Functional Outcome After Repair of Proximal Hamstring Avulsions

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Background: Rupture of the proximal origin of the hamstrings leads to pain, weakness, and a debilitating decrease in physical activity. Repair of these injuries should be based on the expectation that these deficits can be addressed. The goal of this study was to objectively evaluate the efficacy of repair of proximal hamstring avulsions.

Methods: Thirty-four patients were identified retrospectively to have a complete rupture of the proximal origin of the hamstrings based on the presence of a bowstring sign and the results of magnetic resonance imaging (MRI).Patients were contacted for follow-up evaluation to fill out a subjective questionnaire, to undergo functional testing, and to undergo isokinetic testing on a Cybex dynamometer. Twenty-three patients were evaluated.

Results: There were nine acute and fourteen chronic repairs, and the average period of follow-up was 43.3 months. Twenty-one of twenty-three patients reported returning to activity at an average of 95% of their pre-injury activity level at an average of 9.8 months. Eighteen patients reported excellent results; four, good results; and one, fair results. Hamstring strength was an average of 93% and 90% of that in the uninvolved limb at 240° per second and 180° per second, respectively. The hamstrings-to-quadriceps ratio was 56% for 240° per second and 48% at 180° per second. Hamstring endurance was an average of 81% and 91% of the nonoperative limb at 240° per second and 180° per second, respectively. Postoperative quadriceps strength and endurance were positively correlated with return to pre-injury level of activity ($r = 0.6$, $p < 0.05$; and $r = 0.6$, $p < 0.05$) and negatively correlated with time to return to sport ($r = –0.5$, $p < 0.05$; and $r = –0.5$, $p < 0.05$). There was no significant effect associated with age or time from injury.

Conclusions: Repair of a symptomatic and displaced ruptured proximal hamstring tendon yields good subjective and objective functional results with minimal complications. Overall, patients are satisfied with surgical repair and experience return of functional activity with minimal postoperative weakness.

Level of Evidence: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Residual loss of function after complete rupture of the proximal origin of the hamstring tendons has been a suggested indication for surgical repair[1]. The prevalence of complete proximal hamstring ruptures has been reported as 9% of all hamstring injuries[2]. Complete rupture of the proximal origin of the hamstring tendons, as defined by tearing of all three tendons with or without retraction[3,4], has been correlated with persistent pain, decreased function, prolonged time away from sport, appreciable weakness, and late sciatic nerve palsy[3,5-8]. The purpose of this study was to objectively evaluate the efficacy of proximal hamstring repair with use of isokinetic testing of strength and endurance, and correlate the isokinetic data to return to activity, postoperative pain, satisfaction, age of patient, delay in surgical intervention, and sex in a series of twenty-three consecutive patients with a mean follow-up of 43.3 months.

Materials and Methods

All subjects gave informed consent to participate in the study, and the study was approved by our institutional review board.

Disclosure: None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work. One or more of the authors, or his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete **Disclosures of Potential Conflicts of Interest** submitted by authors are always provided with the online version of the article.

Fig. 1

Clinical photograph showing a positive bowstring sign, which is the absence of palpable hamstring tendons distally.

The operative records at the hospital were retrospectively reviewed for the period from 1998 through 2008. The inclusion criteria included complete three-tendon avulsion of the hamstring tendons (semitendinosus, semimembranosus, and long head of biceps femoris), surgical repair without augmentation, and follow-up of at least twelve months. The clinical diagnosis was made when several physical examination findings were present, including absence of palpable tension in the distal part of the hamstrings with the patient prone and the knee flexed to 90° (Fig. 1). This finding was referred to as a *positive bowstring sign*. Ecchymosis of the posterior aspect of the thigh, a palpable defect of the proximal part of the hamstrings, and weakness in prone knee flexion were also assessed. The diagnosis of a three-tendon avulsion was confirmed with use of noncontrast magnetic resonance imaging (MRI), with use of a combination of fat-suppressed inversion recovery and proton-density-weighted fast-spin-echo sequences in multiple orthogonal planes (Fig. 2).

