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Return to Play Criteria After Adult Lumbar Spinal Fractures: A Review of Current Literature and Expert Recommendations

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Abstract

Purpose of Review Understanding the management of lumbar spinal fractures and return to play (RTP) criteria is an essential component of care for adult athletes. Appropriate management of lumbar spinal fractures must balance minimizing time away from physical activity while also minimizing risk of reinjury. The purpose of this review is to summarize current recommendations on lumbar spinal fracture management and RTP guidelines and to provide expert opinion on areas of discrepancy in the field.

Recent Findings There is a paucity of high-level evidence on the management and return to play criteria for adult lumbar spine fractures in athletes. Much of the data and recommendations are based on expert opinion and studies in pediatric or osteoporotic patients, which may not be applicable to adult athletes.

Summary These data presented here may be used to aid patient-physician conversations and provide guidance on expectations for patients, coaches, and athletic trainers. In general, we recommend that patients be free of lumbar pain, neurologically intact, and have full strength and motion of the lumbar spine and lower extremities before returning to play. Adequate protective equipment is recommended to be worn at all times during practice and play.

Keywords Return to play · Lumbar spine fractures · Spondylolisthesis · Spondylolysis · Adult athletes · Rehabilitation · Management

Introduction

Spinal injuries are particularly common in contact sports such as football, hockey, soccer, and basketball and sports with repetitive flexion and extension motions such as gymnastics and rowing [1–4]. For example, in the National Basketball Association, lumbar spine injuries, including sprains, accounted for 10% of all player injuries and were one of the leading causes of missed games [3]. Given the wide spectrum of spinal injury severity and the paucity of high-level evidence surrounding management of these injuries, there are currently no widely accepted, evidence-based recommendations on return to play after lumbar spine injury.

The epidemiology of lumbar spine trauma remains incompletely characterized. An expert panel convened by the World Federation of Neurosurgical Societies (WFNS) Spine Committee evaluated 39 papers regarding the epidemiology of thoracolumbar spine fractures, ultimately estimating their incidence at 30 per 100,000 people [5•]. Among sporting related causes, airborne sports, alpine winter sports, and watersports have been separately characterized.

According to the National Spinal Cord Injury Statistical Center 2022 report, sports and recreation are estimated to account for 8.3% of all spinal cord injuries and are the fourth leading cause of injury behind unintentional falls, motor vehicle collisions, and firearm injuries [6, 7]. These data may be used to aid patient-physician conversations and provide guidance on expectations for patients, coaches, and

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athletic trainers. The most common presenting spine pathologies for adult athletes are spondylolysis, spondylolisthesis, and fractures of various morphologies.

The purpose of this review is to summarize current recommendations on lumbar spinal fracture management and return to play (RTP) guidelines and to provide expert opinion on areas of discrepancy in the field.

Spondylolysis

Initial Presentation and Work Up

Spondylolysis is a fracture through the pars interarticularis of the lumbar vertebrae and may be unilateral or bilateral and acute or chronic. The prevalence of spondylolysis is noted to be 3–6% in the general population[8–11] and is higher in athletes [1, 2, 12•] with some estimates stating the prevalence is as high as 26% for elite athletes in throwing sports like shotput [1]. Football, gymnastics, rowing, diving, wrestling, weightlifting, and cricket are also common sports likely due to the high frequency of flexion and extension or twisting lumbar spine motion. 1, 2, 4, 13•. Spondylolysis is commonly the result of repeated microtrauma to the posterior elements. An illustrative mechanism can be that of a gymnast repeatedly sustaining hyperextension injuries, ultimately fracturing through the pars. [4]. There is some evidence in elite cricket players that suggests a correlation between reduced baseline lumbar bone mineral density and the risk of lumbar stress fractures [13•].

The most commonly affected spinal levels in all patients are L5 (85–95%) followed by L4 (5–15%) [8, 9]. However, in a small study of volleyball players, L4 was affected in 48% of patients, which may be higher than in other sports [14]. Patients with spondylolysis may present with localized lumbar pain worse with extension. For spondylolysis without spondylolisthesis (translation of the vertebral body), patients are unlikely to present with a neurologic deficit. Spinal deformity on exam is unlikely and if noted should alert a provider to more advanced pathology.

