Snapping Hip Syndrome

36

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Introduction

Audible clicking or snapping around the hip region is a common presentation to the hip clinic. The underlying cause is not due to a single condition but rather to a group of conditions that present similarly. The term "snapping hip syndrome" (SHS) is justified because it brings the attention to the fact that there are multiple causes for hip snapping and the real cause must be identified for successful treatment.

The causes can be classified into:

1. Extra-articular causes
   (a) Iliotibial band (often called external or lateral hip snapping)
   (b) Iliopsoas tendon (often called internal, medial or anterior hip snapping)
   (c) Subluxation of long head of biceps over the ischial tuberosity
   (d) Rectus femoris
2. Intra-articular causes
   (a) Torn labrum
   (b) Loose bodies
   (c) Synovial chondromatosis
   (d) Osteochondral fracture
   (e) Habitual hip dislocation

The most common causes for SHS are snapping iliotibial band (ITB) and iliopsoas tendon (IPT) which are extra articular, presenting laterally and medially, respectively. Intra-articular causes are not common and are covered in other chapters of the book.

"There are multiple causes for hip snapping and the real cause must be identified for successful treatment".

Snapping Iliotibial Band

Pathophysiology

The ITB is a thickening of facia lata over the lateral surface of the thigh. Proximally the band splits into two layers, where it encloses and anchors the tensor fasciae lata and receives, posteriorly, most of the tendon of gluteus maximus. The superficial layer ascends lateral to the tensor fasciae lata ending at the iliac crest; the deeper layer passes underneath the tensor facia lata and blends with the hip joint capsule and the periosteum of the lateral ilium. Distally, the iliotibial tract is attached to Gerdy's tubercle on the anterolateral aspect of the lateral condyle of the tibia, where it is superficial to, and blends with, an aponeurotic expansion from vastus lateralis.

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There are several bursae closely related to the ITB and its attachments. There are three to four bursae around the greater trochanter, allowing easy gliding of nearby tendons. The largest is the sub-gluteus maximus bursa (commonly called the trochanteric bursa) which is situated lateral or superficial to the greater trochanter. It functions as a gliding mechanism for the anterior portion of the gluteus maximus as it passes over the greater trochanter to insert into the iliotibial band. The sub-gluteus medius is another major bursae around the greater trochanter. It is situated posterior and superior to the proximal edge of the greater trochanter. There is one (sometimes two) minor bursa underneath the gluteus minimus muscle. This bursa lies above and slightly anterior to the proximal superior surface of the greater trochanter. Distally, the iliotibial bursa is located between the distal part of the ITB near its insertion on Gerdy's tubercle and the adjacent tibia surface.

Normally, the greater trochanter glides smoothly under the ITB or gluteus maximus muscle. Snapping occurs when a taut (or contracted) ITB or gluteus muscle(s) are "flicked" over the greater trochanter. This can happen when the hip extends from a flexed position (e.g. when standing up) or when the hip flexes from an extended position (e.g. sitting down). Accordingly, with respect to the greater trochanter, the ITB moves either from anterior to posterior or from posterior to anterior, respectively. If this movement happens suddenly, a palpable and/or visible "snap" can result. In severe cases, this "snapping" is visible even during normal daily activities such as walking and sitting down. After a prolonged period of abnormal movements, anatomical changes in the soft tissue and bursae occur, causing pain and discomfort [1, 2].

Snapping can also occur distally with the ITB rubbing against the lateral femoral condyle as the knee flexes and extends, causing inflammation (Runner's knee). The anatomic locations of these two main snapping hip syndromes are illustrated in Fig. 36.1.

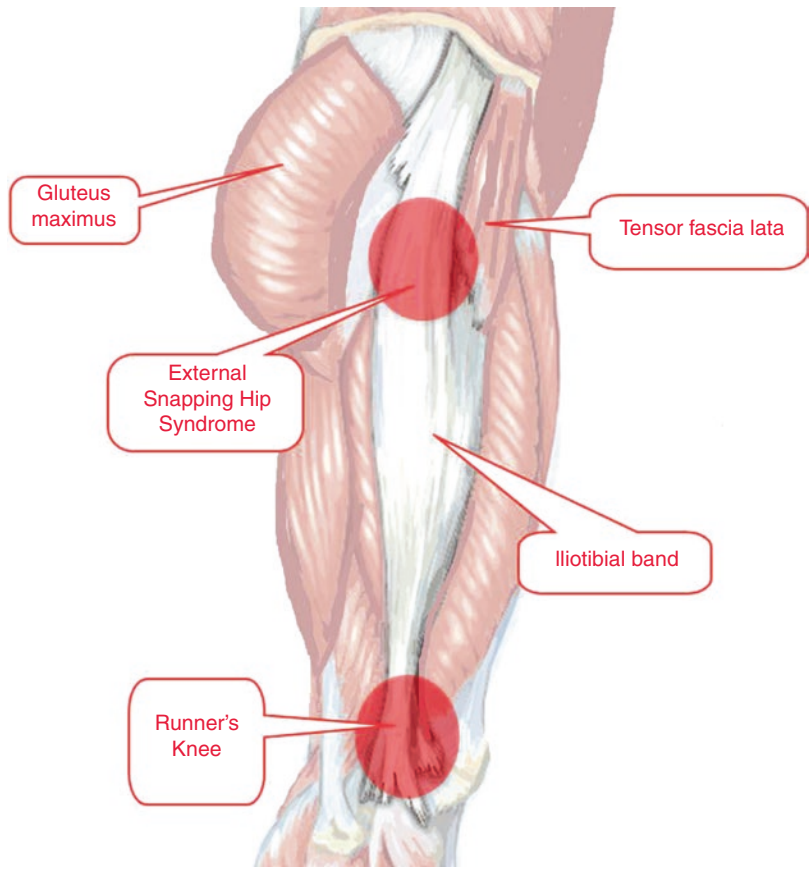

Fig. 36.1 Anatomic locations of iliotibial band syndromes (red circles)

The aetiology of snapping hip syndrome is poorly understood, with substantive overlap between gluteal musscles contractures, iliotibial band syndrome and snapping hip syndrome, further complicating our clinical assessment and treatment. Not all patients who present with snapping hip have tightness in the ITB, gluteus muscles or vice versa; just as not all cases who have ITB or gluteal tightness present with snapping hip. The tightness in the ITB is often attributed to a relative growth mismatch between soft tissues and bones. With ante- or retroversion of the hip, the ITB lies anterior or posterior to the prominence of greater trochanter, respectively. Therefore, it is not maximally stretched at rest and remains relatively short during growth. The translated position of the ITB has a cam effect to the greater trochanter such that with movement, the ITB is tensioned over the greater trochanter and when the tension is suddenly released there is a sudden jerky snap and irritation (Figs. 36.2 and 36.3). This theory of growth mismatch is further supported by two other facts:

1. The condition is often associated with tight hamstring muscles.
2. The gluteus maximus and ITB are more frequently involved (90.5%) than isolated gluteus medius and minimus tightness (9.5%) because those structures cross two growth centres [3].

However, it is difficult to explain the low success rate after lengthening surgery.

