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Research article

Surgical treatment of snapping proximal hamstring tendon syndrome: the resolution of snapping and excellent patient satisfaction

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ABSTRACT

Snapping proximal hamstring is an uncommon phenomenon, with few case reports documenting surgical treatment. The purpose of this study is to report snapping resolution, minimum 2-year post-operative patient-reported outcome (PRO), satisfaction scores and complications from patients who underwent surgical release of the conjoint tendon from the sacrotuberous ligament with reattachment to the ischial tuberosity. Prospectively collected data from two institutional databases were retrospectively reviewed for patients who underwent hamstring repair for partial- or full-thickness tears. Patients were included if they demonstrated 'snapping proximal hamstrings' on preoperative physical examination, including ultrasound confirmation, and repair subsequently performed. Patients were excluded if they had reconstruction of the proximal hamstring tendon or claimed worker's compensation. With a total of 20 patients (15 females and 5 males), successful resolution of snapping was reported in 100% of the cohort. For patients with pre- and post-surgical lower-extremity functional scores (LEFS), post-surgical LEFS were significantly higher than pre-surgical LEFS (pre-surgical: 17.0 ± 4.0, post-surgical: 73.6 ± 3.3, $P < 0.001$). Average post-operative PROs were as follows: International Hip Outcome Tool-12, 92.3 ± 8.3; modified Harris Hip Score, 93.2 ± 7.8; Non-arthritic Hip Score, 92.5 ± 6.8; Hip Outcome Score-Sports Specific Subscale, 94.4 ± 6.7; LEFS, 73.9 ± 3.4; and median visual analog scale of 0 with an interquartile range of 0-1. Patient satisfaction was 'very satisfied' in 19 (95%) patients and 'satisfied' in 1 (5%) patient. At a minimum 2-year follow-up, patients who underwent surgical treatment for chronic snapping of the proximal hamstrings demonstrated complete resolution of painful posterior snapping, reported high PROs and satisfaction, and had no reported post-operative complications.

INTRODUCTION

Coxa saltans, or 'snapping hip', is an often painful, audible snapping upon flexion or extension of the hip that can usually be categorized as internal (snapping of the iliopsoas tendon over the femoral head), external (snapping of the iliotibial band or anterior edge of the gluteus maximus over the greater trochanter) or intra-articular in etiology [1]. However, a rare form of coxa saltans has been identified in which partially ruptured proximal hamstring tendons snap over the ischial tuberosity, causing a painful snapping proximal hamstring [2–5]. Anatomically, the conjoint tendon of the biceps femoris and semitendinosus originates from the ischial tuberosity, and in a portion of the population, it also demonstrates robust attachments to the sacrotuberous ligament (STL) (Fig. 1) [6]. Several case reports have also documented additional etiologies leading to posterior snapping hip symptoms such as ischiofemoral impingement and sciatic nerve snapping [7–9].

In the setting of proximal hamstring tendon avulsions from the ischial tuberosity, these attachments can maintain the continuity of the STL with the conjoint tendon [10]. This specific pathoanatomy with continuity of the STL then allows subluxation of the conjoint tendon over the ischial tuberosity and is responsible for the symptomatic phenomenon of snapping proximal hamstrings (Figs 2a and b and 3).

In the first reported case of 'snapping bottom' by Rask, the resolution of symptoms was achieved by simple tenotomy [2]. Subsequent cases also found success in the use of tenotomy for the resolution of pain and snapping [3, 4]. In 2015, Spencer-Gardner *et al.* were the first to report successful treatment of snapping proximal hamstrings with tendon release and restoration of native anatomy by reattachment of the conjoint tendon to the ischial tuberosity [5]. A case series of 10 patients who did not undergo reattachment of conjoint tendon reported a recovery of 62–66% of hamstring strength compared with the

