Predictive Factors Influencing Functional Results After Proximal Hamstring Tendon Avulsion Surgery

A Patient-Reported Outcome Study After 227 Operations From a Single Center

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Background: Although debilitating, proximal hamstring tendon avulsion injuries are rare and often overlooked or misdiagnosed. Consequently, delayed diagnosis and surgical treatment may result in poor outcomes. Studies investigating a correlation between postoperative functional outcomes and this delay in surgical treatment or other concomitant factors in large cohorts have not yet been performed to our knowledge.

Purpose/Hypothesis: The purpose of this study was to conduct an investigation in a large patient group regarding factors that could influence a patient's functional outcome after hamstring surgery. We hypothesized that this outcome would significantly correlate to the time between trauma and surgery.

Study Design: Case series; Level of evidence, 4.

Methods: Patients who received surgical treatment of proximal hamstring tendon avulsion injuries in our institution between the years 2010 and 2020 were asked to complete a validated, injury-specific outcome measurement, the Perth Hamstring Assessment Tool (PHAT; 0-100 points). In addition to calculating these outcomes, we evaluated the association of the obtained results with possible predictive factors such as age, sex, stump retraction shown on magnetic resonance imaging (MRI), and timing and duration of surgery.

Results: A total of 226 patients (227 operations) were eligible for the study, and 204 cases of hamstring tendon avulsion injury met our inclusion criteria. The return rate for the PHAT questionnaire was 85.3%. The mean PHAT score revealed good results (79.8 ± 19.1). Irrespective of concomitant factors, the scores of male patients were significantly higher compared with those of female patients (83.8 ± 16.9 vs 75.8 ± 20.6 respectively; $P = .004$). The mean time to surgery was 5.7 weeks after trauma, and more delayed surgery correlated significantly with lower PHAT scores ($P = .003$; $r = -0.228$). The mean degree of stump retraction on MRI (5 cm) did not significantly influence PHAT scores ($P = .525$; $r = -0.06$).

Conclusion: Delay of surgery and female sex were disadvantageous in terms of a good functional outcome measure (PHAT score) after hamstring tendon refixation surgery. By contrast, patient age as well as the retraction of the tendon stump on preoperative MRI did not influence PHAT scores in the present study.

Keywords: hamstring repair; functional outcome; time of surgery; predictive factors; proximal hamstring avulsion

Full-thickness proximal avulsion injuries of the common hamstring tendon, in most cases consisting of the biceps femoris and the semitendinosus origin,[15] are rare but debilitating.[2,3,6-8,10,32] Mostly they are sustained during sports or slip accidents and lead to a sudden painful loss of function, occasionally with sciatic nerve irritation due to the proximity between the retracted tendons stump and the sciatic nerve.[3,32] Despite these named impairments, proximal hamstring avulsions often remain undiagnosed or clinically misinterpreted as harmless muscle fiber injuries.[18,26,31] This may consequently result in delayed treatment with a subsequent poor functional outcome.[1,14,26,31] Addressing this

The Orthopaedic Journal of Sports Medicine, 9(10), 23259671211043097
DOI: 10.1177/23259671211043097

issue, van der Made et al[31] described a potential "hamstring injury blind spot" and strongly pleaded for a high level of diagnostic suspicion to aim for a prompt treatment and thus enable best possible outcome results in case of this severe injury.

For this purpose, most of the current literature indicates that optimal treatment results are obtained best by the performance of a contemporary surgical intervention consisting of the refixation of the ruptured tendon.[§] However, to date, little is really known about the pros and cons of an early surgery or of other preoperative concomitant circumstances regarding an optimal treatment outcome.[1,3,9,22,29] For example, only a few studies have actually investigated the correlation between the timing of surgery and measurement outcomes in general.[3,13,17,29,30,32] These studies have, however, revealed inconsistent conclusions—to some extent debatably describing the timing of surgery to be of inferior relevance regarding surgical outcome results.[13,29,32]

In any case, the current knowledge has been gathered from reviews, meta-analyses,[8,17] and studies whose conclusions are based on the investigation of comparably small cohorts[9,19,22,25] with univariate analyses, including a great variety of partially validated or non–injury-specific outcome scores,[1,2,6-8,17,21,26,32] such as the Lower Extremity Functional Scale (LEFS) or the Marx activity score.[4,20] However, using outcome scores, especially validity and specificity, has recently been debated regarding their expressiveness if only "adjusted" to a type of injury instead of being injury specific.[2,7]

