Review

Sportsman's hernia

L. J. Fon and R. A. J. Spence

General Surgical Unit, Belfast City Hospital, Belfast, UK
Correspondence to: Professor R. A. J. Spence, Department of Surgery, Belfast City Hospital, Lisburn Road, Belfast BT9 7AB, UK

Background: **Sportsman's hernia is a debilitating condition which presents as chronic groin pain. A tear occurs at the external oblique which may result in an occult hernia. The definition, investigation and treatment of this condition remain unclear.**

Methods: **A systematic Medline search was performed and all literature pertaining to chronic groin pain, groin injury, sportsman's hernia and sportsman's groin from 1962 to 1999 was retrieved for analysis.**

Results: **The costs of computed tomography and magnetic resonance imaging are such that their routine use for assessment of patients with groin pain cannot be justified. They may, however, be employed in difficult cases to help define the anatomical extent of a groin injury. Plain radiography, ultrasonography and scintigraphy should be the usual first-line investigations to supplement clinical assessment. Herniography may help in situations of obscure chronic groin and pelvic pain. There is no consensus view supporting any particular surgical procedure for sportsman's hernia. A number of reports have been published describing different repairs of the posterior inguinal wall deficiency. Appropriate repair of the posterior wall results in therapeutic benefit in selected cases.**

Conclusion: **The diagnosis of sportsman's hernia is difficult. The condition must be distinguished from the more common osteitis pubis and musculotendinous injuries. Early surgical intervention is usually, although not always, successful when conservative management has failed.**

Paper accepted 7 February 2000 British Journal of Surgery 2000, **87**, 545–552

Chronic groin pain is a major diagnostic and therapeutic dilemma. It is responsible for a significant time away from work and sports competition[1], with a reported incidence between 0·5 and 6·2 per cent[2–5]. Groin injury is particularly common in football players, at least 58 per cent of whom give a history of previous sports-related groin pain[6]. Recurrent groin strain is also common, both in football and hockey players; 6 per cent will suffer at least one episode per season[5]. Over the past decade the number of sports-related injuries has increased as a function of increased athletic activities[7], and the demand for an early return to work and competitive sport puts pressure on the doctor for immediate diagnosis and treatment. A Swedish study reported that in 50 per cent of patients groin pain persisted for over 20 weeks after the causal injury[3].

Groin injury leading to chronic pain is often referred to as the sportsman's hernia[8] or groin disruption[9] and, sometimes, as pubalgia[10]. In many cases, clinical signs are lacking despite the patient's symptoms and there is known to be a high incidence of symptomatic impalpable hernia in patients with obscure groin pain (36–84 per cent)[4–11]. Gilmore popularized the syndrome of groin disruption as 'Gilmore's groin' in the early 1990s and has reported good results from surgical management[12]. Since then many studies have reported a success rate with surgical intervention of 63–90 per cent[13–18]. A recent leading article in this Journal has highlighted the diagnostic difficulty associated with chronic groin pain, especially in the sportsman[19].

Method

A systematic Medline search was performed and the literature pertaining to chronic groin pain, groin injury, sportsman's hernia and sportsman's groin from 1962 to 1999 was retrieved. Further articles, identified from the reference lists of these papers, were also selected and reviewed. Fewer than 40 articles adequately discuss the management of chronic pain in sportsman's hernia.

Pathophysiology

The anatomy of groin hernias is well described in standard surgical textbooks. Chronic groin pain may originate from muscles, tendons, bones, bursas, fascial structures, nerves and joints[20]. In the inguinal canal, the absence of striated muscle at the posterior inguinal wall and the passage of the spermatic cord predispose the abdominal wall to weakness. The guard mechanism of the inguinal canal against abdominal pressure proves insufficient in the case of indirect inguinal hernia. Fruchaud[21], a French surgeon and anatomist, described the musculopectineal gap as a weak area in the deep plane covered only by the transversalis fascia, forming the posterior inguinal wall of the abdomen. Here the transversalis fascia provides the only resistance to intra-abdominal pressure. Stoppa and Van Hee[22] described this area as the herniogenic vocation region.

A deficiency of the posterior inguinal wall is the commonest operative finding in patients with groin pain[8,18]. The deficiency presents as a bulge in the posterior wall and is found in 80–85 per cent of those who have undergone herniorrhaphy for chronic groin pain[8,18]. Gullmo[23] suggested that pain in these circumstances may be caused by a distension of the peritoneum or stretching of the ilioinguinal nerve. Zimmerman[24] suggested that a tear in the conjoint tendon may be the cause of the bulge in the posterior wall and that occult hernia may be a cause of footballer's groin pain. In Gilmore's description of groin disruption, a torn external oblique aponeurosis causes dilatation of the superficial inguinal ring. Together with a torn conjoint tendon, this may cause a dehiscence between the inguinal ligament and the conjoint tendon[12].