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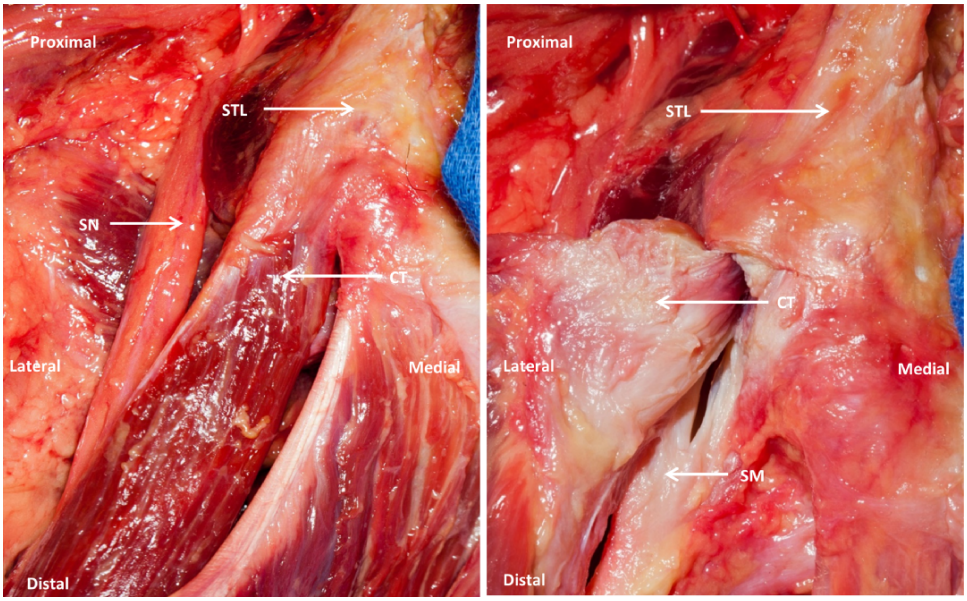

Fig. 1. The left image is a normal cadaveric left posterior hip. The right image is the pathologic variant with the conjoint tendon (CT) reflected from the bone. SN, sciatic
nerve.

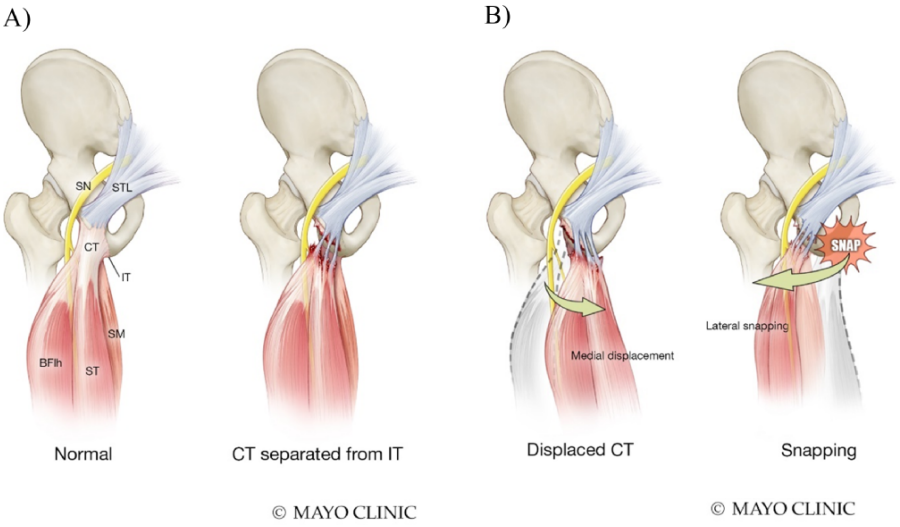

Fig. 2. (a) The left image depicts a posterior view of the left hamstring muscles with an intact conjoint tendon (CT). The right image depicts the avulsion of the proximal hamstring muscles with continued connection of the STL but without displacement. SN, sciatic nerve; IT, ischial tuberosity; BFlh, biceps femoris long head; ST, semitendinosus; SM, semimembranosus. (b) The left image depicts avulsed proximal hamstring muscles that are connected by the STL and are medially displaced. The right image depicts the phenomenon of snapping hamstrings with the partially avulsed complex 'snapping' over the ischial tuberosity going from medial to lateral.

unaffected side [11]. In contrast, patients in a separate study who underwent surgical repair of complete hamstring avulsion demonstrated a recovery of 82% of hamstring strength compared with the unaffected side [12].

