Hip Preservation in the Lacrosse Athlete (Review)

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Abstract

Lacrosse continues to be one of the fastest growing sports in the United States. Despite this, few studies look at evaluation and management of hip related injuries, and one of the leading causes of hip injury, femoroacetabular impingement syndrome (FAIS), in Lacrosse athletes. Stepwise diagnosis and management of FAIS in the lacrosse athlete should take into account the uniqueness of the sport as both a cutting and overhead sport. Prior to proceeding with hip arthroscopy, conservative treatments should be trialed, and even if surgery is required, can often be used to delay surgery until the offseason.

Keywords: (max 6) Hip, groin, femoroacetabular impingement syndrome, labral tear, hip evaluation

Introduction

Hip and groin injuries are common occurrences in athletes that may result in significant time missed from sport.1,2 Femoroacetabular impingement (FAI) comprises a significant portion of these hip and groin injuries. The terminology of FAI “syndrome” (FAIS) emphasizes symptoms in conjunction with structural impingement, evaluated with clinical exam and imaging in addition to the athlete history to arrive at the diagnosis of FAIS.3 FAIS is due to abnormal contact between the femoral head/neck and the acetabulum which manifests as hip pain and loss of hip range of motion.3 Structural hip impingement may derive from an aspheric shape of the femoral head, resulting in diminished head/neck offset, termed cam morphology,1,4,5 or from focal or global acetabular over coverage, termed pincer morphology.6 These deformities are not mutually exclusive, and when both are present in the same hip it is termed mixed type impingement. Untreated hip impingement can lead to eventual damage to the acetabular labrum and articular cartilage, predisposing the hip to early osteoarthritis.7–11

A thorough understanding of the hip joint and surrounding anatomy is crucial in determining accurate diagnosis and precipitating factors to develop targeted treatment and prevention strategies for hip and
groin injuries in the lacrosse athlete. In FAIS, pathology is not necessarily limited to the hip joint. The restricted range of motion associated with the causative bony abnormalities in FAIS may also result in altered extra-articular pelvic motion through compensatory mechanisms. FAIS also has the potential to cause kinetic chain related issues, notably in overhead athletes where hip and core pathology results in increased stress seen by upstream or downstream joints in the kinetic chain. While much has been reported on hip and groin injuries in other cutting and overhead sports, such as soccer, basketball, and tennis, very little has been published on this topic related to lacrosse. This article reviews FAIS hip and groin injuries and outlines strategies for accurate diagnosis, leading to targeted hip preservation treatment options with specific emphasis on the lacrosse athlete, who are unique in that they participate in a sport categorized as both an overhead and cutting sport (Figure 2).16,24

Presentation and Clinical Evaluation

When evaluating hip and or groin pain in the lacrosse athlete, it is important to include FAIS in the differential. The hip and groin can be the location of pain or symptom presentation of multiple other pathologies, and these differential diagnoses should be excluded. These additional differential diagnoses are listed in Table 1. FAIS is believed to be in part developmental, due to the activities athletes perform while the femoral head/neck growth plate is open, resulting in repetitive stresses which stimulate the femoral growth plate to develop excess bone. As a cutting sport, lacrosse involves significant amounts of twisting, torquing, and repetitive impact and thus could pre-dispose for FAIS in this athlete population. As the popularity of the sport of lacrosse grows and year-round competition as well as sport specialization becomes more common, providers should be aware of the demands of these athletes as cutting and overhead athletes. Thorough evaluation of the athlete with hip pain is crucial to avoid misdiagnosing the condition as a “groin strain,” “groin pull,” “tight hip flexors,” or another generalized condition, and subsequently delaying appropriate treatment.

Symptoms

Symptoms associated with FAIS were outlined in the 2016 Warwick Agreement as “motion-related or position-related pain in the hip or groin. Pain may also be felt in the back, buttock, or thigh. In addition to pain, athletes may also describe clicking, catching, locking, stiffness, restricted range of motion or giving way.” Classically, the pain associated with FAIS is most commonly located in the deep anterior groin. Clinicians should ask the athlete to clarify location and activities/positions that provoke their pain. Often athletes may report groin pain with sitting, running, or jumping activities. Painful snapping in the anterior hip may be secondary to iliopsoas inflammation, a diagnosis also known as “internal snapping hip”; wherein the iliopsoas tendon glides across the femoral head and iliopectineal eminence when the hip goes from a flexion and external rotation to an extended position.