Lovell *et al.*[25] reported an incidence of incipient hernia of 50 per cent in their series of 189 athletes. One herniography study revealed a symptomatic impalpable hernia in 51 per cent of male and 21 per cent of female patients[13], and another study reported a hernia in 84 per cent of elite athletes with groin pain[11]. Ekberg[4] described a lower figure (36 per cent) in patients presenting with obscure groin pain. It is also of interest that Hess[26] noted oedema of the spermatic cord at the time of surgery. Berliner[27] biopsied the transversus abdominis aponeurosis in patients with a direct inguinal hernia and a strong family history of inguinal hernia, and found fragmentation and paucity of elastin fibres.

Clinical findings

Although debilitating, groin pain is often vague, leading to a delay in diagnosis. An accurate clinical history and extensive examination of the spine, pelvis, hips, and abdominal and leg musculature plays an important part in determining its cause. The site, duration and nature of the pain should be noted, along with urological symptoms, skeletal problems and rheumatological disorders. Initial symptoms may be minimal and there is some debate about the best time for physical examination of the patient. Hackney[17] argues that this may be after return to exercise and return of the pain.

Polglase *et al.*[18] reported that 59 (92 per cent) of 64 patients presented with a slow onset of pain over a period of time, ranging from 1 to 6 months; the remainder complained of sudden onset. Loftus *et al.*[28] noted that only three (5 per cent) of 63 patients with herniograms had a hernia clinically palpable before exploration; six of 26 had a cough impulse. Diagnostic problems may occur owing to variability in the distribution of the pain and the precise local pathology. Pain is notably worse over the pubic tubercle of the affected side, and the area around the external ring is tender[17]. Gilmore described chronic pain that was aggravated by sudden and twisting movements[12]. Coughing, sneezing and kicking a ball exacerbate the symptoms. Clinical findings typically include a lack of visible external signs in the affected groin, dilatation of the superficial ring (demonstrable by scrotal inversion with the tip of the little finger), a cough impulse and marked tenderness in the opposite groin[12].

Differential diagnosis

The incidence of multiple pathological causes of groin pain is said to be high and may be relevant in up to a quarter of chronic groin pain sufferers[25,29]. This may account for some of the treatment failures. Several comprehensive reviews have also highlighted the wide variety of causes of groin pain[24,30,31] and inadequate treatment may lead to recurrent problems. Apart from hernia, two other major causes of groin pain are muscle and tendon injury, and osteitis pubis[20]. Other less common causes include nerve entrapment and urological pathology. Rarer reported causes include bone and joint disease, such as stress fractures, snapping hip syndrome, spondylolisthesis, early osteoarthritis and slipped upper femoral epiphysis[17].

Muscle and tendon injury

Strain of the muscle–tendon unit is the most common type of injury causing disability in sport[32]. It occurs mainly at the proximal end, either to the tendon itself or to the musculotendinous junction in the muscle belly[33]. The adductor tendon is often involved, especially adductor longus; other muscles likely to be affected include rectus femoris and the rectus abdominis muscle and tendon. The

history is a good guide to identifying muscle and tendon injury. Plain radiography is often normal in muscular injuries of less than 1 week's duration[33]. The role of computed tomography (CT) is unclear as its ability to detect acute muscle injury is limited[18] but it may be of use in chronic or recurrent injury. Magnetic resonance imaging (MRI) is able to characterize muscular or musculotendinous injuries better than CT and it can outline the extent of injury within the muscle group[33]. Ultrasonography has also been used to identify such injuries.

Osteitis pubis

Osteitis pubis is especially common in sports that involve kicking or physical contact, especially football, with a reported radiological incidence in soccer players of 14–28 per cent[14]; there is a higher incidence in more competitive athletes[6]. This injury results from repetitive avulsive trauma near the pubic symphysis, usually involving the adductor muscles or gracilis. The clinical picture includes focal pain or tenderness at the pubic symphysis in 70 per cent of confirmed cases[34], with occasional adductor muscle tenoperiostitis. The history may include a direct blow to the symphysis or pelvic instability from a sacroiliac joint injury.

Radiological changes of osteitis pubis are present in 26 per cent of football players with recurrent groin pain[35]. Radiological hallmarks include non-specific irregularity of the cortical margin and pubic symphyseal widening (more than 7 mm). Erosions may occur leading to sclerosis at the pubic bone margins. Radiological assessment of the symphysis pubis in young men can be difficult, as ossification in that region varies considerably and findings may be misinterpreted[29]. Subacute ischial avulsion may be mistaken for osteomyelitis or neoplasm[36–39]. Radiography should be restricted to cases where there is clinical suspicion of a skeletal abnormality. An isotope bone scan using ^{99m}Tc may assist the diagnosis of osteitis pubis[25] but a negative scintigram does not exclude the diagnosis.

