Time Taken to Resume Driving Following Hip Arthroscopy Surgery

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Abstract

Background: Resuming driving is a common concern among patients undergoing hip arthroscopy. The goals of the current study were 1) to assess whether patients who have undergone right hip arthroscopy have poorer driving performance than patients with normal hips and 2) to analyse the time required to regain preoperative driving performance with respect to different types of operations.

Methods: Forty-seven patients who had undergone right hip arthroscopy and who consented to our test protocol were included in this study. The patients were divided into two groups based on the type of operation that they underwent, namely, the femoroacetabular impingement surgery (FAI) group and the simple hip arthroscopy (SA) group. Using an immersive driving simulator, the patients were tested for brake reaction time (BRT), total brake time (TBT), and brake pedal depression pressure (BPD). Following the surgery, the first assessments were conducted when the patient could comfortably sit on the driving seat, and follow-up assessments were conducted for 6 consecutive weeks at weekly intervals. For the control group, 20 healthy volunteers were put through driving assessments thrice at weekly intervals. Braking parameters were compared between preoperative and postoperative measurements and between studied and controlled subjects.

Results: The preoperative braking parameters of the patients who underwent arthroscopy showed no significant difference compared with normal controls (p values 0. 373, 0.763, and 0.447 for BRT, TBT, and BPD, respectively). All braking parameters returned to normal in 2 weeks in the FAI group and in 1 week in the SA group.

Conclusion: Our study indicates that the driving performance of the patients undergoing right hip arthroscopy have comparable driving performance as compare to the normal hips and that the braking reaction returns to the preoperative state 1 week after SA and 2 weeks after FAI surgery.

Background

Hip arthroscopy is often indicated in young, active adults, and the waiting time required before resuming driving following the surgery is a common concern among patients [1, 2]. Pain, loss of proprioception, and discomfort from the surgical intervention may result in delayed response of the affected leg, which could potentially lead to poor driving performance [3–5]. The literature suggests that driving performance can recover in 2 to 6 weeks following lower leg surgical intervention. This suggestion is based on measurements of patient responses to the accelerator and the brake [1]. Regarding hip arthroscopy, limited evidence is available on when a patient can resume driving following surgery. Similarly, there is limited knowledge on if the painful hip, for which the arthroscopic treatment is indicated, can lead to poor driving performance.

Driving is a complex procedure and multiple factors need to be considered to drive safely. The most important factor for ensuring safety while driving is effective brake response in dangerous situations [1, 6]. However, as it would be unethical to test patients' brake responses in real-life driving scenarios, an alternative method to measure this is necessary.

In this study, we aimed to report the driving performance of patients who had undergone right hip arthroscopy, and the time taken to recover driving performance following the surgery, using an immersive realistic driving simulator. More specifically, the purposes of the current study were 1) to assess whether patients with a hip arthroscopy indicated hip have poorer driving performance than the normal population and 2) to evaluate the time required to regain preoperative braking performance state, with respect to different types of hip arthroscopy surgery.

Methods

This study was approved by the institutional review board of our institution and was enrolled in the prospective database (IRB#2016-08-010, KCT 0002643). Patients who had undergone hip arthroscopy between August 2017 and July 2019 and who fulfilled our inclusion criteria were enrolled in the study. The inclusion criteria were 1) age between 18 and 50 years with valid driving licence, 2) history of routine commute by driving before symptom onset, 3) no influence of underlying diseases or consumption of drugs that may have a potential effect on driving performance, 4) having undergone hip arthroscopy procedure on the right hip, and 5) agreement to undergo simulator test at a weekly interval for 6 weeks. Out of the 55 patients that were initially enrolled, 8 patients were excluded owing to 1) motion sickness during driving simulation and 2) inability to attend the whole 6-week test session. The remaining 47 patients were classified into 2 groups based on the type of the surgery that they underwent: 1) femoroacetabular impingement (FAI) group (n = 29) and 2) simple hip arthroscopy (SA) group (n = 18). Patients who underwent osteochondroplasty of the femoral head cam lesion and the repair of the labrum were allocated to the FAI group. Patients who underwent operations that did not require bony resection or labral repair, and for whom the entire procedure took less than 60 minutes, were allocated to the SA group.

