Open Repair of Complete Proximal Hamstring Avulsions in Workers' Compensation Patients

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Background: Several studies have reported excellent results after surgical repair of proximal hamstring avulsions. However, the effect on these patients of receiving workers' compensation has not yet been explored.

Hypothesis: Workers' compensation patients undergoing proximal hamstring repair of complete tears will have similar outcomes when compared with a matched control group of non–workers' compensation patients.

Study Design: Cohort study; Level of evidence, 3.

Methods: Workers' compensation patients who underwent complete proximal hamstring avulsion open repair between 2010 and 2019 were identified (WC group). A control group was matched by age (±3 years), sex, and body mass index (BMI; ±3). Demographics and patient-reported outcome measures were compared, including standard and custom Marx activity rating scale (MARS), standard and custom lower extremity functional scale (LEFS), and visual analog scale (VAS) for pain. Rate and time to return to work were recorded.

Results: The WC group was composed of 20 patients (8 men, 12 women) with a mean age of 52.3 years and BMI of 32.4. The 20 matched controls (8 men, 12 women) who underwent repair had a mean age of 50.6 years and a mean BMI of 31.2. There was no difference between the groups regarding age ($P = .924$), sex ($P > .999$), or BMI ($P = .330$). The WC group reported similar mean MARS (3.3 vs 5.4; $P = .174$), custom MARS (87.5 vs 97.0; $P = .215$), and VAS pain (3.3 vs 3.8; $P = .698$) scores compared with controls. However, the WC group had significantly lower standard LEFS (69.1 vs 94.1; $P < .001$) and custom LEFS (62.3 vs 87.9; $P < .001$) scores, returned to work at a lower rate (70.0% vs 94.1%; $P = .039$), and required more time to return to work after repair (4.3 vs 3.5 months; $P = .029$) compared with controls.

Conclusion: Workers' compensation patients who underwent open proximal hamstring repair for complete avulsions experienced inferior patient-reported outcomes, required more time to return to work, and returned to work at a lower rate than a matched control group.

Keywords: avulsion; hamstring; tear; work; workers' compensation

Injury of the hamstring muscle group, comprised of the biceps femoris, semimembranosus, and semitendinosus, accounts for nearly 25% of all sport-related injuries.[1,3,13,16,21,25,28,35] Whereas hamstring injury is common, proximal avulsions are far less frequent and significantly more debilitating. Partial tears can be treated nonoperatively or operatively in those who fail conservative treatment, with good clinical outcomes demonstrated in both.[26] Conservative treatment consists of rest, nonsteroidal anti-inflammatory drugs, and eccentric muscle strengthening, with return to activity in 4 to 6 weeks.[2,7,11,16,18,19,20] Complete avulsions, however, require urgent repair, with those done in less than 4 weeks from injury showing superior results.[6,30] Surgical indications include patients with a complete 3-tendon avulsion or a 2-tendon avulsion with greater than 2 cm of retraction.[11] Several studies have shown that surgical repair of proximal hamstring avulsions can result in good-to-excellent outcomes in these patients.[5,7,9,12,27]

Bowman et al[8] examined predictors of clinical outcomes after proximal hamstring repair and found no significant differences in functional outcome scores based on age, sex, body mass index (BMI), smoking status, medical comorbidities, and activity level. Wood et al[34] revealed that acuity

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and tear type (complete vs partial) result in similar functional outcomes at midterm follow-up, although the former was associated with an increased likelihood of returning to preinjury functional status. While identifying predictors is clinically useful for preoperative planning, previous studies failed to evaluate the role of workers' compensation status on outcomes after proximal hamstring repair. The influence of receiving workers' compensation on patients' outcomes after orthopaedic surgery has been assessed broadly in several orthopaedic fields.[14,15,17,23,24,29,32,33] In general, the results of these investigations tend to support that workers' compensation patients have worse functional outcomes and require a longer duration to return to work after surgery as compared with non–workers' compensation patients.

The purpose of this study was to evaluate the effect of receiving workers' compensation on outcomes after complete proximal hamstring avulsion repair. Our null hypothesis was that patients with a workers' compensation claim at the time of surgery will report similar functional outcomes and return-to-work rates and will require a similar duration to return to work compared with their counterparts not receiving workers' compensation.