Management of osteitis pubis is difficult and frustrating[40]. Debate continues between a conservative policy and surgical intervention. Conservative treatment involves aggressive physiotherapy to strengthen the hip rotators, flexors and adductors. Daily stretching should be encouraged, with avoidance of kicking and running, and sport should cease for 3–6 months[1]. The use of intra-articular steroids has not been found to be useful[20,34]. Surgery involving the pubic symphysis, leaving the anterior and posterior ligament intact, has been claimed to relieve the symptom of osteitis[34]. Histological examination of local tissues shows only scattered fibrosis and chronic inflammation[41,42]. The majority of patients respond to conservative treatment and rehabilitation[43] but a successful return to full activity after treatment for osteitis pubis has been reported by some to be as low as 20 per cent[17].

Stress fracture

Stress fracture is common in athletes, especially long distance runners. Pubic rami stress fractures accounted for 1·4–7·8 per cent of all stress fractures[44] and a South African study of 196 runners estimated that 10–15 per cent of pelvic stress fractures occur in women[45]. Others have reported a higher incidence of pelvic stress fractures in women marathon runners, 72 per cent[46] to 79 per cent[30].

Pelvic stress fractures present with a gradual onset of groin and thigh pain[43] leading to inability to run for at least 8 weeks or more after the injury. Physical examination reveals tenderness to deep palpation over the pubic ramus. Athletes are unable to stand and support their full weight on the ipsilateral side[47]. The diagnosis will be missed if the clinician is unaware of the significant number of stress fractures that are not radiologically apparent[48]. Radiographs are often normal, especially early in the disease process; only 38 per cent of clinical pelvic stress fractures show radiologically[47]. Bone scanning reveals increased uptake in the affected ramus[43] owing to increased blood flow and osteoblastic activity. A ^{99m}Tc bone scan is a sensitive method of identifying stress fracture and is appropriate when bony or pubic symphyseal tenderness is found on clinical examination. Diagnosis of stress fracture may be improved by a combination of radiography plus bone scintigraphy or repeated radiographic examination. When ^{99m}Tc scanning is combined with conventional radiography, the accuracy of diagnosis of stress fracture of the pubic bone is increased to 62 per cent[29].

Treatment of pubic stress fracture is rest for 4–6 weeks[45] and avoidance of pain-associated activity; delayed or non-union may occur if the athlete continues to run[46]. Surgery is the treatment of choice in most cases of stress fracture of the femoral neck[9]. Avascular necrosis of the femoral head may also cause pain in the hip or groin. The main cause is trauma, resulting in a subcapital fracture. Fortunately, sports-related dislocation and displaced femoral neck fractures are rare, even in contact sports, but they may go unrecognized especially when there is no associated acetabular rim fracture[49].

Urological disease

Other common causes of obscure groin pain include prostatitis[13], epididymitis, urethritis and hydrocele[10]. Prostatitis is probably the most frequently overlooked

condition. Rectal palpation and positive culture assist in the diagnosis and the treatment is with antibiotics, with or without non-steroidal anti-inflammatory agents[50].

Connective tissue disease

Although rare, the various connective tissue diseases, such as rheumatoid arthritis, should not be forgotten. Diseases such as gout, ankylosing spondylitis, Reiter's syndrome and other spondarthritides may also need to be investigated[51].

Spinal and hip abnormalities

Early assessment of the spine and hip is required to identify sacrolumbar abnormalities and sinister lesions such as bone tumours. Old osteochondritis of the vertebral bodies, disc lesions at L1 or L2, and crush fractures can cause radicular pain and imitate groin strain. Boeda[52] reported lower lumbar and sacral abnormalities responsible for excessive pelvic tilt and secondary stress in 16 athletes. H. Junge (unpublished results) reported a series of pelvic radiographs of 950 athletes that showed minor subluxation of the femoral head associated with groin pain and symphysis pubis lesions.

Nerve entrapment

There has been recent interest in neurogenic groin pain. Lovell *et al.*[25] have studied the clinical presentation of ilioinguinal neuralgia in a series of athletes with groin pain. Diagnosis involves finding tenderness in the region of the iliac fossa and injecting local anaesthetic at this site to relieve the pain[20]. Obturator neuropathy has been described in a series of 32 patients[53]. Diagnosis relies on exercise-induced medial thigh pain over the area of adductors, especially during kicking and twisting. There may be adductor muscle weakness as well as paraesthesia of the medial thigh after exercise and electromyography may demonstrate chronic denervation changes in the adductor muscles. Fascial entrapment of the obturator nerve is possible. Other nerve entrapments in the inguinal region include those of the genitofemoral[54] and ilioinguinal[55] nerves which cause local pain and neurological dysfunction. Nerve entrapment syndromes can be treated by exploration and surgical release of the nerve[53].