Being able to understand the athlete’s symptoms and expeditiously identifying the cause is important as prior research has shown diminished outcomes following treatment of FAIS with hip arthroscopy is linked to prolonged symptom duration. Additionally, recent literature has suggested that greater size of the pre-operative cam deformity can predict increased the severity of acetabular rim chondral...
damage, supporting the direct correlation of the deformity to cartilage damage.\textsuperscript{37} Despite this, recent evidence has shown high rates of symptom duration of greater than 1 year prior to seeing a hip arthroscopy specialist, in addition to seeing multiple physicians prior to presentation and definitive diagnoses of FAIS.\textsuperscript{38}

**Clinical Signs**

A thorough physical exam is of the utmost importance to determine the correct diagnosis of hip or groin pain. Previous studies have outlined physical exam strategies to elucidate clinical signs of FAIS.\textsuperscript{2,39–42} Loss of internal rotation of the hip has been associated with increased alpha angle, which is diagnostic for cam-type impingement (Figure 3).\textsuperscript{40} However, it should be noted that none of the provocative tests discussed here have substantial evidence to validate their accuracy when used in isolation. Thus, the astute medical care provider should be able to use the physical exam and these provocative maneuvers to narrow in on pain generators and gain an understanding of the hip motion and stability.

To guide treatment, it is important to first determine if the pain is coming from the hip or another radiating source. In assessment of athletes with hip pain, it is advised to utilize an efficient and reproducible stepwise process.\textsuperscript{42} Notably in the lacrosse athlete, who is involved in both cutting and overhead/asymmetric activities (Figure 2),\textsuperscript{16,24} the kinetic chain should be evaluated to identify concomitant or adaptive/maladaptive pathology.\textsuperscript{15}

The physical exam can begin with gait assessment (whether an antalgic gait is present or not, whether a Trendelenburg gait is present or not), foot progression angle, and limb alignment, all of which can be assessed by watching the athlete walk. With the athlete standing, the clinician can assess for the presence of varus or valgus limb alignment. The athlete’s gait should be assessed for a limp, shortened stance phase, centering weight over affected limb, as well as foot progression angle being either internally or externally rotated and signs of other foot anomalies, such as pes planovalgus. Alterations can also be made to the athlete’s gait to provoke symptoms and give clues to the pathology. For example, in performing the foot progression angle walking text, athletes with FAIS may have more pain while walking with an intoed gait, while walking with feet externally rotated may exacerbate symptoms in those with hip instability.\textsuperscript{43} It is also important to evaluate for ligamentous laxity, which can be accomplished by calculating the Beighton score.\textsuperscript{42,44}

Hip motion should be assessed for the degree of hip flexion and presence of pain with hip flexion. With hip at 90 degrees of flexion, internal and external rotation can be assessed.\textsuperscript{45} Previous research has demonstrated loss of internal rotation in young athletes corresponding to higher alpha angles (Figure 3) and increased prevalence of degenerative hip changes at five years.\textsuperscript{33} Flexion adduction and internal rotation (FADIR) or anterior impingement test (adduction and internal rotation with the hip at 90 degrees of flexion) should be performed with a positive test reproducing symptoms.\textsuperscript{41} Stability of the hip should also be assessed on clinical exam for presence of symptomatic focal acetabular undercoverage with a number of instability exam maneuvers (Table 2).\textsuperscript{42,46,47}

Hip strength is also assessed. Previous research has shown hip abductor strength is diminished in athletes with FAIS.\textsuperscript{14,48,49} Core muscle injuries (CMIs), formerly known as “sports hernias,” “sportsman hernias,” and “Gilmore’s groin” should be evaluated as well, as there is overlap of symptoms with FAIS and the two diagnosis often occur together.\textsuperscript{50,51} CMI symptoms can be replicated with resisted hip adduction as well as the resisted crunch maneuver.\textsuperscript{51} The location of CMI tends to be more central than
intra-articular pathology, and tenderness over the pubis or along the proximal adductors may be more consistent with CMI, as it is less likely present with FAIS alone. CMI injuries are one site of the adjacent joints and kinetic chain being affected, as is the pubic symphysis which is in very close proximity to the location of CMI. If an athlete complains of knee pain, a thorough assessment of the knee can rule out any primary knee pathology versus referred pain from the hip. The SI joint can be assessed by pain with direct palpation at the SI joint, or with posterior pain replicated in the flexion abduction external rotation (FABER) position. The lumbar spine can be assessed by evaluating whether pain exists with axial loading, or with spine provocative maneuvers such as a straight leg raise or slump test.