Some consider the condition a component of malrotation syndrome because it is often associated—and accentuated—by excessive femoral anteversion and less frequently, retroversion. We define excessive anteversion as internal rotation more than twice the ipsilateral external rotation, and vice versa for retroversion [4].

Natural History

The onset of symptoms usually starts before puberty although almost all only seek medical advice much later. The timing of symptoms is observed to be associated with the pubertal growth spurt. Winston suggested that in the early teenage years, flexibility and strength are developed, allowing extreme range of movements which contribute to symptoms [5].

There is not much known about the natural progression of this condition. In the published literature, the number of patients undergoing surgery for refractory painful snapping ITB is low. The lack of surgical enthusiasm may be due to historically unsatisfying results of surgery [6]. However, we have in similar experience with other authors encountered young adults with significant painful snapping which persisted since childhood [7, 8].

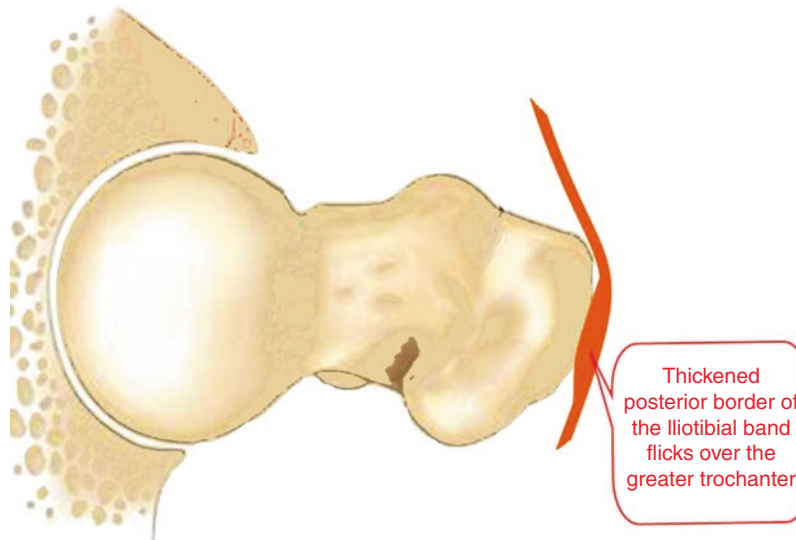

Fig. 36.2 Thickened posterior border of the iliotibial band relation to the greater trochanter

Fig. 36.3 Walking alongside the patient with a hand over the greater trochanter to feel for snapping

"There is not much known about the natural progression of this condition. In the published literature. The lack of surgical enthusiasm may be due to historically unsatisfying results of surgery".

Epidemiology

An accurate incidence and prevalence of snapping ITB is lacking. Reported numbers are most likely an underestimation of true cases [5, 7–10]. In the pediatric and adolescent population, the numbers are even lower or unknown as all of the published English literature on this subject to date has mixed groups of adult and young patients.

Clinical Presentation

Symptoms of snapping ITB can occur in the first decade but most occur around the timing of the pubertal growth spurt. Typically, a patient with a snapping ITB is almost always a female in her early teens. Most are affected bilaterally but one side is often more symptomatic. There is painful lateral hip snapping with pain felt around the greater trochanter, sometimes radiating down the lateral thigh to knee. Symptoms worsen with prolonged walking, standing or with activity. Some patients were severely affected to the point that they could not even lie or sleep on the affected side. Preoperative Patient Reported Outcome Measures reflected the negative impact of this

condition on the patient's quality of life [11–13]. By contrast, there is a subgroup of patients who habitually (and happily) reproduce the snapping.

If the patients are not able to reproduce their snapping, there are several bedside clinical tests described using passive range of movement. Bearing in mind that snapping hip is a dynamic symptom, some authors suggest patients using the "hula-hoop" manoeuvre involving cyclical hip flexion, adduction, extension, abduction and circumduction to elicit snapping [2]. Another examination technique which we find useful is walking alongside the patient with a hand over the greater trochanter to feel for snapping, similar to technique described by Herring [6] (Fig. 36.3).

We routinely examine the patient standing and leaning with full weight onto one leg (adduction in a standing position). The pressure of the examiner's hand at the mid lateral thigh against the ITB commonly reproduces the patient's symptoms at the level of greater trochanter (Fig. 36.4). The Ober test and the modified Ober test are relatively useful to quantify the tightness in the ITB. The pelvis has to be stabilized when performing these two tests, a fact that commonly understated when describing them. To perform the Ober test, the patient is positioned on the side with the bottom hip and knee flexed to flatten the lower back. The pelvis is stabilized with one hand on top and the examiner passively flexes the hip and knee to 90°. The hip is then passively abducted and extended. The examiner then allows the knee to slowly drop by gravity until reaching its final angle. The test is positive if the knee does not reach neutral (0° adduction/abduction). Kendall and colleagues modified the Ober test by extending the knee to 0° which further tightens the ITB [14]. Scully and colleagues described the "reverse Ober's sign" as a pathognomonic finding of gluteus maximus contracture, in which progressive hip abduction occurs when the extended and adducted hip is flexed to 90° or more (see squatting test in type B and C contracture below; Figs. 36.6 and 36.7) [15].

Fig. 36.4 Manual pressure at the mid-thigh reproduces pain at the greater trochanteric area. Patient should be leaning against 1 leg to adduct the leg being examined

In the prone position, we examine the femoral rotation and version using the Staheli technique. The significance of femoral version in the aetiology of the snapping ITB is unknown.

It is important to identify which contracted tissues are present and their respective contribution to the aetiology of the snapping. Ye and colleagues [16] divided the location of contracture based on the clinical findings into the following categories:

Type A: Contracture of the ITB mainly.

Type B: Contracture of the ITB and the gluteus maximus.

Type C: Contracture of ITB, gluteus maximus, medius, gluteus minimus, piriformis, and joint capsule.

For Type A contracture, the patient can squat with their knees closed together throughout the entire process of squatting (Fig. 36.5, 1). A snapping sound can be heard and the movement of the ITB can be felt over the greater trochanter during squatting. There are two sub-types: Type A1, where the lower extremities can be fully crossed and overlapped on sitting (Fig. 36.5, panels 2 and 3), and Type A2 where the lower extremities cannot be fully crossed and overlapped on sitting.