Investigations

High-performance athletes with severe pain or weakness often undergo imaging because their trainers and physicians perceive the need for accurate evaluation of the severity of injury to predict the period of convalescence and eventual return to competition[56]. Various imaging modalities are used to identify hernias and exclude other pathology. The peritoneal lining and hernial contents may be identified indirectly by herniography and directly visualized by ultrasonography, CT and MRI. There are limited reports on the sensitivity and specificity of CT and MRI for groin hernia, most of which are based on descriptions of appearances of various types of hernia[57–60]. Laparoscopy is now also being evaluated in the investigation of sportsman's hernia.

Herniography

Herniography is performed by injecting contrast medium into the peritoneal cavity. The patient is then moved to an upright position and asked to strain. Anteroposterior and oblique views are taken. A number of reports have suggested the use of herniography to diagnose occult symptomatic groin hernia and to evaluate obscure groin and pelvic pain in adults[4,23,61]. Herniography helps to identify the lesion and confirm that surgery may be warranted in the athlete with groin pain. Hernia has been found to be present in 19 (24 per cent) of 79 and 38 (36 per cent) of 106 cases of obscure groin pain in two separate studies using herniography[62,63]. Smedberg *et al.* from Sweden, however, reported a much higher incidence. These authors first found that 51 per cent of men and 21 per cent of women with groin pain had impalpable but symptomatic hernia[13]; a second study reported an incidence of hernia of 84 per cent in elite athletes with groin pain[11]. Herniography has been reported to have a high accuracy (95–99·5 per cent) and low false-negative rate (0·5–4·0 per cent) in the detection of abdominal wall hernia in other series[64–66]. Lovell *et al.*[25], however, reported a lower sensitivity (82 per cent) and specificity (64 per cent), with a predictive value of 89 per cent; furthermore, negative herniography does not exclude an occult hernia. The complication (bowel puncture etc.) rate of herniography is 5–6 per cent[61–67].

Ultrasonography

Ultrasonography is a useful non-invasive adjunct to physical examination and is especially helpful in chronic injury. It provides valuable information such as the extent and location of tendinous injuries, demarcating partial tears as local hypoechoic areas with discontinuity of fibres within the fibrillary tendon tissue[68]. Deitch and Soncrant[69] reported a sensitivity of 97 per cent with ultrasonography, in a series of 70 patients with ambiguous groin pain and questionable diagnosis. However, ultrasonography failed to diagnose two clinically obvious small indirect inguinal hernias. The limitation of the method relates to difficulty in

detecting occult hernias and a negative result does not exclude the diagnosis. Ultrasonography appears to be able to identify patients with a surgically remedial lesion, avoiding prolonged non-operative treatment as well as reducing the frequency of negative surgical exploration. The technique is not widely used in the USA but is more often used in Europe[7].

Computed tomography

CT has established itself as the standard investigation in the evaluation of most soft tissue disease, especially soft tissue tumours and neuromuscular disease[70]. However, its ability to identify abnormalities is limited by its fixed planes[71]. This can be overcome by employing helical CT scanning, which allows multiplanar reconstruction to be performed to permit better detection of hernias during straining. CT, by virtue of its supine scanning position, may fail to detect a reducible hernia[72]. The inferior epigastric vessels, an important landmark for direct and indirect inguinal hernia, cannot be identified clearly in all patients[71].

CT has a more important role in the diagnosis of other pathological causes of chronic groin pain. With a spatial resolution of 1 mm and density resolution less than 0·5 per cent, it has become a standard method of soft tissue evaluation; for example, haematoma within injured muscle can be recognized with ease[73–75].

Magnetic resonance imaging

MRI is superior to CT for musculotendinous imaging because of its better soft tissue contrast, multiplanar capabilities (sagittal, coronal and oblique), lack of ionizing radiation and sensitivity for small lesions[76–78]. MRI can clearly identify structures (inferior epigastric vessels, inguinal ligament, deep and superficial rings, inguinal canal, spermatic cord, round ligament and vascular structures) that are crucial in the assessment and differentiation of inguinofemoral hernias[71]. Van den Berg *et al.*[71] reported a small prospective study of 13 patients in which 11 inguinal hernias were diagnosed correctly. There were no false positives.