The initial work up for spondylolysis should include upright anteroposterior (AP) and lateral lumbar X-rays. For patients with negative AP and lateral X-rays but high clinical suspicion, previous guidelines have recommended also obtaining oblique films. However, due to recent improvements in computerized tomography (CT), we recommend deferring additional X-ray imaging and directly proceeding to lumbar CT without contrast, which has a higher sensitivity for lumbar spine fractures [15]. Single-photon emission computerized tomography (SPECT) scans may be used but are more common in the pediatric population. Magnetic resonance imaging (MRI) is not a sensitive imaging modality for spondylolysis when used in isolation [16].

Management and Rehabilitation

Management of spondylolysis generally consists of conservative management with a period of activity modification and physical therapy. Bracing is also commonly used, though outcome studies have primarily been performed in adolescent patients [17–22].

Patients experiencing pain from chronic stress fractures of the pars are advised to reduce their sports-related activity until symptoms resolve and participate in physical therapy during their recovery. In adolescent soccer players, 82% of patients who underwent 3 months of cessation of play and physical therapy alone were able to return to pain-free vigorous exercise. [17]. Those who fail management with activity reduction may be recommended to undergo 3 months of bracing in a custom thoracolumbar orthosis (TLSO) brace. In one study with gradual return to pre-injury physical activity and bracing, 95% of patients achieved total symptom relief and all patients in the study returned to their pre-injury level of activity by an average of 27-month post intervention [18]. Other studies in adolescents and young athletes have cited improvement after bracing in 78–93% of patients [19–22]; however, the evidence is inconclusive in adults and the decision to brace or not is often provider dependent. Appropriate physical therapy regimens should emphasize hamstring stretching, lumbodorsal fascia stretching, and core strengthening [17, 19].

Based on the available literature, we recommend a trial of activity reduction and physical therapy. Continuous bracing for 3 months in a TLSO may be considered in patients whose pain does not resolve with physical therapy alone. For patients with spondylolysis with neurologic deficits, refractory pain after conservative management, or progression to spondylolisthesis, surgery may be considered, which is discussed in further detail in the following section on spondylolisthesis.

Return to Play

For patients undergoing conservative management for spondylolysis, we recommend abstaining from noncontact sports for a minimum of 4–6 weeks and 8–12 weeks for contact or collision sports. Upon completing this rest, providers should assess the patients for range of motion, pain, and neurologic deficits. For all fractures discussed here, patients should be pain free during sports-related activities and motions, should have full range of motion of the lumbar spine, and be without neurologic deficits before returning to play. Patients may then begin gradually returning to their pre-injury level of activity over the course of several weeks. Patients must wear all appropriate

athletic padding during practice and competition and take additional effort to avoid reinjury. For patients undergoing surgical management, postoperative care is discussed further in the next section.

Isthmic Spondylolisthesis

Initial Presentation and Work Up

Spondylolisthesis is defined as anterior translation of the vertebral body and can be separated into isthmic and degenerative etiologies. While degenerative spondylolisthesis occurs due to degeneration of the facet joints or intervertebral disc, isthmic spondylolisthesis is due to fractures of the pars interarticularis and may be viewed as a progression of spondylolysis with displacement.

Spondylolisthesis is graded based on the percentage of the vertebral body that is translated anteriorly with low grade slips (grade I-II) representing less than 50% slippage and high-grade slips (grade III-IV) representing 50–100% slippage, as shown in Fig. 1 [23]. Low grade slips are more common than high grade.

Patients with spondylolisthesis commonly present with low back pain and point tenderness. Reviews of clinical tests for the diagnosis spondylolisthesis in athletes showed that step-deformity palpation of the lumbar spinous process had the highest specificity (87–100%) of common clinical exam maneuvers and moderate to high sensitivity (60–88%) [24, 25]. Patients with high grade slips are additionally more likely to present with neurologic deficits such as radicular symptoms and weakness, which should prompt rapid evaluation and work up.

