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Original article

AVULSION FRACTURES OF THE ANTERIOR ILIAC SPINE IN CHILDREN AND ADOLESCENTS: CLINICAL OUTCOMES OF NON-OPERATIVE TREATMENT

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Abstract: **Objective:** Avulsion fractures of the anterior iliac spine are injuries typically seen in physically active children and adolescents. There is no clear consensus regarding the optimal treatment, particularly concerning the degree of fragment displacement that warrants surgical intervention.

Aim: The aim of this study was to analyze the clinical outcomes of non-operative treatment of pelvic avulsion fractures in adolescents and to examine the relationship between patient age and rehabilitation duration.

Patients and Methods: A retrospective study was conducted on 12 adolescent patients with radiographically confirmed pelvic avulsion fractures. Data on age, fracture location, injury mechanism, treatment, and rehabilitation duration were collected and analyzed. All patients underwent non-operative management consisting of rest, analgesics, and crutch-assisted ambulation, followed by physical therapy.

Results: All patients were male, with a mean age of 12 years. The most common fracture site was the anterior inferior iliac spine (66.6%). All fractures healed without complications. Rehabilitation duration tended to be shorter in younger patients. Functional outcomes were excellent, with all patients returning to their pre-injury activity levels.

Conclusion: Non-operative treatment is an effective and safe approach for managing pelvic avulsion fractures in adolescents, even in cases with fragment displacement up to 15 mm. It provides excellent functional recovery without complications, supporting its use as the first-line treatment in this population.

Keywords: Avulsion fractures, Pelvis, Adolescents, Children, Treatment.

INTRODUCTION

Avulsion fractures of the pelvis are injuries that predominantly occur in active adolescents (1). In this age group, the strengthening of the lower limb musculature coincides with the development of secondary ossification centers (apophyses) (2). Pelvic fractures account for less than 1% of all pediatric fractures; however, up to 5% of children with blunt trauma sustain a pelvic fracture (3, 4). High-intensity concentric muscle contractions during activities such as running, kicking, and jumping generate substantial tensile forces transmitted through the muscle–tendon complex to the apophysis (5). As the weakest link in this chain, the apophysis is therefore prone to failure (6).

While most published studies emphasize pelvic fractures caused by high-energy mechanisms, the majority of pelvic fractures in children and adolescents actually result from low-energy trauma. These are typically stable pelvic ring injuries or avulsion injuries of the pelvic apophyses (Figure 1), usually presenting with sudden, sharp pain in the pelvic region, sometimes accompanied by an audible cracking sound (7). The pain often subsides with rest but intensifies with physical activity. On clinical examination, localized tenderness, swelling, and restricted range of motion are commonly observed (8).

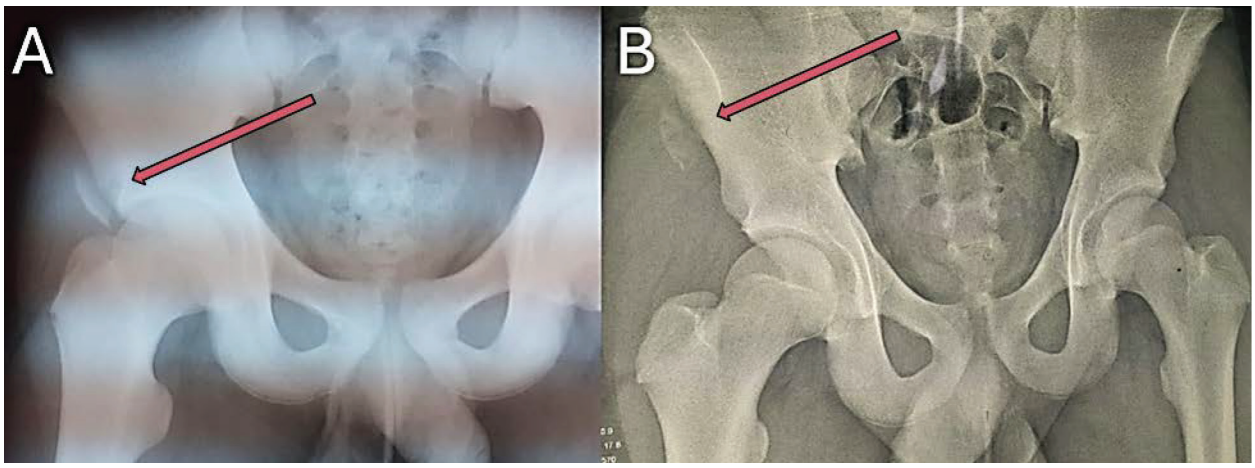

Figure 1. *A. Spina iliaca anterior inferior avulsion fracture. B. Spina iliaca anterior superior avulsion fracture (from the author's personal archive)*

