Journal of Hip Preservation Surgery Vol. 8, No. Suppl. 1, pp. i51–i59
doi: 10.1093/jhps/hnab020
Supplement

The case of 'A Rhino Horn': case report and proposal for modification to the Hetsroni and Kelly classification

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Submitted 25 January 2021; Revised 11 March 2021; revised version accepted 12 March 2021

ABSTRACT

Subspine impingement syndrome by definition involves a prominent antero-inferior iliac spine (AIIS) which can lead to impingement on the femoral neck thereby causing symptoms. We present the case of a 22-year-old semi-professional athlete who presented with a Type III AIIS morphology leading to subspine impingement syndrome and was managed via a mini open anterior approach. Radiological examination revealed a fairly prominent left AIIS resembling the 'horn of a rhino' extending to the trochanteric region anteriorly. A mini-anterior surgical approach was utilized for the resection of the 'rhino horn' and the rectus femoris was reattached. The patient remained asymptomatic at the one-year follow-up and had resumed weightlifting. Following this case, we propose a new classification of the type III AIIS morphology in view of the clinical presentation. The AIIS type III-Standard represents an extension from the acetabular rim to less than 1 cm (type III-S) and type III-Large, with an extension from the acetabular rim beyond 1 cm (type III-L). The type III-L will further be divided into two groups based on its relation to the ilium, type III-Lr ('rib shape') and type III-Lrh ('rhino horn').

INTRODUCTION

A prominent antero-inferior iliac spine (AIIS) morphology has been associated with groin pain and the development of extra-articular joint pathology. Subspine impingement syndrome (SIS) by definition involves prominent AIIS and its associated hip-related symptoms [1, 2]. Hypertrophy of the AIIS can result from repetitive hip flexion such as deep squatting [3, 4]. Prominence of the AIIS has also been associated with chronically malunited avulsion of the rectus femoris insertion [5]. AIIS morphology has been described as three different types. Type I with a normal shape of AIIS that does not reach acetabular rim. Type II morphology where AIIS extending to the level of acetabular rim. Type III morphology of AIIS extending beyond the acetabular rim [2]. Clinical evaluation of SIS includes limited range of motion (ROM), especially in flexion. A positive subspine impingement test is described as anterior hip pain with direct hip flexion above 90° in the supine position [6–8]. Imaging evaluation should include plain radiographs, magnetic resonance imaging (MRI) and computed tomography (CT) with 3D reconstruction. Type III prominent AIIS can be easily observed in plain radiographs, mainly in axial and false profile view. However, CT with 3D reconstruction can provide a detailed assessment of AIIS morphology [9, 10]. Arthro-MRI or 3Tesla MRI usually complete the imaging protocol. MRI imaging assesses the intra-articular lesions that can be associated with SIS. Treatment should be commenced with

conservative means like anti-inflammatory medication, physical therapy and activity modification. If this fails however, surgical treatment has demonstrated good clinical results [11]. Arthroscopic and open approaches have both been described with good outcomes [12].

The aim of this case report is to present current management of subspine impingement syndrome with AIIS morphology type III in a semi-professional athlete by means of a mini open anterior approach.

CASE REPORT

History

A 22-year-old male athlete presented with a history of groin pain during and following sporting activities. Groin pain was worse during maximal flexion of the hip. Over a 3 month span, his activity tolerance reduced considerably and he was unable to squat. He required pain medications specifically anti-inflammatories for both sport and activities of daily living on a regular basis. Apart from well-controlled type 1 diabetes, he was otherwise healthy and played recreational soccer.

Physical examination

He had notable fullness in the anterior aspect of his hip, which was mildly tender on palpation. Anterior impingement test of the hip was positive with limitation of internal rotation (IR) (only 5° of IR with 90° hip flexion). Antero-inferior iliac spine test was positive with a hip flexion limited up to 90°. External rotation was also limited to 20°. His motor strength was well-preserved and no other positive tests on clinical examination.