Similar to spondylolysis, initial work up should consist of upright AP and lateral X-rays. A CT scan may be used to assess fracture morphology, grade of spondylolisthesis, and aid surgical decision making. For patients with neurologic deficits, an MRI is also indicated. Additionally, patients with predominantly night pain that awakens them from sleep should have an MRI to rule out malignancy.

Management and Rehabilitation

Management of spondylolisthesis depends on the grade of the slip and the presence of neurologic deficits. For low grade slips without neurologic deficits, patients can be managed conservatively with activity modification. Low grade slips can safely be managed conservatively as they have low rates of progression to high grade spondylolisthesis. Similar to the physical therapy literature for disc herniation [26], we recommend a gradual return to activity protocol which includes nonimpact aerobic activity at 2 to 4 weeks with the spine in neutral alignment, then advancing to introduction of impact and dynamic exercises at 3 months, and concluding with sport specific exercises between 4 and 6 months.

For grade III-IV slips with greater than 50% of the vertebral body slipped, neurologic deficits, or patients with refractory pain after 6 months of conservative management, surgery is typically recommended. Surgical options for spondylolisthesis include fusion or in some cases direct pars repair.

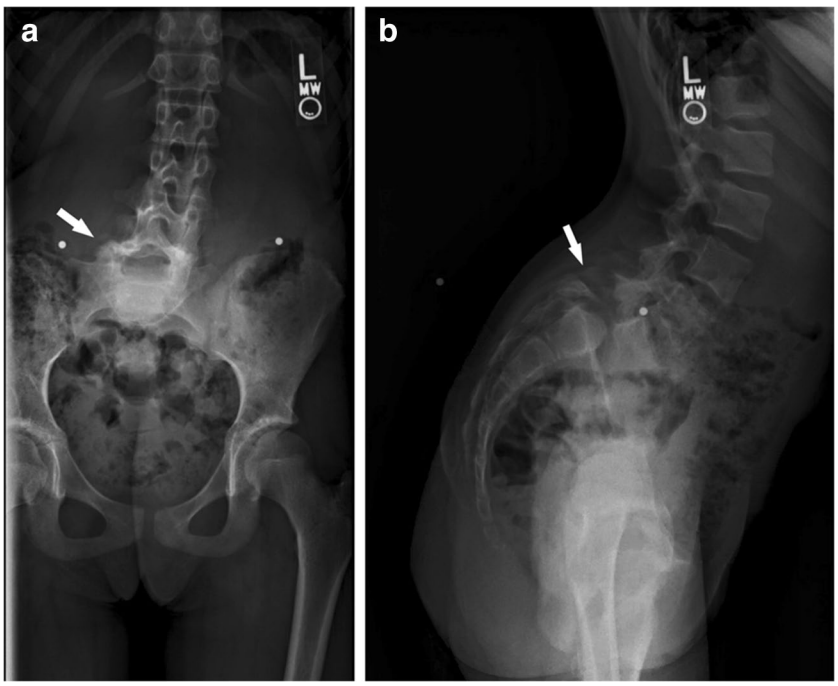

Fig. 1 **a** AP and **b** lateral radiographs of grade 3 L5-S1 isthmic spondylolisthesis in an adolescent dancer who presented with low back pain and a palpable step off

There are numerous available fusion techniques for spondylolisthesis including transforaminal lumbar interbody fusion (TLIF), posterior lumbar interbody fusion (PLIF), anterior lumbar interbody fusion (ALIF), and posterolateral fusion (PLF). When comparing PLF and interbody fusion techniques for the management of isthmic spondylolisthesis, interbody fusion may perform better in terms of pain, functional status, and complication rates at long term follow-up [27]. Overall, the clinical outcomes are comparable for all interbody fusion options, and we recommend choosing a surgical technique based on provider comfort and shared decision-making with the patient.