METHODS

A database query identified all patients who underwent surgical repair of an isolated proximal hamstring avulsion from January 1, 2010, to December 31, 2019. All patients with a workers' compensation claim at the time of proximal hamstring avulsion repair and a minimum of 2-year follow-up were eligible to participate in the study. Only patients with a complete tear of the hamstring origin involving all 3 tendons were included. A control group was created by matching age (±3 years), sex, and BMI (±3) to the workers' compensation group (WC group). Patients in the control group with less than 1 year of follow-up were excluded. Any patient who underwent a concomitant procedure other than neurolysis of the sciatic nerve at the time of open proximal hamstring avulsion repair was excluded from the study. In addition, anyone who was unable to be contacted or unable to complete the postoperative functional questionnaire was excluded. This study was deemed exempt from institutional review board approval.

After obtaining informed consent, demographic data were queried from electronic medical records, which included age at surgery, sex, laterality, BMI, and smoking status. Preoperative magnetic resonance imaging (MRI) and operative reports were reviewed to confirm complete 3-tendon avulsion, degree of tendon retraction (in centimeters), chronicity, and number of anchors used. Patients treated within 4 weeks of injury were categorized as acute, while patients treated after 4 weeks of injury were categorized as chronic. Requirement for revision operation as well as adverse events including infection, lower-extremity deep venous thrombosis (DVT), edema, paresthesia, and gait instability were also recorded from electronic medical records.

Patients were contacted to complete a series of validated questionnaires, including the Marx activity rating scale (MARS), lower extremity functional scale (LEFS), and pain visual analog scale (VAS). A custom MARS (maximum score: 20) and custom LEFS (maximum score: 80), described previously, were used to evaluate activities of daily living and high-level hamstring activities, respectively.[12] The LEFS, custom MARS, and custom LEFS were converted to a percentage to adjust for patients who did not participate in the specified activities. The VAS was scored on a scale of 0 (no pain) to 10 (very painful).

Patients were also asked to provide percentage of strength in comparison with their contralateral leg and overall satisfaction with their procedure on a scale of 0 (unsatisfied) to 100 (very satisfied). A general subjective questionnaire pertaining to return to work, time to return to work, and working capacity upon return was also administered. The subjective questionnaire contained questions about basic daily activities and nerve symptoms.

Surgical Technique

With the patient in the prone position, a transverse incision was made in the gluteal crease, just inferior to the ischial tuberosity. The incision was taken down to the level of the gluteal fascia with careful attention to avoid the posterior femoral cutaneous nerve. The gluteal fascia was incised horizontally, and the gluteal musculature was then retracted superiorly to expose the deep hamstring fascia. A longitudinal incision was made in the hamstring fascia to expose the tendon sheath over the top of the proximal hamstring. The sheath was entered, typically encountering hematoma fluid. The avulsed hamstring tendon was identified, mobilized, and debrided to healthy tissue. A tag stitch was placed in the avulsed tendon. The ischial tuberosity was then identified, and its lateral aspect was cleared of any soft tissue debris using a periosteal elevator. Suture anchors were then placed in the proximal, central, and/or distal ischial tuberosity in an "X" configuration. The

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TABLE 1
Demographic Data of Study Patients (N = 40)[a]

	WC Group (n = 20)	Controls (n = 20)	*P*
Age, y	52.3 ± 7.0 (32.0-61.0)	50.6 ± 10.3 (22.0-65.1)	.924
Follow-up, y	6.1 ± 2.3 (2.4-10.1)	5.3 ± 2.5 (1.2-8.7)	.278
Sex			>.999
Male	8 (40.0)	8 (40.0)	
Female	12 (60.0)	12 (60.0)	
Laterality			.752
Right	9 (45.0)	11 (55.0)	
Left	11 (55.0)	9 (45.0)	
BMI	32.4 ± 6.8 (24.2-49.8)	31.2 ± 8.2 (23.0-55.0)	.330
Smoking status			>.999
Smoker	2 (10.0)	1 (5.0)	
Nonsmoker	18 (90.0)	19 (95.0)	

[a]Results are reported as mean ± SD (range) or n (%). BMI, body mass index; WC, workers' compensation.

