Skeletal Radiol (2001) 30:127–131

ARTICLE

F. Rossi
S. Dragoni

Acute avulsion fractures of the pelvis in adolescent competitive athletes: prevalence, location and sports distribution of 203 cases collected

Received: 5 November 2000
Revision requested: 8 February 2000
Revision received: 26 October 2000
Accepted: 20 November 2000

F. Rossi (✉) · S. Dragoni
Sports Science Institute,
Via dei Campi Sportivi, 46, 00197 Rome,
Italy

Abstract *Objective*. To describe the prevalence, location and sports distribution of pelvic avulsion fractures in adolescent competitive athletes. *Design and patients*. One thousand two hundred and thirty-eight radiographs of the pelvis taken for focal traumatic symptoms in athletes with an age range of 11–35 years over a period of 22 years were reviewed. *Results*. One hundred and ninety-eight adolescent athletes were affected by 203 avulsion fractures of the pelvic apophyses (five cases presented multiple locations). The localisation was the ischial tuberosity (IT) in 109 cases, anterior inferior iliac spine (AIIS) in 45 cases, anterior superior iliac spine (ASIS) in 39 cases, superior corner of pubic symphysis (SCPS) in 7 cases and iliac crest (IC) in 3 cases. Soccer (74 cases) and gymnastics (55 cases) were the sports with the highest number of avulsion fractures documented. *Conclusions*. Apophyseal avulsion fractures of the pelvis in adolescent competitive athletes are most common in soccer and gymnastics. The lesions are usually the consequence of sudden and forceful muscle-tendon contractions during sport activities. Plain radiographs, are determinant for the diagnosis.

Keywords Adolescent competitive athletes · Sport lesions · Pelvic avulsion fractures

Introduction

Avulsion fractures of the apophyses and spines of the pelvis are usually considered uncommon injuries, seen almost exclusively in adolescent athletes mainly as a result of the sudden, forceful or unbalanced contraction of the attached musculotendinous unit, while the subject is engaged in a sporting event such as kicking a ball, running or jumping. [1, 2, 3]. These fractures are usually related to the time of appearance of ossification of the apophyses and their fusion to the corresponding pelvic tuberosities. In acute injuries, the athlete experiences sudden, shooting pain referred to the involved tuberosity and loss of muscular function; swelling and local tenderness can be appreciated by palpation and evoked during passively imposed movements of the appropriate limb. The diagnosis, suggested by physical findings, symptoms, patient's age and biomechanical analysis of the accident, is confirmed by radiographs.

Reports of isolated cases are common in the literature [4, 5, 6, 7, 8], while few large series of pelvic avulsion fractures have been reported [9, 10, 11]. In 1981 Fernbach and Wilkinson [9] reviewed 20 cases of avulsion fractures of the pelvis and proximal femur, most of which occurred in male adolescents engaged in active sports. Metzmaker and Pappas [10] studied 27 cases of avulsion fractures of the pelvis, finding that the areas of injury included the anterior superior iliac spine (ASIS) in 11 cases, the ischial tuberosity (IT) in 6 cases, the anterior inferior iliac spine (AIIS) in 4 cases, and the lesser trochanter (LT) and iliac crest (IC) in 3 cases. Sundar and Carty [11] identified 32 avulsion fractures in 25 patients participating in sports, with eight instances of multiple avulsions. Their patients had a different distribution

of injuries compared with those of Metzmaker and Pappas, as the IT (17 cases) was the most common site and the AIIS (8 cases) was more common than the ASIS (7 cases).

The purpose of this study was to ascertain the prevalence, location and sports distribution of avulsion fractures of the pelvis demonstrated radiographically in a large symptomatic elite athletic population.

Materials and methods

We reviewed 1238 radiographs of the pelvis of competitive athletes (age range 11–35 years) who complained of focal pain or disability related to their sport activity. All the radiographs were performed at the Radiology Department of the Sports Science Institute of the Italian Olympic Committee and interpreted by the senior author (F.R.) during the last 22 years (1976–1998). The radiographic assessment was a standard anteroposterior view of the pelvis supplemented by axial and oblique views when indicated. CT, MRI and scintigraphy were undertaken in only a few cases when the radiographic findings were equivocal or when the injury was not in the acute phase and healing avulsions had an aggressive appearance.