The diagnosis of avulsion fractures relies on patient history—most report acute pain while jumping, kicking a ball, sprinting, or suddenly changing direction—combined with physical examination and radiographic evaluation. Differential diagnoses in pediatric patients include femoral head epiphysiolysis and musculotendinous injuries. Avulsion fractures may occur at several pelvic muscle attachment sites, including the rectus femoris insertion on the anterior inferior iliac spine (AIIS), the ischial tuberosity (IT), the sartorius insertion, the tensor fasciae latae attachment at the iliac crest (IC), and the iliopsoas insertion on the lesser trochanter (LT) (9).

Traditionally, treatment has been non-operative, consisting of analgesia, rest, and gradual rehabilitation. However, no clear consensus exists regarding surgical indications. The degree of fragment displacement and the patient's functional demands remain the primary factors guiding the decision for operative management (10).

Data on complications are limited, but reported issues include nonunion, neurological symptoms, infection, chronic pain, and heterotopic ossification. This lack of evidence highlights the need for further research to establish optimal treatment strategies, surgical criteria, and long-term outcomes in pediatric patients with pelvic avulsion fractures.

The aim of this study is to emphasize the importance of timely diagnosis, to analyze the distribution of pelvic avulsion fractures among adolescents according to age, and to examine the relationship between rehabilitation duration and age. Ultimately, our goal is to confirm that non-operative treatment is an effective approach for managing pelvic avulsion fractures, ensuring favorable outcomes without long-term complications.

MATERIALS AND METHODS

Following approval from the Ethics Committee of the Clinical Hospital Center Kosovska Mitrovica (No. 2389, 04/21/2023), a retrospective review was conducted on patients who presented to our department between January 2015 and January 2023 with symptoms of acute pelvic injury. A total of 12 adolescent patients with radiographically confirmed apophyseal avulsion fractures of the pelvis were included in the study.

Collected variables included age, sex, fracture location, laterality, mechanism of injury, degree of displacement, presence of prodromal symptoms, treatment approach, duration of orthopedic management, length of rehabilitation, and functional outcomes.

Descriptive statistics were used to summarize patient demographics and clinical outcomes. Continuous variables are reported as means and ranges, whereas categorical variables are presented as absolute numbers and percentages.

RESULTS

All 12 patients were male, aged 10–14 years (mean age: 12 years). The age distribution was as follows: two patients aged 10, two aged 11, six aged 12, and two aged 13. The mean age of the cohort was 11.7 ± 1.0 years (range: 10–13).

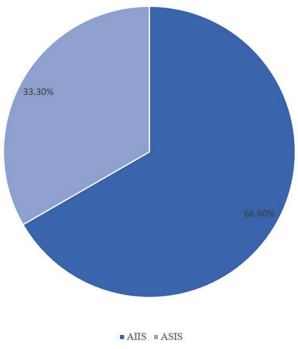

Figure 2. *Distribution of ASIS (anterior superior iliac spine) vs. AIIS (anterior inferior iliac spine) Avulsion Injuries*

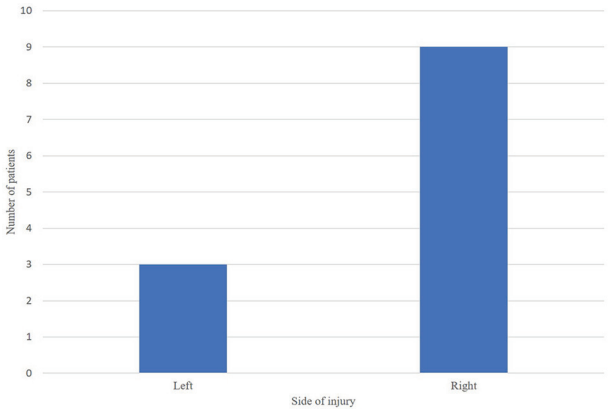

Figure 3. *Injury laterality*

Regarding fracture location, eight patients sustained anterior inferior iliac spine (AIIS) fractures, while four had anterior superior iliac spine (ASIS) fractures (Figure 2). Laterality analysis showed that 75% of injuries occurred on the right side and 25% on the left (Figure 3).

