Back injuries in young fast bowlers — a radiological investigation of the healing of spondylolysis and pedicle sclerosis

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Objective. To demonstrate the efficacy of various radiological diagnostic modalities in assessing lower back pain in young fast bowlers.

Methods. Ten cricketers who presented to either a physiotherapist or a doctor with suspected spondylolysis underwent an X-ray, a single photon emission computed tomography (SPECT) bone scan and a computed tomography (CT) scan to assess the severity of the injury. Three and 12 months after the initial CT scan, second and third CT scans were performed in order to assess whether healing had taken place. After the initial radiological investigation the subjects diagnosed with spondylolysis or pedicle sclerosis underwent prescribed intervention and rehabilitation which included physiotherapy modalities, postural correction, and specific individually graded flexibility, stabilisation, strengthening and cardiovascular programmes.

Results. Radiographs were normal in 8 subjects, while 2 had evidence of sclerosis. The isotope scan showed increased uptake in all of the subjects. The CT scans showed no fracture (N = 3), partial fractures (N = 3), complete fractures (N = 2) and old fractures bilaterally (N = 2). When the follow-up CT scan was carried out at 3 months, 1 of the subjects had developed a partial fracture of the left pars interarticularis on the inferior border, which showed complete union when CT scanned at 12 months. At 3 months the partial and complete fractures showed progressive healing in 2 subjects, with complete healing in all the other cases. Complete healing was achieved in all subjects at 12 months, with the exception of 1 subject who showed near-complete union, with a small area of fibrous union on the inferior border and 2 old bilateral fractures that remained un-united.

Results. From the results it is evident that when a young fast bowler presents with backache after bowling, it would be appropriate to do an X-ray, a bone scan and a CT scan to make the diagnosis. Discontinuing the fast bowling and following an active rehabilitation programme should result in spontaneous resolution and healing of the fracture. If it is not detected early a fibrous or non-union fracture could result.

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Bowling has been found to be the major cause of cricket injuries, with younger players tending to be at the greatest risk of injury.[1-4] Between 38%[5] and 47.4%[3] of schoolboy bowlers were found to have sustained back injuries, while 50%[6] of fast bowlers were diagnosed with a stress fracture of a lumbar vertebra. The prevalence of pars interarticularis (PI) defects in 20 young fast bowlers was found to be 55%.[7] The high prevalence of back injuries in young bowlers is not a result of a single aetiological factor but rather a combination of factors that can predispose these players to injuries. Factors include inadequate physical preparation, postural defects, increased vulnerability to injury because the growth process was not complete, high physical demands, biomechanical aspects of the bowling technique, escalation in training frequency and duration of bowling spells in matches, and repetitive movements.[5, 8-11]

Overuse has been reported to be the major contributing factor to injuries sustained by younger players,[12] with 13 of the 14 recorded stress fractures in the lumbar spine occurring as a result of bowling. It appears that excessive bowling by young fast bowlers occurs because of the need for earlier specialisation, more players competing for their school team and a club team, and young players bowling at provincial practices to allow the batsmen extended batting practice, while the provincial bowlers rest.[12]

Spondylolysis is a defect in the PI believed to be due to a stress fracture, secondary to lower grade trauma from repetitive spinal hyperextension and rotation.[13, 14] The repetitive activity places pressure on the facet joint, damages the PI that is too small to absorb the repeated shocks, and eventually causes fatigue and ultimately induces a micro- or stress fracture.[15]