Fig. 36.5 Type A contracture. *The patient can squat with knees closed together throughout the entire process of squatting and can fully cross and overlap his lower limbs on sitting. Although the ITB is tight, it allows enough adduction to perform these two tasks without limitation*

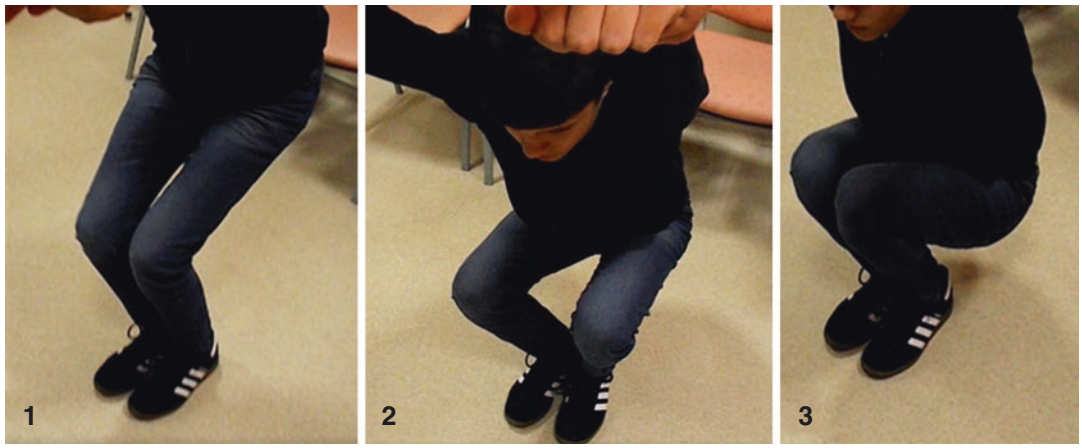

Fig. 36.6 Type B contracure. *In type B contracture, the patient starts squatting with both knees kept together (panel 1); however, he needs to abduct his legs (not able to keep his knees closed) for brief period in mid-squatting position to allow the ITB to slide over the greater trochanter from a posterior position to an anterior position (panel 2); He was then able to bring and keeps his knees together (panel 3). So the patient cannot squat with knees closed together throughout the entire process of squatting. The patient can fully cross and overlap his lower limbs on sitting position*

For Type B contractures, a snapping sound can be heard and palpated as the ITB moves over the greater trochanter during squatting. In this type, the patient is unable to bring their knees together during squatting, and the affected hip abducts and rotates externally as the hip flexes close to 90° (Fig. 36.6, panel 2). With hip flexion greater than 90°, the knees can be brought together (Fig. 36.6, panel 3). The lower extremities cannot be crossed or overlapped after sitting.

For a Type C contracture, the knees turn outward when the patient is walking and cannot be pulled together during squatting and the lower extremities cannot be crossed during sitting (Fig. 36.7). There are two sub-types: Type C1, where the movement of the contracted tissue(s) is palpable, and a snapping sound is audible during squatting; and Type C2

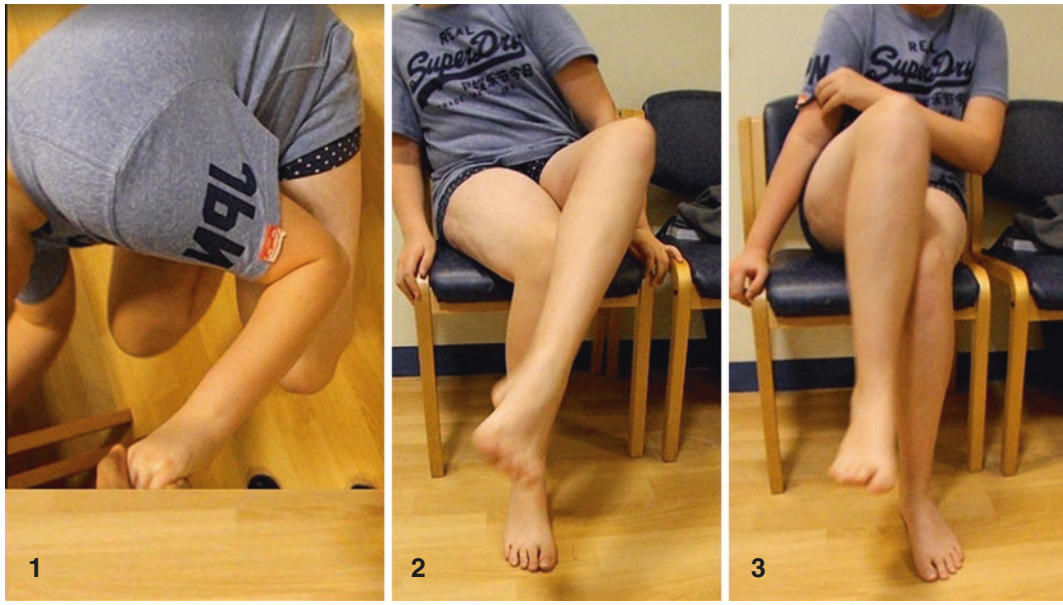

Fig. 36.7 Type C contracture. *In Type C contracture, the patient cannot pull his knees together during squatting and cannot cross his legs when sitting*

where the movement of the contracted tissue(s) is not palpable, but a snapping sound was still audible during squatting. This indicates the presence of adhesions between the contracted tissues.

Essential clinical tests

- Palpable or visible lateral hip snapping is most diagnostic for snapping ITB.
- Unable to bring knees together during squatting, sits in frog-leg position.
- Unable to cross or overlap legs.
- Ober's, modified Ober's and reversed Ober's tests.

Imaging

Our approach in diagnosing snapping ITB has evolved. Initially we performed either an MRI or ultrasound to confirm the cases but as we became more comfortable with clinical examination we now only request further imaging in unclear cases or when surgery is planned. This is important to support the diagnosis and rule out other unexpected or associated pathological conditions.

We would still recommend a plain pelvic X-ray in all cases as a baseline radiological test to rule out bony pathology.

Ultrasound shows a thickened ITB. A dynamic sonogram also confirms the abrupt movement of ITB over the greater trochanter, with hip flexion and extension [10, 17].

MRI complements ultrasound imaging in confirming ITB thickening, or shows focal or atrophic disuse changes in gluteus maximus involvement. Krishnamurty reported on gluteus maximus atrophy of probably disuse origin in a 5 year old girl with symptomatic snapping ITB [17].

"The main purpose of radiological tests is to rule out other pathologies rather than confirming the diagnosis".

Essential imaging test

Plain X-ray to rule out other bony pathology

- In equivocal cases, dynamic ultrasound to show sudden abnormal displacement of ITB or gluteus maximus tendon
- MRI scan before any surgery to rule out other pathologies

Non-operative Management

Modification of activity (including rest) and anti-inflammatories are advised for patients with symptomatic snapping ITB. Physiotherapy is needed to encourage ITB elongation and gluteal strength. Positions that allow the largest change in ITB length in cadaveric and healthy subjects are hip adduction in flexion or extension [14, 18]. Most authors suggest a minimum of 3 months of physiotherapy, incorporating rest, active and passive stretching, posture and neuromuscular control of the trunk, pelvis and lower limb. Corticosteroid or local anaesthesia injection into the trochanteric region can be used in patients with severe symptoms to allow tolerance of physiotherapy. In our experience, most who were managed non-operatively reported resolution or significant improvement and were discharged from further review without surgery.

Operative Management

Surgical intervention is offered to patients whose symptoms are severe and do not respond to non-operative therapy. The principle of surgery is to refashion the ITB in a way to prevent snapping. This may mean lengthening a contracted ITB. However, not all cases have a contracted ITB, or there may be multiple contracted tissues responsible, and thus lengthening alone may not be adequate. Refashioning of the ITB to prevent snapping is more important than lengthening. There are a few reported surgical techniques used to achieve this with varying success rates.

"Surgical intervention is offered to patients whose symptoms are severe and do not respond to non-operative therapy".

"The principle of surgery is to refashion the ITB in a way to prevent snapping".