For the control group, we enrolled 20 healthy volunteers who were routine commuting drivers between 18 and 50 years of age. The control group underwent thorough physical examination to exclude any hip problems, including range of motion, pain on movement, point tenderness, impingement test, flexion-abduction-external rotation test, and straight leg elevation test. Only the subjects who had no abnormalities during physical examination were selected.

Prior to the test, all subjects were questioned regarding their driving experience, including number of hours spent driving each week and year since their acquisition of a driving licence. For patients who had undergone hip arthroscopy, an additional question was asked to determine if they had ceased driving, or decreased the number of hours spent driving, after the initiation of hip pain.

Surgical procedure

All operations were performed by a single surgeon. Indications for surgery, in all patients, were 1) minimum 3 months of conservative treatment, 2) improvement in pain with intra-articular injection, 3) detection of pathologic lesion in radiographic image, and 4) pain severe enough to interfere with daily life. Patients were operated on in the lateral decubitus position, and the operation was initiated using standard lateral and anterolateral portals. The 29 patients who had arthroscopy via FAI (FAI group) underwent interportal capsulotomy to enhance instrument manipulation and had osteochondroplasty of the femoral head with labral repair using 1 to 3 anchors. Of the 18 patients who underwent simple arthroscopy, simple synovectomy was performed in 6 patients, labral debridement and capsular shrinkage in 5, synovial chondromatosis removal in 4, calcification debridement in 2, and ligamentum teres debridement and shrinkage in 1 patient. Interportal capsulotomy was performed in 15 patients from the SA group. Capsule repair was performed only when the surgeon decided that capsulotomy was excessive, as seen in 21 cases in the FAI group and 10 cases in the SA group.

All patients were allowed to ambulate with the assistance of crutches on the first postoperative day. The range of motion exercise was initiated as soon as the pain was tolerable. While the patients who had undergone simple arthroscopy were not restricted from postoperative movement, the patients who had undergone labral repair were discouraged from squatting deeply until the 6th week after the procedure. For pain management, intravenous narcotics were introduced immediately following the surgery and additional injections to subside pain was prescribed according to patient need. Oral pain control pills were prescribed for a minimum of 2 weeks and were re-prescribed when the patient felt it was necessary. The institution typically allows one-week admission for patients undergoing hip arthroscopy.

Simulator set up and test protocol

A modern immersive driving simulator, developed for driver training and research, was used for the current study (Carnetsoft BV, Groningen, Netherland). This driving simulator has shown high validity and excellent test-retest reliability. It has also shown significant sensitivity for testing fitness to drive [7, 8]. The simulator was composed of 3 monitors, a steering wheel, and a pedal unit. As the simulator was configured with an automatic transmission model, a clutch or shifting gear was not used. Three 24-inch monitors were used for display so that a 180-degree field of view could be provided and an additional user interface monitor was used to control the driving scenario. The simulator provided a dashboard that included a speedometer and a tachometer. Audio, which included engine sounds and natural road traffic noises, along with a stereo system, was also provided. In addition, an adjustable driving seat was manufactured for comfortable access to the pedal unit so that the driving simulator could imitate real driving as much as possible (Fig. 1). The driving scenario, a three-dimensional realistic suburban road, was developed specifically for the current study.

The test included an initial 5 minutes of practice driving in a suburban environment followed by a 5-minute driving test. The stopping event was defined by the flashing red stop sign on the screen, which was triggered by the investigator using the separate user interface monitor. The stopping event was initiated only when the driving speed exceeded 60 km/h. Five stopping events were tested during the course of test driving.