In young adult athletes, both Buck's screw fixation and Scott's wire fixation have high rates of pain control, radiographic fusion, and return to pre-injury level of activity [28–31]. However, the efficacy of each technique varied widely by study and most were conducted in non-contact athletes [28–30]. In some very small case series, direct pars repair in adults was found to achieve radiographic pars fusion in 60–100% of patients and reduce disability and pain [32, 33•]. Unfortunately, complications are common occurring in 13–27% of direct pars repairs based on a recent meta-analysis [33•] and are generally thought to be more prevalent as a person ages. As such, direct pars repair remains controversial in adults. Frequent complications include wire or screw breakage, infection, radiculopathy and nonunion [33•, 34, 35]. Minimally invasive pars repair for athletes may have better pain control and faster recovery relative to conventional open repair [36]. Direct pars repair is more commonly recommended for patients with painful spondylolysis or spondylolisthesis refractory to conservative measures and is not recommended for patients with neurologic deficits or patients with degenerative disc disease. Relative to fusion, direct pars repair is advantageous in appropriately selected patients as it preserves lumbar motion.

Return to Play

The grade of spondylolisthesis and selected management dictates the RTP protocol. For nonoperative, conservative management, the return to play protocol involves activity abatement for at least 4–12 weeks, followed by a re-evaluation of symptoms and organized physical therapy. Patients who have achieved complete resolution of pain and neurologic symptoms may gradually return to play.

RTP protocols following operative management of spondylolisthesis are primarily based on expert opinion and surveys of spine surgeons. For patients who underwent direct pars repair in one study, over 80% of patients were able to return to their pre-injury level of activity within a mean of 7 months post-surgery [29]. It is important to note that these patients typically had mild spondylolisthesis and the longer RTP timelines for patients undergoing lumbar fusion are also reflective of more severe disease.

In a survey of members of the Scoliosis Research Society who operate primarily on adolescents, most surgeons recommended returning to noncontact sports (running, tennis) 6 months following lumbar fusion for spondylolisthesis [37]. Most recommended returning to contact sports (soccer, basketball) after 1 year and a third of respondents recommended never returning to collision sports (hockey, football) following surgery [37]. Surgeons were most likely to recommend against return to gymnastics followed closely by football and rugby [37]. Though this study was specific to adolescents, similar guidelines exist in the adult spine literature. In a survey of spine surgeons, adult golfers who underwent lumbar spine fusion for spondylolisthesis are typically allowed to return to play after 6 months of recovery if there is evidence of fusion on radiographs [38]. The second most commonly recommended recovery period was 2–3 months [38]. A 2020 survey of spine surgeons showed the average recommended RTP time after a single-level lumbar fusion without complications was 3 months for non-contact sports and 6 months for high-risk activities or contact sports [39•].

Following lumbar spine fusion for spondylolisthesis, we recommend returning to noncontact sports after 3 months, contact sports after 6 months, and only returning to collision sports under special circumstances. For example, for professional athletes who depend on playing a collision sport for their livelihood, we would recommend extensive patient-physician conversations about the risks and benefits of returning to play. If the fusion is successful, the risk of persistent impairment is low may depend on the length of the fusion construct. In general, we would advise that all athletes be pain free during sports-related activities, have full range of motion, and be without neurologic deficits before returning to sport.

Compression Fractures

Initial Presentation and Work Up

Compression fractures are fractures of the anterior column of the spine and are commonly the result of axial loading injury. Although compression fractures more commonly occur in the geriatric population, they exhibit a bimodal distribution also occurring in in the young with high energy mechanisms including high contact sports. Lumbar spinal trauma secondary to athletics and recreation is particularly prevalent in the young adult male population, as shown in Fig. 2 [40, 41].

Patients commonly present with localized pain and tenderness and may or may not have neurologic deficits. A careful neurologic examination should be conducted of all

