

## APOPHYSEAL AVULSION FRACTURES OF ANTERIOR INFERIOR ILIAC SPINE

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**Abstract**— Goal. We aim to present diagnostic approach and results from surgical treatment in avulsion fractures of the apophysis of Spina Iliaca Anterior Inferior (SIAI).

**Material and methods.** During the period 2011 – 2021, seven(7) children with acute traumatic apophysiolyis of SIAI, were operated on, 61 A1.2 fracture by AO/OTA classification. All of the patients are boys with average age 14,1±1,35 years. In all cases the right SIAI is affected and the mechanism of the injury is sports trauma. The diagnostic methods used by us are complete orthopedic clinical examination, AP radiographs of the pelvis and lateral radiographic projections of the hip joint by modified Dunlap technique and also CT scan with 3D reconstruction of the pelvic bones (3cases). In four (4) cases the apophysiolyis are Salter-Harris type I and in three cases – SH type II. The average size of the avulsed bone fragment is 3cm/1cm measured on CT scan and 29,66±3,14 mm on AP radiographic view. Dislocation of the fractured fragment is greater than 1,5cm. In four children the diagnosis from the outpatient care is neglected or primary wrong. This fact procrastinated the treatment for between 15 and 30 days. In the rest of the cases the treatment is prompt in an urgent matter. For all patients open reduction and internal fixation with screw osteosynthesis is performed by using one (4 cases) or two (2 cases) 3,5mm cannulated titanium screws. Consolidation of the fracture and the functional condition by Lower Extremity Functional Scale (LEFS) have been followed.

**Results.** Radiographic proven consolidation of the fracture occurred in all patient until the 90th postoperative day. Preoperatively LEFS is calculated on 57,48±15,62 points average. On 6th postoperative month in all patients active motions in the ipsilateral hip and knee joints are in full range. LEFS at this time is 92,57±3,10 points average. At the end of the follow up period all children returned to their usual sports activities, as two of them are competing footballers. We have not extracted the osteosynthetic materials in any of the cases.

**Conclusions.** For apophysiolyis of SIAI with dislocation exceeding 1,5 cm and size of the fragment bigger than 2 cm, we recommend surgical treatment by reduction and titanium cannulated screw osteosynthesis. This therapeutic approach ensures both early functional recovery and return to active sports activity in 90th postoperative day. Early diagnosis is essential for good therapeutic outcome. Thus, we recommend mandatory radiographic examination of the pelvis and the hip in two projections, in all cases of painful symptoms in this area or anterior thigh.

**Keywords**— apophysiolyis, spina iliaca anterior inferior, screw osteosynthesis, pediatric pelvic fractures.

## 1. INTRODUCTION

Pelvic apophyses damage is typical trauma in adolescent athletes. In this age group, because of the low trabecular density of the physis, injuries due to excessive traction can cause apophyseal avulsion fractures. The apophysiolyis of spina iliaca anterior inferior (SIAI) has the highest incidence, between 33.2% - 49% of all pelvic apophysiolyises.<sup>5,8,17</sup> It is a result of eccentric contraction of M. rectus femoris. In 1929 Kohler is the first to report a case of avulsion of SIAI, whereas later the pathogenetic mechanisms are described in details by Wuensch (1959), Jansen and Kortmann (1975). However, these injuries are often diagnosed as muscle or tendon sprain with frequently missed or wrong primary diagnosis.<sup>18,21</sup> For this reason we present the experience with this pathology of the Department of Pediatric orthopedics of UHO “Prof. B. Boychev”-Sofia.

## 2. CLINICAL MATERIAL

For a ten-year period 7 children with the considered pathology have been treated in the clinic. All of them are males with average age of  $14.1 \pm 1.35$  years (min-12y.8m., max-16y.5m.). Adolescents have had normosthenic to asthenic body habitus. In all cases, the apophysiolyis is on the right SIAI. In five of the patients the acute moment is during football game and in two during athletics sprint. Sudden onset of acute pain has subsided within 10-15 minutes and the children have continued training. Within the same day, the pain have intensified and it has had inguinal localization. Pain has enhanced by active flexion in the knee joint and movements in all planes in the hip joint. Gait has been impaired. In outpatient care, the diagnosis in four of the children was missed, as it was considered for “sprain” and physiotherapy was prescribed. In two of the adolescent patients the diagnosis is primarily wrong, although AP X-ray of the hip joint was made. In these cases the correct diagnosis has been defined in our clinic between 7th and 15th day after the incident. The other three patients have been diagnosed within first 24 hours of the injury.

According to our diagnostic protocol at admission to the clinic, all children underwent a complete orthopedic clinical examination, radiography of the pelvis in AP view and lateral view of the hip joint using modified Dunlap technique. In three of the children the diagnosis has been confirmed by CT scan with 3D reconstruction of the pelvic bones. On physical examination, there was palpable pain around the affected inguinal area with irradiation towards the anterior and anteo-medial side of the thigh. Active hip flexion and passive extension have been painful and between  $20^\circ$  and  $40^\circ$  below normal ranges. X-ray examinations have shown traumatic apophyseolysis of SIAS with dislocation. In four (4) cases it has been type I by Salter-Harris and in three – SH type II. The size of the avulsed bone fragment is average 3cm/1cm on CT scan and  $29,66 \pm 3,14$  mm on AP radiographic view. According to AO/OTA classification the fracture is group 61A1.2.