MRI is also useful in the differential diagnosis of chronic groin pain. It can demonstrate damage to the conjoint tendon and outline the extent of muscular injury[33]. Macroscopic injury, such as partial tear or complete rupture, can be identified as disruption of muscle and tendon fibres. Fluid accumulation and altered configuration of the muscle and tendon unit may be found. MRI is useful in excluding stress fractures[20] or avascular necrosis of the femoral head. It is superior to CT as an imaging modality for muscle strain injury except in circumstances of late ectopic calcium deposition in injured muscle[79]. MRI is of limited value in the diagnosis of calcified tendinitis and bony abnormality at tendon insertion points; these are better visualized using CT[79].

Despite superior soft tissue contrast, MRI has not been popular as a primary diagnostic imaging tool in the evaluation of groin hernia[71]. CT and MRI cannot be justified on grounds of cost for routine assessment of patients with groin pain but they may be performed in suspicious cases to define the anatomical extent of groin injury. The main advantage of ultrasonography, CT and MRI is their ability to identify conditions other than hernias that may be responsible for the symptoms. However, plain radiography, ultrasonography and scintigraphy should be considered as the first line of investigation to supplement clinical assessment. Herniography should be used in obscure chronic groin and pelvic pain or if a symptomatic occult groin hernia is suspected.

Laparoscopy

The role of laparoscopy in sportsman's hernia is still being evaluated. While it allows an opportunity to examine all the local hernial orifices[80,81] and is more accurate than clinical diagnosis[80], it has a number of limitations. It does not permit an assessment of the anterior wall of the inguinal canal, notably the conjoint tendon, and commits the surgeon to a laparoscopic repair; it adds the risk of complications of laparoscopic surgery. Laparoscopy, however, may have a role in patients who have had multiple repairs.

Management

Conservative measures

Musculotendinous strain of the adductors and other muscle groups is the commonest cause of groin pain. Non-palpable inguinal hernia and subclinical abdominal defects without herniation are often overlooked. Diagnosis of groin pain is further complicated by the presence of multiple pathology[29]. Many patients therefore undergo prolonged periods of physiotherapy with lengthy spells of rest and numerous radiological investigations before referral to the specialist. Initially, conservative management with rest, anti-inflammatory agents, stretching and strengthening exercise should be advised[10]. With such a conservative approach there is a gradual return to sports activity; it may be 3–6 months before full activity can be resumed.

Role of surgery

Opinions about the value of surgery differ greatly. Recent authors have advised modified herniorrhaphy[8,12,15–18,82].

Surgical intervention is contemplated when conservative management has failed. There is no consensus to support any particular surgical procedure.

Gilmore described the surgical restoration of the torn external oblique aponeurosis and conjoint tendon by modified herniorrhaphy, with plication of the transversalis fascia and polyglactin repair of the conjoint tendon. The latter is then approximated to the inguinal ligament with a nylon darn. The external oblique is repaired and the wound closed in layers[12]. Others have approximated the torn edges of the external oblique with simple interrupted sutures rather than using the complex repair suggested by Gilmore. They also have reported good results with full sporting activity within 5–6 weeks in their small study[82].

A number of different modified repairs of the posterior wall deficiency have been described. Malycha repairs the posterior inguinal wall in two layers; a continuous suture is inserted from the pubic tubercle to the internal ring followed by a second layer (with a loose darn over this layer). Smodlaka[14] reported that Nessovic (several hundred athletes) and Polglase *et al.*[18] (64 patients) used the conventional Bassini repair for the weak posterior wall of the inguinal canal with success. Others suggest strengthening the inguinal ligament and transversalis fascia[15], or closing the external ring and subcutaneous cord placement[16]. Hackney[17] reported that Hyde tightens the conjoint tendon by reattaching the insertion of the tendon. Hyde claimed a 90 per cent success rate over 500 operations using this technique[17]. Hackney reported, in his series of 15 athletes, that 13 had returned to full activity and the remaining two were improved by repair[17]. Malycha and Lovell[8] used a repair of the posterior inguinal wall, and 41 of 44 patients returned to normal preinjury activity; 75 per cent obtained good relief and 23 per cent obtained improvement of their initial symptoms. In cases of inguinal hernia, 63–70 per cent of athletes can expect cure from herniorrhaphy and a further 20–31 per cent will improve[13,18]. Only 5 per cent have persistent groin pain and remain unhappy with the result of operation. Division or preservation of the ilioinguinal nerve does not affect the outcome in this respect[18].

Conclusion

Groin pain continues to be an economic and personal burden in terms of absence from sport. It may result in chronic disability, leading to early retirement from competition due to delay or failure in treatment. Many symptoms will settle with conservative or non-operative measures but, despite 'negative' investigation, in severe and/or persistent cases surgical exploration is justified. Appropriate repair of the posterior wall of the inguinal canal has proven to be of therapeutic benefit, offering cure to over 60 per cent of the patients and improvement to a further 20 per cent[18].