Imaging

Antero-posterior (AP) view of the pelvis and the 45° Dunn axial views were obtained. The hip joint space was well-preserved. Bilateral cross-over signs and medialization of ischial spine was observed on the AP pelvis. A prominence of both antero-inferior iliac spines was observed which was more notable on the left. The AIIS was shaped like a 'rhino horn' was found to extend to the trochanteric region anteriorly (Fig. 1). The alpha angle was measured

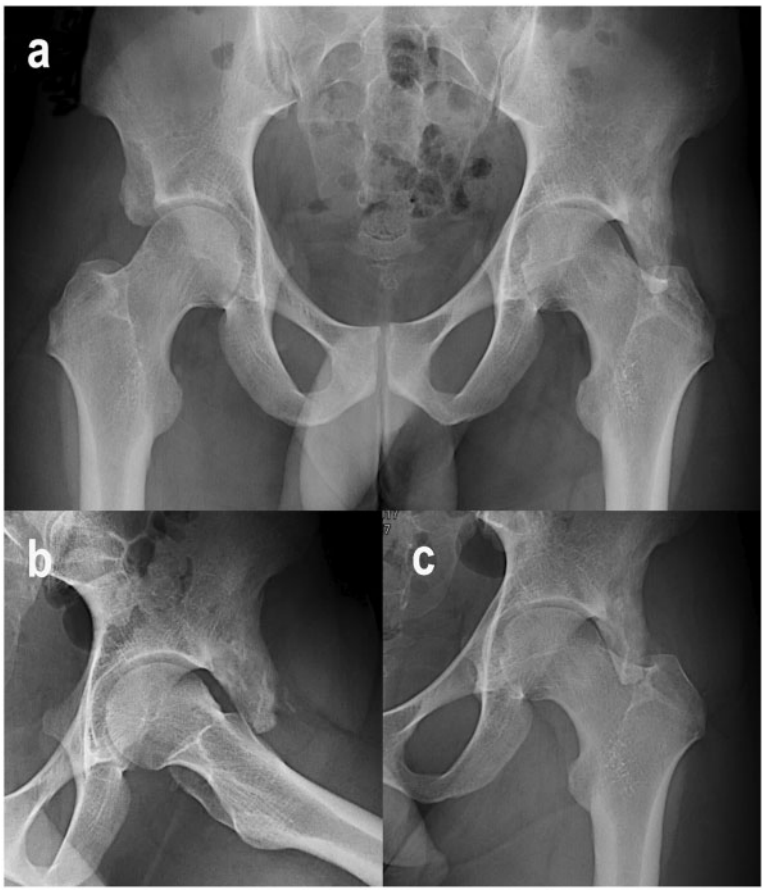

Fig. 1. Pre-operative radiographs. (**a**) AP pelvis view with bilateral prominent AIIS type III. (**b**) Axial view of the left hip with AIIS type III where 'rhino horn' morphology is clearly observed. (**c**) Left hip antero-posterior view.

to be 52°. Mild overcoverage was detected with a Tönnis angle 2° and the Wiberg angle of 47°.

Arthro-MRI

A direct arthro-MRI 1.5 T was obtained following institutional protocol [13]. Lidocaine 1% was added to the contrast solution and 10 kg traction was applied to the affected lower extremity to improve visualization of articular structures. Normal cartilage visualization was appreciated along the joint. Intra-substance changes at antero-superior labrum were detected, with preserved chondro-labral junction. Alpha angle was within normal values (51°). Capsule and other structures were normal. A prominent AIIS was detected, extending anteriorly up to intertrochanteric region (Fig. 2).

Computed tomography

Standard institutional protocol CT Pelvis was performed with 3D reconstruction (Horos™ free software. Horosproject.org). Bilateral AIIS prominence was reported, with left AIIS reaching the intertrochanteric ridge. Left AIIS extend from its insertion at ilium, moving towards the anterior region of the hip. The maximum length was 4.5 cm with a maximum width of 3.05 cm. (Fig. 3).