All patients have undergone surgical treatment - open reduction and cannulated screw osteosynthesis. Surgery has been done under spinal anesthesia. In three of the cases, the operation has been performed within the first 72 hours from the injury and in the rest, between 2 and 4 weeks after the trauma. Intra-operatively we use radioscopic control.

**Surgical technique.** We use the longitudinal part of Smith-Petersen approach. Deep advancement to the fractured fragment is between M. tensor fascia lata and M. sartorius. N. cutaneus femoris lateralis is identified and protected. Avulsed fragment is revealed along with the inserting M. rectus femoris. Fracture surfaces are cleaned of bone debris, interposed periosteum and ligaments. Reduction is performed under X-ray control using a small tapered reduction bone clamp and previously inserted in the fragment K-wire. The last one we use as a joystick and later as a guide wire for the cannulated screw. As soon as proper reposition is achieved, the fixation is done with one (4 cases) or two (2 cases) 3.5 mm cannulated titanium screws. (Figure 1) The screw has to be placed in the bone fragments through the muscle insertion, perpendicular to the fracture line. Drainage is put and left for 24 hours.



Fig1. ♂, 15y.4m. A,B – diagnostic X-rays in AP and lateral views, length of the bone fragment 28 mm. C,D – ST scan – dislocation over 20 mm. E,F – X-rays in two projections on 80th postoperative day – complete consolidation of the fracture.

Postoperative protocol has been divided into 2 phases. During the first phase, covering the period from the operation till the 30th postoperative day, main goals have been pain control and isometric exercises in order to improve vascularization in the area. Permissible hip movements must not exceed 5° of extension in the hip joint with the knee flexed up to 15°. Walking has been performed with aids (crutches), allowing non weight bearing of the affected limb until the 5th postoperative week. Second phase of the rehabilitation protocol includes the period from 30th postoperative day till the end of the 3th month. It is aimed towards painless sitting, rising up, squatting and normalizing of the gait, avoiding dynamic physical activities. Excessive range of motions in the hip joint like high angles of flexion and extension and also running are

forbidden. We have allowed sports activities after the 3th month when the avulsion has been consolidated.

### 3. RESULTS

Follow-up examinations with radiographs have been performed on the 30th and 90th postoperative day and then every 6 months until two years after surgery. Bone healing has been monitored along with functional status according to the Lower Extremity Functional Scale (LEFS) (normal values of 80-100 points).

In all children, radiological bone healing has occurred for 3 months. There are no cases of delayed consolidation, secondary dislocation and migration of osteosynthetic material. Diagnostically on the follow-up X-rays the fracture has completely consolidated on the 18th postoperative month in all children. There is no difference in the closing time of the physis compared to the opposite healthy side. (Figure 1)

Patients' status by LEFS has been assessed preoperatively at an average of  $57.48 \pm 15.62$  points. In all patients, at the 6th postoperative month, the active motions in the hip and knee joint have been in full range. LEFS at the end of this period has been average  $92.57 \pm 3.10$ . At the end of the follow-up period all children returned to their usual sports activities, as two of them are competing football players.

In one patient postoperative neuropraxia of N.cutaneus femoris lateralis has occurred with the clinical expression of Meralgia paresthetica. Symptoms gradually have disappeared without treatment within 90 days.

Mean duration of surgery has been  $69.16 \pm 9.17$  minutes, intraoperative blood loss has not exceeded 50 ml and the X-ray exposure time has been less than 2 minutes.

In none of the cases, we have extracted any osteosynthetic material.

### 4. DISCUSSION

Apophyses of the pelvis, as well as all other growth centers of the child's skeleton are highly specialized bony-cartilage structures that exist throughout the whole embryonic period, during childhood and puberty until the end of growth. The apophysis of SIAI is a secondary center of ossification, which appears during adolescent age, around 13-14 years and ossifies approximately 2 years later.<sup>15</sup> This is the age when traumatic apophysiolysis occurs, between 12 years 6 months and 16 years.<sup>8</sup> It coincides with that from our series. The lesion is more common in boys - 75.5% - 77% of the total studied population.<sup>5</sup> In our clinical study 100% of the cases are males. Most likely this is related to the higher sports activity of the boys at this age in Bulgaria, as we also accept an unproven, probable endocrine cause.