References

1 Muckle DS. Associated factors in recurrent groin and hamstring injuries. *Br J Sports Med* 1982; **16:** 37–9.
2 Cabot JR. Osteopatica dinamica del pubis. In: Hanekopf G, ed. *Proceeding of the XVI World Congress of Sport Medicine*. Hannover: Deutscher Aertze, 1966: 359–64.
3 Renstrom P, Peterson L. Groin injuries in athletes. *Br J Sports Med* 1980; **14:** 30–6.
4 Ekberg O. Inguinal herniography in adults: technique, normal anatomy and diagnostic criteria for hernias. *Radiology* 1981; **138:** 31–6.
5 Jankovic G. Prevention of pubic pain in football players. *Sports Med* 1977; **14:** 623–5.
6 Harris NH, Murray RO. Lesions of the symphysis in athletes. *BMJ* 1974; **iv:** 211–14.
7 Tung GA, Brody JM. Contemporary imaging of athletic injuries. *Clin Sports Med* 1997; **16:** 393–417.
8 Malycha P, Lovell G. Inguinal surgery in athletes with chronic groin pain: 'sportsman's' hernia. *Aust NZ J Surg* 1992; **62:** 123–5.
9 Renstrome PA. Tendon and muscle injuries in the groin area. *Clin Sports Med* 1992; **11:** 815–31.
10 Taylor DC, Meyers WC, Moylan JA, Lohnes J, Bassett FH, Garrett WE Jr. Abdominal musculature abnormalities as a cause of groin pain in athletes. Inguinal hernias and pubalgia. *Am J Sports Med* 1991; **19:** 239–42.
11 Smedberg SG, Broome AEA, Gullmo A, Roos H. Herniography in athletes with groin pain. *Am J Surg* 1985; **149:** 378–82.
12 Gilmore OJA. Gilmore's groin. *Sports Medicine and Soft Tissue Trauma* 1992; **3:** 12–14.
13 Smedberg SG, Broome AEA, Elmer O, Gullmo A. Herniography in the diagnosis of obscure groin pain. *Acta Chirurgica Scandinavica* 1985; **151:** 663–7.
14 Smodlaka VN. Groin pain in soccer players. *The Physician and Sportsmedicine* 1980; **8:** 57–61.
15 Horsky I, Huraj E. Surgical treatment of the painful groin. *Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca* 1984; **52:** 350–3.
16 Schneider R, Kaye J, Ghelman B. Adductor avulsive injuries near the symphisis pubis. *Radiology* 1976; **120:** 567–9.
17 Hackney RG. The sports hernia: a cause of chronic groin pain. *Br J Sports Med* 1993; **27:** 58–62.
18 Polglase AL, Frydman GM, Farmer KC. Inguinal surgery for debilitating chronic groin pain in athletes. *Med J Aust* 1991; **155:** 674–7.
19 MacLeod DAD, Gibbon WW. The sportsman's groin. *Br J Surg* 1999; **86:** 849–50.
20 Flicker P, Taunton J, Ammann W. Osteitis pubis in athletes: infection, inflammation, or injury? *Sports Med* 1991; **12:** 266–79.