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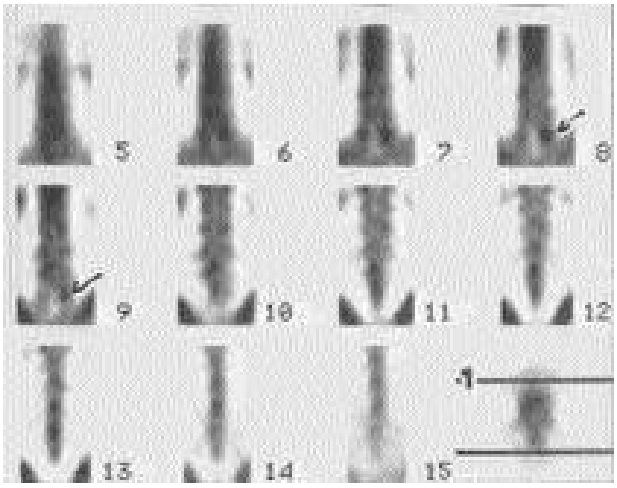
As the PI lies oblique to all three orthogonal planes, visualising the defect using plain radiography of the pars is difficult. Various angled projections demonstrate the PI and lamina in true anterior-posterior and lateral views, including the 45° lateral oblique view,[16] the anterior-posterior view with 30° cranial angulation[17] and the combination of lateral oblique with cranial angulation.[18] However, the success of identifying pars defects using oblique views has varied from 20%[17] to 87%.[19] Fractures are optimally demonstrated when the X-ray beam is tangential to the plane of the fracture, while stress reactions that have not progressed to complete defects will be radiographically occult.[20]



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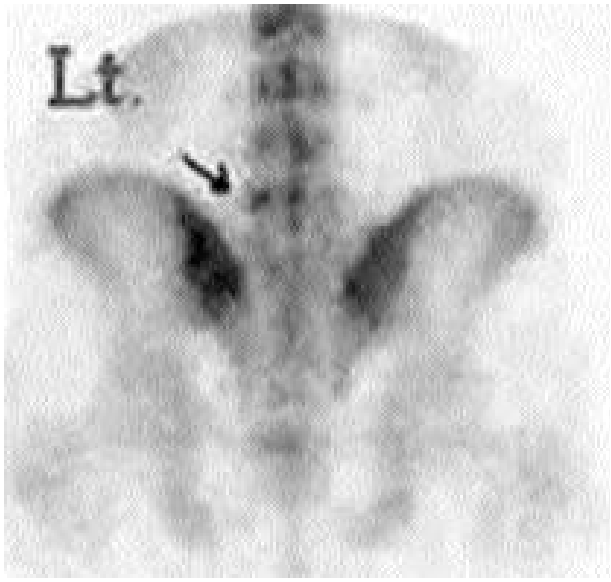

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Fig. 1. SPEC scan of (a) anterior-posterior view showing 'hot spot' at left pedicle of L5, and (b) posterior view of L5 showing 'hot spot'.

Initial studies using radionuclide imaging found discrepancies with radiography. Lesions identified radiographically but showing no activity on diphosphate bone scintigraphy (DBS) were chronic and healed, whereas with increased activity early injuries were represented as radiographically occult stress reactions. Single photon emission computed tomography (SPECT) is nonspecific in that increased activity in the region of the pars may be due to pathology other than spondylolysis.[20] Bone scans do not clearly reveal anatomy and remain positive long after a stress fracture has been diagnosed.[15] Therefore the main value is the identification of an acute stress reaction of the pars before it manifests itself radiologically[20] and not for assessing anatomical healing and long-term prognosis.[15]

Computed tomography (CT) scanning is superior to X-ray and DBS.[21] A reverse angle gantry technique is recommended such that the scan plane is perpendicular to the fracture if the CT is performed specifically to demonstrate a pars defect.[15, 19]

The purpose of this study was to demonstrate the efficacy of various radiological diagnostic modalities in assessing lower back pain in young fast bowlers.

