postoperative BRT. Generalized linear models were used to test for associations between difference in preop vs postop brake time and patient age, sex, BMI, hip side, and patient mean preoperative brake time. A mixed effects model for repeated measures that used all 5 brake times collected from each patient at preoperative and postoperative time point was also performed.

A sample of 100 patients was chosen for this study to provide 80% power to detect a difference of at least 0.1 s in BRT between preoperative and postoperative assessments, overall, and in relevant subgroups of patients of at least 20 patients (eg, to allow assessment of BRT difference by hip side). For these calculations, a paired t-test was used, the standard deviation for BRT was estimated at 0.15 s, and the type I error rate was set at 5%. Twenty-five consecutive patients were chosen for the 2-week repeat analysis as a convenience sample which would provide 90% power to detect a difference of 0.1 s in BRT under the same assumptions.

SAS 9.3 statistical software was used for these analyses. All statistical tests were 2-sided and a P value <.05 was considered statistically significant.

Human Research Ethics Approval was obtained from the Hunter New England Ethics committee (15/02/18/5.06).

Results

Hundred patients with a mean age of 63 years (range 25-86) were included. Half were men, and the majority had a BMI $\geq$ 25 kg/m^2 (Table 1). Underlying hip pathology was predominantly osteoarthritis (82%), followed by dysplasia (10%) and avascular necrosis (8%).

Six THA patients were excluded during the study. Of these, 3 patients underwent traditional posterior approach THA due to equipment unavailability and 1 patient was partially converted into a posterior approach due to difficult exposure during the operation. Further 2 patients were excluded as they did not drive. All patients had their postoperative BRT measurement on postoperative day 1-2 except for 1 patient who was assessed on postoperative day 4 due to logistical issues. No patients were lost to follow-up.

Mean BRT at baseline was 0.63 s (range 0.43-1.44). Mean difference in BRT from preop to day 1 or 2 postoperation showed improved BRT for both mean BRT 0.10 s (range −0.63 to 0.38, $P <$ .0001) and best BRT 0.07s (range −0.57 to 0.33, $P <$ .0001) (Table 2). Ninety-three (93%) patients achieved or improved on their mean preoperative brake time at their postoperative assessment on day 1 or 2 following surgery (Fig. 1). A similar proportion (92, 92%) achieved or improved on their best preoperative brake time at their best postoperative assessment (Fig. 2). We found similar results when all brake times for each patient at each time point were included in a repeated measures mixed effect model (mean difference 0.10 s).

Twenty-five consecutive patients (patient numbers 64-89 of overall cohort) underwent repeat BRT testing at 2-week follow-up appointment. All these patients' 2-week best and mean BRT were better than their preoperative results with a mean improvement for the group of 0.15 s (range −0.78 to −0.004, $P <$ .0001).

Table 1
Subject Baseline Characteristics.

Characteristic	*n* (%)
Age (y)	
<50	10 (10)
50-59	23 (23)
60-69	42 (42)
≥70	25 (25)
Mean (standard deviation)	62.9 (11.4)
Sex	
Male	50 (50)
Female	50 (50)
BMI (kg/m^2)	
20-24	25 (26)
25-29	35 (37)
≥30	35 (37)
Missing details	5
Mean (range)	28.9 (20.3-49.6)
Side of surgery	
Right	56 (56)
Left	44 (44)

Table 2
Comparison of Preoperative and Postoperative Brake Times, Overall and by Hip Side.

BRT (s)	All, $N = 100$				Right Hip, $n = 56$				Left Hip, $n = 44$			
	Preop	Postop	Difference	*P* Value[a]	Preop	Postop	Difference	*P* Value[a]	Preop	Postop	Difference	*P* Value[a]
	Mean (Range)				Mean (Range)				Mean (Range)			
Mean	0.63 (0.43-1.44)	0.53 (0.38-1)	−0.10 (−0.64 to 0.38)	<.0001	0.63 (0.44-1.26)	0.54 (0.41-1)	−0.08 (−0.39 to 0.38)	<.0001	0.63 (0.43-1.44)	0.51 (0.38-0.81)	−0.12 (−0.64 to 0.07)	<.0001
Best	0.54 (0.35-1.28)	0.47 (0.34-0.89)	−0.07 (−0.57 to 0.33)	<.0001	0.54 (0.39-0.97)	0.48 (0.34-0.89)	−0.06 (−0.39-0.33)	<.0001	0.54 (0.35-1.28)	0.46 (0.34-0.71)	−0.08 (−0.57-0.02)	<.0001

[a] Significance at $P < .05$.