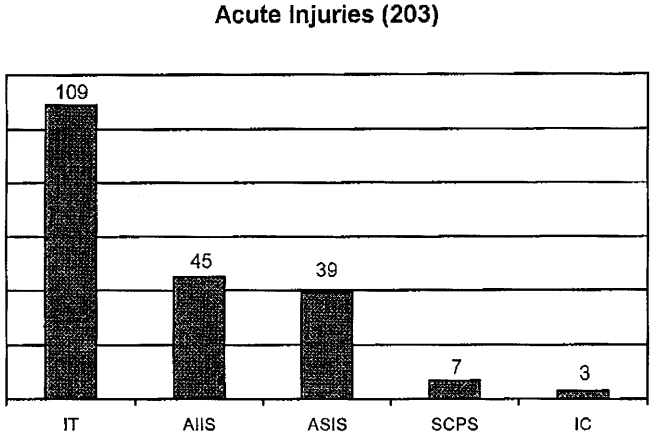


Fig. 1 The locations of the 203 cases. *IT i*schial tuberosity, *AIIS* anterior inferior iliac spine, *ASIS* anteriorn superior iliac spine, *SCPS* superior corner of pubic symphysis, *IC* iliac crest

Results

Two hundred and three acute apophyseal avulsion fractures (16.4%) were identified in 198 adolescent athletes whose frequency and intensity of sport participation were similar. The gymnasts observed were all classified as "top-level athletes", and in this group the lesions were predominantly documented among females. In five patients, four of whom were engaged in soccer and one in athletics, multiple avulsions were present in the IT and the AIIS. The average age was 13.8 years with a range of 11–17 years; all injuries were sports-induced with a distribution which was related to the sport involved. There were 139 males (68.5%) and 64 females (31.5%).

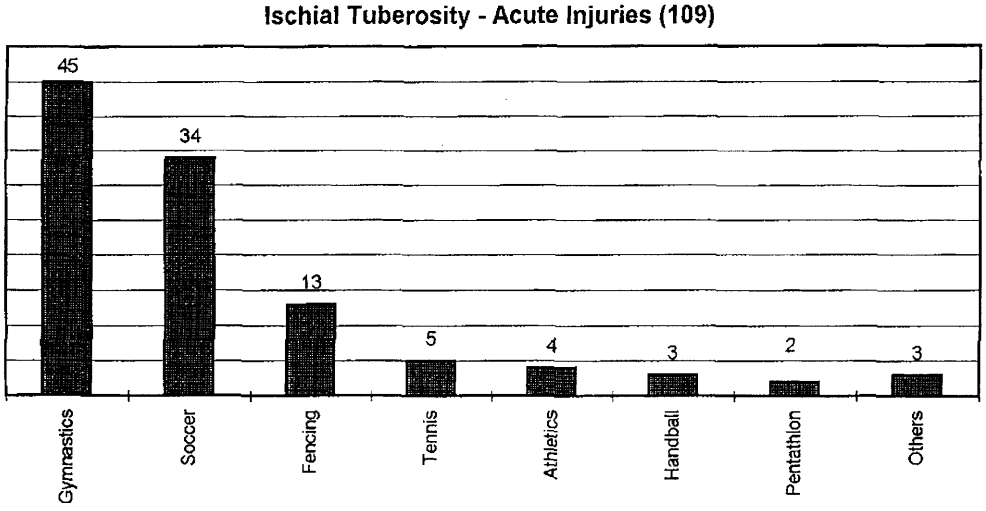
The locations (Fig. 1) of the 203 cases were: IT 109, AIIS 45, ASIS 39, superior corner of pubic symphysis 7 and IC 3.

The distribution with regard to the athletic activity undertaken reveals that gymnastics and soccer were mainly responsible for the IT lesions (Fig. 2–Fig. 7); soccer, athletics and tennis for AIIS lesions (Fig. 3–Fig. 8); soccer, athletics and gymnastics for ASIS lesions (Fig. 4–Fig. 9); and soccer and fencing for SCPS lesions

Table 1 Prevalence of injuries in each sport

Sport	Total no. of avulsion fractures	Total no. of radiographs examined	Prevalence (%)
Soccer	74	418	17.70
Gymnastics	55	111	49.50
Athletics	23	176	13.06

Fig. 2 Sports activities responsible for the ischial tuberosity avulsion fractures