To the best of the authors' knowledge, larger studies using validated, hamstring injury–specific outcome measurements that also focus on predicting factors such as time of surgery or preoperative magnetic resonance imaging (MRI) findings regarding the surgical outcome, are rare.[3,27]

The aim of our study was to investigate a large patient group of surgically treated patients in our institution regarding their postoperative functional outcome using an injury-specific patient-reported outcome score, the Perth Hamstring Assessment Tool (PHAT).[6,7] To identify predictive factors for postoperative outcome, the obtained results were evaluated and correlated to concomitant factors such as patient age, sex, surgical timing and length, and amount of stump retraction on preoperative MRI. We hypothesized that the results of the PHAT would significantly correlate with the time between trauma and surgery, as well as with the degree of stump retraction on preoperative MRI.

[§]References 2, 3, 6-8, 10, 12, 17, 25, 30, 32, 33.

METHODS

The present study is based on analyzing anonymized secondary data only, justified by section 35 of the German National State Data Protection Act, and any information that could identify patients was not used in the analysis. All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the Declaration of Helsinki and its later amendments or comparable ethical standards.[34] No members of the public or patients were involved in the design, conduct, or interpretation of the data.

Data Collection

For this retrospective case series, all included patients received proximal full-thickness hamstring avulsion surgery between January 2010 and June 2020 at our institution. Patient data were collected from our internal documentation hospital database. All medical records were reviewed, and patient data, patient history, and surgical documentation were reported for all cases. Furthermore, all MRI scans were reviewed and evaluated according to the preoperative retraction of the tendon stump.

Patients with a follow-up less than 6 months after surgery or who subsequently could not be contacted owing to a change of contact details were excluded from the study. Also, patients who previously had been treated for chronic tendinosis (for >3 months) of the proximal common hamstring tendon with or without subsequent partial or subtotal ruptures (acute-on-chronic)[1] were excluded.

While age, sex, and timing and length of surgery were gathered from the records, additional information concerning the origin of trauma was not collected for further investigation. In addition, corresponding MRI records were assessed using an internal image-viewing program (discussed in *Stump Retraction on MRI*).

Indication for surgical treatment was a complete full-thickness rupture of the common hamstring tendon with or without rupture of the semimembranosus tendon.[12,17,24] Regarding the retraction of the tendon on MRI, the decision for a surgical approach was made based on a previously proposed stump retraction benchmark of 2 cm by the Wood classification.[9,11,12,16,21,33] Patients with a tendon retraction of less than the named benchmark (Wood type 4) were informed and counseled for nonoperative treatment; they received surgical treatment only in cases of severe symptoms (eg, sciatic nerve irritations, large hematoma) or on their explicit wish. Cases with a tendon retraction of more than 2 cm (Wood type 5) were advised to undergo surgical refixation of the tendon.

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Final revision submitted May 18, 2021; accepted May 27, 2021.

The authors have declared that there are no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval was waived per governmental guidelines (section 35 of the German National State Data Protection Act).

All patients included for further assessment were contacted via telephone and/or mail to obtain their informed consent for participation in the study. Simultaneously, they were asked to complete the PHAT questionnaire. Patients were asked to return the completed questionnaire within 2 months. Those who had not returned the questionnaire in the given time frame were repeatedly contacted as a reminder or to resolve potential misunderstandings. Whereas epidemiologic, surgical, and imaging data were recorded once, the questionnaires were completed and collected twice during this study (in 2016 and 2020).

PHAT Questionnaire

The PHAT is a widespread novel, injury-specific, and validated scoring system specifically developed to evaluate the functional outcome of proximal hamstring injuries.[6,7] The self-administered scoring system assesses the patient's pain and contains a categorical assessment of the patient's subjective physical outcome and their activity levels. All answers are subsequently converted into a scoring system with a total minimum score of 0 (major complaints, no physical activity possible) and a maximum score of 100 (no complaints, full physical activity possible). All returned and correctly completed questionnaires were converted and statistically evaluated.

Surgical Procedure

Patients were surgically treated by open, anatomic refixation of the tendon at its footprint at the ischial tuberosity.[15,23] Over the investigative period, all procedures were performed by 2 senior surgeons (R.B. and U.B.). Further, surgical procedures were performed as previously described.[1-3,6,7,12,24,27,31] The skin incision was made depending on findings from the preoperative clinical and MRI evaluation, especially with respect to stump retraction as well as sciatic symptoms, the timing of the injury (acute, delayed, or chronic), and cosmetic aspects. Skin incision was performed either transversally in the subgluteal fold (for acute injury with no sciatic symptoms) or longitudinally centered over the tendon (for delayed or chronic procedures, cases of sciatic symptoms, or for cases with a relevant proximity between the tendon stump and the sciatic nerve on MRI).