Most injuries (n = 10) occurred during football, while two were sustained during handball. None of the patients reported prodromal symptoms. One patient presented with a fracture displacement of 13 mm.

Clinically, all patients reported acute, sharp pain at the time of injury, limited hip range of motion, and difficulty walking independently. Radiographic imaging confirmed apophyseal displacement of up to 13 mm in all cases.

All patients were managed conservatively, including analgesics, bed rest with the hip flexed and slightly abducted, and ambulation with axillary crutches. Six patients (50%) underwent orthopedic treatment for five weeks, four (33%) for six weeks, and two (17%) for four weeks. The mean duration of orthopedic treatment was 5.2 ± 0.7 weeks (range: 4–6). Follow-up radiographs confirmed fracture healing in all cases, after which physical therapy was initiated (Figure 4).

Rehabilitation duration varied with age. Seven patients (58%) completed rehabilitation within four weeks, three (25%) within three weeks, and two (17%) within five weeks. The mean rehabilitation duration was 3.9 ± 0.7 weeks (range: 3–5). The majority of 12-year-olds completed rehabilitation within four weeks (Figure 5).

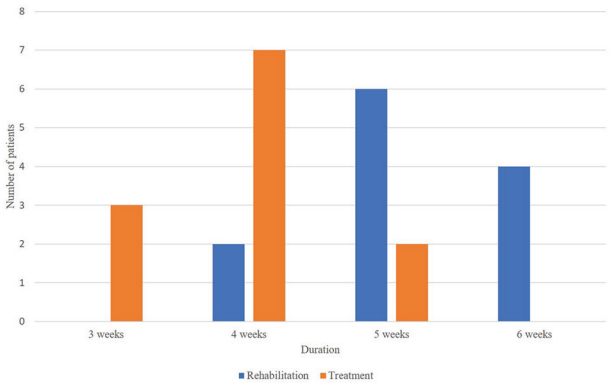

Figure 5. *Number of patients by duration (weeks) of treatment and rehabilitation*

All patients returned to their pre-injury activity levels within an average of nine weeks after the injury (range: 7–11). No complications were observed during treatment or follow-up.

DISCUSSION

Avulsion fractures of the pelvis in physically active adolescents represent a considerable challenge for orthopedic surgeons. At present, there is no clear consensus or evidence-based guideline regarding the optimal management of these injuries. Although our study does not specifically address the pathophysiology of avulsion fractures, it is important to highlight certain aspects.

The apophyses involved in these injuries appear to be particularly vulnerable prior to full ossification.

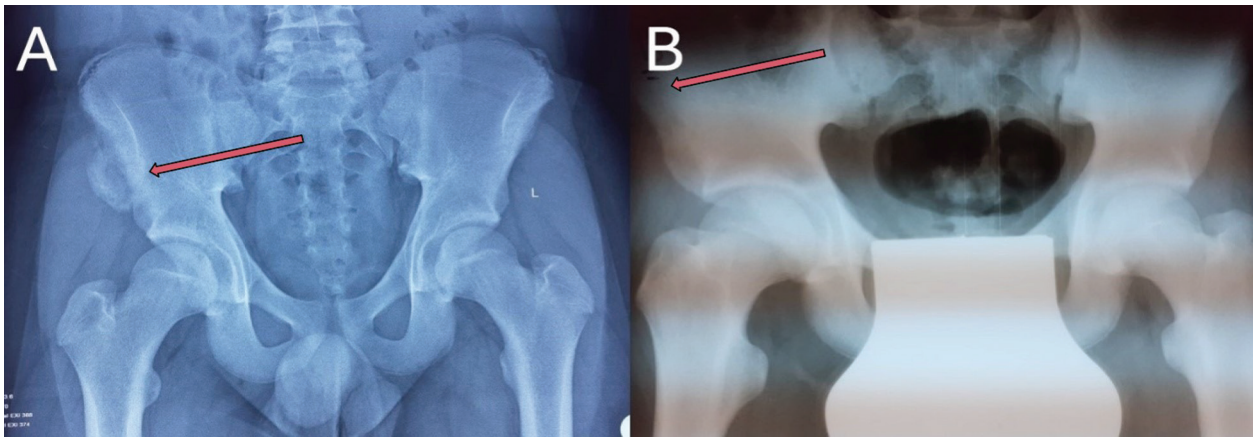

Figure 4. *A. Consolidated anterior superior iliac spine fracture following rehabilitation. B. Consolidated anterior inferior iliac spine fracture following rehabilitation (from the author's personal archive)*