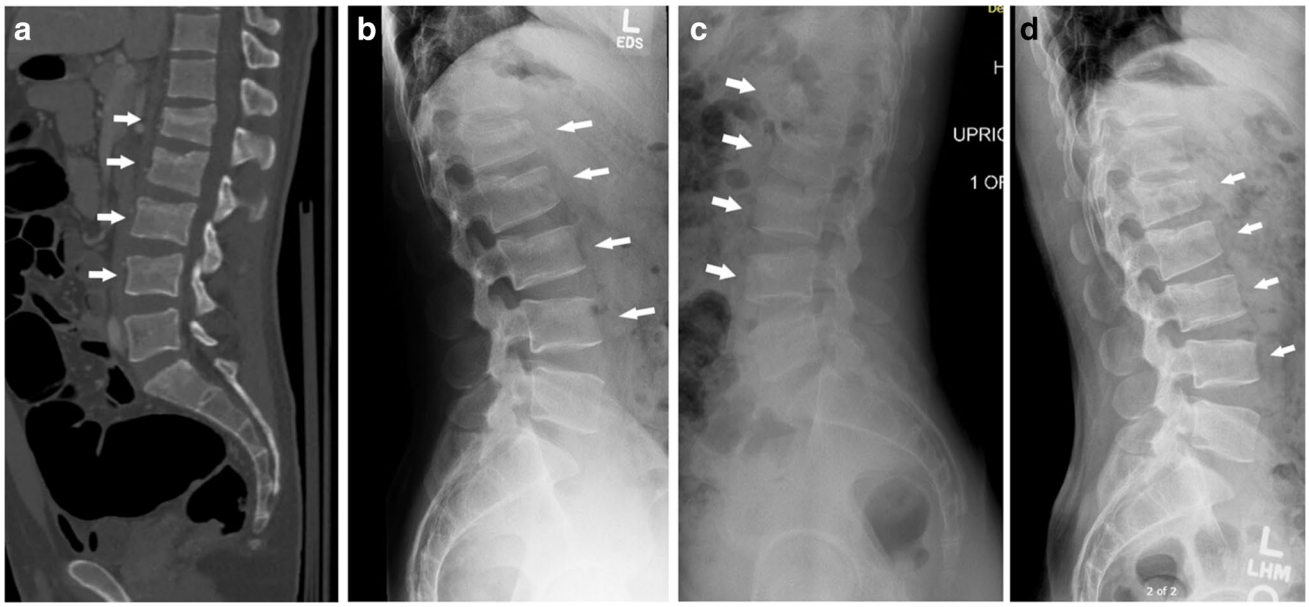

Fig. 2 **a** Sagittal CT and **b** initial upright lateral radiograph of an adult male patient with L1-4 compression fractures who was neurologically intact on presentation. **c** Three-week and **d** 6-month upright radiographs were obtained to monitor stability and recovery

patients with lumbar back pain. A step off adjacent to the spinous processes of the affected levels is canonical but is not a sensitive diagnostic finding in our practice. High resolution CT scan can identify the majority of clinically significant lumbar spine injuries. An MRI is obtained if neurologic deficits are present or suspected. If there is no clear evidence of an unstable injury pattern, our evaluation includes upright AP and lateral X-rays to rule out significant kyphosis and associated flexion-distraction type injuries where alignment in the upright imaging is compared supine alignment from the injury CT scan.

Management and Rehabilitation

Compression fractures without neurologic deficits may be treated conservatively with activity abatement and organized physical therapy [42]. We recommend serial radiographs over 3 months, with physical therapy focusing on back range of motion and strengthening beginning around 8–12 weeks. There is some evidence that early gentle physical activity may aid functional recovery [43]; however, this data may not be generalizable to athletes and further studies with a high-level of evidence are needed to validate the best non-operative strategies in this patient population.

Return to Play

To our knowledge, there are no studies examining return to play criteria in vertebral compression fractures. Per our experience managing these fractures generated through other mechanisms, patients may return to play if the following two conditions are met: (1) serial radiographs demonstrate no change in alignment after 3 months and (2) patients remain pain free after 3 months. We note that the return to play timeline is based strongly on clinical judgment and communication with the patient about risks and benefits of returning to the pre-injury level of activity.

Assuming resolution of pain and the absence neurologic deficits, we typically advise that patients may resume athletic participation in 3 months and may return to prior activity levels on a gradual basis.

Burst Fractures

Initial Presentation and Work Up

Like compression fractures, burst fractures are the result of supraphysiologic axial loading of the spine, with an additional fracture line extending into the posterior vertebral body which creates a burst fragment that could be potentially retropulsed into the canal (Fig. 3). Burst fractures are relatively uncommon in athletes and when they occur are more frequently reported in the cervical spine than lumbar spine [44–47]. The exception to this principle maybe motocross which in one study showed that 95 out of 174 adult riders with spinal cord injuries had thoracolumbar burst fractures [48].