During dissection of the ruptured tendon stump, a visual and haptic identification of the sciatic nerve was performed routinely. A laborious neurolysis and marking of the sciatic nerve by a vessel loop (Figure 1) was performed in only delayed and chronic cases or in certain cases with a complex identifiable intraoperative site.

After preparation and debridement of the tendon footprint at the ischial tuberosity, 3 suture anchors (surgeon's preference: Bio FASTak Suture anchor or Corkscrew FT; Arthrex) were positioned ascending into the ischial tuberosity with respect to the tendon insertion footprint and anatomy. FiberWire sutures (Arthrex) were passed through the particular tendons, which were then reattached from proximal to distal using the anchor pulley system.

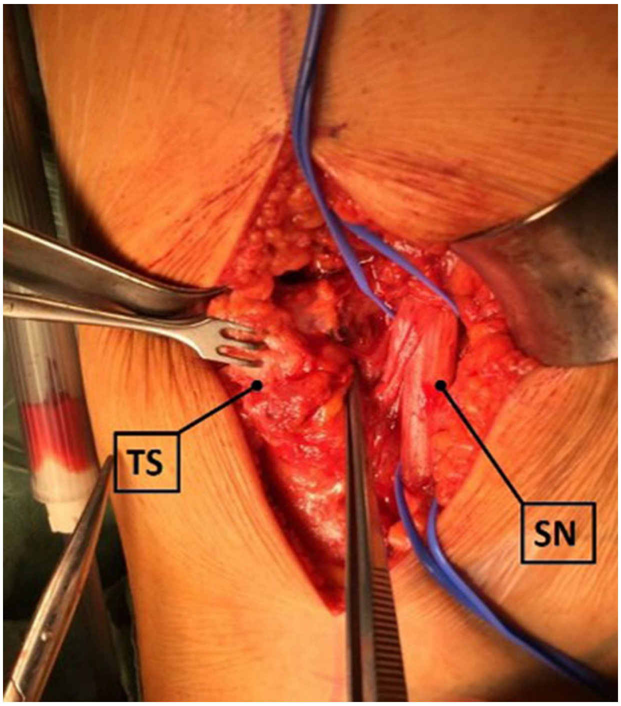

Figure 1. Operation site of a 56-year-old female patient with a right-sided injury; the time of surgery was 9 weeks after trauma. After longitudinal incision, the sciatic nerve was identified and neurolysis performed. The nerve was first marked with a blue vessel loop for further stump dissection. SN, sciatic nerve; TS, tendon stump.

In none of the included cases was grafting between the retracted stump and the ischial tuberosity necessary.

In all cases, postoperative rehabilitation consisted of partial weightbearing on crutches for 4 weeks, followed by an increase in weightbearing for an additional 2 weeks. To restrict active knee flexion, a rigid brace (knee flexion angle 20°) was prescribed at night to avoid uncontrolled movements during sleep for 4 weeks. Strength training of the hamstrings was allowed at a minimum of 8 weeks after surgery. Stepwise passive hip flexion and knee extension by the treating physiotherapist were allowed within a painfree range starting the day after surgery.

Classification of Results

Time and Length of Surgery. The time to surgery was documented in weeks from the initial trauma to surgery. Here, the week was recorded in which the surgery was performed after the initial trauma had taken place. For example, if the patient received surgery during the third week after the trauma had occurred, time to surgery was recorded as 3 weeks. The length of surgery was recorded in minutes.

In keeping with previous classifications,[3,13,27-29] the overall timing of the surgery was classified into 3 groups: acute (<4 weeks), delayed (within 1-3 months [4-13 weeks]), and chronic (>3 months [>13 weeks]) after the suffered trauma.