During this phase, the apophyseal growth plate is exposed to an increased risk of improper ossification and subsequent avulsion, especially in adolescents undergoing periods of rapid growth. It is assumed that accelerated growth of the long bones in the lower extremities may lead to muscle contracture and tightness around the hip and knee, thereby amplifying the pathophysiological impact of eccentric muscle contractions on the apophysis (11). Furthermore, the increased frequency and intensity of physical activity in this population additionally contribute to apophyseal vulnerability (11).

The results of our study demonstrate that all participants were male. This gender distribution may be explained by the fact that, in Serbia, boys are generally more physically active than girls. The lower representation of girls in sports is influenced by cultural factors, lifestyle patterns, and lower overall participation in organized physical activities. Pelvic avulsion fractures remain a rare type of injury, most commonly occurring in physically active adolescents (12).

In adolescents, the epiphyseal plates are not yet fused, which makes them more susceptible to eccentric muscle contractions that alter the anatomical relationship between the growth plate and adjacent bone structures (13). In our cohort, the highest incidence of avulsion fractures was observed in 12-year-olds, representing 50% of all patients (n = 6). This may be explained by the fact that children at this age are often more physically active compared with their peers, while the epiphyseal growth plate still lacks closure zones.

To the best of our knowledge, no previous studies have examined the prevalence and laterality of pelvic avulsion fractures. In our series, slightly more injuries occurred on the right side (75%).

Our findings are consistent with other studies identifying running and kicking as the most frequent mechanisms of injury (8, 10-14). Schuett et al. reported that kicking is the most frequent cause of AIIS avulsion fractures, whereas running is the most common mechanism for ASIS avulsion fractures (15). All participants in our study presented with acute pain, limited active and passive range of motion, and inability to walk independently.

Diagnosis in our patients was based on the mechanism of injury obtained from history taking and confirmed with radiographic imaging, which demonstrated apophyseal displacement of up to 13 mm. Standard pelvic radiographs in two planes are recommended in cases of suspected pelvic avulsion fracture (14). In our series, no additional diagnostic modalities were required, as clinical examination consistently supported the diagnosis. However, other authors have emphasized that when plain radiographs are inconclusive, MRI or ultrasound may be useful to detect occult fractures or associated soft-tissue injuries (15). As a differential diagnosis, we initially considered epiphysiolysis of the femoral head, which was excluded by radiographic evaluation.

Other authors have suggested a broader spectrum of differential diagnoses (16, 17, 18). For example, Gidvani et al. reported eight cases of ischial tuberosity avulsion fractures that were initially misdiagnosed as muscle–tendon ruptures (19). Such misdiagnoses resulted in unnecessary and more extensive surgical procedures. These findings underline the importance of timely and accurate diagnosis to ensure appropriate management.

In pelvic avulsion fractures, displacement of bone fragments is often limited by the thick periosteum and surrounding pelvic fascia in adolescents. Consequently, non-operative management combined with a structured rehabilitation program is generally considered the preferred approach for treating non-displaced fractures (20).

In accordance with current treatment protocols, and given that the displacement of the apophysis in our cohort was 13 mm, we opted for non-operative treatment. Current evidence recommends conservative management for avulsion fractures with displacement up to 15 mm, with many studies confirming favorable functional outcomes. This strategy also avoids exposing adolescents to the risks associated with anesthesia. Our treatment protocol included analgesics, activity restriction, and two weeks of bed rest with proper limb positioning, followed by the use of crutches for 4–6 weeks (21).

In our study, six patients (50%) were treated for five weeks, four (33%) for six weeks, and two for four weeks. When analyzing the relationship between treatment duration and patient characteristics, we observed that the largest group—four patients aged 12 years—required five weeks of rehabilitation. This correlation may be explained by the higher activity levels and rapid growth characteristic of this age group, which increase their susceptibility to injury. Additionally, younger patients generally required shorter rehabilitation periods, with an average reduction of seven days compared with older adolescents. This observation supports the view that orthopedic treatment tends to be shorter in children than in older patients.