TABLE 2
Comparison of MRI and Intraoperative Characteristics of Proximal Hamstring Tendon Tears[a]

	WC Group (n = 20)	Controls (n = 20)	*P*
Retraction, cm	4.25 ± 2.7 (2.0-10.0)	4.0 ± 2.6 (2.0-12.0)	.799
Chronicity			>.999
Acute	15 (75.0)	14 (70.0)	
Chronic	5 (25.0)	6 (30.0)	
Anchors used	4.3 ± 1.2 (2.0-5.0)	3.6 ± 1.3 (2.0-5.0)	.101

[a]Results are reported as mean ± SD (range) or n (%). MRI, magnetic resonance imaging; WC, workers' compensation.

sutures were passed from inferior to superior in a horizontal mattress suture configuration and were tied down from superior to inferior. The wound was then irrigated, the fascia was closed, and the wound closed in layers.

For the first 14 days after avulsion repair, patients were provided a custom-fit hip orthosis and allowed toe-touch weight-bearing. After a gradual increase in weight-bearing between postoperative weeks 2 to 6, patients begin active range-of-motion and isotonic exercises over the following 4 weeks. An assessment was performed at 10 weeks with the goal of returning to sporting activities when isokinetic testing was 80% of the unaffected side.

Statistical Analysis

Descriptive statistics, including mean, range, and standard deviation, were calculated. The Wilcoxon rank-sum test was used to compare continuous variables with nonparametric data among the patients with workers' compensation claims and those without, while the Student *t* test was used to compare continuous variables with parametric data among the 2 groups. The Fisher exact or chi-square test was used to compare categorical data. All *P* values <.05 were considered statistically significant.

RESULTS

A total of 28 patients with workers' compensation claims at the time of surgery met the inclusion criteria; of these, 3 (10.7%) patients declined participation, and 5 (17.9%) were unable to be reached because of invalid or expired contact information. A total of 20 (71.4%) patients receiving workers' compensation at the time of proximal hamstring repair completed the postoperative surveys and were included in the final analysis (WC group). A matched control group of 20 patients without workers' compensation claims at the time of proximal hamstring repair was created using the criteria described previously. A comparison of demographic data is provided in Table 1.

Preoperative magnetic resonance imaging and intraoperative data are provided in Table 2. Overall, there were no significant differences between the 2 groups regarding the degree of tendon retraction, proportion of acute versus chronic tears, or mean number of anchors used. Further, the median days between date of injury and date of surgery was 21.5 days in the WC group and 22 in the control group ($P = .338$). There was no significant difference between the 2 groups in rate of adverse events (20.0% in WC vs 0.0%; $P = .108$), and no patient in either group required reoperation ($P \geq .999$).

Patient-reported outcome scores are provided in Table 3. Overall, the mean standard and custom MARS did not significantly differ between the 2 groups. Both the standard and custom LEFS scores were significantly lower in the WC group compared with the control. The 25-point difference between groups was greater than the 9-point minimal clinically important difference established for LEFS.[4,22] These functional differences were further reflected in the

TABLE 3
Patient-Reported Outcomes After Proximal Hamstring Avulsion Repair[a]

	WC Group (n = 20)	Controls (n = 20)	*P*
MARS	3.3 ± 3.8 (0.0-12.0)	5.4 ± 4.9 (0.0-14.0)	.174
Custom MARS	87.5 ± 26.7 (0.0-100.0)	97.0 ± 10.2 (55.0-100.0)	.215
LEFS	69.1 ± 21.8 (28.1-100.0)	94.1 ± 9.8 (63.2-100.0)	**<.001**
Custom LEFS	62.3 ± 24.7 (31.3-100.0)	87.9 ± 14.1 (53.8-100.0)	**<.001**
VAS pain	3.3 ± 3.6 (0.0-10.0)	3.8 ± 4.2 (0.0-10.0)	.698
Strength, %	82.6 ± 18.2 (43.0-100.0)	90.8 ± 10.2 (70.0-100.0)	.171
Satisfaction	91.7 ± 12.7 (51.0-100.0)	96.7 ± 5.2 (85.0-100.0)	.284

[a]Results are reported as mean ± SD (range). Boldface *P* values indicate statistically significant difference between groups ($P < .05$). LEFS, lower extremity functional scale; MARS, Marx activity scale; VAS, visual analog scale; WC, workers' compensation.