Thirty-four patients met the inclusion criteria. Patients were contacted and invited to return to the hospital to fill out a subjective survey, to undergo functional testing, and to undergo isokinetic testing on a Cybex dynamometer (Cybex International, Ronkonkoma, New York). The postoperative evaluations included in the study were carried out by third-party physical therapists, and a formal physical examination was not included as a part of the encounter.

The nonvalidated questionnaire consisted of a number of questions, developed by the senior author (R.W.), aimed at asking the patient to subjectively evaluate the reasons for electing surgery and to score the postoperative outcome (see Appendix).

Thigh circumference, at the midpoint between the lateral epicondyle and the tip of the greater trochanter, of both lower extremities was measured with a metric tape measure and calculated as a ratio of the unaffected leg to grossly measure any side-to-side muscle atrophy.

The results of a single-leg hop test for distance were also evaluated and compared with the results from the uninvolved extremity as a functional measure of the repair. This test was used because there is some evidence to suggest that there is an indirect correlation between improvement in isokinetic hamstring strength and improvement in the single-leg hop test[9]. This test also requires lower-limb control and proprioception, for which the hamstring muscle is critical. Cybex testing measured the peak torque and total work of both knee flexion and knee extension at two different isokinetic speeds. Initially, 240° per second was used as an estimation of a functional speed, since walking requires approximately 233° per second[10]. To ensure that strength was adequately tested, 180° per second was used as a higher resistance speed. Peak torque is the highest muscular force output at any moment during the repetition and is equivalent to muscle strength. Total work is indicative of a muscle's capability to produce force through a range of motion and is equivalent to muscle endurance. All objective measures were compared with the unaffected limb and were reported as a percentage. The hamstrings-to-quadriceps ratio was then calculated for strength at both isokinetic speeds.

The functional testing and Cybex strength and endurance testing were carried out by an independent physical therapist.

Demographics

The most common activity at the time of injury was waterskiing (six patients), followed by slip and fall (four patients), and running or sprinting (three patients) (Table I). According to the history of the patients, all of the injuries had followed a hyperflexion of the hip with knee extension. The most common reason for presentation to the clinic was the inability to return to sports activity (seven patients), followed by weakness (six patients), and pain (four patients) (see Appendix).

Surgical Technique and Postoperative Protocol

With the patient prone, a longitudinal incision is made at the edge of the gluteus maximus muscle. A longitudinal incision was used to minimize excessive traction on the gluteus maximus muscle and the inferior gluteal nerve and also to allow for adequate mobilization of appreciably displaced soft-tissue tears. The gluteus maximus muscle is retracted proximally, and the fascia distal to the transverse gluteus maximus fibers is then identified and opened longitudinally. The posterior femoral cutaneous nerve and the inferior cluneal nerves are carefully protected. The tendons and avulsion site are next identified, where there is usually a large hematoma present in acute

TABLE I Mechanism of Injury in the Twenty-three Patients

Waterskiing	6
Slip and fall	4
Running or sprinting	3
Soccer	2
Football	2
Ice hockey	2
In-line skating	1
Dancing	1
Tennis	1
Wrestling	1

injuries. Traction sutures are then placed in the tendon, and the tuberosity avulsion site is debrided. The sciatic nerve lies lateral and anterior on the surface of the semimembranosus and semitendinosus. The sciatic nerve dissection is more difficult to perform after four weeks have passed since the occurrence of the injury, as scar tissue can begin to encase the nerve, making it difficult to mobilize the nerve safely; thus, the dissection is best performed by someone experienced in nerve dissection. With use of two Orthocord sutures (DePuy Mitek, Raynham, Massachusetts), two sets of Krackow stitches are placed in the tendon and allowed to exit proximally (Fig. 3). The tuberosity is debrided to bone, and two UltraFix RC anchors (ConMed Linvatec, Utica, New York) are placed in the tuberosity approximately 1 in (2.54 cm) apart. The tendons are repaired back to the lateral aspect of the ischial tuberosity. When distinguishable, the semimembranosus tendon was placed more lateral than the semitendinosus and the biceps femoris tendons in their anatomic locations[4]. One limb of the Krackow suture is pulled through the anchor, pulling the tendon to bone and tied in place. Two anchors at a minimum are used to recreate a tendon footprint on the tuberosity, which creates more surface area for the tendon-to-bone healing, similar to techniques used for rotator cuff repair. This can usually be done with minimal knee flexion if done early (earlier than four weeks after injury). If the repair is performed later than that, knee flexion may be required to approximate the tendon to the ischial tuberosity.