The current literature on snapping proximal hamstrings is limited, particularly regarding clinical outcomes and complications of surgical repair. Therefore, the purpose of this study is to report snapping resolution, minimum 2-year post-operative patient-reported outcome (PRO) and satisfaction scores from patients who underwent surgical release of the conjoint tendon from the STL with reattachment to the ischial tuberosity and complications. We hypothesize that patients undergoing hamstring tendon release and reattachment will demonstrate resolution of painful snapping and high PRO and satisfaction scores at a minimum 2-year follow-up.

MATERIALS AND METHODS

After obtaining Institutional Review Board approval, prospectively collected data from two institutional databases were retrospectively reviewed for patients who underwent hamstring repair for partial- or full-thickness tears (Current Procedural

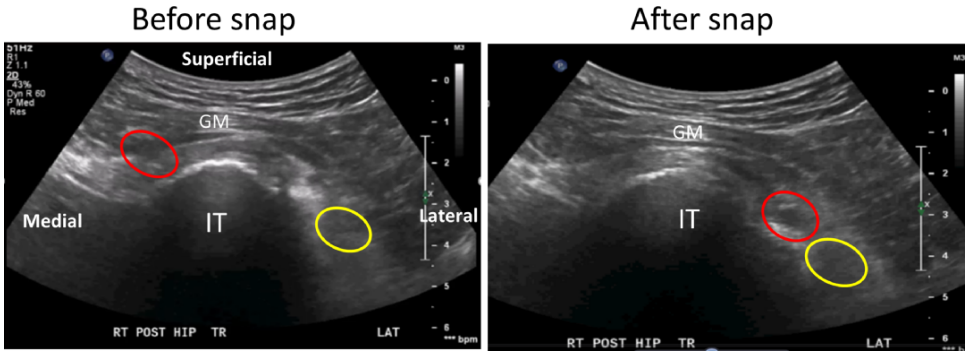

Fig. 3. Ultrasound images demonstrating subluxation of the conjoint tendon over the ischial tuberosity. The STL can be seen encircled more medially and superficially than the sciatic nerve (bottom right) before and after snapping. The gluteus maximus (GM) and ischial tuberosity (IT) are also visualized. Note that the superficial probe placement is at the top of the image.

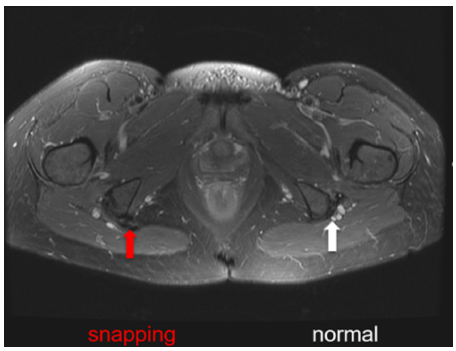

Fig. 4. Magnetic resonance image demonstrating tear/disruption of the injured snapping proximal hamstring tendon (red arrow) compared with the uninjured contralateral tendon (white arrow).

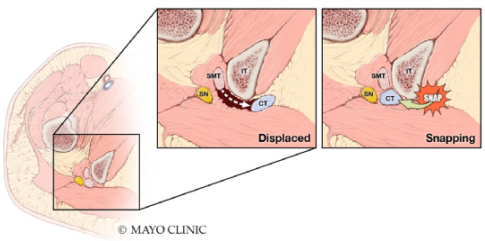

Fig. 5. An axial illustration of the left leg at the level of the ischial tuberosity (IT). On the left, the avulsed conjoint tendon (CT) that remains connected by the STL (not shown) is medially displaced. On the right, the CT is snapped over the ischial tuberosity from medial to lateral. SMT, semimembranosus tendon; SN, sciatic nerve.