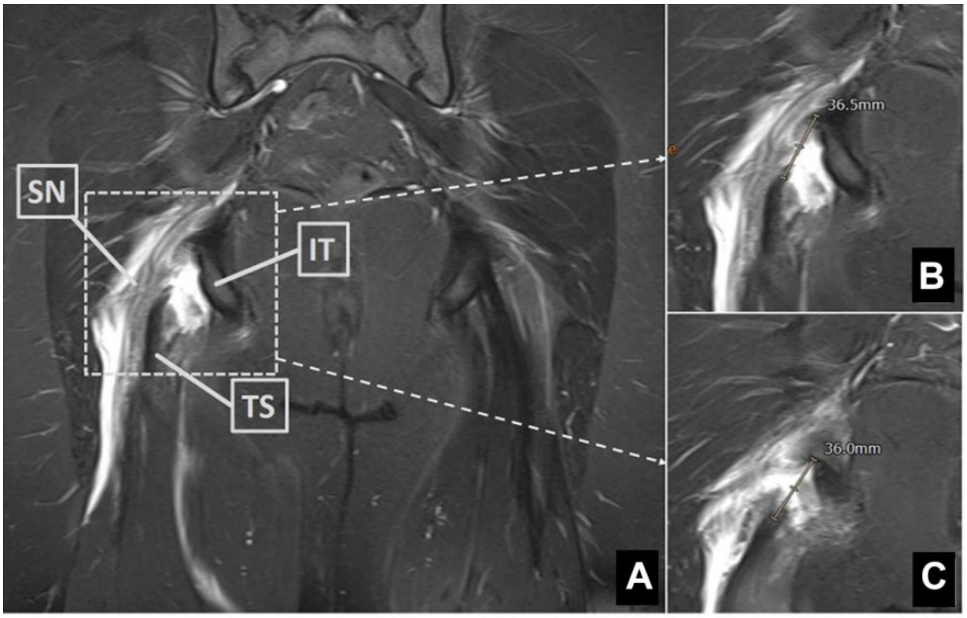

Figure 2. (A) Magnetic resonance imaging measurement of a right-sided injury 1 week after trauma. Detailed view: (B) measurement of biceps tendon and (C) measurement of semitendinosus tendon. IT, ischial tuberosity; SN, sciatic nerve; TS, tendon stump.

Stump Retraction on MRI. All available MRI scans were reviewed by a single senior surgeon (R.B.). As accurately as possible, given the inherent methodical limitations of such measurements,[28] the retracted stump was identified and its distance to the footprint was measured on sagittal plane MRI (T2-weighted short-tau inversion recovery; 4-mm thickness; repetition time, 7140 milliseconds; echo time, 65 milliseconds). Distances were documented in ascending 5-mm increments, beginning at 1 cm (Figure 2).

Statistical Analysis

Descriptive statistics were calculated for all registered scores. Results of all scores allowed accuracy to 1 decimal place. The Shapiro-Wilk test was used to prove normal distribution. Since all data were nonparametric, we performed either the Mann-Whitney U test to analyze differences between 2 groups or the Kruskal-Wallis test for differences between more than 2 groups, and the Spearman rank correlation test (r) was used to analyze the data for linear correlation. The level of significance was set at $P < .05$. Data were gathered and sorted using Microsoft Excel 2016, and IBM SPSS (version 24.0) was used for statistical analysis.

RESULTS

Demographic Data

Overall, 227 full-thickness hamstring avulsion injuries were surgically treated in our institution during the assigned period. After the exclusion of 23 cases (19 patients had ongoing treatment of chronic tendinosis >3 months, 4 patients had a follow-up <6 months), 204 cases in 203 patients were considered for this study. One patient received surgical treatment on both sides within an interval of 3 months. In summary, 174 of 204 completed questionnaires were sent back, resulting in a return rate of 85.3%. These 173 patients composed the study cohort.

The mean follow-up for receiving the completed PHAT questionnaires from the cohort was 26.2 ± 15.5 months. The gathering of the questionnaires at 2 points in time did not reveal noticeable differences (mean follow-up: 27.5 ± 15.5 months in 2016 vs 25.7 ± 13.6 months in 2020).

Sex distribution was equal, both in the entire operated cohort (N = 227; 108 [47.6%] women, 119 [52.4%] men) and in the ultimately included cases (n = 174; 85 [48.9%] women, 89 [51.1%] men). When divided by decade, most patients were between age 40 and 60 years (Figure 3). The right side was more often affected than the left side (102 [58.6%] vs 72 [41.4%] cases; $P = .023$).

Outcome Data

Irrespective of any epidemiologic or concomitant aspects, the mean total PHAT score of the whole cohort was 79.8 ± 19.1. The scores of male patients were significantly higher in comparison to those of female patients ($P = .004$) (see Table 1). Regarding the age of the cohort, female patients on average were significantly ($P = .011$) older at the time of surgery (see Table 1).