The patient is placed in a custom pelvic-thigh-hip spica orthosis that is fitted preoperatively and allows for the hip to be maintained in extension and the knee left free (see Appendix). Postoperatively, the patient may bear full weight with the aid of crutches while wearing the brace. The brace is used for six weeks to protect the repair, after which a rehabilitation program is started. Although the ideal period of immobilization is not known, a period of six weeks of protection for a tendon-to-bone surface repair appears to be beneficial for successful healing[11]. Some chronic repairs may require maintaining the knee in some flexion to minimize tension on the repair. Rehabilitation starts at six weeks with progressive hip motion and a strengthening program. Running is restricted for a minimum of twelve weeks because it takes this amount of time to reestablish hip motion, muscle strength, and endurance. There is some evidence in the literature to suggest that tendon-to-bone healing is not biomechanically mature until twelve weeks[12].

Statistical Methods

Differences in clinical measurements between men and women were assessed with use of the Wilcoxon rank sum test. Spearman correlation coefficients were calculated to evaluate bivariate relationships between age, time to return to sport, percent return to pre-injury level, satisfaction level, questionnaire responses,

Fig. 2

Fat-suppressed inversion-recovery MRI in the coronal plane, showing a retracted tear of the proximal hamstrings with surrounding edema.

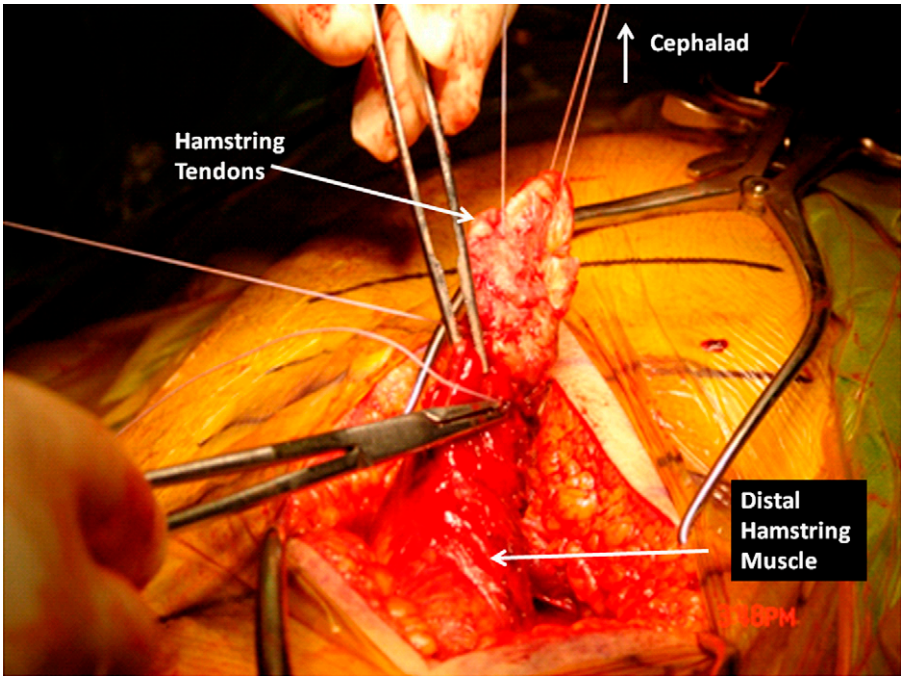

Fig. 3

Surgical photograph showing mobilized proximal hamstring tendons with Krackow stitches in place and exiting proximally.

and isokinetic testing results. All analyses were performed with use of SAS version 9.1 software (SAS Institute, Cary, North Carolina.)