All patients had 8 sessions, overall, of simulation driving during the course of the study. The index driving test was performed prior to the operation to set the baseline. Prior to the test, the patients had detailed instruction sessions on what to expect during the simulation. The first postoperative driving test was performed whenever the patient felt comfortable sitting on the driving seat and when they felt ready to attempt simulation driving. The second test was performed on the 7th day following the operation, and the tests were repeated at weekly intervals for 6 weeks. On the day of the simulation driving test, all patients refrained from taking opioid medication if they had been prescribed any. The 20 healthy volunteers (control group) also had same 5 minutes of practice driving followed by 5 minutes of test driving. This was repeated thrice at weekly intervals to find out if acclimatisation to the driving simulator may have had any potential effects on the result.

For the outcome, brake reaction time (BRT), total brake time (TBT), and brake pedal depression (BPD) for each of the 5 stopping events were measured and the means of the 5 results for each parameter were used for analysis. BRT was defined as the time period from the first flash of the red stop sign on the screen to the patient setting their foot on the brake pedal. TBT was defined as the time period between the stopping event and the car stopping completely. BPD was measured as a percentage of brake pedal pushed by the participant with respect to the pedal being fully pushed[1].

For patient-reported outcomes, visual analogue scale (VAS) and international hip outcome tool (iHOT-33) scores were measured in all subjects prior to the test. Additionally, the VAS was measured before each set of the driving test being performed. All patients were recommended to not drive for 6 weeks following the surgery.

Statistics

Statistical analysis was performed using SPSS 21 software (SPSS Inc, USA). Continuous variables were recorded as means and standard deviations (SD). Independent T test was performed to compare the driving performance of the patients at preoperative state and that of the control group, while analysis of variance (ANOVA) was used to compare the variables between the SA, FAI, and control groups. Paired T test was used to analyse the time required to regain preoperative driving performance after hip arthroscopy, and repeated-measures ANOVA was performed to assess whether a learning effect occurred in the control group. The sphericity of the repeated ANOVAs was tested with the Mauchly test, and the Greenhouse-Geisser correct was utilised when sphericity was violated. Linear regression analysis was performed to assess the correlation between patient-reported outcomes (VAS) and patient reactions to braking. Significance was set to an alpha of 0.05 for all analyses.

Results

The mean age of patients undergoing hip arthroscopy was 36.2 ± 7.9 years (female: 8). No significant difference was found between the different groups in terms of age, sex, and experience in driving. At the time of surgery, 3 patients had completely stopped driving for a mean duration of 2.1 months prior to the operation. Another 9 patients answered they had cut down on driving time owing to discomfort. The demographic data and preoperative patient-reported outcomes of the studied and controlled groups are listed in Table 1.

Table 1
Demographic information of studied patients and control cohort.

	Control (n = 20)	Overall (n = 47)	FAI (n = 29)	SA (n = 18)
Age (yr)	35.2 ± 7.5	36.2 ± 7.9	37.0 ± 9.2	35.8 ± 6.4
Sex (% female)	40	36	34	337/18 39
Driving experience (yr)	7.0 ± 4.2	9.2 ± 6.3	8.8 ± 7.0	10.2 ± 5.5
Preop VAS	-	5.9 ± 1.0	6.2 ± 0.9	5.8 ± 1.0
Preop iHOT-12	-	41.3 ± 9.4	40.8 ± 9.6	44.7 ± 8.9
Ceased or decreased number of driving (%)	-	25	20	33

VAS = visual analogue scale; iHOT = international hip outcome tool

The mean BRT, TBT, and BPD of patients who underwent hip arthroscopy prior to the operation showed no significant difference compared with the control group. Moreover, no significant difference was found when these were compared among the control, SA, and FAI groups, indicating that the painful hip, which is indicated for hip arthroscopy, does not influence braking reaction (Table 2).