The majority of patients (n = 143; 82.2%) underwent surgery within 4 weeks after trauma. The mean time to surgery for the whole cohort, however, was almost 6 weeks (5.7 ± 12.8 weeks). No significant difference in time to surgery was found between the sexes (see Table 1). When

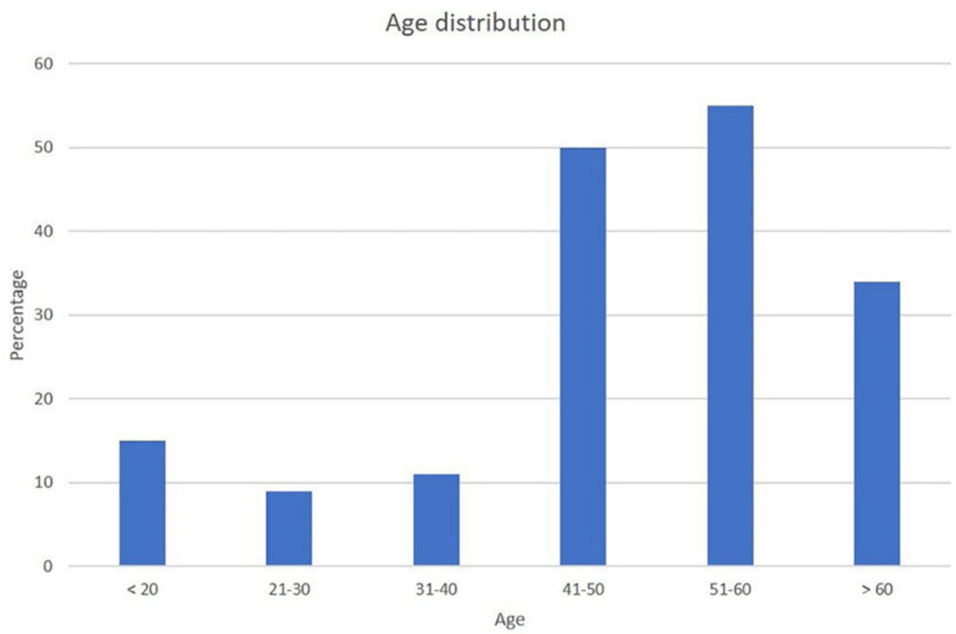

Figure 3. Age distribution in years at time of surgery.

TABLE 1
Overall Data for PHAT Outcome Measurements and Concomitant Factors[a]

	Whole Cohort (N = 174 Cases)	Men (n = 89 Cases)	Women (n = 85 Cases)	*P*
PHAT score	79.8 ± 19.1 (12-100)	83.8 ± 16.9 (12-100)	75.8 ± 20.6 (17-100)	**.004**
Age, y	48.9 ± 14.6 (11-79)	45.4 ± 17.1 (13-79)	52.5 ± 10.3 (11-74)	**.011**
Time to surgery, wk	5.7 ± 12.8 (1-76)	6.0 ± 13.7 (1-76)	5.5 ± 12.0 (1-72)	.057
Length of surgery, min	56.5 ± 27.5 (27-234)	58.1 ± 32.1 (27-234)	54.8 ± 21.9 (27-134)	.757
Stump retraction, cm	5.0 ± 2.7 (1-20)	4.8 ± 2.5 (1-11)	5.2 ± 2.9 (1-20)	.504

[a]Data are reported as mean ± SD (range). Bold *P* values indicate statistically significant difference between men and women ($P < .05$). PHAT, Perth Hamstring Assessment Tool.

classified into timing subgroups, 82.2% of all operations were classified as acute, 8.6% as delayed, and 9.2% as chronic.

Correlating Baseline Findings to Outcome

Correlating the whole cohort with the PHAT scores and other concomitant factors revealed an overall association between the time to surgery and PHAT score (Figure 4). This correlation between PHAT score and time to surgery was significant, irrespective of patient sex. When the PHAT scores were assessed in relation to the timing of surgery (acute, delayed, or chronic), a general decrease in outcome between the 3 groups could be found. Interestingly, however, this correlation was not significant when broken down by sex (Table 2) (Figure 5).

Regarding the whole cohort as well as the female cohort in particular, the time from injury to surgery was significantly correlated with the duration of surgery, with longer time to surgery leading to more extended length of surgery (whole cohort, $r = 0.383$, $P < .001$; females, $r = 0.377$, $P < .001$) (see Table 2).