Treatment

An initial trial of conservative management was attempted but since there was no improvement after a 6-months surgical intervention was recommended. The anterior hip capsule was approached via the mini-anterior approach through a window between the tensor fascia lata and the sartorius/rectus femoris muscles. The prominent AIIS was visualized, extending from its wide base at the ilium to the intertrochanteric ridge, parallel to the anterior capsule. The maximum length of the AIIS was 4.5 cm with a width of 3 cm (Fig. 4).

The AIIS was resected with a 5 mm round burr, starting at the wide implantation at the ilium. The anterior rectus attachments on the prominent AIIS were dissected and the complete AIIS fragment was completely released. We continued with the complete excision of the AIIS to the base of the ilium. Intraoperative subspine impingement test was performed until absence of mechanical conflict with hyperflexion (120°). Direct portion of rectus femoris was reattached to the ilium with two anchors (Peek Press FT™ 2.6 mm Conmed©) (Fig. 5). The hip joint was examined

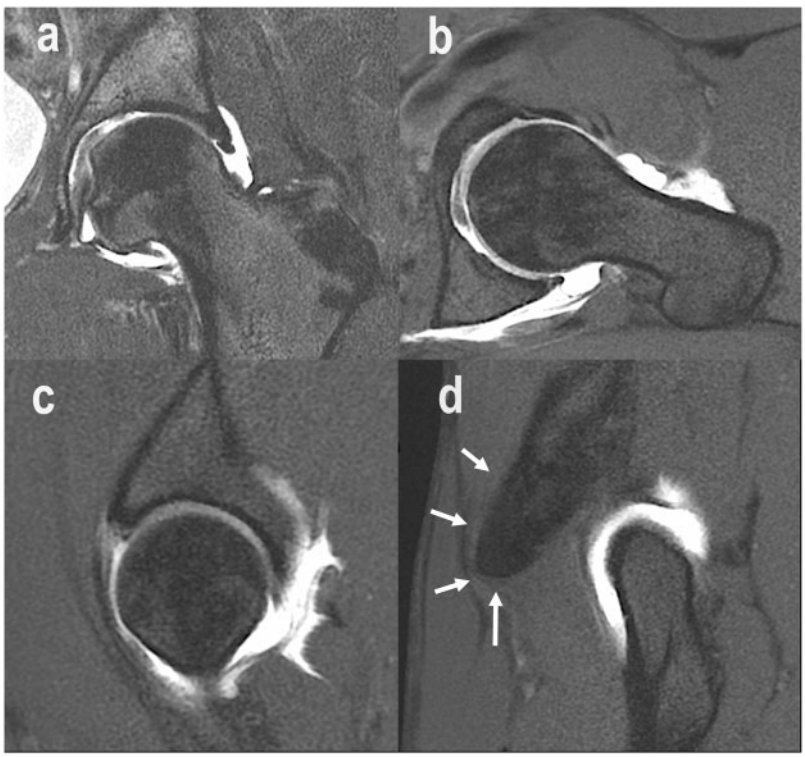

Fig. 2. Direct Arthro-MRI with traction. (**a**) Coronal cut of the left hip. (**b**) Axial reconstruction. (**c**) Sagittal oblique view. (**d**) Sagittal view. AIIS type III (white arrows) with a broad base of implantation into ilium.