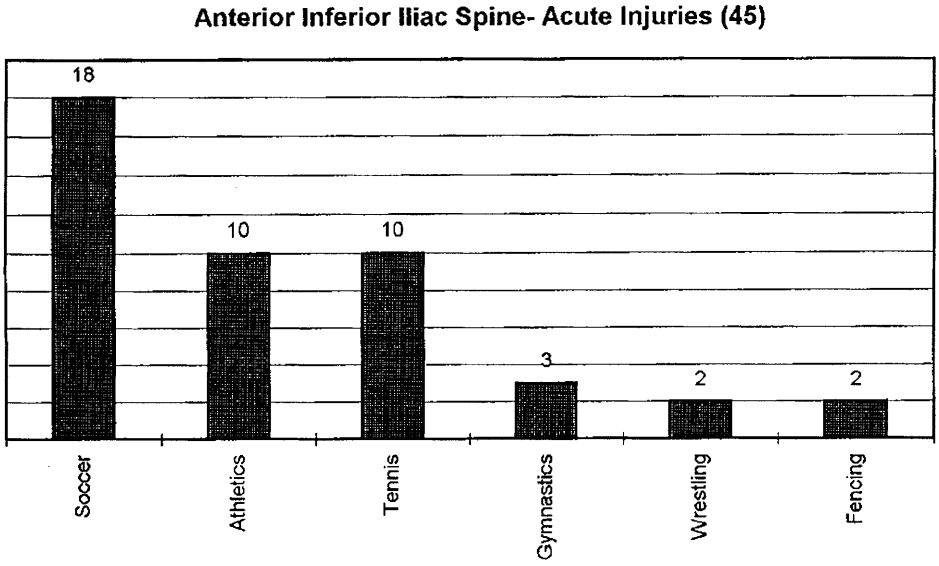


Fig. 3 Sports activities responsible for the anterior inferior iliac spine avulsion fractures

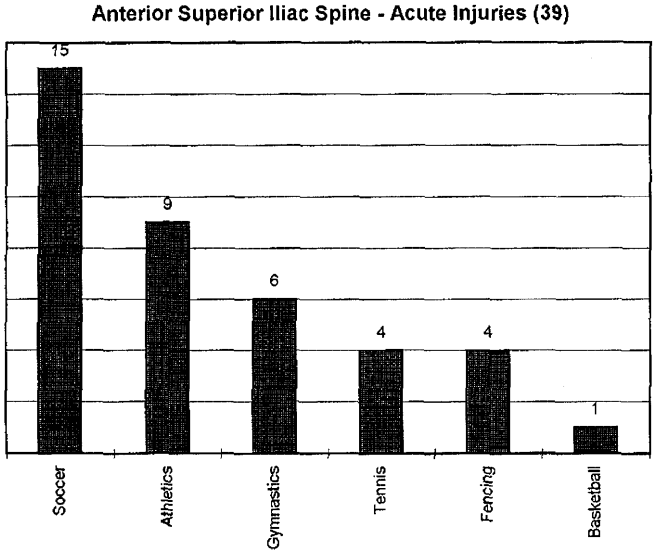


Fig. 4 Sports activities responsible for the anterior superior iliac spine avulsion fractures

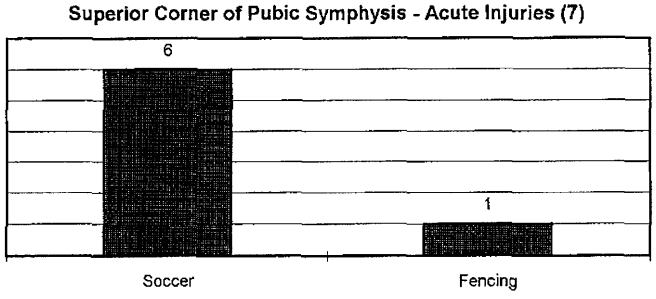


Fig. 5 Sports activities responsible for the superior corner of pubic symphysis avulsion fractures

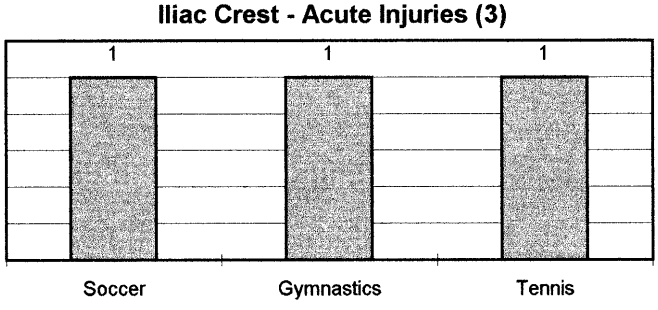


Fig. 6 Sports activities responsible for the iliac crest avulsion fractures

(Fig. 5–Fig. 10). The three cases of IC avulsion were in soccer, gymnastics and tennis (Fig. 6–Fig. 11).