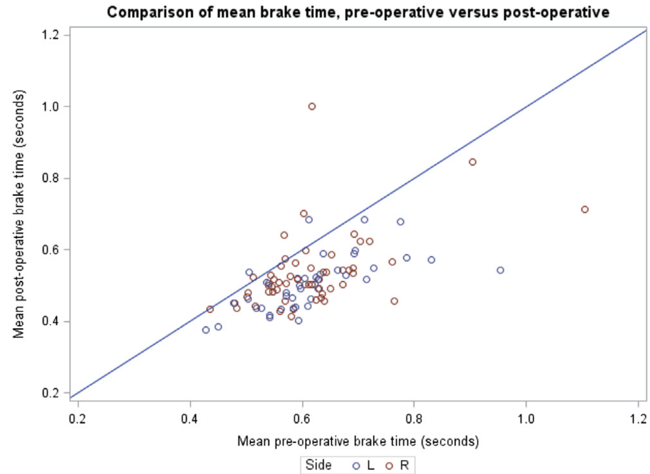

Fig. 1. Comparison of mean brake time, preoperative vs postoperative.

Factors associated with the size of the difference in brake time preop vs postop were the patient's preoperative brake time ($P < .0001$) and BMI ($P = .02$). Results were similar for each side (left and right hip) (Figs. 1 and 2). There was no statistically significant difference in mean preoperative and postoperative brake times nor in the difference in best preoperative vs postoperative brake times between left and right hips (Table 2).

Discussion

Driving is an important aspect of daily life for many people. Ability to drive can also have an economic impact when necessary for employment commitments. While patients look forward to getting back on the road as soon as they can, it is important to ensure they only do so once it is safe. Some of the available recommendations suggest avoiding driving for 6 weeks following THA [9,10], while other reviews have suggested that there is no conclusive evidence to allow definitive recommendations [5,6]. Driving authorities and insurance companies look to the treating physician for advice on this following surgical intervention [7]. Another study found that 81% of SuperPATH THA patients were driving comfortably by 4 weeks postoperation, with 42% driving by 2 weeks [18].

Ability to drive is a complex task to perform and assess. Given the function of the lower limbs in mobilizing into and out of

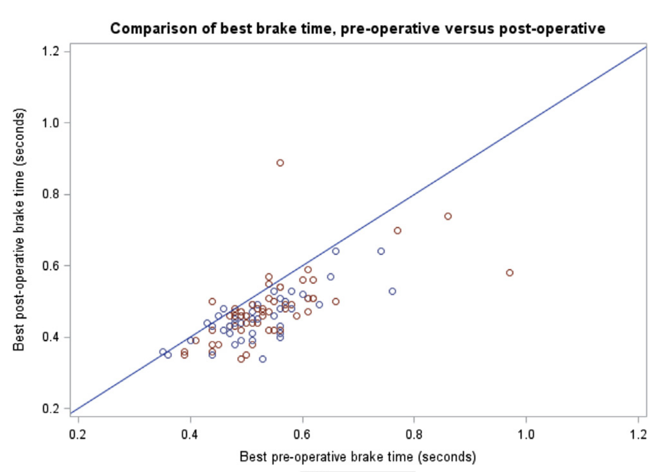

Fig. 2. Comparison of best brake time, preoperative vs postoperative.

vehicles as well as using accelerator and brake pedals, other studies investigating this following hip [11-14] and knee [19-23] arthroplasty have focused on BRT as a measure of ability to drive following surgery. Guidelines on normal BRT have a wide range across the world, varying from 0.7-1.5 s [10]. As patients are legally allowed to drive preoperatively, we considered this an acceptable reference BRT for individuals' ability to drive.