When we compared PHAT scores between specific age groups (Table 3), results indicated significant sex-based differences in only the 41- to 50-year and 60-year and older groups ($P = .03$ and .029, respectively).

There were no significant correlations between stump retraction and PHAT score (see Table 2), as well as between stump retraction and every other investigated concomitant factor (age, sex, timing of surgery, and length of surgery).

DISCUSSION

Besides the main outcome, overall our study revealed excellent results with an average PHAT score of almost 80, which is on average higher than comparatively and previously described scores after operatively treated hamstring avulsions.[2,3,6,7] However, the most important finding is that there were clearly identifiable concomitant factors that appeared to influence these patients'

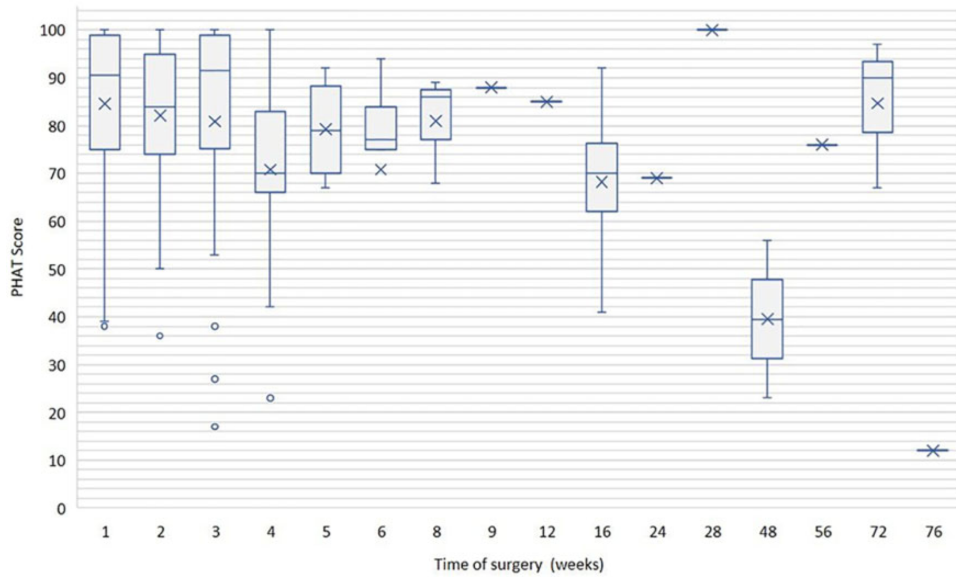

Figure 4. Time to surgery (weeks) in relation to Perth Hamstring Assessment Tool (PHAT) score. Boxes represent interquartile range, whiskers represent overall range, X's show the mean, crosslines indicate median, and circles represent outliers.

TABLE 2
Correlation Between PHAT Scores and Particular Concomitant Factors[a]

	Whole Cohort		Men		Women	
	r	*P*	*r*	*P*	*r*	*P*
Age vs PHAT score	–0.04	.648	0.035	.743	0.015	.893
Time to surgery vs PHAT score	–0.228	**.003**	–0.207	.053	–0.169	.127
Length of surgery vs PHAT score	–0.11	.123	–0.146	.176	–0.089	.419
Stump retraction vs PHAT score	–0.06	.525	–0.065	.616	–0.01	.940
Time to surgery vs length of surgery	0.383	**<.001**	–0.207	.053	0.377	**<.001**

[a]Bold *P* values indicate statistical significance ($P < .05$). PHAT, Perth Hamstring Assessment Tool.

postoperative functional outcome after surgical proximal hamstring repair.

First and likely most relevant of all, regarding all included patients irrespective of age and sex, the functional outcome of the PHAT score significantly correlated with the time between trauma and surgical intervention. This finding confirms our hypothesis. Mainly, in spite of successful tendon repair, we assumed that this decreasing functional outcome might be because of progressing and irreversible muscular degeneration with a consecutive decrease in strength, as previously described.[3,8,27] Furthermore, delayed or even chronic repairs might result in a "bulkier" tendon scar at the ischial tuberosity accompanied by a higher incidence of sitting pain or impairments during physical activity.[2,8]

This supports the repeatedly expressed demand[27,31] for a high level of attentiveness when it comes to the clinical assessment of severe proximal hamstring injuries, to enable the timely diagnosis and potential subsequent surgical intervention.