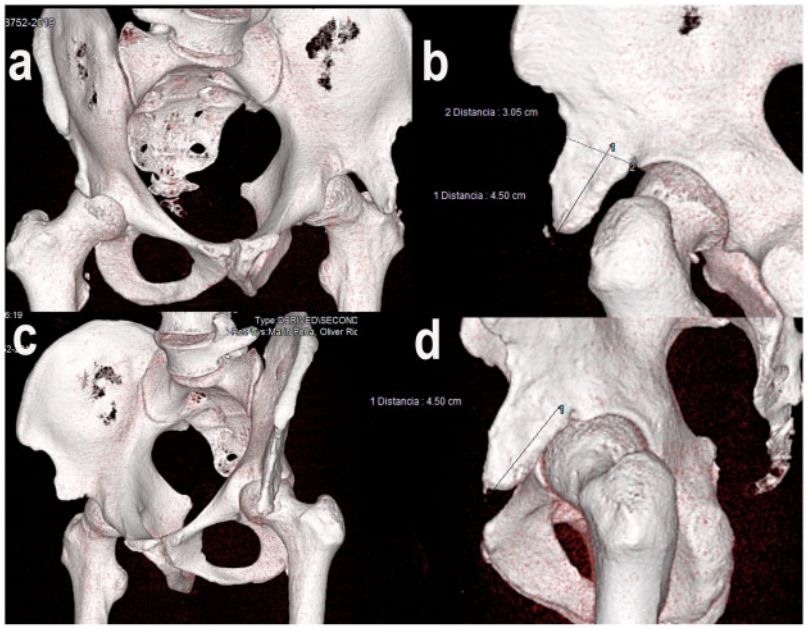

Fig. 3. 3D reconstruction of computer tomography images (Horos™ free software. Horosproject.org). (**a**) Bilateral AIIS type III. View from right side. (**b**) Left hip AIIS type III 'rhino horn' morphology with a wide base in its proximal contact with ilium (3.05 cm width) and a large extension up to the intertrochanteric ridge (4.5 cm length). (**c**) Bilateral AIIS type III. View from left side. (**d**) Left hip AIIS type III (4.5 cm length).

Fig. 4. Mini-anterior approach of the left hip. AIIS type III (white arrows). Patient positioned supine with skin incision from antero-superior iliac spine (upper left corner image). Capsular exposure (image bottom left corner). 3D CT reconstruction to explain patient positioning and bone orientation (upper right corner).

through a 'T' shape capsular opening. Arthroscopically assisted, no disruption of the chondro-labral junction was observed and no labral elevation was detected with impingement and subspine tests. The capsule was closed with Ethibond™ 3-0 suture (Ethicon-Johnson& Johnson©). The fascia and the subcutaneous layers were closed subsequently.

Post-operative management

Post-operative heterotopic calcification prophylaxis included Etoricoxib 60 mg QDS for 3 weeks. Thromboprophylaxis was commenced with bemiparin sodium 3500 QD for 3 weeks. The patient was allowed to walk with crutches and partial weight bearing since same day and was recommended to do this for the first 3 weeks. Post-operative rehabilitation protocol began with stationary bike and isometric exercises at the 3rd week. Hip flexion was restricted to 90° and hip extension was avoided during the first 4 weeks.

At six weeks, plain radiographs and CT 3D reconstruction demonstrated a nearly normal AIIS morphology (Fig. 6). The patient walked without crutches pain free and was able to flex the hip more than 100°. Subspine test and impingement test were negative (Fig. 7a and b images).

At sixteen weeks, the patient resumed sport activities without any limitation. He was able to continue with deep squatting exercises with moderate weights (Fig. 7). The patient was able to resume weightlifting practice at 6 months and participate in competitive events at 1 year. Patient reported outcome measures improved as follows: global