Terminology, CPT, code 27385) between January 2012 and December 2019 with a minimum 2-year follow-up. The patient charts were then reviewed to only include patients for this study who demonstrated 'snapping proximal hamstrings' on preoperative physical examination. One patient who claimed worker's compensation was excluded. All repairs were conducted by one of the two surgeons.

The relevant preoperative patient evaluation consisted of the history of pain symptoms in the posterior hip around the gluteal fold associated with visible and/or audible snapping of the hip. On physical examination, such snapping was reproduced on active hip flexion for all patients. On magnetic resonance imaging, partial- or complete-thickness tears of the proximal hamstring tendon were identified (Figs 4 and 5). Dynamic ultrasound was used to confirm the diagnosis.

The surgical technique consisted of an open approach with the patient in the prone position, beginning with a transverse incision in the gluteal fold through the subcutaneous tissues and gluteal fascia. The gluteus maximus was retracted proximally to expose the proximal hamstring tendon origin. The posterior femoral cutaneous and sciatic nerves were identified, mobilized and protected. Scarring was common when associated with preoperative nerve-related symptoms. In all cases, intra-operative examination of the conjoint tendon revealed tearing from the ischial tuberosity bone attachment but maintenance of connection to the STL. The conjoint tendon was released from its proximal attachments to the STL and tagged for later repair. The anatomic footprint of the conjoint tendon attachment on the ischial tuberosity was prepared with a curette, and the tendon was reattached with three to four double-loaded suture anchors according to the footprint area size. The suture configuration consisted of a combination of running Krakow sutures and mattress sutures.

Post-operative rehabilitation consisted of the use of a hinge knee brace locked in 70° of flexion for 3 to 4 weeks. Crutches were typically used until 6 weeks post-operatively. Gradual rehabilitation of function began from initially limiting hip flexion and knee extension immediately post-surgically to re-establishing full range of motion before full weight-bearing and strengthening. After 3 months, squats, quadriceps extension, hamstring curls and core exercises were used for strengthening. Sports activity was typically allowed at 5 to 6 months.

With a minimum 2-year follow-up, patients' scores for the visual analog scale (VAS) for pain, patient satisfaction and the following PROs were analyzed: International Hip Outcome Tool (iHOT-12), modified Harris Hip Score (mHHS), Non-arthritic Hip Score (NAHS) and Hip Outcome Score-Sports Specific Subscale (HOS-SSS). The NAHS, mHHS, iHOT-12, HOS-SSS and iHOT-12 were all scored from 0 to 100, with higher scores

representing more favorable outcomes. Lower-extremity functional scores (LEFS) were also analyzed; LEFS were scored from 0 to 80, with lower scores representing greater disability. The VAS for pain was evaluated from 0 (no pain) to 10 (worst pain), and patient satisfaction was evaluated similarly from 0 (lowest satisfaction) to 10 (highest satisfaction). An encrypted electronic questionnaire was used to collect patient reports including post-surgical complications.

All data were analyzed using Microsoft Excel. Data analysis consisted of descriptive statistics for demographics including age, sex and Body Mass Index (BMI). Mean and standard deviation were calculated for continuous variables except for VAS scores, which did not follow a normal distribution, and thus median and interquartile range were calculated. Patients with pre- and post-surgical LEFS were analyzed using two-tailed paired *t*-test. Statistical significance was set at $P < 0.05$.

RESULTS

Twenty patients (15 females and 5 males) were included in this study. Within the cohort, 35% had partial-thickness tendon tears and 65% had full-thickness tears. Patient ages ranged from 28 to 64 years with a mean of 59.8 ± 10.2 years. Patient BMIs ranged from 17.4 to 32.4, with a mean of 25.6 ± 4.4. Patient-reported mechanism of injury was falling for six patients (30%), running for four patients (20%), sports (one each of water skiing, football, softball and snowboarding) for four patients (20%) and unknown for the remaining six patients (30%). Time from injury to surgery ranged from 5 weeks to 22.8 years, with a median of 59.1 weeks. The mean follow-up time was 5.1 ± 1.6 years from the date of surgery.