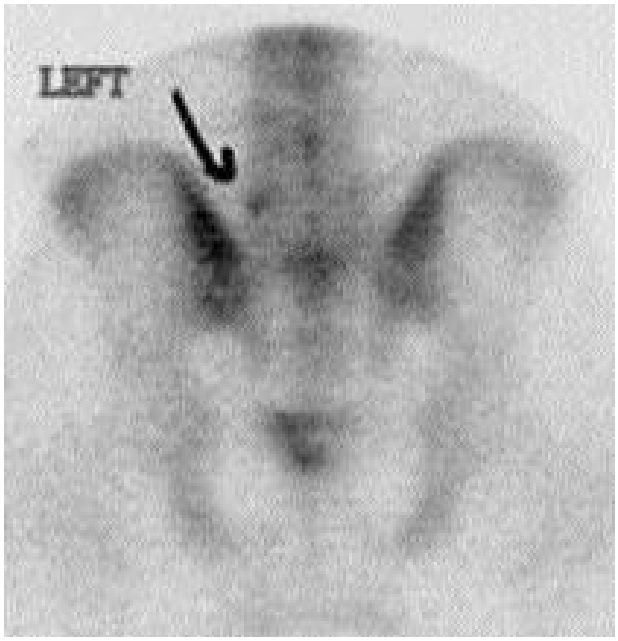
Method

Subjects included 10 cricketers who presented to either a physiotherapist or a doctor with lower back pain associated with fast bowling and who were diagnosed with suspected spondylolysis. Once the protocol of the research had been explained to the players and they had given consent, they all underwent an X-ray and a SPECT bone scan. If the bone scan

Fig. 2. Orientation of the 'reverse angle' axial images to be acquired in the CT scan.

was positive then a CT scan was used to assess the severity of the injury, and to identify whether any bony or intervetebral disc abnormalities were present. If the isotope bone scan was negative the player did not form part of the group. Permission to conduct the study was obtained from the Human Ethics Committee of the University of Port Elizabeth.

In this study lumbar radiography was used as a screening test and included anterior-posterior, lateral, flexion and extension stress and two oblique views. The bone isotope scan was done to localise the area of injury or 'hot spot' in order to identify either cortical or cancellous bone injury (Figs 1 and 2) and to allow the CT scan to be localised to the level of recent injury. The CT scan of the relevant level of the active or 'hot' area on the isotope scan was done using 3 mm thick slices, spiral at 2:1 pitch, 1.5 s cycle, 146 mA(219 mAs total), and 140



(a)

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Fig. 3. Isotope scan showing (a) a 'hot spot' in left L5 pedicle, and (b) sclerosis, but no fracture at this site, confirming a bone stress reaction before cortical fracture has occurred.

(a)

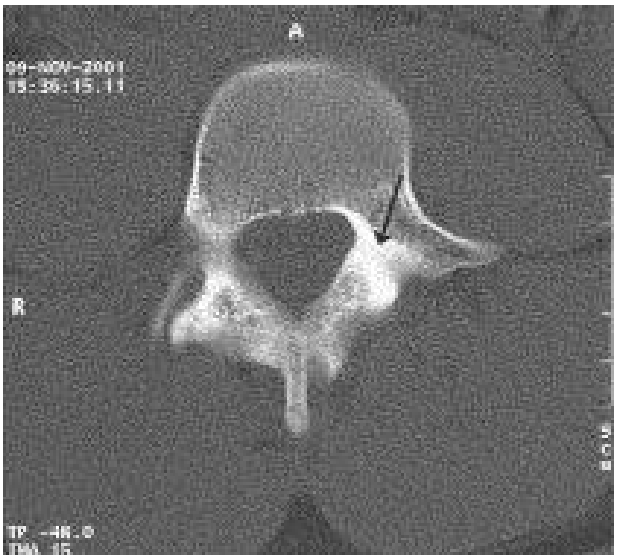

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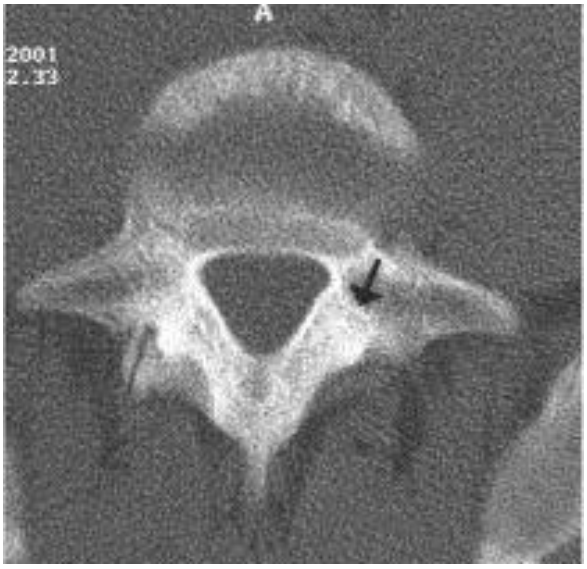
Fig. 4. CT scan showing (a) a partial fracture through left PI and (b) a complete union fracture with sclerosis, 12 months later.