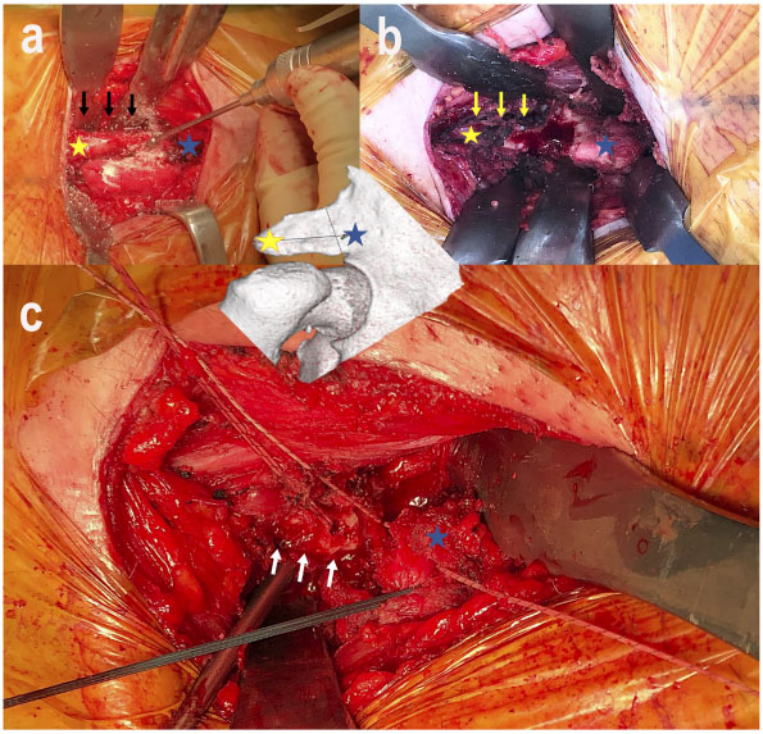

Fig. 5. Prominent type III AIIS resection. (**a**) AIIS (black arrows) resection with a 5 mm burr from the ilium insertion of the AIIS (blue star). (**b**) Complete reattachment of AIIS (yellow arrows) from its ilium insertion (blue star). (**c**) Reattachment rectus femoris (white arrows) with two anchors into the remaining AIIS (blue star). 3D CT reconstruction (central image) to explain patient positioning and bone orientation (upper right corner). Ilium insertion of the AIIS (blue star) and free margin of the AIIS (yellow star).

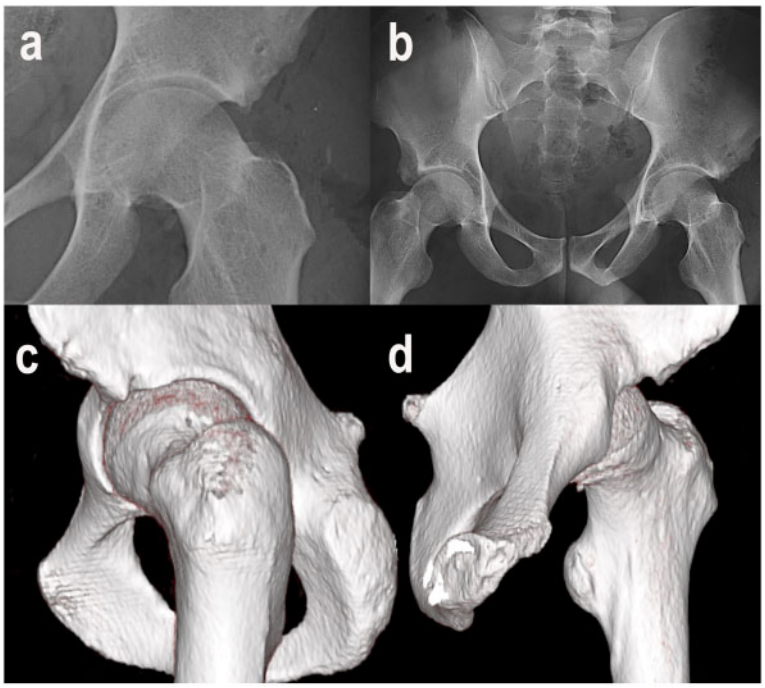

Fig. 6. Post-operative radiograph and CT 3D reconstruction (6 weeks). (**a**) Post-operative axial view radiograph. (**b**) Post-operative AP pelvis view radiograph. (**c** and **d**) Post-operative CT 3D reconstruction showing AIIS type III resection.

