AVULSION FRACTURES IN ATHLETES

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ABSTRACT

34 cases of avulsion fractures are described. Each fracture took place during athletic training or competition. Excepting six sportsmen participating in a general fitness programme, every patient was an active competitive athlete. There were six women and 28 men; their average age was 20.1 years, raised by a few middle-aged "fitness sportsmen". Most avulsion fractures took place in sprinters and hurdlers; next were middle and long distance runners, footballers, fitness joggers, skiers and ice-hockey players. The most usual location of a fracture was the anterior pelvic spines; avulsion fractures were also detected in various parts of lower limbs. There were fewer avulsion fractures in the area of the trunk and upper extremities. Roetgenologically, the diagnosis of an avulsion fracture is generally easy to make. However, the diagnosis is facilitated by knowing the mechanism of the injury, the technique of the athletic event, and some of the training methods. Generally, a fracture heals well, even if it requires both sufficient immobilisation and some delay in resuming physical exertion.

INTRODUCTION

An intense muscle contraction may result in the rupture of a muscle or tendon, or in an avulsion fracture. Especially in adolescence, the insertions of muscles are mechanically weak points in the skeleton, the reason why children have avulsion fractures together with epiphyseal injuries, some of the typical injuries in adolescence (Funk, 1975; Marti and Brunner, 1973; Zsedenyi and Arato, 1967). These fractures may take place during intense muscular movements in sport and physical exercise (Franke, 1975; Plaue, 1967; Voss, 1939). They are also seen in people engaged in heavy physical labour (Laarman, 1975; Lönnerblad, 1933). The clinical picture and pathological mechanism of these avulsion fractures was explained as early as the 1930's (Pirker, 1934; Wachsmuth and Wölk, 1935; Wagner, 1932).

In articles describing athletic injuries, symptoms and signs of certain avulsion fracture mostly have been explained (Dimon, 1972; Horntrich and Horschig, 1972; Krahl, 1973a; Slocum and Larson, 1964). There is however, little material on the interdependence of avulsion fractures caused by sports. In Finland, only a few

separate cases have been described (Peräsalo et al., 1955). The purpose of this study was to gather together avulsion fractures caused by sport, and to examine their particular characteristics.

MATERIAL AND RESULTS

The material was collected in 1969-1976 at the Sports Clinic of the Deaconess Institute of Oulu, and at the Departments of Surgery and Diagnostic Radiology of University Central Hospital of Oulu. The material consisted of 34 patients, all of which had got an avulsion fracture during or as a result of an athletic performance. 28 of them were competitive athletes, 6 of them were sportsmen engaged in a general fitness programme. There were 6 women and 28 men.

Table I illustrates the age and sex classification of the material. Most of it consisted of young athletes of 11-15 years of age. The average age of the whole group was 20.1 years. Most of the subjects were sprinters and hurdlers, middle and long-distance runners, footballers and fitness joggers (Table II).

TABLE I
Age and sex of athletes with avulsion fractures

Age	Women	Men	Total
≤ 10 y	1	—	1
11-15 y	2	11	13
16-20 y	1	6	7
21-30 y	—	7	7
≥ 31 y	2	4	6
Total	6	28	34

TABLE II
Event and sex of athletes suffering from avulsion fractures

Sports event	women	men	total
sprints and hurdles	2	5	7
middle- and long distance	—	—	—
running	2	2	4
football	—	4	4
jogging	1	3	4
skiing	1	2	3
ice-hockey	—	3	3
high jump	—	1	1
long jump	—	1	1
discus throw	—	1	1
javelin throw	—	1	1
hammer throw	—	1	1
bandy	—	1	1
volleyball	—	1	1
boxing	—	1	1
weight-lifting	—	1	1
Total	6	28	34

The anatomical location of the avulsion fractures is given in Figure 1. Avulsions of the anterior pelvic spines were the most common ones. There were 9 avulsions in anterior superior and 4 in anterior inferior iliac spine. The connection between the sports event and the location of the avulsion fracture is illustrated by Table III. Excepting three cases, in which the X-ray pictures were taken later, the roentgenological finding was diagnostic immediately. These three cases were avulsions in the tibial tuberosity, the spinous process of the 12th thoracic vertebra, and the ischial spine. In them, calcification and roentgenological alterations did not come out until the X-ray pictures were repeated several weeks later.

Operative treatment was applied in two avulsion fractures of the calcaneum and one of the tibial tuberosity.

Fig. 1. Anatomical location of avulsion fractures

Plaster cast immobilisation was applied in two cases of tibial tuberosity in one case of anterior superior iliac spine, and in one of calcaneal avulsion fractures. All fractures healed well.

DISCUSSION

Generally, the injury mechanism causing avulsion fractures is an indirect one (Funk, 1975; Slocum and Larson, 1964). A sudden, intense and often uncoordinated muscle contraction results in the tearing off of the insertion point of a muscle or tendon from the bone.