(a)



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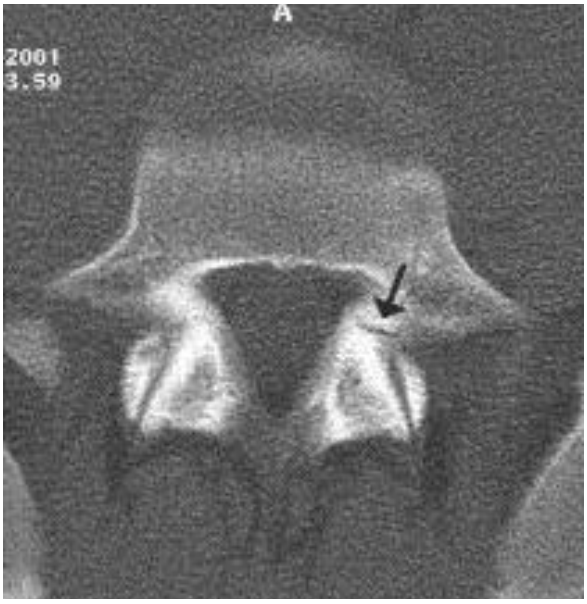

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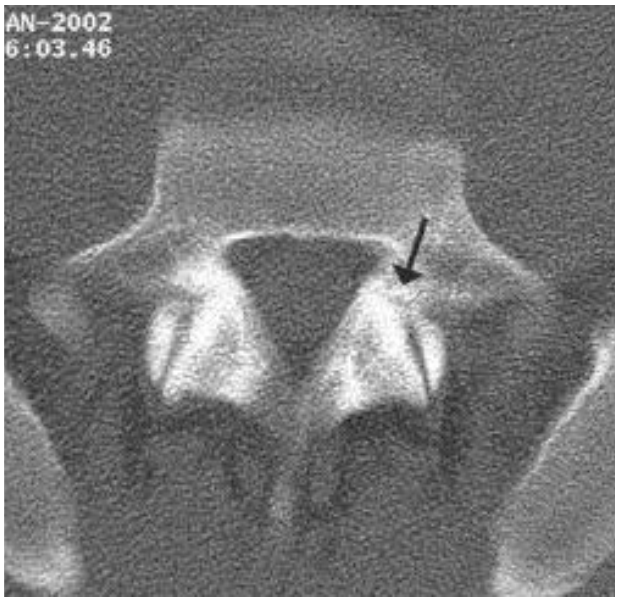


(d)

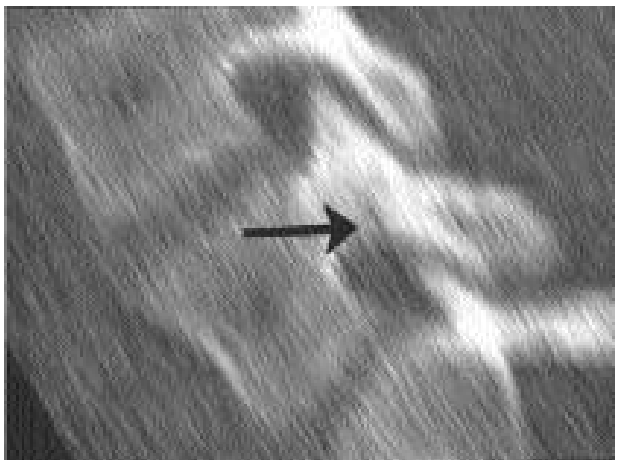
Fig. 5. CT scans through left PI fracture showing (a) subtle partial fracture through inferior half of PI, (b) left PI intact on more cranial image, (c) fractured PI on the more caudal image, and (d) 1 year later the fracture line is still present, but is partially healed.

kV. The reverse gantry angle CT orientation was used in order to scan the 'in-plane' with the posterior element bony ring of the injured vertebrae to ensure that the scan plane was close to 90° to the usual orientation of the PI fracture line (Fig. 3).