Fig. 7. Post-operative clinical progression. At 6 weeks, (**a**) flexion above 100° was achieved and (**b**) subspine impingement test was negative, improving adduction–internal rotation. 16 weeks visit, (**c**) left hip extension during weightlifting practice and (**d**) weighted deep squatting.

iHOT 33 score from 31.6 pre-operatively to 92.7 at 1 year post-operatively. iHOT33 Function from 36.89 pre-operatively to 94 at 1 year post-operatively. iHOT33 Sport from 12.02 pre-operatively to 86.6 at 1 year. iHOT33 Job from 56.75 pre-operatively to 96.25 at 1 year. iHOT33 Social/Emotional from 41 pre-operatively to 92 at 1 year. Regarding Hip Outcome Score (HOS), both subscales improved at one year. HOS-ADL subscale from 75 pre-operatively to 97.06 at 1 year and HOS-Sport subscale from 47 pre-operatively to 94.44 at 1 year post-operatively.

DISCUSSION

Subspine impingement syndrome with the associated 'rhino horn' shape of the AIIS can be an important cause of limitation of ROM and can influence the quality of life and also participation in sporting activities. A continuous indulgence in sporting activity during childhood and adolescence that causes repetitive traction of rectus femoris from its proximal insertion has been proposed as a risk factor for developing a prominent AIIS [14]. Our patient indulged in weightlifting practice since childhood, confirming our suspicion about a chronic injury to the rectus femoris insertion in both hips. However, acute injury with a displaced avulsion of the AIIS has also been described as a cause of SIS [15–17]. In our case, we ruled out an acute displaced avulsion as the cause of the 'rhino horn' morphology. Osteogenesis imperfecta was also considered as a risk factor that could potentially lead to heterotopic ossification. Furthermore, osteogenesis imperfecta type V have been proposed to have high incidence of heterotopic ossification, especially at the tendon–bone attachment [18]. Several publications have reported on the prominent AIIS related to heterotopic ossification [9, 19–22]. In most of these publications, radiological findings mostly showed up long (>1 cm) and thin AIIS ('rib shape') instead of the 'rhino horn' shape AIIS with a wide base of implantation that we have shown in our current report. The classification of AIIS morphology has established the Type III morphology as the AIIS prominence extending beyond the acetabular rim, but no difference was described between the 2 mm projection and the 40 mm projection [2, 23]. Moreover, the larger type III AIIS was associated with more limitation in the ROM and consequently, limitations in activities that require deep hip flexion as weightlifting