Successful resolution of snapping was reported in all 20 patients. Patient satisfaction was 'very satisfied' in 19 (95%) patients and 'satisfied' in 1 (5%) patient. Post-surgical iHOT-12, mHHS, NAHS, HOS-SSS, VAS and LEFS were reported (Table I).

In patients with baseline scores ($n = 5$), post-surgical LEFS were significantly higher than pre-surgical LEFS (pre-surgical: 17.0 ± 4.0, post-surgical: 73.6 ± 3.3, $P < 0.001$). Pre- and post-surgical LEFS of this subgroup are shown in Table II. Combined post-surgical LEFS for all 20 patients were 73.9 ± 3.4. No complications were reported for any of the 20 patients.

DISCUSSION

The purpose of this study was to report the resolution of snapping, post-operative PRO and satisfaction scores and post-operative complications from 20 patients who underwent surgical release of the conjoint tendon from the STL with reattachment to the ischial tuberosity. Resolution of snapping was achieved in all patients, with 95% of patients reported being 'very satisfied' and 5% reported being 'satisfied'. PRO scores were high, and in a small subgroup of patients with pre-surgical LEFS, post-surgical LEFS were significantly improved. No post-surgical complications were reported.

Table I. *Two-year post-surgical PRO scores*

	n	*Mean*	*SD*
iHOT-12	15	92.3	8.3
mHHS	15	93.2	7.8
NAHS	15	92.5	6.8
HOS-SSS	15	94.4	6.7
LEFS	20	73.9	3.6
VAS	15	0 (median)	1 (IQR)

SD, standard deviation; IQR, interquartile range.

Table II. Pre- and post-surgical LEF scores

	Pre-surgical (n = 5)	*Post-surgical* (n = 5)	P *value*
Subject 1	15	72	
Subject 2	20	76	
Subject 3	12	70	
Subject 4	22	72	
Subject 5	16	78	
Mean ± SD	17.0 ± 4.0	73.6 ± 3.3	<0.001

SD, standard deviation.

The subluxation of the conjoint tendon over the ischial tuberosity in the snapping proximal hamstring causes pain in the posterior buttock area rather than the anterior groin or lateral hip seen in external or intra-articular coxa saltans [1, 3]. Resolution of posterior snapping was achieved for all patients in this study. As snapping proximal hamstring has thus far been a rare phenomenon, there have been few case studies documenting surgical treatment. Aside from Spencer-Gardner *et al.* who performed a case of repair and reconstruction for this condition in 2015 [5], the few other documented cases to date have been treated with simple tenotomy [3, 4]. Clinically, we find that patients may have had a chronic history of proximal hamstring tendinosis that progresses to full-thickness tearing, leaving the attachment to the STL intact, and thereby creating the snapping. Additionally, inflammation and scarring in the area surrounding and adjacent to the STL may further contribute to pain symptoms. A 2009 case series on surgical repair for proximal hamstring tendinopathy encountered 4% of cases requiring re-operation due to residual symptoms <12 months after the initial repair; re-exploration demonstrated tight adhesions and scar tissue involving the hamstring origin and sciatic nerve, and symptoms improved after the adhesions and scar tissue were taken down [13]. The results of our study suggest that the release of the conjoint tendon from the STL with reattachment to the ischial tuberosity can resolve the main symptom of painful snapping similarly to tenotomy.