Refashioning/Lengthening of the Iliotiobial Band

Conventional open surgery has been utilised to lengthen and refashion the ITB. This can be performed either proximally or distally.

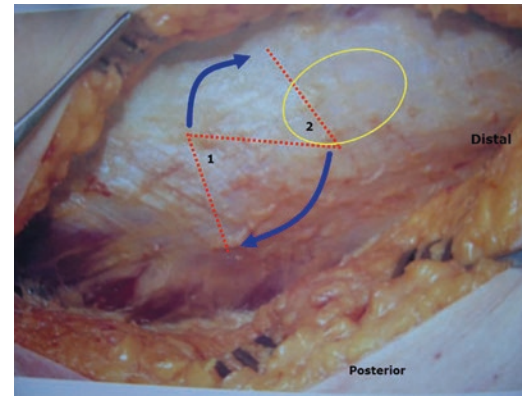

Fig. 36.8 Z-lengthening of the iliotibial band. *Z-lengthening of the fascia lata just proximal to the greater trochanter (yellow circle). The two flaps (denoted with 1 & 2) were repaired fully proximal to the greater trochanter to decrease the chance of bony protrusion through the fascia defect*

Brignall and Stainsby described a Z-lengthening of the fascia lata just proximal to the greater trochanter [19]. The two flaps of the Z-lengthening were repaired fully proximal to the greater trochanter to decrease the chance of bony protrusion through the fascia defect (Fig. 36.8). The technique was reproduced by Provencher et al. [20]. In these two papers, there were 14 patients ranging in age from 14 to 38 years, with a minimum follow-up of 6 months. All patients reported resolution of snapping post-operatively. One patient (7%) required revision surgery resulting in complete pain relief and lasting for the next 6 years. Two patients (14%) complained of occasional achiness after activity. Another patient required additional surgery to address concomitant labral pathology.

A similar Z-lengthening was performed in three military personnel with a painful snapping ITB but with varying results [21]. 1 had resolution of symptoms, 1 had persistent pain but no snapping, and 1 experienced recurrence of pain and snapping 8 months after surgery. The symptoms in these patients started whilst on duty, indicating the plausible causative role of persistent and strenuous activity in snapping ITB.

White and colleagues performed a longitudinal fascia lata split over the greater trochanter with six transverse step cuts on either side of the split [8] (Fig. 36.9). 12 out of 16 patients (75%),

Fig. 36.9 Longitudinal and transverse step cuts technique where a longitudinal incision in the fascia lata is made over the greater trochanter with six transverse step cuts on either side of the split

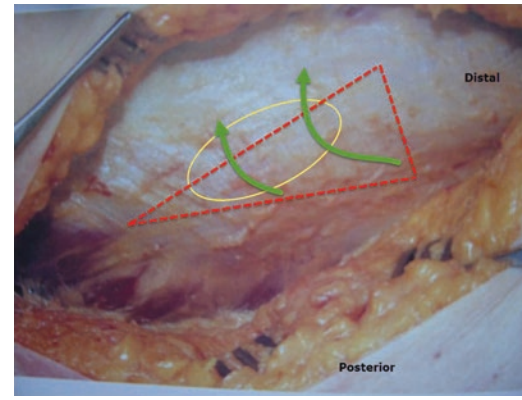

Fig. 36.10 Turned flap technique. *The posterior thick edge of the ITB is identified and its tightness confirmed. The band is then cut horizontally, halfway across the width, then vertically for about three inches. The vertical release can be carried as far proximally as needed until the snap disappears on flexion. The resulting flap of ITB is then turned on itself and sutured to the substance of the tensor fascia lata muscle anteriorly*

aged between 15 and 65 years-old, had resolution of snapping and pain. Two of the remaining four underwent a second surgery to relief persistent snapping within the first 6 months post-operatively.

Larsen and Johansen associated snapping hip with a thickening of the ITB passing over the greater trochanter [22]. Therefore, they resected the posterior half of the ITB at the insertion of the gluteus maximus in 24 patients (31 hips) aged between 15 and 78 years-old, and reported their symptoms at 1 to 11 years followup. 70% of the operated 31 hips had complete resolution of snapping and pain. The remaining 10% (3 hips) had painful snapping and 20% had asymptomatic snapping. Two of the patients with a persistently painful snapping ITB underwent further surgery with good results.

Sharda and colleagues [23] reported on their technique of partial release and anterior transposition of the ITB. In their technique, the posterior thick edge of the ITB is identified and its tightness confirmed by placing the leg in adduction and flexion. The band is then cut horizontally, halfway across the width, then vertically for about three inches. The vertical release can be carried as far proximally as needed until the snap disappears on flexion. The resulting flap of ITB is then turned on itself and sutured to the substance of the tensor fascia lata muscle anteriorly (Fig. 36.10).

One of our senior author's (SA) preferred technique is a "Line-to-Diamond release". In this technique, we establish the manoeuvres to reproduce the snapping in individual cases. Either endoscopically or through a mini-incision, we cut the ITB over the greater trochanter transversely, leaving a 1 to 2 cm wide cuff of tendon anteriorly and posteriorly to maintain the continuity of the ITB while still allowing for lengthening (Fig. 36.11). The result is a diamond-shaped defect in the ITB. The size and the extent of the release (i.e. "the diamond") should be large enough for the snapping to disappear during hip motion. This may mean that the remaining posterior band has to be fully released.

The rationale for distal ITB release is to perform surgery away from the site of inflammation (i.e. at the greater trochanter) to decrease the risk of scar tethering which may lead to recurrence. This technique can be performed under local or general anaesthesia. A Z-lengthening of the distal ITB is performed approximately 10 cm above the knee joint line [7, 13]. Similar to the prophylactic ITB

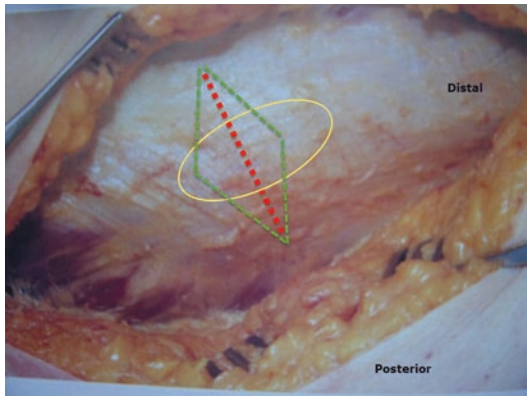

Fig. 36.11 Line-to-diamond release. *"Line-to-diamond release". The ITB is cut transversely over the greater trochanter leaving a 1 to 2 cm wide cuff of tendon anteriorly and posteriorly to maintain the continuity of the ITB while still allowing for lengthening*

release performed in congenital femoral lengthening, the operated leg is adducted across the contralateral side to maximally stretch the ITB in the supine position. The Z-plasty is done with an anterior transverse cut distally and posterior cut proximally because we have found that the posterior edge of the ITB is less well defined distally. No restriction of movement is imposed post-operatively. Sayed-Noor and colleagues reported on resolution of snapping and pain using this technique in five patients at 1 year follow-up [7] (Fig. 36.12).