All patients used axillary crutches during the treatment period, which was crucial in partially neutralizing muscle forces during contraction, thereby reducing pain and preventing further displacement at the fracture site. The non-operative treatment we applied,

followed by structured physical therapy, resulted in excellent clinical and functional outcomes in all cases. Rehabilitation duration ranged between three and five weeks, depending on patient age and physical condition. Interestingly, the largest proportion of patients completing rehabilitation within four weeks were also 12 years old, consistent with the higher incidence of avulsion fractures at this age.

After two treatment sessions, patients were able to discontinue the use of crutches. Similar results were reported by Metzmaker et al., who successfully managed 27 cases of pelvic avulsion fractures using a structured five-phase rehabilitation protocol (22). Kjellin et al. treated adolescent athletes involved in sports that include sprinting, jumping, and sudden changes of direction (such as football, athletics, and gymnastics) using a conservative approach—rest, activity modification, analgesics, and gradual rehabilitation. Return to sports was permitted once pain subsided and muscle function normalized. Most patients recovered without lasting effects (23). In a review by Yanagisawa et al., a gradual approach to rehabilitation was emphasized, starting with pain management and progressing through mobility exercises, strengthening, and sport-specific training. Despite the prevalence of these injuries, the review highlighted a lack of new knowledge regarding pelvic sports injuries, with only fifteen articles published between 2013 and 2023 meeting the inclusion criteria (24).

Although conservative treatment is generally effective, it can occasionally have adverse effects on the patient's health in both the short and long term. However, in our cohort no complications were observed, and all patients successfully returned to their pre-injury activity levels. We attribute these outcomes to timely diagnosis, appropriate immobilization, and the implementation of structured physical therapy. These factors highlight the importance of taking such injuries seriously and ensuring that adolescents remain disciplined throughout the rehabilitation process to achieve optimal functional recovery.

When treating adolescents, it is also essential to consider their long-term well-being. Any compromise in the treatment protocol at this stage may result in complications that manifest later in life, particularly when patients assume physically demanding occupations. Reported potential complications include heterotopic ossification and femoroacetabular impingement (FAI) (25). Both conditions may lead to chronic pain in the fracture region and a consequent reduction in physical activity (26, 27).

In our study, functional results were excellent, and no complications occurred, further confirming that non-operative management is an appropriate treatment option for avulsion fractures with displacement up to 15 mm. These findings are consistent with previously published studies, which also support conservative treatment as the primary approach for minimally displaced pelvic avulsion fractures (28, 29).

CONCLUSION

Based on our research, we conclude that pelvic avulsion fractures most commonly occur in adolescents around the age of 12. Non-operative treatment, which in our cohort lasted an average of five weeks, followed by approximately four weeks of rehabilitation, resulted in excellent functional outcomes. Consistent with findings from the literature, our study supports the view that conservative management should be considered the first-line treatment for pelvic avulsion fractures with displacement up to 15 mm.

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Data Availability Statement: Requests to access the datasets should be directed to the corresponding author.

Note: Artificial intelligence was not utilized as a tool in this study.

Sažetak

AVULZIONE FRAKTURE PREDNJE ILIJAČNE BODLJE KOD DECE I ADOLESCENATA: KLINIČKI ISHODI NEOPERATIVNOG LEČENJA

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Uvod: Avulzione frakture prednje ilijačne spine predstavljaju povrede tipične za fizički aktivnu decu i adolescente. Još uvek ne postoji jasan konsenzus o optimalnom načinu lečenja, posebno kada je reč o stepenu dislokacije fragmenta koji zahteva hiruršku intervenciju.

Cilj: Cilj rada je bio da se analiziraju klinički ishodi neoperativnog lečenja avulzionih fraktura karlice kod adolescenata i da se ispita odnos između uzrasta i trajanja rehabilitacije.

Materijal i metode: Sprovedena je retrospektivna studijana 12 adolescentnih pacijenata sa radiografski potvrđenim avulzionim frakturama karlice. Analizirani su podaci o uzrastu, lokalizaciji preloma, mehanizmu povrede, načinu lečenja i trajanju rehabilitacije. Svi pacijenti su lečeni neoperativno – mirovanje, analgetici i upotreba štaka, a potom fizikalna terapija.

Rezultati: Svi pacijenti su bili muškog pola, prosečne starosti 12 godina. Najčešće mesto preloma bila je prednja donja ilijačna spina (66,6%). Svi prelomi su zarasli bez komplikacija. Kod mlađih pacijenata rehabilitacija je trajala kraće. Funkcionalni ishodi bili su odlični, sa povratkom svih pacijenata na nivo aktivnosti pre povrede.