Additionally, all patients in this study were satisfied with their outcomes and reported high PRO scores (>92 for outcome measures scored from 0 to 100 and 73.9 for LEFS scored from 0 to 80). Previous case reports have primarily only documented the resolution of pain and snapping symptoms without further classification of outcome scores [2, 3]. In the case report by Shur *et al.*, simple tenotomy resulted in the affected limb demonstrating a power of 4+ on the Medical Research Council scale, corresponding to reduced muscle strength compared with normal [4]. If one compares the PROs of this study with those of endoscopic and open proximal hamstring tendon repairs for non-snapping chronic partial and complete hamstring avulsions, they are similar. In a 2021 case series of 50 patients from three tertiary care institutions by Maldonado *et al.*, post-operative PROs for such surgeries were as follows: iHOT-12, 87.17 ± 17.54; mHHS,

91.94 ± 9.96; NAHS, 91.33 ± 9.99; HOS-SSS 87.15 ± 18.10; and VAS, 1.16 ± 1.92 [14]. In another study from 2012, 12 patients who underwent primary repair of chronic proximal hamstring avulsions had post-surgical LEFS of 71.5 with a range of 50–80 [15]. The findings of this investigation generally align with the current literature documenting post-surgical outcomes of primary repair for chronic non-snapping proximal hamstring injuries. Moreover, our results suggest impairment of lower-extremity function due to snapping proximal hamstring injury with low pre-surgical LEFS (17.0 ± 4.0). This functional score was subsequently improved by surgical release and reattachment to a level consistent with similar proximal hamstring repair surgeries for non-snapping injuries in the subgroup of five patients.

The post-surgical complication rate of this study was 0%. Although prior case reports of snapping proximal hamstring treated with tenotomies have not reported any complications either, the existing literature on the repair of non-snapping hamstring injuries has documented several post-surgical complications. A 2015 systematic review of 13 studies and 387 patients who underwent repair for non-snapping proximal hamstring avulsions reported major complications including 3% of patients with re-rupture requiring re-operation, 3% with wound infection and 1% with deep vein thrombosis, and minor complications including 3% with stiffness in the operative leg, 9% with numbness/tingling in the incisional area and a highly variable 8–61% rate of residual pain symptoms [16]. In the previously discussed case series by Maldonado *et al.*, 6% of patients experienced post-operative complications, 4% had posterior thigh numbness and 2% had hematoma requiring evacuation [14]. Care must be taken to protect the sciatic nerve during operation, as a 2015 case report described severe iatrogenic sciatic nerve injury following repair of a chronic (8 weeks) proximal hamstring tendon avulsion that led to total denervation of muscles innervated by the fibular and tibial divisions of the sciatic nerve [17]. Given the complex anatomy and proximity to the sciatic nerve, neuromonitoring or nerve stimulation may be warranted on a case-by-case basis. Overall, the limited literature to date suggests that surgical repair of the proximal hamstrings for snapping and non-snapping injuries is a relatively safe procedure with low rates of post-surgical complications.

The present study has several limitations. As a case series, there was no control group for comparison. Although the study design is retrospective, the data collection was performed prospectively, which may mitigate potential bias contributed by the retrospective design. Despite having pre- and post-surgical LEFS for several patients, the number of these cases is small and pre- and post-surgical values were not available for all outcome scores investigated, limiting the ability to make robust conclusions regarding improvement from pre-surgical status. The data were sourced from two institutional databases, one of which ($n = 15$) collected post-surgical iHOT-12, mHHS, NAHS, HOS, VAS and LEFS, while the other ($n = 5$) collected pre- and post-surgical LEFS only. Similarly, the overall sample size of 20 patients was likely insufficient to elucidate a full picture of post-operative complication risk although the existing literature on similar hamstring repair surgeries suggests low complication rates, with some complications such as the development of complex regional pain syndrome showing up in only 1 out of 387 cases [16]. Although the follow-up time was at least 2 years, a longer follow-up is needed to determine the longevity of results, especially given the rarity of the snapping hamstrings phenomenon and this procedure of surgical tendon release and reattachment being a novel treatment of the said condition.

CONCLUSION

Patients who underwent conjoint tendon release from the STL and reattachment to the ischial tuberosity for chronic snapping proximal hamstring due to proximal hamstring tendon tears demonstrated resolution of painful posterior snapping, high post-operative PROs, improved LEFS post-operatively compared with preoperatively and satisfaction with no reported post-operative complications at a minimum 2-year follow-up.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, A.J.K., upon reasonable request.

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CONFLICT OF INTEREST STATEMENT

None declared.

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