**Imaging**

A standard set of radiographs is used to evaluate each athlete presenting with hip or groin pain. These include standing AP pelvis, false profile, and 45-degree Dunn lateral (Figure 3). Radiographs are evaluated for signs of osteoarthritis (minimum joint space <2mm, Tönnis grade 2 or higher), indications of hip dysplasia or hip instability (lateral center edge angle <25 degrees, acetabular depth <9mm, Tönnis angle >12 degrees), indications of pincer type impingement or acetabular retroversion (positive cross over sign, posterior wall sign, positive ischial spine sign), and joint congruency. The 45 degree-Dunn lateral is used to assess femoral head-neck offset and presence of cam deformity, commonly defined as an alpha angle of >55 degrees (Figure 3). The false profile view gives an evaluation of the anterior coverage of the acetabulum and subspinous morphology. Further evaluation of presence of labral tear, articular cartilage damage, and any other intra-articular pathology is achieved with magnetic resonance imaging (MRI) (Figure 4). This is typically done on a 3-T MRI without intra-articular contrast, which has shown high rates of accuracy in a hip that has never before been operated on. If prior surgery has been performed, a magnetic resonance arthrogram (MRA), with intra articular contrast, is preferred for better differentiation of expected post-operative changes versus true pathology. If surgery is determined to be the best option for the athlete, or if further evaluation of athlete’s acetabular coverage or femoral version is needed, low dose, three-dimensional (3D) computed tomography (CT) can be obtained. This provides further understanding of the athlete’s acetabular coverage, femoral and acetabular rotational profile, and subspine region morphology.

It is important to recognize that the imaging findings of FAIS are common in asymptomatic individuals. In the general population, the prevalence of asymptomatic cam morphology was found to be 23.1% and labral injury was found on 68.1% of MRIs without intra-articular contrast. In athletes, the prevalence of an asymptomatic cam was between 37%-54.8%, and in athletes at the National Football League Scouting Combine, those with a history of hip pain or injury had a prevalence of cam- and/or pincer-type FAI in 94.3% of athletes. While the prevalence of radiographic markers of FAIS is not known in lacrosse athletes, it is likely similarly high, and thus the combination of history, presentation, physical exam findings with the radiographic findings is important in determining the management of FAIS.

**Management of FAIS**

*Nonoperative treatment options for FAIS*
Treatment of the lacrosse athlete with FAIS should account for the demands of the sport. The lacrosse athlete must not only be able to fulfill the requirements of a cutting sport, but also must be able to pivot and rotate their hips repetitively for the throwing component of their sport. Initial treatment may consist of non-steroidal anti-inflammatories (NSAIDs) for pain control and to decrease inflammation in conjunction with a physical therapy program. If further pain control is needed, an intra-articular corticosteroid injection can be performed, having both diagnostic and therapeutic benefits. This is also an option if the timing of the season does not allow for the postoperative rehabilitation (more below). Education of positions that create impingement (especially deep hip flexion and hip internal rotation as well as high hip flexion stretching) should be provided and athletes should be counseled on ways to avoid these impingement positions through activity and weightlifting modifications. Simple examples can include avoiding cross-legged sitting, adjusting chair height to avoid deep flexion of the hips, and modifications to lower body lifting to avoid excessive hip flexion. However, this may be difficult to avoid in the throwing athlete, where internal rotation of the lead leg is a necessary component of the throwing motion (Figure 1).

Athletes should understand the cornerstone of nonoperative treatment is physical therapy with specific attention to postural alignment, core strengthening, and hip strength and lower body control. In a cutting sport, such as lacrosse, addressing hip abductor weakness commonly seen in FAIS may also help combat other lower extremity injuries and altered kinematics seen with hip abductor weakness. Certain positions can also be avoided, such as high hip flexion stretching, which can aggravate impingement and subsequent pain in athletes with FAIS. Additional considerations of the requirements of specific positions of play should be part of the discussion as to whether nonoperative management is possible. For example, if a player’s position as a face-off athlete requires crouching and squatting, this can inevitably exacerbate FAIS symptoms.

Several studies have assessed the effects of physical therapy for the diagnosis of FAIS, especially as it compares to operative outcomes. In a randomized controlled trial conducted by the FASHIoN Study Group, there was a minimally clinically important difference (MCID) favoring hip arthroscopy over physical therapy. Additionally, a recent meta-analysis showed significant improvement activity of daily living and quality of life favoring hip arthroscopy versus conservative therapy.