Zaključak: Neoperativno lečenje je efikasan i bezbedan pristup u terapiji avulzionih fraktura karlice kod adolescenata, čak i kod dislokacija fragmenta do 15 mm. Ovaj pristup omogućava odličan funkcionalni oporavak bez komplikacija i treba ga smatrati metodom prvog izbora u ovoj populaciji.

Ključne reči: avulzione frakture, karlica, adolescent, dete, lečenje.

REFERENCES

1. Schiller J, DeFroda S, Blood T. Lower extremity avulsion fractures in the pediatric and adolescent athlete. J Am AcadOrthop Surg. 2017; 25(4): 251-9. doi:10.5435/jaaos-d-15-00328.

2. Ghanem IB, Rizkallah M. Pediatric avulsion fractures of pelvis: current concepts. Curr Opin Pediatr. 2018; 30(1): 78-83. doi: 10.1097/mop.0000000000000575.

3. Orthobullets. Pediatric pelvis fractures [Internet]. Orthobullets; 2025 [cited 2025 Oct 26]. Available from: https://www.orthobullets.com/pediatrics/3000/pelvis-fractures--pediatric.

4. DeFrancesco CJ, Sankar WN. Traumatic pelvic fractures in children and adolescents. Semin Pediatr Surg. 2017; 26(1): 27-35. doi:10.1053/j.sempedsurg.2017.01.006.

5. Vlahek P, Matijević V. Lower extremity injuries in novice runners: incidence, types, time patterns, sociodemographic and motivational risk factors in a prospective cohort study. Acta Clin Croat. 2018; 57(1): 31–8. doi:10.20471/acc.2018.57.01.04.

6. Calderazzi F, Nosenzo A, Galavotti C, Menozzi M, Pogliacomi F, Ceccarelli F. Apophyseal avulsion fractures of the pelvis: a review. Acta Biomed. 2018; 89(4): 470–6. doi: 10.23750/abm.v89i4.7632.

7. Anduaga I, Seijas R, Perez-Bellmunt A, Casasayas O, Alvarez P. Anterior iliac spine avulsion fracture treatment options in young athletes. J Invest Surg. 2020; 33(2): 159–63. doi: 10.1080/08941939.2018.1483447.

8. Eberbach H, Hohloch L, Feucht MJ, Konstantinidis L, Sudkamp NP, Zwingmann J. Operative versus conservative treatment of apophyseal avulsion fractures of the pelvis in adolescents: a systematic review with meta-analysis of clinical outcome and return to sports. BMC Musculoskelet Disord. 2017; 18(1): 162. doi:10.1186/s12891-017-1527-z.

9. Willinger L, Schanda JE, Lorenz S, Imhoff AB, Buchmann S. Surgical treatment of two adolescent athletes with dislocated avulsion fracture of the anterior superior iliac spine (ASIS). Arch Orthop Trauma Surg. 2017; 137(2): 173–7. doi: 10.1007/s00402-016-2596-4.

10. Best R, Meister A, Huth J, Becker U, Meier M. Surgical repair techniques, functional outcome, and return to sports after apophyseal avulsion fractures of the ischial tuberosity in adolescents. Int Orthop. 2021; 45(8): 1853–61. doi: 10.1007/s00264-021-04959-w.

11. Longo UG, Ciuffreda M, Locher J, Maffulli N, Denaro V. Apophyseal injuries in children's and youth sports. Br Med Bull. 2016; 120(1): 139-57. doi: 10.1093/bmb/ldw041.

12. Sinikumpu JJ, Hetsroni I, Schilders E, Lempainen L, Serlo W, Orava S. Operative treatment of pelvic apophyseal avulsions in adolescent and young adult athletes: a follow-up study. Eur J Orthop Surg Traumatol. 2018; 28(3): 423–9. doi: 10.1007/s00590-017-2074-x.

13. Caine D, DiFiori J, Maffulli N. Physeal injuries in children's and youth sports: reasons for concern? Br J Sports Med. 2006; 40(9): 749-60. doi: 10.1136/bjsm.2005.017822.