Soccer, gymnastics and athletics had the highest prevalence of injuries when the total number of lesions in each sport was compared with the overall number of radiographic examinations performed in that sport (Table. 1).

Three athletes underwent surgical treatment (1 IT, 2 ASIS) while the remainder have been treated by conservative means consisting of initial rest and then mobilisation with gradual relief of symptoms. After an adequate rehabilitation to restore strength and endurance, the majority of the 195 athletes returned to their normal athletic activities without restrictions.

Twenty-five athletes with an age range of 22–35 years who had “old” injuries resulting from previous misdiagnosed acute avulsion fractures were also identified. The location of the injuries in these cases was the IT (5 athletics, 3 soccer, 1 martial arts, 1 ice skating), AIIS (4 soccer, 4 athletics, 2 field hockey) and ASIS (3 soccer, 1 martial arts, 1 tennis).

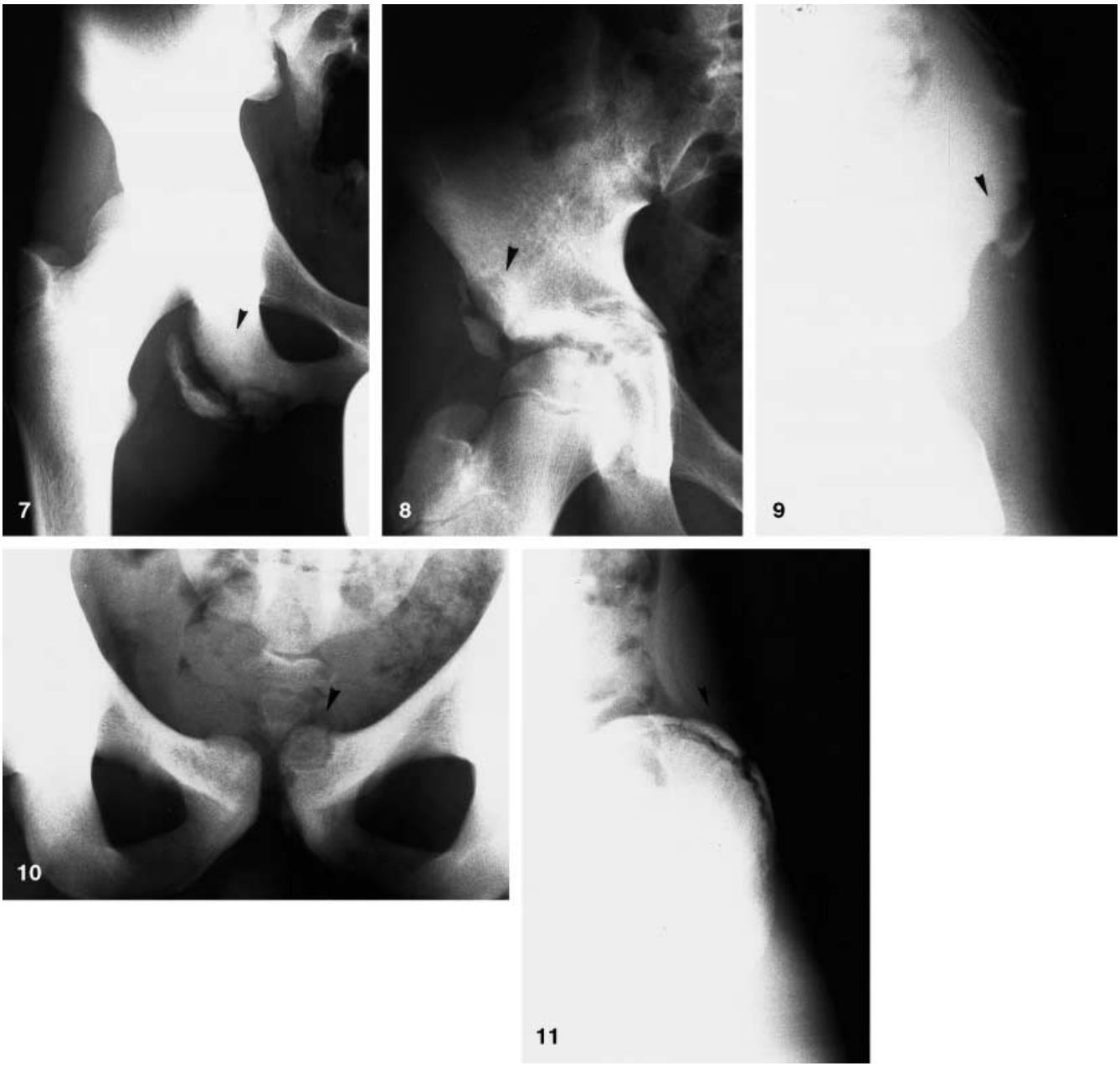


Fig. 7 Ischial tuberosity apophyseal avulsion in a 15–11 year old gymnast

Fig 8 Anterior inferior iliac spine avulsion in a 17 year old sprinter

Fig. 9 Anterior superior iliac spine avulsion in a 16 year old soccer player

Fig. 10 Superior corner of pubic symphysis avulsion in a 16 year old fencer

Fig. 11 Iliac crest apophysis avulsion in a 14 year old tennis player

Discussion

The results confirm the opinion that acute apophyseal pelvic avulsion fractures are not rare clinical entities in adolescent athletes engaged in high-level sport activities.

The location of the injuries in our study, which demonstrates a higher prevalence of avulsion fractures at the IT, followed by AIIS and ASIS, differs from that reported by Metzmaker and Pappas [10]. This is particularly true when analysing the data related to adolescent soccer players and especially female gymnasts, in whom the most vulnerable apophyses were those of the IT, AIIS and ASIS.

Although the number of lesions demonstrated among soccer players is of no great surprise given the large number of people participating in this sport, there is considerable concern with regard to the high number of apophyseal avulsion fractures observed in female gymnasts considering the small number of elite gymnasts. Radiographic studies of the pelvis in 10 members of an international women's gymnastics team who had symptoms of variable severity, revealed seven with an avulsion of the apophysis of the IT, which was bilateral in two cases.