**Hip Arthroscopy for the treatment of FAIS**

In those where expected treatment benefit is not obtained by nonoperative management, surgical options are discussed. For femoroacetabular impingement, this most often involves hip arthroscopy. Though less common, certain athletes with FAIS may still benefit from open procedures such as a surgical hip dislocation, including those with the diagnoses of coxa profunda or acetabular overcoverage. With hip arthroscopy, a spectrum of intraarticular and extraarticular pathology can be addressed. This often involves management of labral tears with concomitant procedures such as femoral neck osteoplasty, acetabular rim resection, subspine decompression, and chondroplasty as indicated.

Research on outcomes following hip arthroscopy specific to the lacrosse athlete is limited. Klingenstein et. al. performed a retrospective review of high-level (varsity, collegiate, and professional) baseball and lacrosse athletes. Their results showed that by 12 months postoperatively, 33 out of 34 athletes
returned to previous level of sport and demonstrated an increase in the modified Harris hip score from 70 to 92. The authors also provide insight into the mechanical nature of impingement in the throwing motion of the lacrosse athlete. During the follow through, they described the lead hip going into internal rotation, flexion, and adduction leading to impingement which is compounded as weight is transferred to the lead leg, resulting in increased trauma to the site of impingement (Figure 1).16

Using other sports with a similar biomechanical demand as lacrosse, such as soccer, basketball, and field hockey, one can evaluate results by sport category as opposed to analyzing each sport separately.24 In a recent meta-analysis cutting sport athletes were found to return to sport at a rate of 90.3% at an average of 8.5 months after hip arthroscopy.75 In the authors’ experience, most athletes who do not have confounding injuries or pathology are returning to sport a minimum of 4-6 months after surgery.

Immediately after hip arthroscopy, the authors’ preference is that athletes are 20% weight bearing on the operative extremity. Physical therapy begins within the first 1-3 days following surgery to begin gluteal activation exercises. They then wean off the crutches typically between postoperative weeks 2-3. Hip extension and external rotation are limited for the first 6 weeks to protect the labral and capsule repairs performed at the time of surgery. Starting at 6 weeks postoperatively, range of motion therapy and progressive strengthening are performed. The athlete is held from impact activities for the first 3 months. At approximately 3 months, restrictions are lifted and a sport specific progression begins. This typically lasts between 1-3 months, and athlete response to progression as well as return to sport testing administered by physical therapy will inform full return to competition (between 4-6 months after surgery). Athletes should be counselled of potential development of hip flexor/iliopsoas tendinitis as they begin to increase impact and running activities.

Considerations

For the in-season or immediately pre-season athlete, presentation, imaging, and clinical exam should be considered when determining best course of treatment. When discussing potential treatment options, the surgeon should gain understanding of the athlete’s current ability to compete as well as the progression of his/her symptoms and treatment goals going forward. For the athlete electing to proceed with sport, symptom management strategies should be discussed, including NSAIDs, strengthening programs, and judicious use of intra articular injections. There is little evidence available on the long-term consequences of playing with hip discomfort, yet athletes should be counselled on potential worse outcomes in delayed surgical management of FAIS.35,69,76,77

For athletes who are asymptomatic, the role of screening for hip pathology such as FAIS is controversial. While studies have demonstrated that athletes with limited range of hip motion have a high incidence of radiographic FAI and show increased degenerative changes on MRI when compared to matched controls,78,79 currently, the standard of care in diagnosing and subsequently surgically treating FAIS is reserved for symptomatic patients only. However, consideration should be given to the fact that the athlete may not realize he or she is symptomatic of hip problems, and instead believe he or she has a ‘groin sprain/pull’ or ‘adductor strain/pull.’ It is worth considering the addition of hip motion assessment to pre-season medical evaluation to identify hips at risk. Specifically, hips with limited internal rotation may be further evaluated for provocative test maneuvers, and if possible, imaging in the form of radiographs and/or MRI could be pursued.
Declaration of interests
The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:
Andrea Spiker reports a relationship with Stryker that includes: consulting or advisory.

Summary
Lacrosse athletes present unique features of an overhead and cutting sport. Athletes with continued groin pain should be evaluated for FAIS. Trial of nonoperative management may be effective to return the athlete to support, or at least allow the athlete to complete the season of play. High rates of return to sport have been observed in both overhead and cutting athletes undergoing hip arthroscopy.