TABLE 4
Patient-Reported Outcomes After Acute Proximal Hamstring Avulsion Repair[a]

	WC Group (n = 15)	Controls (n = 14)	*P*
MARS	3.5 ± 4.3 (0.0-12.0)	4.4 ± 4.4 (0.0-14.0)	.547
Custom MARS	88.7 ± 29.7 (0.0-100.0)	95.7 ± 12.1 (55.0-100.0)	.975
LEFS	80.3 ± 20.2 (37.5-100.0)	94.3 ± 10.1 (63.2-100.0)	**.027**
Custom LEFS	66.9 ± 25.9 (31.3-100.0)	88.6 ± 12.0 (64.5-100.0)	**.008**
VAS pain	3.5 ± 3.7 (0.0-10.0)	4.0 ± 4.0 (0.0-10.0)	.673
Strength, %	80.6 ± 20.1 (43.0-100.0)	91.8 ± 10.6 (70.0-100.0)	.096
Satisfaction	93.1 ± 13.1 (51.0-100.0)	96.7 ± 5.3 (85.0-100.0)	.673

[a]Results are reported as mean ± SD (range). Boldface *P* values indicate statistically significant difference between groups ($P < .05$). LEFS, lower extremity functional scale; MARS, Marx activity scale; VAS, visual analog scale; WC, workers' compensation.

responses to the subjective questionnaire. A significantly higher proportion of WC patients reported that their affected leg impeded their normal activities at least once weekly (25% vs 0%; $P = .006$). Only 13 (65.0%) patients in the WC group revealed that they could participate in strenuous sporting activity compared with 20 (100.0%) patients in the control group ($P = .006$). Despite this difference in sporting activity, there were no differences in the frequency each group experienced loss of leg control while walking briskly or running ($P = .108$) or muscle cramps in the affected leg ($P = .353$). There were also no differences between the 2 groups in pain as measured by the VAS, subjective strength compared with the contralateral side, and satisfaction.

When analyzing those patients who underwent repair of acute tears, there was again no significant difference in standard MARS, custom MARS, VAS pain, strength, or satisfaction between the 2 groups. However, the WC group reported significantly lower standard LEFS (80.3 vs 94.3; $P = .027$) and custom LEFS scores, (66.9 vs 88.6; $P = .008$). Patient-reported outcomes for the patients who underwent repair of acute tears are provided in Table 4.

A similar proportion of patients received neurolysis of the sciatic nerve during tendon repair in each group (35.3% in WC vs 28.6%; $P > .999$). When surveyed regarding neuropathic symptoms, specifically the presence of tingling or numbness of the foot, a greater proportion of patients in the WC group reported they were symptomatic compared with controls (25.0% vs 0.0%; $P = .047$). In contrast, there was no difference in the proportion of patients who reported tingling or numbness in the posterior thigh between the 2 groups upon postoperative follow-up (WC, 65.0%; controls, 35.0%; $P = .089$). In reviewing the electronic medical record, 2 of the 40 (5.0%) patients evaluated in our study reported to have posterior thigh paresthesia at the time of last clinic follow-up. In addition, 2 patients were reported to have gait instability. Finally, 1 patient reported the presence of lower extremity edema. No significant difference was demonstrated between the proportions of patients in the WC group who experienced adverse events versus the control.

A total of 20 patients in the WC group and 17 in the control group reported that they were employed before injury. The 3 remaining patients in the control group reported retiring before injury. The WC group returned to work at a lower rate (70.0% vs 94.1%; $P = .039$) and required significantly more time to return to work after hamstring repair compared with controls (4.3 ± 1.7 vs 3.5 ± 3.2 months; $P = .029$). A similar proportion of patients in the WC and control groups reported returning to working at a similar capacity in comparison with their preinjury abilities (92.9% vs 81.2%; $P = .602$). When analyzing the return-to-work rate in patients who underwent repair within 28 days or fewer, the WC group returned to work at a significantly lower rate (10/15 [67%] vs 14/14 [100%]; $P = .042$). However, there was no significant difference in the duration required to return (WC group: 3.9 ± 1.2 months; controls: 3.6 ± 3.4 months; $P = .180$).