Source of Funding

There was no external funding source.

Results

Twenty-three of thirty-four patients returned for follow-up isokinetic testing. There were fifteen men and eight women (a total of twelve right and eleven left limbs). The average follow-up period was 43.3 months (range, one to nine years). Seventeen patients had a follow-up period that was greater than two years. The average age at the time of surgery was forty-six years (range, nineteen to sixty-five years). The mean interval from injury to surgery was four months (range, six days to eighteen months) (see Appendix). Overall, there were nine acute repairs (i.e., repairs made less than four weeks after the time of injury) and fourteen chronic repairs (i.e., repairs made more than four weeks after the time of injury). Tendon displacement ranged from 2 to >12 cm. Comparisons of clinical measurements for men and women showed that women had a significantly longer mean time to surgery (264 days for women versus seventy-two days for men; $p = 0.009$). Women also had a longer mean postoperative follow-up time (1663 days for women versus 911 days for men; $p = 0.02$).

Subjective Questionnaire Results

Twenty-one of twenty-three patients returned to sporting activity, at an average of 9.8 months (range, three to thirty-six months) after repair. Eighteen of the twenty-three patients had 100% confidence in the leg at an average of eleven months (range, three to thirty-six months); however, five never felt 100% confident.

Postoperative complaint measures (i.e., to measure pain, stiffness, weakness, and numbness) were based on a 100-mm visual analog scale in which zero indicated no complaints and 10 indicated the maximum number of complaints, or the worst case (Table II).

Eighteen of twenty-three patients reported excellent results; four patients, good results; and one patient, fair results; no poor results were reported (see Appendix). The group reported an average return to pre-injury level of function or sport as 95%. Nineteen of twenty-three (83%) reported no symptoms of sciatica, three reported occasional symptoms, and one reported persistently present symptoms. The patient in the chronic repair group with the persistent sciatica was the same patient who reported the fair result; however, the symptoms of sciatica were present preoperatively. All three patients who reported occasional sciatica reported excellent results, and all had undergone chronic repairs.

Functional Testing

All patients were evaluated at 5 of 5 strength of hamstrings and quadriceps bilaterally by manual muscle testing. Thigh circumference was equivalent in both limbs. The side-to-side comparison for the single-leg hop distance was equivalent in both limbs (see Appendix).

Isokinetic Testing

The isokinetic data for the hamstrings and quadriceps muscles are represented as a percentage of the result in the unaffected leg for both functional speeds (Table III). Hamstring strength

TABLE II Patient Self-Reported Postoperative Complaints

Complaint	Number of Patients Reporting (N = 23)	Average Score*
Pain at rest	4	2
Pain at night	2	4
Pain with general activity	4	3
Pain with prolonged sitting	14	3
Weakness with general activity	9	3
Weakness with strenuous activity	11	3
Incisional numbness	14	4
Numbness in thigh, leg, foot	9	3
Cosmetic defect	14	4
Overall stiffness	8	2
Stiffness in morning	8	3
Stiffness in afternoon	6	2
Stiffness with strenuous activity	10	3

*Based on 0-10 scale, with 0 indicating no complaints and 10 indicating the maximum number of complaints, or the worst case.

was an average of 93% and 90% of that in the uninvolved limb at 240° per second and 180° per second, respectively. Hamstring endurance was an average of 81% and 91% of the uninvolved limb at 240° per second and 180° per second, respectively. The average hamstrings-to-quadriceps ratio was 56% at 240° per second and 48% at 180° per second. All p values were >0.05, suggesting no significant difference in flexion or extension strength or endurance between the operatively treated and noninvolved limbs.

Women had significantly lower quadriceps peak torque at 240° per second as compared with men (86% of the strength of the noninvolved limb, as compared with 102% of the strength of the noninvolved limb for men; $p = 0.04$).