Despite being somewhat self-explanatory, our results on this unique cohort confirm the findings of previous studies, case series on much smaller cohorts,[2,3,12,25,27,30] and systematic reviews,[8,17] all of which recommend early diagnosis and treatment.

Recently, Shambaugh et al[27] evaluated 93 hamstring repairs in 92 patients over a period of 10 years. Corresponding to our findings, they concluded that patients who received surgical repair of the hamstring more than 6 weeks after trauma may experience more functional impairments than patients who received an acute surgical intervention.[20] As mentioned by Shambaugh et al and others,[1,3,8,22] the use of non–injury-specific and nonvalidated outcome scores (including the standard LEFS, customized LEFS,[4] standard Marx activity score, and customized Marx) to evaluate the outcome of hamstring injuries should at least be discussed. Previous studies have revealed noticeable ceiling effects in some non–injury-specific scores, leading to a possible overestimation and overly positive display of the results.[2,21,30] Thus, only a weak correlation between the hamstring injury–specific PHAT score and the LEFS, customized LEFS, Marx, and customized Marx scores was found, indicating that the PHAT score is perhaps the more accurate test score[2,3,5-7] and enhancing our findings.

Another interesting finding of our study is that the stump retraction on the preoperative MRI scan that one would have expected (and we hypothesized) to be of significant relevance regarding the postoperative functional outcome[27] does not seem to play such a decisive role. To the

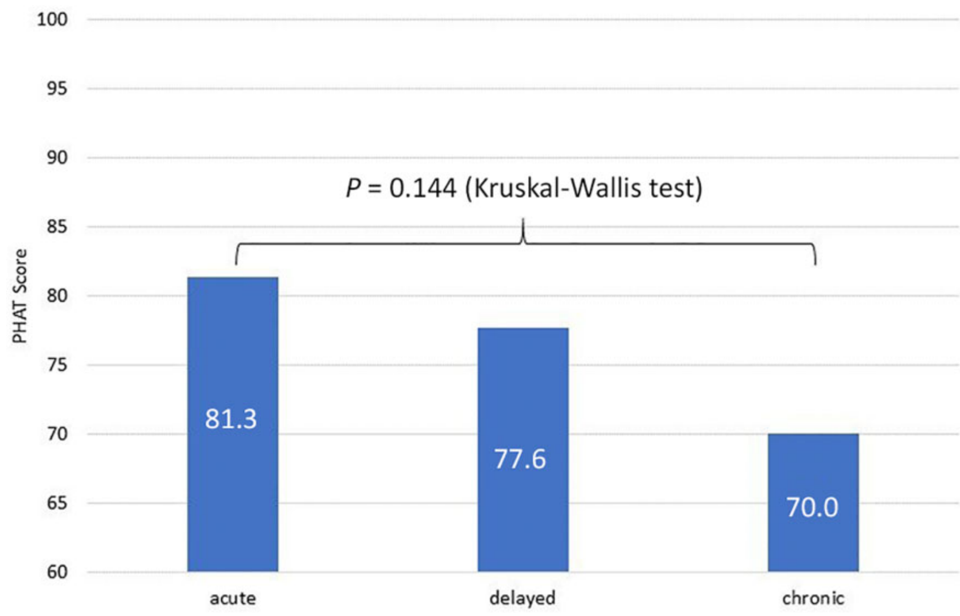

Figure 5. Timing of surgery (acute, chronic, or delayed) in relation to Perth Hamstring Assessment Tool (PHAT) score.

TABLE 3
PHAT Scores by Age Group Stratified According to Sex[a]

	Males		Females		
Age Group, y	No.	PHAT Score	No.	PHAT Score	*P*
41-50	22	85.77 ± 13.03 (69-100)	28	74.82 ± 19.44 (24-100)	**.030**
51-60	21	76.00 ± 22.86 (12-100)	34	75.44 ± 23.04 (17-100)	.931
>60	17	88.12 ± 15.55 (36-100)	17	76.41 ± 20.13 (23-100)	**.029**

[a]Reported as mean ± SD (range). Bold *P* values indicate statistically significant difference between men and women ($P < .05$). PHAT, Perth Hamstring Assessment Tool.

best of the authors' knowledge, so far no previously conducted study observed the exact quantitative amount of stump retraction on the MRI scan in relation to the functional outcome. Instead, the type of injuries was described and either classified by a benchmark[22,33] of 2 cm or merely distinguished by the amount of ruptured tendons.[27] However, in contrast to the description in other studies,[24,27] irrespective of the amount of retraction, none of our patients, in either acute or chronic surgical procedures, required any type of bridging grafts.