DISCUSSION

The role of receiving workers' compensation on outcomes has been thoroughly evaluated in other aspects of orthopaedic surgery. Kim et al[17] assessed outcomes after arthroscopic rotator cuff repair and found significantly lower range of motion, American Shoulder and Elbow Surgeons score, University of California Los Angeles Shoulder Score, and VAS scores in patients receiving workers' compensation compared with controls. Interestingly, these differences, originally measured at 1-year follow-up, had become insignificant once workers' compensation had expired.[17] Similarly, Salvo et al[29] reported lower Hip Outcome Scores in patients with workers' compensation claims after hip arthroscopy. The effect of workers' compensation status on surgical outcomes is multifactorial and likely due to differences in preoperative functional status as well as workplace environment and demands.

The standard and custom MARS were used to assess sporting and daily activity, respectively. The custom MARS varies from the standard MARS in that it has questions that focus on the function of the hamstring group specifically, including ability to put equal weight on both knees, standing, walking, walking up 1 flight of stairs, and getting up from a seated position without assistance. This differs from the standard MARS, in which the focus is on running, cutting, decelerating, and pivoting. Arner et al[2] reported outcomes in 64 patients, including 48 athletes, after repair of partial hamstring avulsions at 6.5 years of follow-up. The mean MARS of 12.4 in their patient population was greater than both the WC (3.3) and control (5.4) cohorts evaluated in the present study.[2] The discrepancy between the studies likely reflects the different degree of initial injury and different baseline activity levels between the 2 populations, with the majority of those evaluated by Arner et al being athletes and all with partial injuries. In comparison, Bowman et al[9] reported a slightly greater mean MARS of 6.5 at 32 months postoperatively after repair of partial tears in 17 patients, irrespective of athletic status. The mean custom MARS, which better gauges daily activity rather than high-intensity athletics, was reported as 100% by both Arner et al and Bowman et al.[9] These historical averages were most similar to the controls in the present study (97.0%) rather than the WC group (87.5%), although the difference in the custom MARS in our cohorts did not reach statistical significance.

The standard and custom LEFS were used to assess lower extremity function. The custom LEFS assesses activities in which the hamstring group is heavily utilized in hip extension and knee flexion. This is highlighted by the inclusion of activities such as pushing off with the back foot during walking, standing from a chair or from a squat, lunging forward, kicking, climbing a ladder, and touching toes with knees locked. Shambaugh et al[31] examined 65 complete proximal hamstring avulsions and reported a mean LEFS of 90.6% in the acutely treated group and 90.9% in the group treated after 3 weeks, who were assessed after a follow-up period of 3.6 years and 3.9 years, respectively. Bowman et al[9] reported a similar mean score of 91.6% at 2.7 years. A previous study of recreational athletes that was conducted by the current authors (Cohen et al[12]) revealed a slightly greater LEFS of 96.0% at 6.5 years of follow-up. In the present study, the control cohort provided similar scores compared with historical reports (94.1%). In contrast, the WC group was found to have significantly lower mean scores (69.1%) at final follow-up. As with the standard LEFS, the custom LEFS of the control group (87.9%) was most similar to the scores reported by Arner et al[2] (90.0%) and Bowman et al[9] (83.3%). However, the WC group was found to have significantly lower custom LEFS scores (62.3%).

A significantly higher proportion of WC patients reported that their affected leg got in the way of their normal activities at least once weekly (25% vs 0%; $P = .006$). This is comparable with the study population in Cohen et al,[12] in which 11% of the study reported that their affected leg got in the way of their normal activities at least weekly. The proportion of patients that reported they could participate in strenuous activity was significantly lower in the WC group (65%) compared with controls (100%). Despite this inferior outcome in the WC group, the WC group's results are in line with those reported by Cohen et al, in which 67% reported they could participate in strenuous activity.

One of the symptoms commonly reported after proximal hamstring avulsions is sciatic nerve paresthesia. In our study, 65% of the WC group and 35% of the control group reported neuralgia symptoms of the posterior thigh. This is comparable with the 47% of patients who reported neuralgia in Cohen et al.[12] We were unable to distinguish whether the reported thigh symptoms in our group were attributed to persistent incisional numbness or true neuralgia. While the difference in reported neuralgia symptoms in the posterior thigh between the 2 groups did not reach statistical significance, the difference in neuralgia symptoms in the foot did, with a greater frequency reported in the WC group (25% vs 0%). Despite inferior results in the custom and standard LEFS scores, greater difficulty with daily activities, decreased participation in strenuous activities, and greater instances of neuralgia symptoms in the foot, both groups exhibited relatively low levels of pain, similar strength relative to the unaffected leg, and excellent satisfaction with the procedure.