Analysis of the relationships between age, time to return to sport, percent return to pre-injury level, function, satisfaction level, and isokinetic testing showed the following correlations. Returning to a pre-injury level of function was positively correlated with greater quadriceps strength and endurance at 180° per second ($p < 0.05$, $r = 0.6$; and $p < 0.05$, $r = 0.6$, respectively). The amount of time needed to return to sports had a negative correlation with hamstring endurance at 240° per second ($p = 0.05$, $r = –0.4$) and quadriceps strength and endurance at 240° per second ($p = 0.02$, $r = –0.5$; and $p = 0.02$, $r = –0.5$, respectively), i.e., higher postoperative hamstring endurance and quadriceps strength and endurance was correlated with a quicker return to sport. There was no correlation found between isokinetic testing and age or hamstring tear chronicity (see Appendix). There were no significant correlations between the degree of tendon displacement and the isokinetic outcomes. However, there was a trend toward a negative correlation between the degree of retraction and hamstring total work at 180° per second ($r = –0.53$, $p = 0.065$), suggesting that greater tendon displacement may lead to a lower hamstrings endurance result.

Spearman correlations between individual questions from the questionnaire and isokinetic testing showed significant correlations between some of the questions and postoperative quadriceps strength and endurance (Table IV), for example,

TABLE III Isokinetic Data as Percent of Result in Uninvolved Lower Limb

	180° per second (Average) *(%)*	180° per second (Range) *(%)*	240° per second (Average) *(%)*	240° per second (Range) *(%)*
Peak torque				
Hamstring	90	60-124	93	68-138
Quadriceps	100	59-127	97	52-131
Total work				
Hamstring	91	64-153	81	45-158
Quadriceps	102	63-146	99	53-131

TABLE IV Spearman Correlations Between Individual Questions from the Questionnaire and Isokinetic Testing*

Question	Isokinetic Test	N	r^2	P Value	95% CI Lower Limit	95% CI Upper Limit
Pain at rest	pt180extr	23	–0.4	0.05	–0.701	0.007
Pain at rest	tw180extr	23	–0.5	0.03	–0.729	–0.049
Pain with general daily activities	tw180extr	23	–0.5	0.01	–0.765	–0.131
Pain with prolonged sitting	pt180extr	23	–0.6	0.002	–0.806	–0.235
Pain with prolonged sitting	tw180extr	23	–0.5	0.01	–0.767	–0.135
Numbness along healed incision	pt180extr	23	–0.5	0.01	–0.759	–0.117
Overall stiffness in the operated leg	pt180extr	23	–0.4	0.04	–0.706	–0.003
Overall stiffness in the operated leg	tw180extr	23	–0.5	0.01	–0.756	–0.110
Stiffness after strenuous activity	tw240extr	23	–0.4	0.05	–0.696	0.016
Stiffness after strenuous activity	tw240flexr	23	–0.5	0.01	–0.759	–0.117
How long did it take for you to return to sports (months)?	pt240extr	22	–0.5	0.02	–0.755	–0.085
How long did it take for you to return to sports (months)?	tw240extr	22	–0.5	0.02	–0.751	–0.076
How long did it take for you to return to sports (months)?	tw240flexr	22	–0.4	0.05	–0.715	0.001
How long did it take for you to return to sports (months)?	pt180extr	22	–0.4	0.05	–0.711	0.011
To what % of your previous level of sporting activity did you return?	pt180extr	20	0.6	0.004	0.213	0.823
To what % of your previous level of sporting activity did you return?	tw180extr	20	0.6	0.003	0.230	0.828

*pt = peak torque, tw = total work, 180 = 180° per second, 240 = 240° per second, extr = extension, flexr = flexion, r^2 = Spearman correlation coefficient, and CI = confidence interval.

with regard to pain and stiffness with activity, and with regard to time to return to full activity.

Complications

There were no wound complications, infections, or re-ruptures in any of the patients. Fourteen of the twenty-three reported some loss of sensation along the incision. Fourteen reported a cosmetic defect in the area of the incision. There were four reported cases of postoperative sciatica, and all involved chronic repairs.

Discussion

The data from this study suggest that patients who undergo repair of complete rupture of the proximal hamstring tendons have good subjective and objective outcomes.