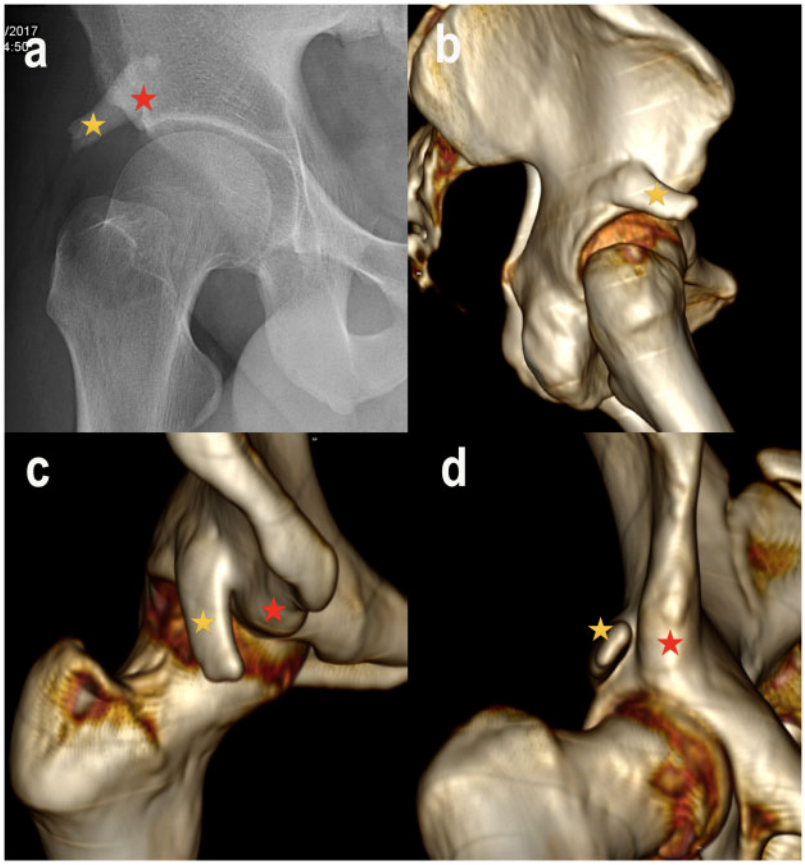

Fig. 8. Type III-Lr AIIS ('rib' morphology). (**a**) Thin and large AIIS (type III-Lr). (**b–d**) 3D CT reconstruction Type III-Lr AIIS ('rib' morphology). Heterotopic calcification of the reflex part of the rectus femoris (yellow star) and visualization of AIIS (red star).

[3, 4, 11]. Excellent results have been published with arthroscopic treatment of subspine impingement [5, 11, 12, 24] but no distinction has been made regarding arthroscopic treatment management of type II and type III AIIS morphology. Furthermore, different management strategies should be considered if we compare type III morphology that extend up to 1 cm beyond the acetabulum and those that extend beyond 1 cm. Larger type III (>1 cm beyond acetabular rim) are usually associated with significant damage to the rectus femoris and may require a more complex tendon reconstruction. Shape of the proximal junction to the ilium could also influence surgical planning. Wide base implantation in large type III AIIS ('rhino horn' morphology), will be more difficult to excise than those with a cylindrical or tubular morphology ('rib' morphology). Even though, both 'rib' shape or 'rhino horn' could be managed arthroscopically, the mini-anterior approach could be an alternative to treat 'rhino horn' type III AIIS due to its versatility that allows AIIS resection, rectus femoris reinsertion and also the treatment of intra-articular pathology. In line with the previous considerations, we propose classifying AIIS type III into two groups. AIIS type III-Standard, with an extension from the acetabular rim to less than 1 cm (type III-S) and type III-Large, with an extension from the acetabular rim beyond 1 cm (type III-L). The type III-Large (type III-L) will be further subdivided into two groups based on its proximal junction to ilium, type III-Lr ('rib shape') (Figs. 8 and 9) and type III-Lrh ('rhino horn') (Fig. 9). Proposed development mechanism, clinical management and treatment options for different type III AIIS morphologies are summarized in Table I. As proposed in recent publications, 3D printing models could have a role for better understanding and choosing the best treatment option in this Subspine Syndrome Type III [25].

Improvement in hip specific clinical scores was observed after arthroscopic and open treatment of subspine impingement syndrome. IHOT33 and HOS-ADL and HOS-Sport have been widely used in preserving hip surgery and demonstrated the benefit of this surgery in sport practice patients. Minimal clinically important difference (MCID) and substantial clinical benefit (SCB) of