14. Cirimele V, D'Amone G, Stellato L, Ferrini A, Gregori P, Faiella E. Magnetic resonance imaging in the evaluation of avulsion injuries of the pelvis and hip in adolescent professional footballers: a case series. J Orthop Case Rep. 2024; 14(5): 147-52. doi: 10.13107/jocr.2024.v14.i05.4466.

15. Schuett DJ, Bomar JD, Pennock AT. Pelvic apophyseal avulsion fractures: a retrospective review of 228 cases. J Pediatr Orthop. 2015; 35(6): 617–23. doi: 10.1097/bpo.0000000000000328.

16. Malina RM, Peña Reyes ME, Eisenmann JC, Horta L, Rodrigues J, Miller R. Height, mass and skeletal maturity of elite Portuguese soccer players aged 11-16 years. J Sports Sci. 2000; 18(9): 685–93. doi: 10.1080/02640410050120069.

17. Ferraro SL, Batty M, Heyworth BE, Cook DL, Miller PE, Novais EN. Acute pelvic and hip apophyseal avulsion fractures in adolescents: a summary of 719 cases. J Pediatr Orthop. 2023; 43(4): 204–10. doi: 10.1097/bpo.0000000000002355.

18. Ruffing T, Rückauer T, Bludau F, Hofmann A, Muhm M, Suda AJ. Avulsion fracture of the lesser trochanter in adolescents. Injury. 2018; 49(7): 1278–81. doi: 10.1016/j.injury.2018.04.030.

19. Gidwani S, Jagiello J, Bircher M. Avulsion fracture of the ischial tuberosity in adolescents - an easily missed diagnosis. BMJ. 2004; 329(7457): 99-100. doi: 10.1136/bmj.329.7457.99.

20. Otto A, Banke IJ, Mehl J, Beitzel K, Imhoff AB, Scheiderer B. Retrograde fixation of the lesser trochanter in the adolescent: new surgical technique and clinical results of two cases. Arch Orthop Trauma Surg. 2019; 139(4): 537–45. doi: 10.1007/s00402-018-3091-x.

21. Cai W, Xie Y, Su Y. Comparison of non-surgical and surgical treatment using absorbable screws in anterior-superior iliac spine avulsion fractures with over 1.5 cm displacement. OrthopTraumatol Surg Res. 2020; 106(8): 1299–304. doi: 10.1016/j.otsr.2020.02.014.

22. Metzmaker JN, Pappas AM. Avulsion fractures of the pelvis. Am J Sports Med. 1985; 13(5): 349–58. doi: 10.1177/036354658501300510.

23. Kjellin I, Stadnick ME, Awh MH. Orthopaedic magnetic resonance imaging challenge: apophyseal avulsions at the pelvis. Sports Health. 2010; 2(3): 247-51. doi: 10.1177/1941738109347976.

24. Yanagisawa Y, Yamazaki M. Rehabilitation for returning to sports in individuals with sports-induced pelvic injuries—a narrative review. J Phys Fitness Sports Med. 2024; 13(4): 125-9. doi: 10.7600/jpfsm.13.125.

25. Čengić T, Jurković D, Hajsok H, Smoljanović T, Novosel L, Rotim K, et al. Hip arthroscopy: residual cam deformity combined with loose bony fragment in hip capsule. Acta Clin Croat. 2021; 60(4): 777-82. doi:10.20471/acc.2021.60.04.28.

26. Di Maria F, Testa G, Sammartino F, Sorrentino M, Petrantoni V, Pavone V. Treatment of avulsion fractures of the pelvis in adolescent athletes: a scoping literature review. Front Pediatr. 2022; 10: 947463. doi: 10.3389/fped.2022.947463.

27. Novais EN, Riederer MF, Provance AJ. Anterior inferior iliac spine deformity as a cause for extra-articular hip impingement in young athletes after an avulsion fracture: a case report. Sports Health. 2018; 10(3): 272–6. doi: 10.1177/1941738117744547.

28. Ferlic PW, Sadoghi P, Singer G, Kraus T, Eberl R. Treatment for ischial tuberosity avulsion fractures in adolescent athletes. Knee Surg Sports Traumatol Arthrosc. 2013; 22(4): 893–7. doi:10.1007/s00167-013-2570-4.

29. Su Y, Chen K, Qin J. Retrospective study of open reduction and internal fixation of lateral humeral condyle fractures with absorbable screws and absorbable sutures in children. Medicine (Baltimore). 2019; 98(44): e17850. doi: 10.1097/md.0000000000017850.

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