Previous studies investigating BRT in THA are based on traditional approaches and maintenance of hip precautions [11-14]. Only one study has investigated BRT following a muscle sparing approach THA [15]. All patients included in this study undergoing SuperPATH THA did not have any hip restrictions imposed on them from the time of surgery. Thus they would be safe to sit in any variety of vehicle they needed to. At day 1 or 2 postoperation, BRT showed a statistically significant improvement for the cohort compared to preoperative measures for both the best and mean BRTs. This would suggest that from a BRT point of view, patients should be able to drive by day 2 postoperation.

Although pain score assessment was not a part of this study, improvements in BRT following right THA are likely due to a combination of increased hip joint mobility and improvement in hip pain from more severe preoperative disease pain to lesser postoperative surgical pain. The similar improvements in BRT following left THA compared to right THA are likely due to the pain-relieving benefits of the operation. Patients who have relief of their left hip pain following THA are going to be more comfortable in a seated driving position and therefore able to focus and react better to stimuli. Additionally, sudden movements of the right hip such as those needed to rapidly lift off the accelerator pedal and depress the brake pedal can also involve transference of weight to the pelvis and left hip. Thus patients' BRT can improve after left THA. This is similar to the findings by Ganz et al in their series [13].

We acknowledge that driving safety goes beyond BRT and can be affected by use of opioid analgesia. Similar overall BRT improvements were found comparing the preoperative results to the postoperative 2-week subset of patients. This subset of patients' postoperative measures were performed to assess maintenance of BRT once weaned off opioids and local anesthetic effects, as we have previously found that over 90% of SuperPATH THA patients are off all opioids by 2 weeks postsurgery [18].

There are limitations in this study. First, the results cannot be directly extrapolated into the driving of manual vehicles that require use of a left leg clutch. However, our results still support the ability to perform a timely emergency brake using the right leg for drivers of manual vehicles. We would also expect the successful results to carry over to left hips and clutch use, although further investigation would be needed to confirm this. Second, we have not investigated or followed the time period for all individual patients to achieve their baseline BRT, and focused on the cohort measure instead. Of the 7 patients who did not match their preoperative mean BRT, we feel the size of difference was negligible for the latter 6 patients (Table 3). Furthermore, all 6 of these results are equal to or better than the lower threshold of published minimum normal BRT of 0.7 s [10,24]. The one other patient who did not achieve preoperative mean BRT showed an approximately 60% higher BRT postoperatively for both mean BRT (0.62 s preop vs 1 s postop) and best BRT and a similar (0.56 s preop vs 0.89 s postop). This patient had developmental dysplasia of the hip of the operative hip and a BMI of 38.29. We could not identify any other reasons for this patient's unsuccessful result; however, the postoperative BRT result was still below the published maximum normal BRT of 1.25 s [24].

This study will help doctors better advice patients on the expected time frame to return to driving following microinvasive THA. Our results indicate that BRT normalizes within 1-2 days following SuperPATH THA. Assuming BRT was the only limiting factor to driving after THA, patients may be able to safely resume driving much quicker than thought earlier. However, there are many other factors involved, and recommendations on early return to driving should be individualized to each patient by the treating surgeon. Future research could involve local motoring bodies' driving tests or simulations as a way to further assess ability to drive post THA in a real-life setting.

Table 3
Patients with Lower Postoperative Mean BRT.

Age	Sex	BMI	Preop BRT (s)	Postop BRT (s)	Side of Surgery
53	Female	38.29	0.62	1.00	Right
61	Female	34.77	0.57	0.58	Right
56	Female	31.86	0.51	0.54	Left
51	Male	30.77	0.51	0.52	Right
72	Female	37.1	0.57	0.64	Right
68	Male	24.2	0.60	0.70	Right
62	Female	29.0	0.61	0.68	Left

Conclusion

In patients undergoing microinvasive THA, BRT reaches preoperative values by day 2 postsurgery. Patients undergoing microinvasive THA may be suitable to drive earlier than the previously recommended 6 weeks postsurgery.

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