As with all patients with lumbar back pain and a concerning mechanism of injury, the initial workup entails a

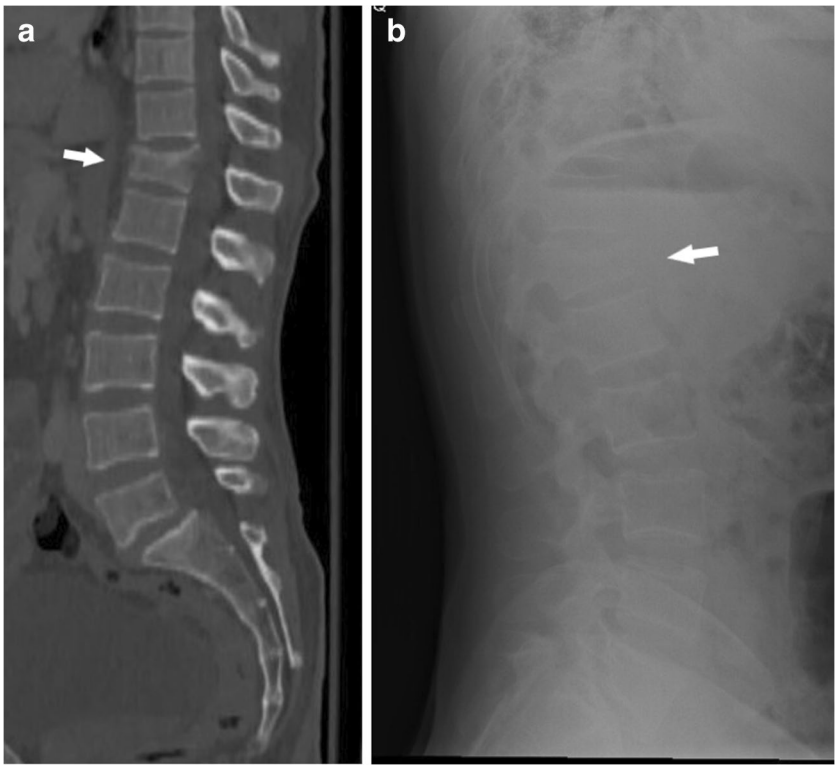

Fig. 3 **a** Sagittal CT and **b** initial upright lateral radiograph of an adult female patient with T12 burst fracture who was neurologically intact on presentation and managed nonoperatively

meticulous neurologic examination. Initial imaging should consist of upright AP and lateral X-rays to assess spine stability under physiologic loads.

Management and Rehabilitation

Burst fractures generally have a more severe presentation than compression fractures and may require operative management. However, a randomized control trial of stable burst fractures without associated neurologic deficits demonstrated better pain and functional outcomes in the nonoperative group at long-term follow-up compared to the operative group [49]. Though evidence suggests that outcomes may be dependent on long-term sagittal alignment and kyphotic deformity [50] and as such, we recommend close follow-up of nonoperative patients for at least 6 months to look for changes in sagittal alignment and consideration of stabilization if there is evidence of instability.

Return to Play

There is no literature on outcomes following burst fractures in athletes that may guide return to play criteria. We note that the return to play timeline is based strongly on the severity of the fracture and risk for further displacement, clinical judgment, whether surgery was performed, and communication with the patient about risks and benefits of returning to the pre-injury level of activity.

Our return to play recommendations for burst fractures vary depending on their severity. For fractures managed operatively, return to play is generally not advised in collision sports except under special circumstances, such as for professional athletes, and following extensive discussion with the patients on risk and benefits.

For nonoperatively managed fractures, assuming resolution of pain and the absence neurologic deficits, we typically advise that patients wait a minimum of 6 months following complete recovery before resuming physical activity, potentially longer if the physical activity was the precipitating event, and athletic participation in 9 months. They may return to prior activity levels afterwards on a gradual basis. Close follow-up with a spine surgeon, serial upright radiographs, and consultations prior to any escalation in activity level, is recommended.