Ability to return to and duration of time away from work after repair of complete proximal hamstring avulsions has not been previously reported in any population. Given that the WC group were more likely to report lower functional outcomes and difficulties with normal as well as strenuous activities, it is not surprising that this group returned to work at a significantly lower rate and at a later time point compared with controls. However, in patients who were able to return to work, there was no difference in the proportion who returned to a similar working capacity to their preinjury abilities between the 2 groups. The lower-than-expected rate of return to work in the WC group aligns with the published literature. Salvo et al[29] found that only 58% of patients had returned to work at final follow-up after hip arthroscopy, while Morris et al[23] revealed an even lower rate of 14.2% after reverse shoulder arthroplasty. Although direct comparisons are not possible, these findings

underscore the poorer outcomes associated with return to work in these patient populations.

As Wood et al[34] demonstrated, the interval in which proximal hamstring avulsions are repaired may affect patient outcomes. As such, we performed a subgroup analysis on patients who had their surgical repair performed in 28 days or fewer. This subgroup analysis overall further reflected the results of the entire cohort, with the 15 patients in the WC group demonstrating significantly lower LEFS and custom LEFS scores than the 14 patients in the control group who underwent repair within the acute timeline. Likewise, there were no significant differences in the other patient-reported outcome scores. In this subgroup, patients in the WC group returned to work at a lower rate. However, the differences in duration required to return to work were not significant. Taken as a whole, these findings further support that WC status may lead to inferior outcomes.

Further, duration required to return to work may be partly influenced by chronicity to repair in addition to workers' compensation status. However, conclusions are limited by the small sample size of the chronic repairs.

In the present study, there were no instances of infection, DVT, or revision surgery recorded in the electronic medical record. This aligns with the low rates reported in historical comparisons: Blakeney et al[6] reported 5 of 94 (5.3%) patients evaluated in their study developed wound infection, with 1 requiring operative washout. They reported that no patients developed re-tear. Bowman et al[9] reported 1 (5.9%) postoperative abscess formed after the 17 partial tear repairs they performed. Brucker and Imhoff[10] reported 1 case of a dislocated anchor attributed to mishandling of the hip-knee-ankle orthosis that required revision surgery to replace the suture anchor. Rust et al[27] reported superficial wound infection/dehiscence requiring oral antibiotics in 3 of 72 patients (4.2%) and 1 instance of rerupture requiring revision repair.

In a study similar to this present study, Cohen et al[12] reported that 1 patient developed a lower extremity DVT and was prescribed anticoagulation medication for 3 months. In that study, the authors reported 5 of 52 (9.6%) patients with persistent posterior thigh numbness due to injury to the posterior femoral cutaneous nerve during surgical repair that did not resolve by the last follow-up. Rust et al[27] reported that postsurgical posterior thigh numbness was noted in 9 of 72 patients evaluated (12.5%). This compares with 2 of the 40 (5.0%) patients evaluated in our study reported to have posterior thigh paresthesia at the time of last clinic follow-up via electronic medical record, separate from patient survey results. The deviation from the 65% of the WC group and 35% of controls who reported numbness on patient surveys may indicate that examiners are not assessing for this carefully during patient follow-up visits.

Limitations

This was a retrospective study and therefore may have been affected by patient-recall bias. Preoperative functional outcome scores could not be collected and therefore the magnitude of improvement after hamstring repair could be not assessed. This study used matching to control for confounding variables such as age at surgery, sex, and BMI but is limited by the small number of patients evaluated. Further, different occupation types or levels of work were not evaluated or compared between the 2 groups, which may have biased the results. Finally, injury mechanism or trial of nonoperative management was not evaluated in this study.

CONCLUSION

The results of this study indicate that patients receiving workers' compensation at time of treatment may experience lower patient-reported outcomes and a longer duration of time to return to work after repair of complete proximal hamstring avulsion. Despite these differences, patients can expect similar outcomes regarding pain, leg strength, and overall satisfaction.

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