Operative treatment of proximal hamstring tears has been suggested for osseous avulsions with 2 cm or more displacement, for partial tears for which nonoperative treatment is unsuccessful, and for complete three-tendon tears with or without displacement[3,4].

Return to Activity and Hamstring Strength and Endurance

In a series by Wood et al.[3] involving seventy-two consecutive proximal hamstring repairs with six months of follow-up, 80% of the patients had returned to their pre-injury level of sports. In addition, the mean postoperative isotonic hamstring strength was 84% and the mean hamstring endurance was 89% of the contralateral side[3]. Konan and Haddad reported on ten patients who had complete tears and who were all semiprofessional or professional athletes and presented within five weeks of injury; nine of the ten patients returned to their previous level of sports within six to nine months. All ten patients reported subjective excellent functional results by twelve months, and isokinetic testing showed an average hamstring peak torque of 82.78% by six months, compared with the preoperative level, which averaged 56%[13]. Brucker and Imhoff reported on eight patients who had a complete rupture of the proximal origin of the hamstring tendons; six underwent early surgical repair within three weeks. Four of these six returned to their previous level of sports activities by nine to fifteen months. At an average follow-up of twenty months, the average hamstring peak torque was 88.8% of the noninjured side, compared with a 55% preoperative average[14]. Klingele and Sallay reported on eleven patients who had complete proximal hamstring rupture; seven of nine athletically active patients returned to their sports activities at an average of six months. At an average follow-up time of thirty-four months, the average hamstring strength, as tested

with use of a Cybex dynamometer, was 85.3% of the uninjured side[5]. Sarimo et al. reported on forty-one patients with complete proximal hamstring avulsions and found that twenty of twenty-seven recreational athletes returned to their preinjury level of sports activities within four to ten months[15]. Cohen and Bradley reported on seven patients for whom the average time to return to function and/or athletics was 8.5 months; by the six-month follow-up, six of the seven had returned to their preoperative level of sport and daily activity[4]. Lempainen et al. reported on forty-seven athletes who had partial tears of the proximal origin of the hamstrings; of these patients, forty-two were initially treated nonoperatively with unsatisfactory results, and forty-one of those forty-two patients returned to their preinjury level of sports activity after an average of five months (range, one to twelve months)[16].

In this series, twenty-one of twenty-three patients returned to sporting activity at an average of 9.8 months and returned to an average of 95% of their pre-injury level of function. The average postoperative hamstring strength was 90% (180° per second) and 93% (240° per second) of the uninvolved limb. The average hamstring-to-quadriceps ratio was 48% at 180° per second and 56% at 240° per second.

Timing of Repair

Some studies have suggested that delayed repair has been associated with poorer results and reduced hamstring strength and endurance[3,7,15], while other studies showed no difference[5,14]. One study of seventy-two consecutive repairs showed that, while there was no overall significant difference in hamstring strength and endurance between acute and chronic cases, there was an association between chronic complete avulsions with retraction and decreased hamstring strength and endurance, and a more technically challenging repair[3]. Sarimo et al. reported that twenty-nine of their forty-one patients had good or excellent results, while twelve patients had moderate or poor results. The good or excellent group had an average delay of 2.4 months from the time of injury to the time of surgery, while the moderate or poor group had an average delay of 11.7 months, and the difference was significant[15]. Sallay et al. reported on twelve patients with proximal hamstring injuries that were treated nonsurgically; only seven patients returned to their preinjury sports at a lower level, and five patients with complete disruptions were unable to return to sports. Two of these five underwent delayed repair at six months and three years, respectively, and a strength deficit persisted, ranging from 20% to 55%[7]. Brucker and Imhoff reported on eight patients who had a complete rupture of the proximal origin of the hamstrings; six of the patients had surgery within two weeks after the injury, one had surgery at nine weeks, and one had surgery at twenty-two weeks, and there was no difference in postoperative isokinetic testing according to surgical delay[14]. Klingele and Sallay reported on eleven patients with proximal hamstring rupture; there was no difference in postoperative isokinetic testing between acute (i.e., repair less than four weeks after injury) and chronic (i.e., repair more than four weeks after injury) surgical repair[5].