All the radiological information was collected at the Greenacres Hospital, Port Elizabeth, with identical collection and analysis of the data for each session. Three experienced radiologists assessed the CT scans for spondylolysis, pedicle sclerosis, PI defects and congenital anomalies.

Sclerosis of the PI was recorded when there was increased CT density of the PI, the pedicle or the posterior-lateral margin of the vertebral body in the absence of any fracture or widening of the pars. A report was compiled for the orthopaedic surgeon who advised the patient on the status of the injury. The information was passed on to the physiotherapist for further assessment, treatment and rehabilitation.

The clinical assessment involved a full musculoskeletal screening by a physiotherapist. Problems with posture, muscle imbalance, flexibility, strength, neural tightness and instability of both the scapula and pelvis were assessed. All subjects were taken off bowling and any activity that involved extension and rotation of the lower back for a 3-month period. Patients received a specific graded programme depending on the severity of their injury. After 3 and 12 months the follow-up CT scans were done to assess the amount of healing that had occurred.



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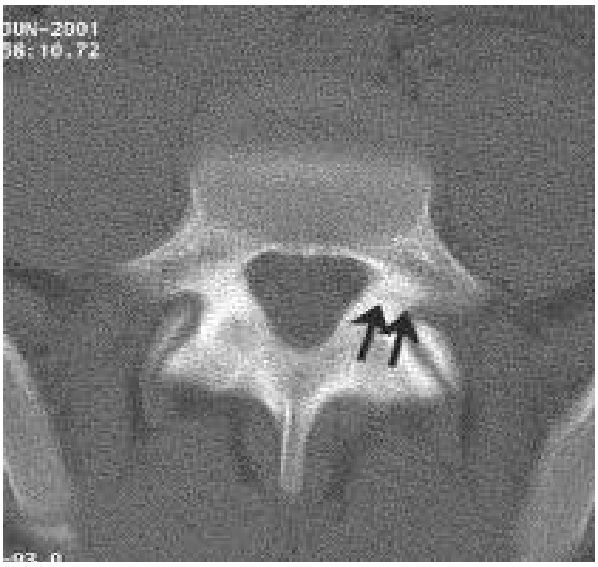

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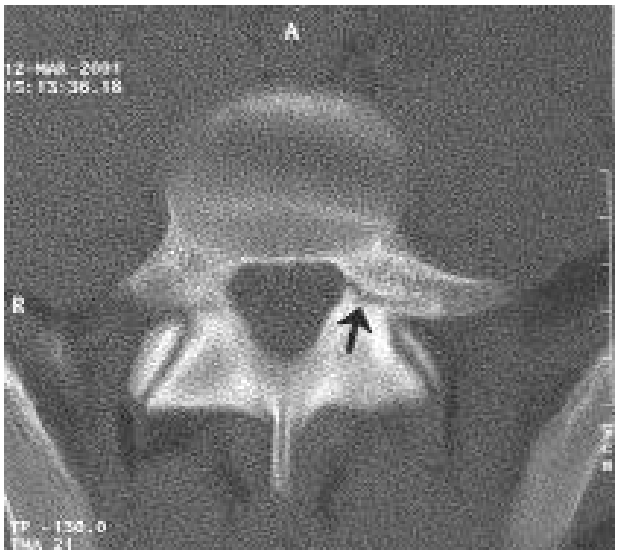