In a recent study, Bowman et al[9] correlated the type of injury on the MRI scan to its predicting relevance for the postoperative outcome. Analyzing 58 patients in a retrospective review, no significant difference in the surgical outcome was found, based on the classification of the tear.

Of course, as recently described by Six et al,[28] the applied method of determination of the stump's dehiscence on the MRI scan might lack accuracy owing to the difficulty of defining the precise amount and degree of ruptured fibers. However, we assume that instead of the retraction, it is rather the adhesion of the stump in its surrounding soft tissue that appears to complicate the repair. Again, this is probably more influenced by the duration of time between injury and treatment than by the amount of the stump's retraction.

A third remarkable finding of our study is that the outcome results of female patients seem to differ significantly from those of their male counterparts. Of course, one could argue that the lower postoperative PHAT scores of female patients might be explained by, on average, female participants were almost 7 years older than the male cohort. However, when we compared median rather than mean age, the difference between the sexes was only 3 years, leading to the assumption that female sex might be a crucial factor.

Furthermore, our large sample size allowed a further differentiation into age and sex subgroups (see Table 3). However, the following analysis of the relevant single age groups revealed a significant difference of the inferior PHAT score in women between ages 40 and 50 years and older than 60 years. This suggests that perhaps the preeminence of a female sex might be disadvantageous for an optimal postoperative functional outcome. Our conclusion correlates with the findings of the 2020 study by Shambaugh et al,[27] in which female sex was also described to be a negative predictor of surgical outcome.

Not least, demographically our results are in accordance with a large descriptive survey of 263 cases over 15 years by Irger et al.[18] Here, the authors also found no overall sex-based difference, but female patients were on average slightly older than male patients at the time of injury and treatment. However, their mean difference in age amounted to only 4 years and a median age was not described. Another study of the same working group[32] regarding 94 patients did not show any significant difference in a patient's age in relation to their sex. However, both named studies did not correlate their demographic findings to a postoperative outcome, which of course limits the discussion regarding this point.

There are some weaknesses to our study. The most obvious limitation is the retrospective study design itself with its inherent limitations. Despite the very large sample size, measuring outcome in retrospect does not adequately address the possibility of the multifactorial development of postoperative outcomes with increasing follow-up. Furthermore, long-term follow-up questionnaires contain an inevitable possibility of bias.[27] In return, objective measurements performed by independent investigators are missing, as well as objective functional testing of strength and performance. However, given the rarity of this injury, high-volume operating centers being able to perform preferably large prospective studies are just about to arise. So far, all current studies of this severe injury struggle with the same flaw, which we at least tried to address by observing an especially large sample size.

Second, the follow-up period for all patients was not consistent. It would have been an advantage to record the PHAT score after a preassigned time before and after surgery. However, it was our intention to develop an understanding of possible influencing factors after hamstring surgery, which was best achieved using a large sample size at the cost of this inconsistency.

Furthermore, our study did not include other potentially relevant concomitant factors such as activity level, body mass index, or systemic diseases such as diabetes. However, as our study is the first to evaluate concomitant factors in such a high number of patients, we initially limited the investigated preoperative risk factors to the most relevant ones and with the surgeon's viewpoint in mind.

Not least, the accuracy of determining the stump retraction on the preoperative MRI scan is arguable. Proportions of the fibers of the particular tendons of the common hamstring stump are not always clearly identifiable on a post-traumatic MRI scan. Hence, the distance of these fibers to their exact origin at the ischial tuberosity can be determined only approximately at best. This is in accordance with the published reliability results of Six et al[28] confirming the inherent measurement flaws of determining stump retractions on MRI scans.

In our study, stump retraction distance was measured in millimeters and classified into groups with ascending steps of 5 mm. Of course, the validity of our measurements could have been improved by repeated measurements in terms of time and investigator. However, although representing a definite flaw in our method, we would not expect repeated measurements to reveal significance regarding the outcome or the timing/duration of surgery.

CONCLUSION

Our study confirmed the hypothesis that the timing and length of surgery is a relevant predictor for the degree of functional outcome after proximal hamstring surgery. In addition, whereas a patient's age did not impair expected functional outcome, female sex negatively affected results. The degree of stump retraction appeared to have no relevance regarding functional outcome. Our study confirms that a contemporary diagnosis with a prompt surgical intervention leads to the best possible functional outcomes after proximal hamstring avulsion.

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