ABSTRACT

Posterior lumbar apophyseal ring (PLAR) fractures are rare in adolescents. We report 4 such cases in Chinese adolescents. Two of the patients had a slipped capital femoral epiphysis; 3 of them were overweight/obese. All presented with low back pain and radicular pain. Apophyseal fractures of the upper lumbar spine usually involve the lower end plate, whereas those of the lumbar sacral spine usually involve the upper end plate. The radiological features and pathophysiology are discussed. Two of the patients were treated with laminotomy and diskectomy after conservative treatment failed. All patients had complete resolution of their neurological deficits at a mean follow-up of 2 years. Despite its benign nature, long-term follow-up is necessary to define the natural course and prognosis of the disease. A high index of suspicion is needed to diagnose these fractures in adolescents.

Key words: adolescent; lumbar vertebrae; spinal fractures

INTRODUCTION

Posterior lumbar apophyseal ring (PLAR) fractures are rare in adolescents.1–3 A high index of suspicion, detailed history review, physical examination, and computed tomography (CT) are needed to make the diagnosis.4

CASE REPORTS

Case 1

In May 2001, an 11-year-old overweight boy (body mass index [BMI], 25.5; 62 kg/1.56 m²) presented with a one-week history of pain in the left calf, with no previous trauma. The pain developed after standing or sitting for over 5 minutes. The straight leg-raising test was 20° on both sides. There was no cross sciatica or neurological deficit. Radiographs of both hips were normal, but the L5/S1 disc space was narrowed (Fig. 1a). Magnetic resonance imaging (MRI) showed central protrusion of the L5/S1
disc, with a firm to hard consistency (Fig. 1b). The
diagnosis of apophyseal ring fracture from the upper
end plate of S1 was confirmed using CT (Figs. 1c and
1d). His symptoms did not improve after 4 weeks
of physiotherapy and analgesics. To decompress
the tight S1 roots, the lower border of the L5 lamina
was fenestrated and the central disc protrusion was
removed. His symptoms improved considerably
after surgery. The straight leg raising test improved
to 70° and the leg and back pain subsided completely
2 months later. At the 2-year follow-up, the patient
had recovered fully and reported no recurrence of his
symptoms.

Case 2
In June 2000, an 18-year-old overweight man (BMI,
27.3; [81.8 kg/1.73 m]²) presented with a 2-month
history of low back pain after contusion to the back
during a football game. The pain was over the lower
lumbar spine and radiated to the medial surface of
his left calf. There was no neurological deficit and no
endocrinopathy. He had a full range of movement
in his lumbar spine. He had undergone fixation of
a slipped capital femoral epiphysis 7 years earlier.
Radiographs revealed a small bone fragment posterior
to the lower end plate of L4 (Fig. 2a). CT revealed an
apophyseal ring fracture from the lower end plate of
L4 with bulging of the L4/L5 disc (Figs. 2b and 2c).
The patient was treated with physiotherapy, and the
back pain gradually subsided after 2 months. At the
3-year follow-up, the patient had recovered fully and
reported no recurrence of his symptoms.

Case 3
In August 2001, a 12-year-old obese boy (BMI, 31.5;
[90.9 kg/1.7 m]²) presented with a 4-month history
of low back pain radiating to the right leg, and no previous trauma. He had a mild limp but no leg weakness or numbness. The straight leg raising test was 40° and 20° on the left and right sides, respectively, with cross sciatica. Radiographs showed narrowing of the L4/L5 disc space (Fig. 3a) and bulging of the acetabulum floor, indicating soft bone. CT and MRI showed a fracture of the apophyseal ring of the upper end plate of L5 (Figs. 3b to 3d). The child was treated with physiotherapy, and the back pain gradually subsided. At the 2-year follow-up, the patient had recovered fully and reported no recurrence of his symptoms.

Case 4

In February 2003, a 16-year-old boy (BMI, 21.4; [64 kg/1.73 m]²) presented with a 2-month history of low back pain radiating to the right leg after having a buttock contusion following a basketball injury. He walked with a limp and listed to the right side. There was no scoliosis or hamstring tightness. The straight leg-raising test was 50° on the right side with cross sciatica. He had numbness in the distribution of the L4 dermatome and grade-4 weakness from the L4 to S1 myotomes. The patient had a known history of G6PD deficiency and long-sightedness. He had undergone screw fixation for a slipped capital femoral epiphysis on the left hip at the age of 12 years. An endocrinopathy screen was normal. Radiographs showed a decreased disc space at L2/3 and partial sacralisation of L5 (Fig. 4a). Non-contrast 3-mm axial sections using a sagittal reconstructed CT demonstrated multiple Schmorl’s nodes at the end plates from L1 to L4 and corresponding bulging discs at L2/3 and L3/4. A quadrilateral-shaped bone density measuring 4x6 mm in the cephalic extent of the left L2/3 neural foramen was shown, as was a corresponding bone defect in the posterior lower aspect of L2 (Figs. 4b and 4c). MRI showed a thin L5/S1 disc, lumbar spondylosis with desiccation of L1/2 and L3/4 intervertebral discs and multiple-level bulging of the intervertebral discs including L2/3, L3/4 and L4/5. The cauda equina was especially crowded together at L2/3 (Fig. 4d). No fracture or abnormality of the posterior apophyseal ring was noted. The patient underwent fenestration and disectomy with trimming of the lower apophyseal ring of the ossified L2. At 2 weeks, motor and sensory function of the right lower limb had gradually recovered. The straight leg-raising test was 90° on the right side. The power in all myotomes and the touch sensation had returned to normal. At the one-year follow-up, the patient had recovered fully and reported no recurrence of his symptoms.