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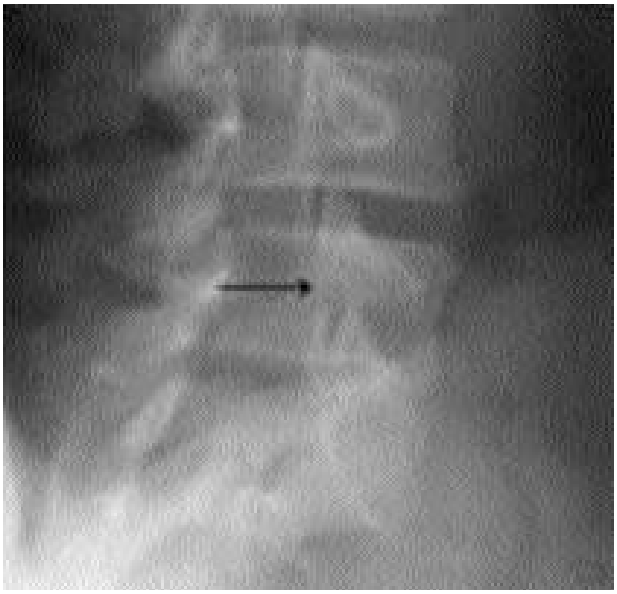

(d)

Fig. 6. CT scan showing (a) partial fracture through inferior half of left PI, (b) fracture before partial healing, (c) significant healing after 3 months but subtle line of non-bone union remains, which was unchanged at 12 months, and (d) plain X-ray at time of CT scan does not show fracture line, highlighting the relative insensitivity of X-ray to the more subtle injuries.

Results and discussion

The players varied in age from 15 to 22 years, with all of them playing first team school cricket or premier league cricket. Of the 10 subjects 8 showed normal radiographs, with evidence of sclerosis in the left pedicle of the L4 and the right PI of the L5 in 2 subjects. The isotope scan showed increased uptake in all 10 subjects, 3 to the left pedicle of L5, 2 to the left PI of L4, 4 to the left PI of L5, and 1 subject showing an increased uptake in the left PI of L4 and the left and right PI of L5.

The initial CT scans showed no fracture in 3 subjects, although the isotope scan had shown evidence of increased uptake in the PI at L4 (N = 1) and the L5 (N = 2). All 3 subjects had normal radiographs. When the follow-up CT scan was carried out at 3 months, 1 of the subjects had developed a partial fracture of the left PI on the inferior border that showed complete union when CT scanned at 12 months.

The initial CT scan showed partial fractures in 3 subjects. These 3 subjects showed normal radiography and increased uptake in the area identified with a partial fracture. The exception was 1 subject whose isotope scan showed an increased uptake of the left pedicle of L5, although a bilateral partial fracture was found on the inferior border of the PI of L5. Of the 3 partial fractures identified at the initial CT scan, 2 were on the inferior border of the left PI and 1 occurred bilaterally on the inferior border of the PI at L5. The 3-month CT scan showed progressive healing in 1 subject, with the other 2 subjects showing complete healing. The third CT scan showed complete union in 2 subjects; the third subject showed a near-complete union, with a small area of fibrous union on the inferior border (Figs 4 - 6).

The initial CT scan showed complete fractures in 2 subjects. One subject showed normal radiography and isotope scan images, with the CT scan revealing a fracture of the left PI of the L5. The X-ray and isotope scan of the other subject showed a sclerotic area on the left pedicle of L4 and an increased uptake in the left PI of L4, respectively, while the CT scan revealed a fracture of the left pedicle of the L4. The 2 complete fractures, 1 of which was already showing signs of healing at the time of the first CT scan, showed complete union at 3 months and 12 months. The initial CT scan showed that 2 of the injuries were old bilateral fractures that did not unite.

From the results available it is evident that when a young fast bowler presents with backache after bowling, it would be appropriate to do an X-ray, a bone scan and a CT scan to make the diagnosis. Furthermore, discontinuing the fast bowling and following an active rehabilitation programme should result in spontaneous resolution and healing of the fracture. If early detection is not carried out a fibrous or non-union fracture could result and young players who achieve only a fibrous union of the fracture have a greater chance of suffering recurring pain 3 - 4 years later .[15] Therefore, players, coaches, administrators and parents should be aware of the physical demands and stresses placed on the back of the young fast bowler, and the need to ensure early intervention if there appears to be any sign of injury to the lower back as a result of bowling.

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