21 Fruchaud H. *Anatomie Chirurgicale Des Hernies De L'aine*. Paris: G. Doin, 1956.
22 Stoppa R, Van Hee R. Surgical anatomy of the groin region. *Acta Chir Belg* 1998; **98:** 124–6.
23 Gullmo A. Herniography. The diagnosis of a hernia in the groin and incompetence of the pouch of Douglas and pelvic floor. *Acta Radiol Suppl* 1980; **361:** 1–76.
24 Zimmerman G. Groin pain in athletes. *Aust Fam Physician* 1988; **17:** 1046–52.
25 Lovell G, Malycha P, Pieterse S. Biopsy of the conjoint tendon in athletes with chronic groin pain. *Aust J Sci Med Sport* 1990; **22:** 102–3.
26 Hess H. Leistenschmerz-Atiologie. Differential diagnose und therapeutische Moglichkeiten. *Orthopade* 1980; **9:** 186–9.
27 Berliner SD. An approach to groin hernia. *Surg Clin North Am* 1984; **64:** 197–213.
28 Loftus IM, Ubhi SS, Rodgers PM, Watkin DFL. A negative herniogram does not exclude the presence of a hernia. *Ann R Coll Surg Engl* 1997; **79:** 372–5.
29 Ekberg O, Perrson NH, Abrahamsson P, Westlin NE, Lilja B. Long standing groin pain in athletes. A multidisciplinary approach. *Sports Med* 1988; **6:** 56–61.
30 Hughes D, Maguire K. Groin pain in sport. *Excel* 1988; **5:** 3–5.
31 Corrigan B, Stenstone B. Hip and groin problems in runners. *Patients' Management* 1985; **9:** 33–42.
32 Berson BL, Rolnick AM, Ramos CG, Thornton J. An epidemiologic study of squash injuries. *Am J Sports Med* 1981; **9:** 103–6.
33 Brandser EA, el-Khoury GY, Kathol MH, Callaghan JJ, Tearse DS. Hamstring injuries: radiographic, conventional tomographic, CT, and MR imaging characteristics. *Radiology* 1995; **197:** 257–62.
34 Vincent C. Osteitis pubis. *J Am Board Fam Pract* 1993; **6:** 492–6.
35 Eissmann HJ. Zur aetiologie, symptomologie differential diagnose therapie und prophylaxes des leistenschmerzes bein jugendlichen fussballspielern. *Medicine du Sport (Berlin)* 1972; **12:** 80–92.
36 Finby N, Begg CF. Traumatic avulsion of ischial apophysis simulating neoplasm. *N Y State Journal of Medicine* 1967; **67:** 2488–90.
37 Metzmaker JN, Pappas AM. Avulsion fractures of the pelvis. *Am J Sports Med* 1985; **13:** 349–58.
38 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.
39 Barnes ST, Hinds RB. Pseudotumor of the ischium. A late manifestation of avulsion of the ischial epiphysis. *J Bone Joint Surg Am* 1972; **54:** 645–7.
40 Hanson P, Angerine M, Juhl J. Osteitis pubis in sports activities. *The Physician and Sportsmedicine* 1978; **10:** 111–4.
41 Grace JN, Sim FH, Shives TC, Coventry MB. Wedge resection of the symphysis pubis for the treatment of osteitis pubis. *J Bone Joint Surg Am* 1989; **71:** 358–64.
42 Middleton RG, Carlile RG. The spectrum of osteitis pubis. *Compr Ther* 1993; **19:** 99–102.
43 Barry NN, McGuire JL. Acute injuries and specific problems in adult athletes. *Rheum Dis Clin North Am* 1996; **22:** 531–49.
44 Orava S, Puranen J, Ala-Ketola L. Stress fractures caused by physical exercise. *Acta Orthop Scand* 1978; **49:** 19–27.
45 Pinshaw R, Atlas V, Noakes TD. The nature and response to therapy of 196 consecutive injuries seen at the runner's clinic. *S Afr Med J* 1984; **65:** 291–8.
46 Pavlov M, Nelson TL, Warren RF, Torg JS, Burnstein AH. Stress fractures of the pubic ramus. A report of twelve cases. *J Bone Joint Surg Am* 1982; **64:** 1020–5.
47 Noakes TD, Smith JA, Lindenberg G, Wills CE. Pelvic stress fractures in long distance runners. *Am J Sports Med* 1985; **13:** 120–3.
48 Norfray JF, Schlachter L, Kernaghan WT Jr, Arenson DJ, Smith SD, Roth IE *et al.* Early confirmation of stress fractures in joggers. *JAMA* 1980; **243:** 1647–9.
49 Resnick D, Guerra J Jr. Stress fractures of the inferior pubic ramus following hip surgery. *Radiology* 1980; **137:** 335–8.
50 Abrahamsson PA, Westlin NE. Symphysitis and prostatitis in athletes. *Scandinavian Journal of Urology and Nephrology* 1985; **19**(Suppl 93): 15–35.
51 Neipel GA, Sitaj S. Enthesopathy. *Clinics in Rheumatic Diseases* 1979; **5:** 857–63.
52 Boeda A. Apropos de la maladie des adducteurs. *Medicine Du Sport (Paris)* 1973; **47:** 127.
53 Bradshaw C, McCrory P, Bell S, Brukner P. Obturator nerve entrapment. A cause of groin pain in athletes. *Am J Sports Med* 1997; **25:** 402–8.
54 Rischbieth RH. Genito-femoral neuropathy. *Clinical and Experimental Neurology* 1986; **22:** 145–7.
55 Kopell HP, Thompson WAL, Postel AH. Entrapment neuropathy of the ilioinguinal nerve. *N Eng J Med* 1962; **266:** 16–19.
56 Pomeranz SJ, Heidt RS Jr. MR imaging in the prognostication of hamstring injury. Work in progress. *Radiology* 1993; **189:** 897–900.
57 Wechsler RJ, Kurtz AB, Needleman L, Dick BW, Feld RI, Hilpert PL *et al.* Cross-sectional imaging of abdominal wall hernias. *AJR Am J Roentgenol* 1989; **153:** 517–21.
58 Harrison LA, Keesling CA, Martin NL, Lee KR, Wetzel LH. Abdominal wall hernias: review of herniography and correlation with cross-sectional imaging. *Radiographics* 1995; **15:** 315–32.
59 Zarvan NP, Lee FT Jr, Yandow DR, Unger JS. Abdominal hernias. CT findings. *AJR Am J Roentgenol* 1995; **164:** 1391–5.
60 Bennett HF, Balfe DM. MR imaging of the peritoneum and abdominal wall. *Magn Reson Imaging Clin N Am* 1995; **3:** 99–120.
61 Hall C, Hall PN, Wingate JP, Neoptolemos JP. Evaluation of herniography in the diagnosis of an occult abdominal wall hernia in symptomatic adults. *Br J Surg* 1990; **77:** 902–6.
62 Cohen RH, Turkenberg JL, van Dalen A. Herniography in 79 patients with unexplained pain in the groin: a retrospective study. *Eur J Radiol* 1990; **11:** 184–7.
63 Makela JT, Kiviniemi H, Palm J, Myllyla V. The value of