Table 2
Comparison of braking parameters between studied and control groups

		Preoperative value in study group	Control	P value
BRT (ms)	Overall	742.2 ± 84.7	763.3 ± 75.4	0.373
	FAI	743.4 ± 78.8		0.672
	SA	740.3 ± 94.4		
TBT (ms)	Overall	3341.5 ± 648.3	3250.8 ± 613.8	0.763
	FAI	3533.8 ± 616.5		0.081
	SA	3031.7 ± 594.4		
BPD (%)	Overall	99.1 ± 3.6	98.4 ± 5.0	0.447
	FAI	98.6 ± 5.3		0.483
	SA	100.0 ± 0.0		

BRT = brake reaction time; TBT = total braking time; BPD = brake pedal depression; FAI = femoroacetabular impingement group; SA = simple arthroscopy group

Patients agreed to start the first postoperative driving test at a mean duration of 3.5 days after the procedure. The SA group was able to perform the test at 3.1 ± 1.2 days while the FAI group performed the first test after a mean duration of 4.1 ± 1.9 days. All patients had ceased taking intravenous opioid injections by the first trial but were still taking oral pain medications. Of the 47 patients, 5 replied that they were taking pain medications at the time of the last trial, which was performed 6 weeks after the operation.

Compared with the preoperative state, significant prolongation of all parameters was observed in both the FAI and SA groups at the first trial. At 1 week, significance was noticed only in BRT and BPD of the FAI group. No significant difference was found thereafter in both groups. Overall, the studied patients had prolonged results in all three parameters at the first trial with the BRT and BPD remaining prolonged up to the first week (Table 3).

Table 3
Difference in brake reaction parameters compared with preoperative value

	FAI group		SA group		Overall patients	
	Mean ± SD	P value	Mean ± SD	P value	Mean ± SD	P value
First BRT	-462 ± 301	**.000**	-714 ± 402	**.000**	-561 ± 367	**.000**
BRT week 1	-105 ± 142	**.007**	-59 ± 219	.329	-87 ± 179	**.013**
BRT week 2	-21 ± 67	.215	13 ± 73	.521	-8 ± 70	.660
BRT week 3	-14 ± 83	.500	5 ± 114	.862	-7 ± 97	.769
BRT week 4	57 ± 91	.772	70 ± 111	.516	62 ± 99	.487
BRT week 5	14 ± 94	.547	16 ± 100	.553	15 ± 95	.386
BRT week 6	46 ± 94	.806	52 ± 111	.693	48 ± 100	.639
First TBT	-540 ± 478	**.000**	-383 ± 363	**.002**	-480 ± 430	**.000**
TBT week 1	105 ± 332	.209	177 ± 550	.251	133 ± 437	.090
TBT week 2	150 ± 323	.074	132 ± 301	.125	143 ± 308	.016
TBT week 3	67 ± 354	.447	116 ± 252	.108	86 ± 307	.118
TBT week 4	76 ± 351	.959	94 ± 332	.879	83 ± 336	.951
TBT week 5	184 ± 481	.134	236 ± 361	.030	203 ± 424	.011
TBT week 6	237 ± 391	.024	75 ± 291	.353	175 ± 353	.015
First BPD	23.5 ± 14.9	**.000**	18.5 ± 2.3	**.000**	21.6 ± 12.5	**.000**
BPD week 1	12.3 ± 6.6	**.000**	3.6 ± 2.7	.208	8.9 ± 9.3	**.000**
BPD week 2	0.6 ± 2.4	.332	-0.7 ± 1.6	.671	1.0 ± 4.4	1.0
BPD week 3	0.0	-	-0.7 ± 0.7	.336	-0.3 ± 1.7	.325
BPD week 4	0.0	-	-1.4 ± 1.4	.336	-0.5 ± 3.5	.325
BPD week 5	0.0	-	-1.4 ± 1.4	.336	-0.5 ± 3.5	.325
BPD week 6	0.0	-	-1.4 ± 1.4	.336	-0.5 ± 3.5	.325

BRT = brake reaction time; TBT = total braking time; BPD = brake pedal depression; FAI = femoroacetabular impingement group; SA = simple arthroscopy group

The patients’ pain scale (VAS) improved following the surgery from 4.9 ± 1.7 immediately after the operation to 2.3 ± 1.2 at 6 weeks after the operation. However, when braking parameters were compared with VAS, we found no correlation, indicating that pain does not significantly influence the braking parameters (Table 4).