Globally, the incidence of pelvic avulsions is not precisely determined. The reason is the frequent underestimation of symptoms and lack of exact diagnosis. They are estimated to be 4% of all pelvic fractures and 1.4% of all athlete fractures.<sup>11</sup> Meta-analyzes identify avulsion of SIAI as the most common apophysiolysis in the pelvic

region.<sup>5, 8</sup> Our observations also confirm this, as for the same period we have had only sporadic cases of injuries of other pelvic apophyses.<sup>1</sup> As a rule, lesions are result of sports trauma. Most often during playing football, rugby, athletics or gymnastics in the moment of a sudden change of direction, sudden accelerating and decelerating movements and uncontrolled football kicks.<sup>3, 16, 18</sup> The mechanism is avulsion of the apophysis by the head of M.rectus femoris during sudden intense contraction, in extended hip joint and flexed knee against or without resistance. This leads to the formation of traction forces, causing a fracture, passing through the weakest, from a biomechanical point of view, layer of the physis – the one of cartilage degeneration. It is extremely rare that the lesion is a consequence of repetitive submaximal stresses, previous apophysitis or direct impact.<sup>7, 9</sup>

Diagnosis of the avulsion is easy if it is clinically suspected. A history of acute inguinal or anterior femoral pain during sports activities, associated with positive radiographic findings is sufficient to diagnose Salter-Harris type damage of SIAI. In case of unclear X-ray data, it is necessary to perform a CT-scan. The one with 3D reconstruction is also useful for analyzing the size of the fractured fragment and for better planning of the osteosynthesis. However, the main thing is to perform radiography in AP projection of the entire pelvis, for a comparative study in relation to the contralateral painless side. As we have repeatedly emphasized in other pathologies of the pediatric hip joint, performing a lateral radiograph in Dunlap or "frog leg" position is mandatory.

Exact and early diagnosis is crucial for prompt treatment in order to reduce short-term disability and accelerate the return to full functional activity. Both conservative and surgical treatment are used.<sup>3, 8</sup> Authors recommending non-operative methods offer rest of the affected limb and M.rectus femoris with bed rest for 4 weeks, followed by a period of about 5 weeks of progressive physiotherapy. According to them, this usually allows full functional recovery in a period ranging from 2 to 5 months.<sup>12, 17, 18, 20</sup> Possible complications of conservative treatment include nonunion or heterotopic ossification. These issues may be associated with chronic pain at the site of the previous fracture and may lead to significantly reduced ability for active sports and may additionally require subsequent surgical treatment.<sup>2, 6, 8, 13</sup>

Patients with high functional requirements and with a bone fragment larger than 2 cm, displaced more than 2 cm are indicated for surgical treatment.<sup>10, 14, 19, 22</sup> These are also our indications for surgery. Orthopedic surgery allows more stable fixation by osteosynthesis, faster functional recovery and reduced period of immobilization. In literature the reported osteosyntheses used for fixation are metal and resorbable screws in 76%, K-wires in 15% and plates in 9% of the cases.<sup>8</sup> According to us 3.5 mm titanium cannulated screws are preferable. They provide a more stable fixation, precisely navigated with radioscopy placement of the guide wire and avoid postoperative immobilization in plaster or orthosis. We consider the extraction of the screw unnecessary due to its titanium structure, which is not a contraindication for MRI examination if needed in the future. As for the number of screws, one or two, we leave it to the surgeon's discretion, according to the achieved intraoperative stability. We recommend the use of washers for the screws, especially for smaller bone fragments and for single screw fixation. Intraoperative blood loss in our clinical series is minimal and the X-ray exposure of the surgical team and the patient is under 90 seconds.

In the literature, the rates of postoperative complications are comparable to those of conservative treatment. Meta-analysis of Eberbach et al. (2017) shows that the percentage for nonunions is lower in surgically treated (0%) than in non-operatively treated patients (2,4%), heterotopic ossifications are more common in the operative subgroup (8,2%) than in the conservative subgroup (2,4%). Neurological complications and functional limitations are present in both subgroups in about 2% of the cases.<sup>8</sup> In all reported cases of postoperative meralgia paresthetica, symptoms resolve spontaneously within few months, similar to our case.<sup>4, 10, 14</sup> Main advantage of surgical treatment is the shortened recovery period. According to various authors, the return to sports is shorter after surgery, as it is an average of 12,6 weeks, compared to an average of 17 weeks with conservative therapy.<sup>8</sup> Earlier return to active exercises, due to stable fixation and reduced pain levels, allows adolescents to maintain thigh muscle strength and cardiorespiratory endurance.<sup>10,14</sup> To a large extent this is due to the proper postoperative physiotherapy. We apply our own physiotherapy protocol, presented in details in our previous publications.<sup>1</sup>

## 5. CONCLUSION

We recommend, for apophysiolyse of SIAI with dislocation more than 1,5 cm and size of the bone fragment larger than 2 cm, surgical treatment by reduction and titanium cannulated screw osteosynthesis. This therapeutic approach ensures both early functional recovery and return to active sports activity after 90th postoperative day. Essential for good therapeutic outcome is the early diagnosis. That is why we emphasize on the mandatory radiographic examination of the pelvis and the hip in two projections, in all cases of painful symptoms in the hip or anterior thigh area.

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