Pretell and colleagues reported good results using this technique in 10 out of the 11 patients (90%) [13]. Their single unsatisfactory case subsequently underwent a proximal Z-lengthening of the ITB to improve her symptoms.

"The rationale for distal ITB release is to perform surgery away from the site of inflammation (i.e. at the greater trochanter) to decrease the risk of scar tethering which may lead to recurrence".

Endoscopic Lengthening of the Iliotibial Band

This technique yields smaller scars compared to the open proximal release. Ilizaliturri and colleagues performed a diamond-shaped ITB resection at the level of greater trochanter and gluteus maximus tendon insertion using endoscopic methods [11]. Of the ten patients in their series, 9 reported complete resolution of snapping and pain at minimum of 1-year follow-up. The remaining patient reported mild, persistent snapping but pain free.

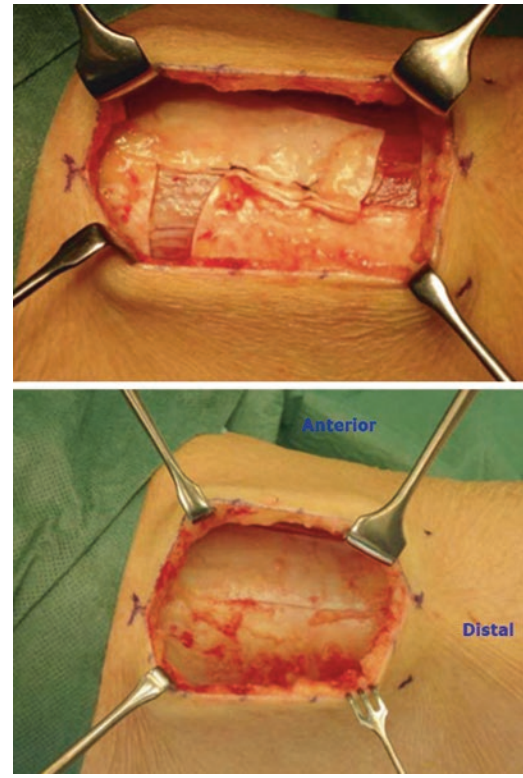

Fig. 36.12 Distal Z-lengthening. *The Z-plasty is done with an anterior transverse cut distally and posterior cut proximally. Pictures are courtesy of Professor Arkan Sayed-Noor*

Polesello and colleagues were concerned regarding the void created by partial resection of the ITB and its effect on abductor strength [12]. They instead tenotomised the gluteus maximus from its femoral insertion. At minimum 22 months' follow-up, six out of eight patients (75%) reported improvement in Harris Hip Scores (HHS) with resolution of snapping and pain. One patient underwent revision surgery for further release of the gluteus maximus tendon with the addition of a tensor fascia lata lengthening. Another patient reported resolution of pain in

the lateral thigh but still complained of mild snapping and pain in the ischial region. They recommended squatting in the postoperative period to stretch the gluteus maximus. They did not report on the effect of the surgery to the shape of the buttock.

Minimally Invasive Lengthening of the Iliotibial Band

The diamond-shaped ITB resection at the level of greater trochanter and gluteus maximus tendon release can be done through a relatively small incision (2 to 3 cm) instead of an endoscopic procedure (Fig. 36.13). It can be performed more quickly and does not require endoscopic skills.

Percutaneous Lengthening of the Iliotibial Band

An interesting concept was introduced by a group of surgeons in China [16]. Using skin landmarks on patient in the supine and neutral position, a line joining the anterior superior iliac spine and lateral edge of patella is drawn. A mark 5 cm distal to the ASIS on that line is identified. Then, in a maximal adduction and internal rotation position, a scalpel is introduced into the mark and directed posteriorly but not extending past the posterior edge of greater trochanter to divide the contracted bands of tensor fascia lata and ITB. Remarkably, outcomes in all 35 patients were good, but there was no mention of how the results were measured. Nevertheless, this technique warrants further detailed evaluation.

Fig. 36.13 Minimally invasive ITB release

Essential surgical techniques

Avoid surgery in habitual snapping ITB or pre-menarchal patients (risk of recurrence).

- Ensure adequate release is performed regardless of the method chosen.

Snapping Iliopsoas (Extra-Articular Internal Snapping Hip)

Pathophysiology

The iliopsoas tendon is formed by three muscles: the iliacus, psoas major and psoas minor. The tendon originates superior to the level of the inguinal ligament and inserts directly onto the lesser trochanter. The iliacus tendon has a more lateral position than the psoas major tendon and fuses progressively onto the psoas tendon. In a cadaveric study utilizing arthroscopy, Blomberg and colleagues reported the ratio of iliopsoas tendon:muscle belly at the level of the labrum, femoral neck and lesser trochanter to be 40:60, 53:47 and 60:40, respectively [24]. The iliopectineal eminence and the anterior edge of the pelvis is considered to be a pulley for the iliopsoas muscle and tendon.

A snapping iliopsoas typically occurs when the hip moves from flexion, abduction and external rotation, to extension, adduction and internal rotation. During this motion, the taught iliopsoas tendon abruptly flips over the iliopectineal eminence, from lateral to medial [10] (Fig. 36.14).

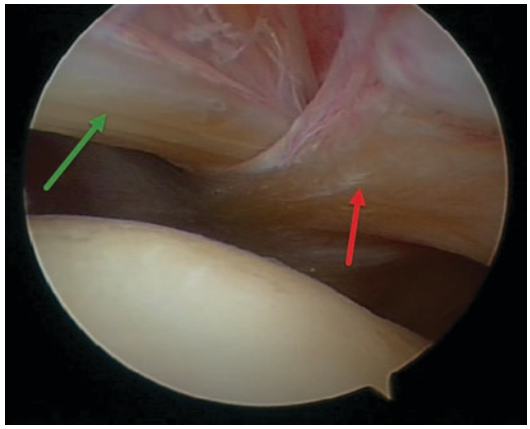

Fig. 36.14 Arthroscopic picture of the iliopsoas tendon. *This arthroscopic picture shows the iliopsoas tendon (green arrow) above the hip joint capsule (red arrow). Notice the close proximity of the femoral head to the tendon. The psoas tendon comes in contact with the femoral head between 0–15° of hip flexion* [31]. *Picture is courtesy of Professor Tim Board, Wrighington Hospital, UK*

Other less common mechanisms have been proposed, including accessory iliopsoas tendon slips, snapping over a ridge at the lesser trochanter, snapping of the iliofemoral ligament over the femoral head, subluxation of the long head of the biceps at the ischium, and snapping at the anterior inferior iliac spine (AIIS) [25–28]. The iliopsoas tendon can also snap over a prominent or malpositioned acetabular cup after total hip replacement [29, 30].

> ***"A snapping iliopsoas occurs when the hip moves from flexion, abduction and external rotation, to extension, adduction and internal rotation. During this motion, the taught iliopsoas tendon abruptly flips over the iliopectineal eminence, from lateral to medial".***

Natural History

The natural history is still not well understood although some have suggested that a symptomatic snapping iliopsoas is not indicative of future problems. The few patients who seek medical assessment reported chronic affliction and poor functional outcome scores that require management. The symptoms associated with a snapping iliopsoas in adolescence can persist into adulthood [32].