References


67. Zogby AM, Bomar JD, Johnson KP, Upasani V v., Pennock AT. Nonoperative Management of Femoroacetabular Impingement in Adolescents: Clinical Outcomes at a Mean of 5 Years: A


Table 1. Differential Diagnosis of Hip or Groin Pain (other than FAIS)

<table>
<thead>
<tr>
<th>Differential Diagnosis of Hip or Groin Pain other than FAIS (with typical location of pain)</th>
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<tbody>
<tr>
<td>Osteitis Pubis (midline pain)</td>
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<td>Stress Fractures (femur, ischium, pubis)</td>
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<tr>
<td>Avulsion Fractures (from AIIS, ASIS, iliac crest, lesser trochanter, ischium)</td>
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<tr>
<td>Intra-articular cartilage damage (femoral or acetabular cartilage, deep joint pain)</td>
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<td>Nerve Compression/Radicular Pain (lateral femoral cutaneous nerve, sciatic nerve)</td>
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<td>Adductor Strains (medial thigh or pubic ramus)</td>
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<td>Core Muscle Injury (pubic ramus, medial thigh)</td>
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<td>Iliopsoas Strains (anterior hip)</td>
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<td>Gluteus tears or tendinopathy (lateral hip)</td>
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<td>Snapping Hip (internal at anterior hip/groin or external at lateral hip)</td>
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<td>Osteoid osteoma (of femur or acetabulum)</td>
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Table 2. The senior author's preferred clinical documentation for examination of hip motion and rotation profile as well as provocative tests.

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<th>Hip Motion and Rotational Profile</th>
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<tr>
<td>Flexion</td>
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<td>Internal Rotation (IR) at 90°</td>
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<td>External Rotation (ER) at 90°</td>
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<td>IR in Hip Extension</td>
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<td>ER in hip Extension</td>
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<td>Hip Abduction</td>
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<td>Prone Thigh/Foot Angle</td>
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<td>Prone IR/ER</td>
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<td>Hip Craig’s Test (Trochanteric Prominence Angle)</td>
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<th>Provocative Tests</th>
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<td>Sub-Spine Impingement Sign (Anterior Pain with</td>
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<td>Impingement (Flexion, Adduction, Internal Rotation or FADIR)</td>
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<td>Superolateral Impingement / Anterior/superior Capsule Irritation (Flexion, Abduction, Internal Rotation or FABER)</td>
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<td>Trochanteric Pain Sign (Posterolateral pain in FABER)</td>
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<td>Instability (Extension / ER with Anterior Pain)</td>
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<td>Posterior Impingement (Extension / ER with Posterior Pain)</td>
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<td>Lateral Rim Impingement (Pain with abduction)</td>
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<tr>
<td>Ischio-Femoral Impingement Sign (Posterior pain with Ext / ER)</td>
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<td>Stinchfield Test (pain with resisted straight leg raise)</td>
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<td>Prone Apprehension Relocation Test (PART)</td>
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IR = internal rotation; ER = external rotation

Figure 1. Flexion, adduction, and internal rotation of the lead leg during the throwing motion of a lacrosse athlete. Photo of: Tyler Warner, PLL Whipsnakes LC midfielder. Courtesy of Catherine Logan, MD.
Figure 2: Lacrosse is a unique sport as combines skills of both overhead and cutting sports. Myles Jones, PLL Redwoods LC midfielder taking a shot. Courtesy of Photographer: Sam Brettschneider, Premier Lacrosse League.

Figure 3: A) Standing AP pelvis with measurement of lateral center edge angle. Using the center of the femoral head, the angle of a line perpendicular to the ischial tuberosities and a line from the center of the femoral head to the lateral acetabulum is measured. B) Supine 45-degree Dunn view of left hip with measurement of alpha angle. This is measured from a line starting at the center of the femoral head, parallel to the femoral neck and a line from the center of the femoral head to the point at which the femoral head/neck exits a perfect circle. C) Standing false profile view of left hip.
Figure 4: 3T MRI A) Sagittal T2 sequence of left hip showing anterosuperior labral tear (arrow). B) Coronal T2 sequence showing labral tear (arrow) and lateral cam deformity (asterisk).
Informed Patient Consent

The author(s) should confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

Please refer to Elsevier’s policy regarding written patient consent requirements
https://www.elsevier.com/about/policies/patient-consent#:~:text=That%20individual%2C%20legal%20guardian%20or%20writing%20of%20all%20such%20conditions

☐ Complete written informed consent was obtained from the patient for the publication of this study and accompanying images.

☒ The authors declare that informed patient consent was not provided for the following reason:

As this is a review article, no patient informed consent was necessary.