DISCUSSION

Of 65 reported cases of PLAR fracture, the youngest occurred in a 10-year-old girl and the eldest was 45 years of age. Only 14 patients were younger than 20 years of age. The apophyseal ring ossifies between the ages of 4 and 6 years and fuses at 18 years. It is firmly attached to the annulus fibrosus by Sharpey fibres. The posterior longitudinal ligament, spanning the posterior vertebral body, is also firmly...
anchored to collagen fibres of the annulus fibrosis. The osteo-cartilaginous portion between the apophyseal ring and vertebral body is relatively weak. Chronic stress or repeated trauma may account for prolapsed intervertebral discs and apophyseal ring fractures in adolescents. In a cadaveric study of degenerative changes in the lumbar-sacral spine with end-plate lesions, maximal stress was concentrated at the dorsal lumbar junction. Scheuermann’s disease in PLAR fractures may be the consequence of repeated trauma. Congenital anomalies or early degenerative changes may be associated with PLAR fractures in adolescents, including lumbarisation, sacralisation, and spinal dysraphism. In a cadaveric study, Schmorl’s nodes or end-plate lesions were related to disc degeneration in the posterior lumbar spine. In the T10 to L1 region, end-plate lesions are more common in the lower than upper vertebral end plates (upper border of the disc), regardless of sex and age. In the L2 to L5 region, the difference is not apparent. The most commonly involved level of apophyseal fracture is L4/5, accounting for more than 90% of cases. As an upper lumber vertebral apophyseal fracture is rare, the association of Schmorl’s node and a slipped capital femoral epiphysis in case 4 warrants further investigation.

The most common symptoms of PLAR fractures are low back pain and radicular pain due to nerve root irritation. Other symptoms and signs include a limping gait due to listing, para-lumbar muscle spasm and tenderness, restricted back motion, tight hamstrings, a waddling gait with flexed knees, and neurological deficits caused by compressed nerve roots. A systemic enquiry and complete neurological examination is mandatory. Cauda equina syndrome presenting with sphincter disturbance has been reported in apophyseal ring fracture. Differential diagnoses include tumour, infection, Schmorl’s node, calcification of the posterior longitudinal ligament, calcification of the annulus, limbus fracture, and fracture of the posterior margin of a lumbar vertebral body.

In our cases there was a strong association of adolescent apophyseal ring fracture with a slipped capital femoral epiphysis and overweight/obesity. Being overweight puts persistent and excessive stress on the lumbar spine. Prior to fusion of the ring apophyses, the osteo-cartilaginous junction presents a relative weakness. A single traumatic event may result in an apophyseal ring fracture in the adolescent spine. Based on observations from 3-dimensional computed tomography, a high incidence of irregularities in the cartilage of the end-plate contribute to fragility of the end-plate. This therefore increases the risk of underlying collagen defects in adolescents, predisposing them to apophyseal ring fractures. There is a high incidence of congenital anomalies among a distinct subgroup with specific characteristics (taller and heavier). It has been postulated that a slipped vertebral apophysis is synonymous with a slipped capital femoral epiphysis. Contrary to a herniation due to degenerative changes in the annulus, a slipped
disc and apophyseal ring fracture fragment may precipitate a disc impingement in adolescents.\textsuperscript{5,12} CT is superior to plain radiographs or MRI for detecting apophyseal ring fractures.\textsuperscript{1,3,6,7} Appropriately angled CT scans can give exact information on site, size and shape of the bony fragment.\textsuperscript{4,13} All our patients belonged to group I of Yang’s classification of PLAR fractures.\textsuperscript{6} MRI has the advantage that it can show prolapsed intervertebral discs and any associated nerve root compression useful for guiding surgical decision and intervention. Plain radiographs are useful for assessing congenital anomalies, Scheuermann’s disease, Schmorl’s nodes, decreased disc spaces and spinal alignment.

Conservative treatment such as rest, analgesics, modification of activity and physical therapy should be used initially to manage PLAR fractures. It is not known whether the fracture fragment will eventually be resorbed or cause more extensive ossification. The indication for surgical decompression is failure of conservative treatment, with persistent back pain adversely affecting the patient’s ability to function, with or without neurological deficits. Surgical outcomes are usually favourable.\textsuperscript{12} Removal of the offending fracture fragments and disc materials through a posterior approach results in complete recovery, but persistent weakness is not unusual.\textsuperscript{7} Interlaminar laminectomy without fusion is the best procedure, but there is a risk of excessive nerve root traction.\textsuperscript{3} Recurrence requiring further surgery is seldom reported due to short-term follow-up.

CONCLUSION

A high index of suspicion is needed to diagnose PLAR fractures in adolescents with low back pain and radicular pain. PLAR fracture is strongly associated with a slipped capital femoral epiphysis and being overweight in Chinese adolescents. It may share the same underlying pathophysiology as that of slipped capital femoral epiphysis.

REFERENCES