herniography in the diagnosis of unexplained groin pain. *Ann Chir Gynaecol* 1996; **85:** 300–4.
64 Gallegos F, Glass HG, Lynch RH. Inguinal herniography in cases of unilateral hernia to detect a contralateral hernia. *Int Surg* 1974; **59:** 279–81.
65 White JJ. Herniography – a perspective. *Surgery* 1978; **83:** 363–4 (Editorial).
66 White JJ, Haller JA Jr, Dorst JP. Congenital inguinal hernia and herniography. *Surg Clin North Am* 1970; **50:** 823–37.
67 Yilmazlar T, Kizil A, Zorluoglu A, Ozguc H. The value of herniography in football players with obscure groin pain. *Acta Chir Belg* 1996; **96:** 115–18.
68 Kalebo P, Karlsson J, Sward L, Peterson L. Ultrasonography of chronic tendon injuries in the groin. *Am J Sports Med* 1992; **20:** 634–9.
69 Deitch EA, Soncrant MC. Ultrasonic diagnosis of surgical disease of the inguinal–femoral region. *Surg Gynecol Obstet* 1981; **152:** 319–22.
70 Riddlesberger MM Jr. Computed tomography of the musculoskeletal system. *Radiol Clin North Am* 1981; **19:** 463–77.
71 van den Berg JC, de Valois JC, Go PM, Rosenbusch G. Dynamic magnetic resonance imaging in the diagnosis of groin hernia. *Invest Radiol* 1997; **32:** 644–7.
72 Harrison LA, Keesling CA, Martin NL, Lee KR, Wetzel LH. Abdominal wall hernias: review of herniography and correlation with cross-sectional imaging. *Radiographics* 1995; **15:** 315–32.
73 Shirkhoda A, Mauro MA, Staab EV, Blatt PM. Soft-tissue hemorrhage in hemophiliac patients. Computed tomography and ultrasound study. *Radiology* 1983; **147:** 811–14.
74 Swensen SJ, McLeod RA, Stephens DH. CT of extracranial hemorrhage and hematomas. *AJR Am J Roentgenol* 1984; **143:** 907–12.
75 Wolverson MK, Crepps LF, Sundaram M, Heiberg E, Vas WG, Shields JB. Hyperdensity of recent hemorrhage at body computed tomography: incidence and morphologic variation. *Radiology* 1983; **148:** 779–84.
76 Beltran J, Noto AM, Herman LJ, Lubbers LM. Tendons: high-field strength, surface coil MR imaging. *Radiology* 1987; **162:** 735–40.
77 Rosenberg ZS, Cheung Y, Jahss MH. Computed tomography scan and magnetic resonance imaging of ankle tendons: an overview. *Foot and Ankle* 1988; **8:** 297–307.
78 Speer KP, Lohnes J, Garrett WE Jr. Radiographic imaging of muscle strain injury. *Am J Sports Med* 1993; **21:** 89–96.
79 Garrett WE Jr. Muscle strain injuries: clinical and basic aspects. *Med Sci Sports Exerc* 1990; **22:** 436–43.
80 Crawford DL, Hiatt JR, Phillips EH. Laparoscopy identifies unexpected groin hernias. *Am Surg* 1998; **64:** 976–8.
81 Carter JE. Combined hysteroscopic and laparoscopic findings in patients with chronic pelvic pain. *J Am Assoc Gynecol Laparosc* 1994; **2:** 43–7.
82 Williams P, Foster ME. 'Gilmore's groin' – or is it? *Br J Sports Med* 1995; **29:** 206–8.