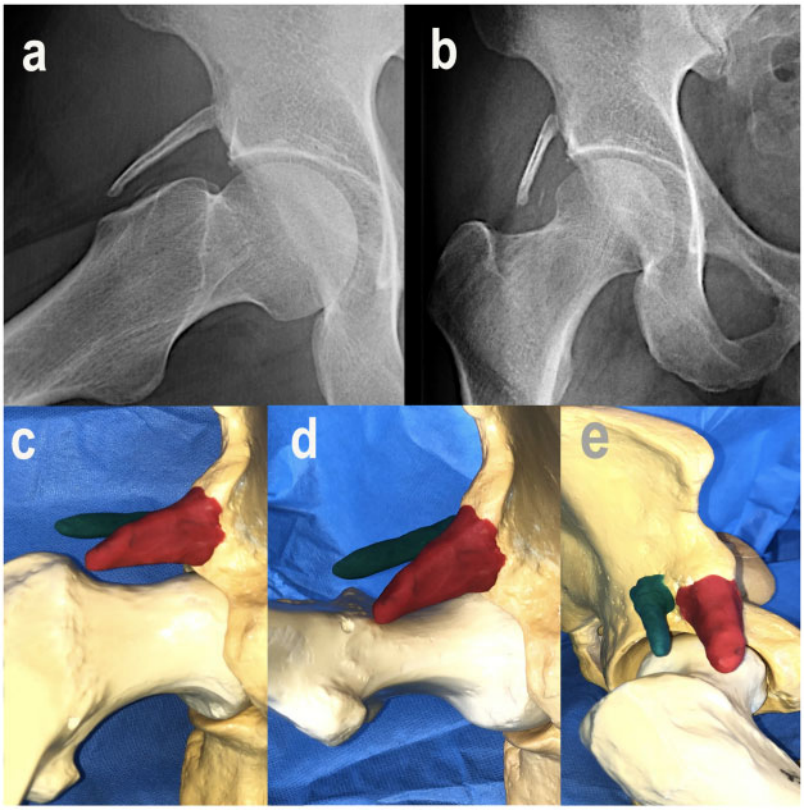

Fig. 9. Type III-Lr AIIS ('rib' morphology). (**a** and **b**) plain right hip AP and axial views of Type III-Lr AIIS ('rib' morphology). (**c–e**) Sawbones model of proposed type III-L classification: Type III-Lr associated to direct part of rectus femoris acute/chronic injury (in green) and Type III-Lrh associated to reflex part of rectus femoris acute/chronic injury (in red).

Table I. Classification of Type III AIIS (beyond acetabular rim) and descriptions

AIIS type III	*Distance (beyond acetabular rim)*	*Junction to ilium*	*Developmental mechanism*	*Shape*	*ROM limitation*	*Surgical approach*
Type III-S (standard)	<1 cm	broad	Chronic repetitive traction direct portion of rectus femoris (during development)	'bump'	++	Arthroscopic
Type III-Lrh (large 'rhino horn')	>1 cm	wide	Chronic repetitive traction (during development) or chronic avulsion direct portion of rectus femoris	'rhino horn'	+++	Arthroscopic or mini-anterior
Type III-Lr (large 'rib')	>1 cm	thin	Heterotopic calcification of the reflex part of the rectus femoris	'rib'	+	Arthroscopic or mini-anterior

patient reported outcomes were established to objectively measure clinical results. Threshold value for MCID ranged between 10.7 and 12.1 in iHOT33, 8.3 and 9.8 in HOS-ADL, and 12.1 and 14.5 in HOS-Sport. Moreover, SCB values have been directly associated to the clinical benefit appreciated by the patient. SCB threshold values ranged between 24.5 and 38.8 in iHOT33, 10 and 20.6 in HOS-ADL, and 29.9 and 41 in HOS-Sport [26]. Compared with

pre-operative values, one-year post-operative improvement in our patient was 57.24 in iHOT33, 22.06 in HOS-ADL and 47.22 in HOS-Sport. These results by far exceed MCID and SCB.

CONCLUSION

Subspine impingement can negatively impact hip function and overall quality of life. A large type III AIIS morphology (type III-L) could be associated with important limitations in these patients. Surgical management can be an effective definitive treatment. Future studies should assess anatomical variations associated with symptomatic morphology particularly the wide base of insertion of the 'rhino horn'.

CONFLICT OF INTEREST STATEMENT

All authors have nothing to disclose that could have direct or potential influence or impart bias on the work.

FUNDING

This paper was published as part of a supplement financially supported by the European Society for Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) www.esska.org.

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