Table 4
Correlation between visual analogue scale (VAS) and braking parameters

	r^2	slope	P value
VAS vs BRT	0.197	0.003	0.558
VAS vs TBT	0.178	0.003	0.164
VAS vs BPD	0.085	-0.078	0.247

VAS = visual analogue scale; BRT = brake reaction time; TBT = total braking time; BPD = brake pedal depression

Discussion

The results of the current study indicate that driving performance, as measured by the patient's response to brake with the driving simulator, shows no significant difference between patients who have painful hip indicated for hip arthroscopy and the asymptomatic controls. Additionally, our results indicate that the patient brake response recovers to the preoperative state within 2 weeks after hip arthroscopy. The pain did not correlate with the time the patient took to return to the preoperative driving state.

The time required to return to driving following the orthopaedic intervention is of great concern to patients, but there are few studies dealing with this issue [1, 9]. Endangering patients by testing their driving performance in real-life situations is highly unethical; therefore, most of the available literature on testing postoperative driving fitness utilises driving simulators. While various parameters have been used for this assessment, the ability to brake is recognised as the most important ability for safe driving[1, 9]. Currently, there is no established threshold for guaranteed safe driving, but BRTs between 750 and 1500 ms have been suggested by various institutions [10, 11]. Using simulator data, studies have reported that patients return to average driving performance approximately 2–6 weeks after total knee arthroplasty [6, 12–14] and 4 to 8 weeks after total hip arthroplasty [15–17].

In contrast to arthroplasty surgeries, arthroscopy involves less injury to the periarticular muscle structure, resulting in less postoperative change to strength and function. It can therefore be hypothesised that driving performance could be recovering earlier with arthroscopy surgery [18]. The studies have shown that the brake reaction function returns to baseline at approximately 1 to 6 weeks following knee arthroscopy [19–22]. To our knowledge, there are 3 studies that looked into the time required to recover driving fitness after hip arthroscopy. Two studies specifically assessed patients undergoing arthroscopic FAI surgery using a simple driving simulator. Interestingly, these two studies reported conflicting results. Vera et al examined 19 patients, who underwent FAI surgery, and compared the response to braking events in an age- and sex-matched cohort [3]. The study reported no differences in patient BRT at 2 weeks after surgery compared with preoperative value or BRT of control. This study was largely limited by the relatively small sample size as it included only 11 patients with right hip arthroscopy. In contrast, the study by Balazs et al tested 59 patients undergoing FAI surgery [4]. This study reported patients undergoing arthroscopic FAI surgery have prolonged preoperative BRT compared with healthy controls, and significantly prolonged BRT postoperatively, which normalised at 4 weeks. This study, however, did not disclose the number of patients undergoing arthroscopy on the right side.

A study by Momoya et al analysed patient brake performance using a realistic driving simulator similar to the one used in our study. Their study tested 14 patients who underwent right hip arthroscopy surgery and compared various parameters related to braking performance with 17 healthy volunteers [2]. The authors noticed significant improvement in brake performance in the first 2 weeks and concluded that driving after 2 weeks following right hip arthroscopy is recommended. The study was limited by the different degrees of soft tissue and bony intervention, which may have influenced braking performance, and by its modest sample size.

In our study, we classified the studied subjects according to the degree of soft tissue and bony procedure performed. Our result showed that braking parameter in patients undergoing SA normalised by 1 week compared with 2 weeks in the FAI group, suggesting that the degree of procedure on the hip joint may influence brake response. Another important finding of the current study is that while FAI or hip pain may lead to daily activity necessitating intervention, it does not lead to poor driving performance. This result is consistent with the report by Momaya et al and by Veral et al, but conflicts with the one by Balaz et al. This conflict may be derived from the patients' preoperative conditions. Our patients had a mean preoperative VAS of 5.9 and a mean iHOT score of 41.3, which is slightly higher than in the study by Balazs et al. Moreover, although we refrained from using strong analgesics such as opioids on the day of the testing, the patients were allowed to take mild pain medications such as acetaminophen or anti-inflammatory pills that do not have sedative effects. Additionally, the mean difference in BRT in the study by Balazs et al was 53 ms, which appears to be a very small difference. The mean difference in our study was 21 ms, and we believe this is a negligible difference.