TABLE III
Connection between event and the location of the avulsion fracture

Location of the fracture	ant.sup.il.spine	ant.inf.il.spine	tibial tuberos.	add.tub.	calcaneus	med.fem.epicond.	olecranon	tarsal navicular	lesser trochanter	major trochanter	spin.proc. Th XII	transv.proc. L II	costa XII	med.humeral epicond.	tuberos. isch.	
Sports event																total
sprints/hurdles	4		1					1	1							7
other running	2	2														4
jogging					2	1				1						4
football	1	2				1										4
ice-hockey	1		1												1	3
bandy														1		1
volleyball					1											1
long jump			1													1
high jump	1															1
javelin throw													1			1
discus throw												1				1
hammer throw											1					1
skiing				3												3
boxing							1									1
weight-lifting							1									1
total	9	4	3	3	3	2	2	1	1	1	1	1	1	1	1	34

In the literature, avulsion fractures in several points of the skeleton have been described. Some of the most common locations are the anterior iliac spines (Benke, 1957; Burghardt, 1974; Krah, 1973b; Nabe and Böttger, 1969), tibial tuberosity (Maresova, 1968; Reichelt, 1972; Will, 1952), ischial spine (Dreick, 1970; Grass-hoff, 1974; Kressin, 1968; Wuschech et al., 1968) and

calcaneal bone (Arner and Lindhom, 1959; Cherry, 1947; Lyngstadaas, 1971; Plettner, 1971). On the other hand, some of the most unusual locations of avulsion fractures are, among others, the insertion points of both medial and lateral collateral ligaments of the knee (O'Donoghue, 1970; Saegesser, 1957), tibial inter-condylar ridge (Meyers, 1975), lower tip of patella

(Devas, 1975; Schaer, 1934), medial and lateral humeral epicondyles (Adams, 1965; O'Donoghue, 1970), front corner of talus (Knoll, 1931; Tittel, 1964), lesser trochanter (Landgrot and Pribyl, 1968; Sweetman, 1972), major trochanter (Witt, 1967), coracoid process of scapula (Benton and Nelson, 1971), lesser tuberosity of humerus (La Briola and Mohaghegh, 1975), the insertion point of gracilis muscle in symphysis (Luschnitz et al., 1968), and the insertion point of adductor muscles (Witt, 1967).

Other injuries may also be caused by this same avulsion fracture mechanism, due to an intense movement and muscle contraction. Subcutaneous muscle and tendon ruptures are, by far, the most common indirect athletic injuries (Hort, 1975; McEntire et al., 1972; Ryan, 1969; Strandell, 1942; Wegner, 1962), but also throwing fracture of humerus (Arndt and Usbéck, 1968; Gregersen, 1971; Peltokallio et al., 1968, Voss, 1939), arm wrestling fracture of humerus (Brismar and Spangen, 1975; Schneider, 1971), and jumping fracture of femoral diaphysis (Litton and Peltier, 1963) have been described.

In this study, the patients are all Northern Finnish athletes. Some of them had taken part in intensive fitness exercise programmes. When examining the respective locations of the fractures, it is noticeable that the frequency of specific locations of injury follow the classifications given in the literature. The average age of the subjects is raised by the "fitness sportsmen"; otherwise, it would have been approximately 15 years, at which age avulsion fractures have most often been found to occur.

Avulsion fractures were seen most frequently in sprinters and hurdlers. In other cases, avulsion fractures in runners had taken place during speed training, or during a maximum effort towards the end of the race. One girl, in the final sprint of the Finnish Cross Country Championship run, sustained an avulsion fracture in the anterior superior iliac spine, nevertheless, she won her event. In total, 11 athletes from the whole series, 32.3% were competitive runners. If the fitness joggers are included in this group, the total percentage of the runners was 44%. As to the cross-country skiers, avulsion fractures were caused by sudden twisting or staggering, usually at fast speed, in a downhill stage of a race. The skiers, as a result of the avulsion fracture, were characterised by the Stieda-Pellegrini change in the region of medial femoral condyle. In other sports, avulsion fractures took place during sudden effort. In several cases, the mechanism was that of an acceleration or deceleration movement. As to the athletes themselves, they

usually thought the movement causing the fracture had usually been uncoordinated, or technically unsuccessful.

Some of these avulsion fractures were not instantaneous; i.e. an athlete had felt pain in the fracture site before the actual rupture had taken place. A few examples can be given; avulsion fractures of the tibial tuberosity, and two of the anterior superior iliac spine. In the literature, so-called "stress avulsions" are mentioned in some parts of the skeleton, for instance in iliac spines, and tibial tuberosity apophyses in adolescence; spinous processes of the lower cervical vertebrae; in the lower pole of the patella etc. (Devas, 1975; Lönnerblad, 1933; Reichelt, 1972; Tomola, 1968).

Unusual sites of avulsion fractures in the series were those of the tarsal navicular, 12th rib, a transverse process of the 2nd lumbar vertebra, and the spinous process of the 12th thoracic vertebra. An avulsion fracture of the tarsal navicular occurred in the upper proximal edge of the bone. A triangular-shaped fragment was separated from it, but during the follow-up, it became well ossified. In athletes, a corresponding fracture has been described by Knoll (1931) and Tittel (1964). The loosening of the bone is caused by a rupture of the ligament due to pronounced plantar flexion. The latter avulsion fractures were seen in muscular athletes taking part in javelin, discus and hammer throwing. They took several months to heal well enough to become symptomless. At first, an avulsion fracture in an ischial spine could not be seen in the primary X-rays. It was only several weeks later that slight calcification, with separation from the bone, could be detected. Clinically, the diagnosis was suspected at first. For two months, competitive sports were stopped because of pain.

Generally, the roentgenological diagnosis of an avulsion fracture is easy to make. However, it requires both an exact knowledge on the mechanism of the injury, and the technique and the training methods used in the event. According to each case, individual means of treatment are chosen; generally, these injuries heal well. As a complication, hypertrophy of a bone (or a "pseudotumor") is described; this may occur if the rest from physical stress is not long enough (Barnes and Hinds, 1972; Heipertz, 1972). A fracture may leave complications handicapping the continuing of sports (Schlonsky and Olix, 1972). In this study, however, no complications nor any residual damage causing trouble in sports afterwards, could be detected, except in two fitness-skiers, who had pain in the site of calcified collateral ligaments of the knee. Symptoms could be managed by conservative therapy.

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