Etiologically the data collected suggest that these lesions are the result of indirect trauma, due to the tearing action exerted by a sudden, violent concentric or eccentric muscle contraction. In gymnasts, injuries to the IT are generally related to sudden and excessive passive lengthening of the hamstring muscles during floor exercises. Injuries to the ASIS and AIIS in soccer generally result from an excessive upwards movement of the leg in "kicking the air" or a powerful shot at goal with maximum flexion of the hip and extension of the knee. In addition, moderate trauma in the form of repeated pulling stresses imposed by intensive training, weakens the cohesion of the epiphyseal plate. The relatively weakened epiphyseal plate may then give way due to excessive functional demands provoked by hypertrophic muscles whose contractile power has been enhanced by training.

Plain radiographs, supplemented by oblique or axial projections, suggested by clinical suspicion and a familiarity with musculotendinous anatomy, are determinant for early diagnosis, carefully directed treatment and for assisting rehabilitation.

References

1. El-Khoury GY, Brandser EA, Kathol MH, Tearse DS, Callaghan JJ. Imaging of muscle injuries. Skeletal Radiol 1996; 25:3–11.
2. Tehranzadeh J. The spectrum of avulsion and avulsion-like injuries of the musculoskeletal system. Radiographics 1987; 7:945–974.
3. Kujala UM, Orava S. Ischial apophysis injuries in athletes. Sports Med 1993; 16:290–294.
4. Rossi F, Conti F. Isolated tear fracture of the apophyseal nucleus of the anterior or inferior iliac spine. It J Sports Traumatol 1979; 1:161–175.
5. Rossi F, Santilli G. Detachment of the apophyseal nucleus of the ischial tuberosity in adolescent athletes. Med Sport 1976; 29:447–472.
6. Veselko M, Smrkoly V. Avulsion of the anterior-superior iliac spine in athletes: case report. J Trauma 1994; 3:444–446.
7. Zenteno BC. Avulsion fracture of the pelvis in a high jumper: case report. Clin J Sports Med 1993; 3:268–269.
8. Lambert MJ, Fligner DJ. Avulsion of the iliac crest apophysis: a rare fracture in adolescent athletes. Ann Emerg Med 1993; 22:1218–1220.
9. Fernbach SK, Wilkinson RH. Avulsion injuries of the pelvis and proximal femur. AJR 1981; 137:581–584.
10. Metzmaker JN, Pappas AM. Avulsion fractures of the pelvis. Am J Sports Med. 1985; 13:349–358.
11. Sundar M, Carty H. Avulsion fractures of the pelvis in children: a report of 32 fractures and their outcome. Skeletal Radiol 1994; 23:85–90.