Epidemiology

Although consistently mentioned in the literature to be less common than snapping ITB, there are increasing interests and publications on this subject. Estimations from authors in North America suggest an incidence of snapping iliopsoas between 5% to 10% but only few are symptomatic enough to require intervention [33, 34]. A study of 653 dancers in New York presenting with musculoskeletal complaints revealed a 7.5% prevalence of iliopsoas symptoms, including symptomatic snapping [35]. There was a higher proportion of dancers aged below 18 years old (12.8% vs. 7%) affected. Females outnumbered the male patients. Some have bilateral symptoms but usually one side is worse [32, 35]. Both snapping ITB and iliopsoas can occur together.

Repetitive and strenuous hyperextension of the hip and lumbar spine was suggested to be a risk factor for a symptomatic snapping iliopsoas, the hyperlordotic posture resulting in a more prominent femoral head over which the snapping occurs [35].

Clinical Presentation

The patient with a snapping iliopsoas localizes the snapping to the anterior hip. The associated pain may radiate to the thigh. There also may be concomitant ipsilateral lower back pain [35]. Exacerbating activities include walking, running (particularly in the late stance phase), ballet, and squatting position during weightlifting [36]. It is difficult to differentiate pain originating from the snapping iliopsoas versus intra-articular pathology. If a snapping iliopsoas is reproducible, there is a characteristic palpable clunk in the groin.

The snap can sometimes be appreciated in the femoral triangle with the hip at 30 to 45° of flexion. Movements that reproduce the snapping tend to involve hip Extension, Adduction and Internal

Rotation (EAdIR test) from the figure-of-four position. Thomas test may demonstrate a tight psoas muscle. Passive stretching of iliopsoas is restricted by pain in 74% of dancers with painful snapping iliopsoas. Pain with resisted hip flexion in external rotation may indicate an associated iliopsoas tendinitis or bursitis [35].

We routinely examine for femoral torsion. Sub-optimal outcomes after psoas lengthening in patients has been associated with increased femoral anteversion. This should be considered in pre-operative counselling between surgeon and patient [37]. We also assess for intra-articular pathology using the FAdIR (flexion, adduction and internal rotation) or impingement test.

Essential clinical tests

- Thomas test
- EAdIR test
- Exclude other aetiologies of hip snapping (e.g. ITB)

Imaging

We routinely perform plain radiographs to exclude potential causative or associative factors such as hip dysplasia, femoroacetabular impingement, or peri-articular exostoses.

Dynamic ultrasound is challenging due to the position of hip required to produce the snapping. However, in the experienced hands with the right patients, it can show a sudden change in the position and shape of the iliopsoas tendon in addition to a temporal association with joint positioning and pain [10]. Ultrasound can also demonstrate a persistent tightness of the iliopsoas tendon post-operatively in patients who experienced a partial response following tendon release [38].

We have no experience in performing iliopsoas bursography. Ilizaliturri endoscopically found concomitant intra-articular injuries in 4 out of 7 adult patients with snapping iliopsoas tendon [39]. We do not routinely perform MRI in adolescents with snapping iliopsoas if the clinical diagnosis is clear unless we contemplate surgery.

Essential Imaging

- Dynamic ultrasound to confirm temporal association of iliopsoas snapping with pain
- MRI to exclude intra-articular cause of pain if indicated

Non-operative Management

As iliopsoas snapping generally occurs during specific activities and forceful ranges of hip movement, the best conservative management is rest and avoidance of those activities. All patients should undergo a physiotherapy programme which includes iliopsoas stretching, concentric strengthening of hip rotators, eccentric strengthening of hip flexors and extensors, pelvic mobilisation, and anti-lordotic exercises, for a minimum of 3 months. In four reported operative series, up to 63% of patients improved with physiotherapy intervention [32, 36–39]. All 49 dancers with symptomatic snapping iliopsoas responded to 12 weeks of conservative management [35]. Injection of corticosteroid and local anaesthesia can help with pain relief although the snapping can persist.

Operative Management

The principal feature of surgical intervention described to date involved fractional lengthening or release of the iliopsoas tendon using either an open or endoscopic approach. The site of the release is determined by the site of snapping. Regardless of the approach, the effect of surgery on hip flexor strength is a recurrent theme of concern, apart from injuries to the femoral neurovascular bundle and lateral femoral cutaneous nerve. Advances in hip arthroscopy have made arthroscopic and endoscopic psoas tendon release more popular (Fig. 36.15). Via and colleagues [40] reviewed the literature on endoscopic psoas tendon release and his findings are summarised in Table 36.1.

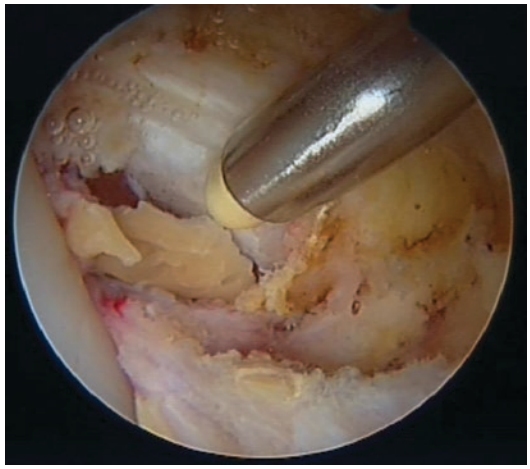

Fig. 36.15 Arthroscopic release of the iliopsoas tendon. *Advancements in arthroscopic skills and tools have made the identification and release of the iliopsoas tendon relatively easy. Picture is courtesy of Professor Tim Board, Wrighington Hospital, UK*

"Advances in hip arthroscopy have made arthroscopic and endoscopic psoas tendon release more popular".

Jacobsen and Allen performed a fractional lengthening of 20 iliopsoas tendons through an anterior hip approach in 18 patients; 85% reported subjective improvement, 75% had complete resolution of their snapping, and 25% had some residual snapping. However, 15% of the patients had subjective weakness and 10% needed revision surgery [48]. Gruen and colleagues performed a fractional lengthening of the iliopsoas at the pelvic brim with 100% resolution of symptoms in 11 patients but 45% of patients reported subjective weakness. Taylor and Clarke reported on release of the iliopsoas at the lesser trochanter using a medial approach in 14 patients (16 hips). Fifty-seven percent experienced complete resolu-