In this series, the Spearman correlations for bivariate relationships showed no significant correlations between the postoperative isokinetic data and acute versus chronic repair or age of the patient. This observation that chronic repairs did as well as acute repairs is similar to other observations in the literature, as discussed. However, all of the patients with sciatic nerve symptoms had chronic repairs. A surgical delay of more than four weeks after the injury significantly increases the difficulty of the nerve dissection. Four of fourteen (29%) patients who had chronic repairs had postoperative sciatic nerve symptoms, a fact that argues against nonoperative treatment. In addition, the age of the patient had no effect on the postoperative isokinetic results, suggesting that increasing age does not compromise the result of a repair.

This study has limitations. One major limitation is the lack of a nonoperative control group. Unfortunately, this was not a randomized study, and therefore any patients chosen for nonoperative treatment would likely represent a dissimilar cohort and could not be compared. A second limitation is that the questionnaire that we used has not been validated. It was designed by the senior author because there was no validated outcome instrument for proximal hamstring repair available to us at the time of the study. However, Spearman correlations between individual questions from the questionnaire and isokinetic testing showed significant correlations between some of the questions and postoperative quadriceps strength and endurance. Some of these correlations included pain and stiffness with activity, time to return to full activity, and the percent of the pre-injury level of activity to which they returned. Therefore, isokinetic testing may be a good objective test to use as a prerequisite to return to play for these patients who undergo reconstruction of the proximal origin of the hamstrings, just as it is for patients who have had anterior cruciate ligament reconstruction. The correlation to quadriceps function and not hamstring function can likely be explained by the relatively low hamstring-to-quadriceps ratio. This relative hamstring weakness, as compared with the quadriceps, suggests that it is important to rehabilitate both the hamstrings and the quadriceps in order to have a successful outcome. A third limitation is that the study is a retrospective case series. However, the isokinetic and functional testing were done by third-party physical therapists, and the data analysis was done by a third party as well. Neither evaluation group was directly involved with the surgery or postoperative care, but they were not blinded to the surgery performed, so some bias may be present.

Summary

Complete rupture of the proximal part of the hamstrings is an indication for surgery, and therefore diagnosis of the extent of the rupture is critical. The absence of palpable tension of the distal portion of the hamstrings, referred to as a positive bowstring sign, was present in all patients in our series. This sign suggests that there has been excessive lengthening of the proximal part of the tendons. Evaluation of the tension of the distal portion of the hamstrings with the patient supine and both the hip and knee flexed to 90° has also been described[17].

The patients with chronic tears had pain with straight-leg raise. Some patients with chronic tears also had increased limb motion with straight-leg-raise testing compared with the contralateral extremity due to lengthening of the hamstrings, although this increased motion was not significant in this series. The degree of displacement of a complete rupture is an important factor in guiding treatment; nonoperatively treated tears with >2 cm of displacement were associated with pain, weakness, and some dysfunction, similar to results reported previously[4]. Therefore, our indications for surgical treatment are complete, three-tendon avulsions with >5 cm of displacement; tears with >2 cm of displacement with a positive bowstring sign; and chronic tears (in which repairs are made after four weeks postinjury) with any amount of displacement and causing significant pain or debilitating weakness. The degree of difficulty of nerve dissection for chronic tears makes surgical repair of acute, 2 to 5-cm, retracted tears a better option. Proximal hamstring tears with <2 cm of displacement, or asymptomatic chronic tears with anyamount of displacement, are treated nonoperatively. Patients with symptoms of sciatica are informed that these symptoms may not be completely resolved with surgery.

Appendix

eA Tables and figures showing the reasons for presentation, the time interval until surgery, self-reported clinical satisfaction, the thigh circumference and single-leg hop distance, the p value correlation between acute and chronic repairs for each isokinetic measure, the subjective questionnaire, and the standard fitted pelvic-thigh-hip spica orthosis used for postoperative immobilization are available with the online version of this article as a data supplement at jbjs.org. ■

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