To our knowledge, our study is the only one which tested the study group at weekly intervals. We believe that this short duration between test sessions may provide more precise timing on the normalisation of the braking response, which was 2 weeks in the FAI group and 1 week in the SA group. Again, this result is consistent with the report by Momaya et al and by Veral et al but conflicts with one by Balaz et al, who reported a significant difference at 2 weeks. We were unable to find why such a conflict occurred among the studies.

On the other hand, while the VAS improved consistently following the surgery, we found that the patients' pain did not correlate with their performance to brake. It could be hypothesised that the pain may be evoked as the patients step on the brake pedal, and that this may potentially decrease the stepping force, but such a trend was not found. A potential reason for this would be that the pain has improved significantly following the surgery and the amount of pain the patients experienced at the test sessions was not significant enough to influence the result.

The simulation seems to be the only viable option to test the patients' fitness to drive, but this also provides a number of limitations. First, we tried to make the simulation environment as close to a real driving setting as possible but driving in actual automobile will different as there would be vehicle movement during actual driving. Additionally, patients will likely be more cautious when they are driving on the real road and this may have affected the result. Normalisation of the reaction to braking may be the essential prerequisite for return to driving; however, driving is a complicated procedure and there are numerous other factors that may affect safe driving. Therefore, it should be noted that the return of the reaction to braking to the preoperative state presented in our study does not guarantee the safety of driving after 2 weeks. The second limitation of this study is the potential learning effect, namely, the participants getting acquainted to the simulation driving. To validate whether the learning effect influenced the result of the testing, the control groups underwent the driving test 3 times at 1-week intervals, and our result showed that there was no learning effect during the 3-week trial. This suggests that the subjects reacted to the braking event as soon as possible; therefore, the braking response did not improve even with acclimation. On the other hand, the patients underwent 8 sets of tests and the learning effect may have occurred during the span of the test. Similarly, some patients may be more familiar with simulation driving. This so-called learning phenomenon has been tested previously by Momoya et al, who reported that no such phenomenon occurred over the 8 weeks when test sessions were carried out at 2-week intervals. Third limitation is with the relatively small sample size. Our study used 47 patients undergoing hip arthroscopy, making it one of the largest series that underwent a driving simulation test. Nonetheless, the larger sample size may provide a more precise threshold for when the braking time may normalise.

Conclusion

Our simulation study shows that the driving performance of the patients undergoing right hip arthroscopy have comparable driving performance as compare to the normal hips. Also the study indicates that it would be potentially dangerous for a patient to start driving before 2 weeks after the FAI surgery and before 1 week after the SA. While further validation may be required, the surgeon should caution the patient to limit driving until their reaction to step on the break returns to normal.

List Of Abbreviations

BRT: brake reaction time

TBT: total braking time

BPD: brake pedal depression

FAI: femoroacetabular impingement group

SA: simple arthroscopy group

VAS: visual analogue scale

iHOT: international hip outcome tool

Declarations

Ethics approval and consent to participate

The study was approved my institutional review board of Chosun University Hospital prior to the enrolment of the subjects (IRB#2016-08-010). Written consents were acquired from all participants in priori.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests with regards to this study.

Authors' contributions

The study was designed by SJ and KSA. The manuscript was written by SJ and JHJ. BRK and HBC analyzed the data and performed statistical analysis. SHL gave essential advice during the writing process. All authors have approved the final version of the manuscript.

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Figures

Figure 1

Driving simulator set up with the patient in FAI group driving at 1 week posteoperatively.