Table 36.1 Literature review of endoscopic release of the iliopsoas tendon

Study	Year	Site	*N*	F/U	Results	Recurrence
Ilizaliturri et al. [39]	2005	Lesser trochanter	7	21	Intra-articular concomitant injuries were identified and treated in 4 cases. No snapping symptoms were present in any patient after surgery nor at the last follow-up at, on average, 21 months. Significant loss of flexion strength was present after surgery but had improved by 8 weeks	0
Flanum et al. [41]	2007	Lesser trochanter	6	12	Preoperative HHS averaged 58 points. After surgery, all patients had hip flexor weakness, used crutches for 5 weeks, and had 6-week scores that averaged 62 points. The patients continued to improve, and at 6 and 12 months, their scores averaged 90 and 96 points, respectively, and none had recurrence of their snapping or pain	0
Anderson and Keene [42]	2008	Lesser trochanter	15	9	Preoperative mHHS averaged 41 and 44 points for the competitive and recreational athletes, respectively. After surgery, the 2 groups used crutches for 4 weeks, and had 6-week scores that averaged 87 and 63 points. At 6 months, their scores averaged 94 and 98 points, and at 12 months, 96 and 97 points, and none had recurrence of their snapping or pain. All 15 athletes returned to full participation in their sport at an average of 9 months after surgery	0
Wettstein et al. [43]	2006	Trans-capsular release	9	3	No complications, and their hip flexion strength was restored to normal within 3 months	0
Contreras et al. [44]	2010	Trans-capsular release	7	24	All patients had resolution of snapping. The mean VAS score for pain fell from 7.7 pre-operatively to 4.3 by 3 months ($p = 0.051$), and 2.4 (0 to 8) ($p = 0.011$) by 24 months. The mean mHHS increased from 56.1 pre-operatively to 88.4 at 1 year ($p = 0.018$) and to 87.9 (49.5 to 100) at 2 years ($p = 0.02$). There were no complications and no weakness occurred in the musculature around the hip	0

Table 36.1 (continued)

Study	Year	Site	*N*	F/U	Results	Recurrence
Ilizaliturri [45]	2014	Trans-capsular release (Group 1)	14	24	6 in group 1 (4 male and 2 female patients; mean age, 35.6 years) and 14 in group 2 (5 male and 9 female patients; mean age, 32.7 years). Associated injuries were found and treated in 4 patients in group 1 and 10 patients in group 2. Every patient in both groups had an improvement in the WOMAC score. One patient in group 2 presented with recurrence of snapping that required surgical intervention. No complications were seen.	1
		Lesser trochanter (Group 2)	6	24		0
Hwang [46]	2015	Trans-capsular release	25	24	Snapping sounds had disappeared by the 2-year follow-up in 24 of the 25 patients. All patients who had presented with loss of flexion strength postoperatively showed recovery at postoperative week 6 to 10. HHS improved from 65 points preoperatively to 84 points postoperatively ($p < 0.001$). Seven hips (28%) had an excellent score, 15 hips (60%) a good score, 2 hips (8%) a fair score, and one hip (4%) a poor score ($p < 0.001$).	2
El Bitar et al. [47]	2014	Fractional iliopsoas tendon lengthening	55	24	Overall, 45 patients (81.8%) reported resolution of painful snappingAll PROs showing statistically significant improvement postoperatively (NAHS: 57.6 ± 20.6 preoperatively vs. 80.2 ± 19.2 at 2 years; HOS-ADL: 60.9 ± 21.4 preoperatively vs. 81.8 ± 20.6 at 2 years; HOS-SSS: 43.4 ± 24.6 preoperatively vs. 70.0 ± 26.7 at 2 years; and mHHS: 62.3 ± 16.4 preoperatively vs. 80.5 ± 18.3 at 2 years) ($P < 0.001$ for all)Forty-five patients (81.8%) reported good/excellent satisfaction (≥7 out of 10)	10

VAS Visual Analogue Scale, *HHS* Harris Hip Score, *mHHS* modified Harris Hip Score, *WOMAC* Western Ontario and Mc-Master Universities Osteoarthritis Index, *NAHS* Non-Arthritic Hip Score, *HOS-ADL* Hip Outcome Score-Activity of Daily Living, *HOS-SSS* Sport-Specific Subscale, *N* Number, *F/U* Follow up in months, *PROs* patient-reported outcomes

tion but 14% demonstrated weakness with hip flexion greater than 90°.

In studies reporting only on surgery for the symptomatic snapping iliopsoas, the frequency of hip flexor weakness varied and involved patients undergoing either open or endoscopic releases at any level of release or lengthening. Some authors reported improvements in hip flexor strength 8 weeks post endoscopic release at the lesser trochanter [39, 42]. A year following surgery, all 15 patients in their series returned to their preoperative competitive or recreational sports [42]. Ilizaliturri and colleagues performed a non-randomised comparison between 6 adult patients undergoing release at the lesser trochanter and 14 undergoing release at the labrum level, both endoscopically [45]. Both groups reported similar postoperative functional scores at 2-year follow-up but the authors did not report on hip flexor strength. In a cohort of patients aged 18 to 55 years old, a subgroup of patients undergoing endoscopic psoas lengthening at the joint level exhibited weaker hip flexion when seated but not when supine, at follow-up period of 16 to 30 months, compared to a similar group who had other arthroscopic procedures without psoas lengthening [49].

Dobbs and colleagues reported on this subject in adolescents [38]. They performed fractional lengthening of the iliopsoas at the musculotendinous junction using a relatively extensive modified iliofemoral approach in 9 patients aged between 14 and 17 years old. One patient had recurrent but less severe snapping. At minimum 2 years of follow-up, all patients reportedly had returned to pre-operative activities, including competitive athletics, with no gross weakness of hip flexors in the sitting position. There were, however, patient reports of subjective hip flexor weakness beyond 90-degree flexion. In the biggest series of surgical cor-

rection of snapping iliopsoas, Hoskins and colleagues performed fractional lengthening of the iliopsoas tendon, from the level of lesser trochanter to superior femoral head, in 80 patients aged between 15 to 52 years-old over a 20 years period [50]. Two of these patients reported permanent hip flexor weakness post-operatively.

With regards to the endoscopic lengthening of painful snapping, 90 to 100% of operated patients demonstrated resolution of symptoms at minimum 10 months of follow-up [34, 39, 42, 45, 49]. By contrast, an open release or fractional lengthening achieved less consistent resolution of symptoms, with up to 38% having residual pain or snapping [32, 36, 38, 48, 50].

Other Rare Causes of Extra-Articular Snapping Hip Syndrome

The pathologies associated with the snapping hip discussed above are by no means an exhaustive list. Another interesting and seemingly common cause of lateral hip snapping reported in Asian countries is gluteus maximus contracture. This contracture may result from intramuscular injection of antibiotics or immunizations, although there is also a possible hereditary linkage [1, 16, 51].

Subluxation of the tendon of origin of the long head of the biceps femoris muscle (or *snapping bottom*) is another rare cause of snapping hip. It has similar features to the bicipital tendonitis in the shoulder. It occurs in a patient who wears out this attachment through a lifetime of hyperflexion hip movements, such as are required in bending to reach the floor. In older patients, a simple tenotomy is indicated if conservative measures fail. This condition should be differentiated from the "*weaver's bottom"* (i.e. ischio-gluteal bursitis), even though biceps subluxation may be a cause for that bursitis [52].

The rectus femoris tendon can snap over the femoral head causing pain. The incidence of this mechanism is currently not known but it is believed it is more common than previously thought. Pelsser and colleagues [10] reported the sonographic findings of 20 patients (36 hips) with snapping hips. Five cases showed features of rectus abnormalities but were not attributed to the pathophysiology of the rectus femoris snapping. Rectus femoris snapping is often associated with calcific tendonitis of the tendon. Snapping can be reproduced during active hip extension. However, if the snapping bundle is fully muscular, snapping may not be felt or heard in the absence of contraction [53]. This poses a substantive diagnostic challenge. Plain radiograph and MRI scan may show features of calcific tendonitis. Dynamic ultrasonography and CT scanning allow a precise diagnosis and subsequent treatment with CT-guided steroid injection. Failure of conservative treatment is an indication for surgery (open or endoscopic) [54].

Classic Papers

Brignall CG, Stainsby GD. The snapping hip. Treatment by Z-plasty. J Bone Joint Surg Br. 1991;73:253–4. [19] The authors described a Z-plasty technique to lengthen the ITB with good results, changing attitudes toward surgical treatment of the condition. They reported results on 5 patients (8 hips), aged 14 to 32 years-old, with a follow-up period of 1 to 8 years. All patients reported an absence of snapping post-operatively: 3 patients had excellent pain relief, and 2 patients (3 hips) had occasional ache above greater trochanter, associated with exercise. One patient required a second more extensive Z-plasty to resolve her symptoms.

Ye, B. Zhou, P. Xia, Y. Chen, Y.Yu, J. Xu, S. New Minimally Invasive Option for the Treatment of Gluteal Muscle Contracture. Orthopedics. 2012;35(12):e1692-e1698. [16] This paper increased our understanding of the condition and its spectrum, introduced a clinically-based classification relevant to the types of the intervention required. It also introduced a new non-invasive technique.

Dobbs, M.B., Gordon, J. E., Luhmann, S.J. Szymanski, D. A. Schoenecker, P. Surgical correction of the snapping iliopsoas tendon in adolescents. J Bone Joint Surg Am. 2002;84:420–4. [38] The only report exclusively

on patients less than 18 years old. 15 patients (17 hips) were seen initially. 6 patients responded to physiotherapy. The remaining 9 patients underwent fractional lengthening of iliopsoas at the musculotendinous junction via a modified iliofemoral approach. Minimum follow-up was 2 years. Although 1 patient experienced less severe and less frequent snapping, every patient returned to pre-operative sports activity. No hip flexor weakness was detected, examined simply with patient sitting and flexion against examiner's arm.

Anderson SA, Keene JS. Results of arthroscopic iliopsoas release in competitive and recreational athletes. Am J Sports Med. 2008;36:2363–71. [42] Detailed report on work-up for patients with snapping iliopsoas, selecting patients who responded transiently to iliopsoas bursa injection. Fifteen of 54 patients (28%) had resolution of symptoms after injection and physical therapy. Fifteen patients who were into athletics and had only transient relief underwent endoscopic release of the iliopsoas tendon at the lesser trochanter. All patients reported immediate postoperative hip flexor weakness but they regained their active range of movement by 6 weeks. One year after surgery, all patients reported complete alleviation of symptoms and had no recurrence of the painful snapping of their hip. They also demonstrated normal hip flexor strength by clinical examination.

Key Evidence

Pierce, T. P., Kurowicki, J., Issa, K., Festa, A., Scillia, A. J., McInerney, V. External snapping hip: a systematic review of outcomes following surgical intervention: External snapping hip systematic review. Hip Int. 2018 Jun 1:11. [55] A recent systematic review of a total of 7 studies that were analysed for the incidence of recurrence, revision surgery, complications, and return to pre-injury activity level. They found that there was a recurrence rate of 7% (n = 8 of 113 hips) with a low rate of revision surgery required (1%). The cumulative complication rate was 9% (n = 10 of 113) with all complications being residual weakness. Additionally, most patients returned to their pre-injury level of activity. The authors concluded that operative treatment for external snapping hip is both safe and efficacious, with a high rate of return to their pre-injury activities. When recurrence does occur, it is often painless and does not usually require revision surgery.

Noehren, B., Davis, I., Hamill, J. Clinical biomechanics award winner. 2006 prospective study of the biomechanical factors associated with iliotibial band syndrome. Clin Biomech. 2007 Nov;22(9):951–6. Epub 2007 Aug 28. [4] The study prospectively compared lower extremity kinematics and kinetics between a group of female runners who developed iliotibial band syndrome and healthy controls. They found that the iliotibial band syndrome group exhibited significantly greater hip adduction and knee internal rotation.

Pelsser, V, Cardinal, É, Hobden, R, Aubin, B, Lafortune, M. Extra-articular snapping hip: sonographic findings. AJR Am J Roentgenol. 2001;176:67–73. [10] The authors used ultrasound to identify abnormal displacement of the iliopsoas or ITB in snapping cases and to confirm the clinical diagnosis. They correlated onset of pain with time and anatomic location of snapping.

Larsen E, Johansen J. Snapping hip. Acta Orthop Scand. 1986;57:168–70 [22]. This paper emphasised the importance of the thickened posterior part of the ITB. Partial resection was performed. The authors reported the results of 24 patients (31 hips) aged 15 to 78 years-old, with a follow-up period of 1 to 11 years. Twenty-two of 31 hips had complete resolution, 6 experienced painless snapping, 3 had a persistently painful snap, 2 of which underwent revision surgery with good results.

Hoskins, J.S., Burd, T.A., Allen, W.C. Surgical correction of internal coxa saltans: a 20-year consecutive study. Am J Sports Med. 2004;32:998–1001. [50] Largest reported retrospective series of 80 patients (92 hips) with snapping iliopsoas. Results of 80 out of 85 patients who underwent fractional lengthening of iliopsoas tendon were reported at an average follow-up of 6 months followed by a telephone review 5 years post-operatively.

Warnings to surgeons—complications occurred in 32 of 80 patients. These included: recurrent or persistent snapping and pain, paraesthesia in the anterior thigh, hip flexor weakness, superficial infection, and haematoma requiring immediate surgical exploration. Revision surgery carried risks of heterotopic ossification ($n = 1$) and femoral nerve palsy ($n = 2$).

Via, A. G., Basile, A., Wainer, M., Musa, C., Padulo, J., Mardones, R. Endoscopic release of internal snapping hip: a review of literature. [40] Muscles Ligaments Tendons J. 2016 Dec 21;6(3):372–377. A review of the literature regarding endoscopic releases of iliopsoas and comparing the results surgery based on the site of the release. Authors concluded that most cases resolve with conservative treatment. Surgery is indicated in recalcitrant cases. Better results have been reported with endoscopic iliopsoas tendon release compared with open techniques, which may be related to the treatment of concomitant intra-articular pathologies. Furthermore, endoscopic treatment showed fewer complications, decreased failure rates, and reduced postoperative pain.

Zeman, P., Cibulkova, J., Kormunda, S., Koudela, K., Jr., Nepras, P., Matejka, Arthroscopic transcapsular iliopsoas tenotomy from the peripheral versus the central compartment in internal snapping hip syndrome. Short-term results of a prospective randomised study. Acta Chir Orthop Traumatol Cech. 2013;80(4):263-72. [56] This is the only prospective randomised study comparing arthroscopic central compartment trans-capsular iliopsoas tenotomy to the peripheral compartment in 19 patients. The authors found that arthroscopic iliopsoas tenotomy approached from the peripheral compartment resulted in significantly fewer cases of genital paraesthesia and provided significantly better clinical outcomes in comparison with tenotomy from the central compartment.

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