Spinous and Transverse Process Fractures

Initial Presentation and Work Up

Spinous and transverse process (Fig. 4) fractures are relatively uncommon injuries in athletes and are most commonly documented in case reports [51, 52]. They generally occur from a twisting injury, repetitive use in an abnormal position, or direct blow, such as equestrian riders being kicked or crushed by their horse [51–53]. Patients are unlikely

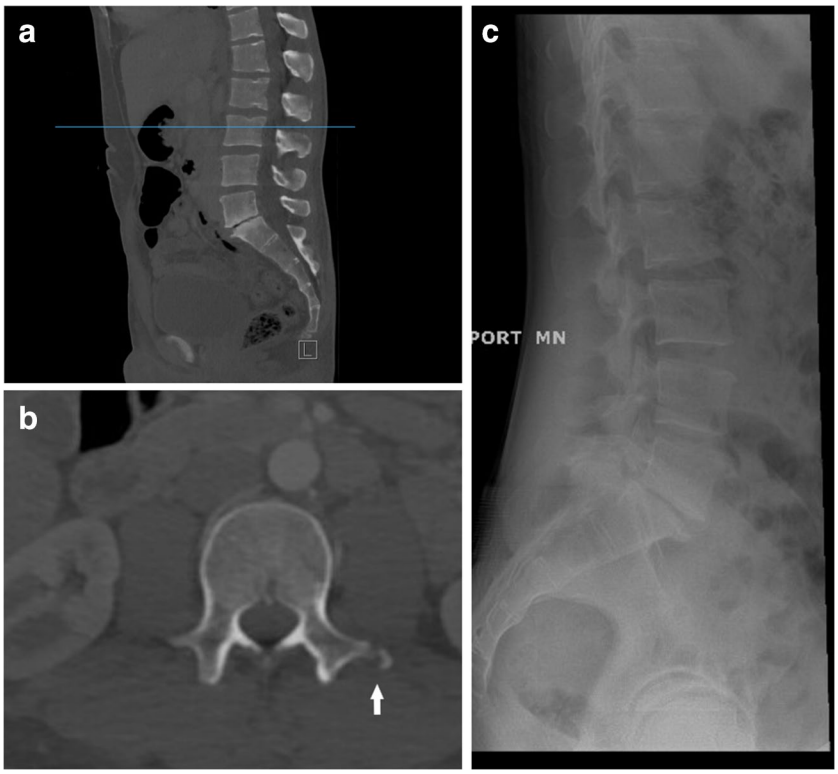

Fig. 4 **a** Sagittal CT, **b** axial CT, and **c** initial upright lateral radiograph of an adult male patient presenting with an L3 transverse process fracture and L5-S1 spondylolisthesis. He had localized tenderness to palpation of the L3 transverse process fracture and L5 radiculopathy

to present with neurologic deficits. Initial work up should include upright AP and lateral X-rays. Advanced imaging is unlikely to be indicated in isolated spinous or transverse process fractures. It is crucial to rule out occult flexion-distraction injuries.

Management and Rehabilitation

Most patients with spinous and transverse process fractures can be managed conservatively with pain control and rest. Bracing is unlikely to be of benefit for these patients. Physical therapy is typically not required.

Return to Play

As the spine is inherently stable in these fracture patterns, patients can return to play when they are pain free, typically after several weeks of rest. Reinjury may worsen pain and prolong recovery but is unlikely to result in new neurologic deficits.

Conclusions

Lumbar spine fractures are a relatively common cause of pain and time away from play in adult athletes. The information included here is relevant to both professional and recreational athletes; however, additional care should be taken when discussing RTP with professional athletes as it relates to their livelihood and future earning potential. These data may be used for early expectation setting with patients, coaches, and athletic trainers and to guide management and treatment.

A careful neurologic examination should be conducted on all athletes presenting with low back pain. The initial work up of patients with lumbar pain often includes upright AP and lateral X-rays possibly followed by an MRI if neurologic compromise is suspected or a CT scan to further characterize fracture morphology. For patients with neurologic deficits, prompt referral to a spine surgeon is recommended.

Return to play protocols are primarily based on expert opinion and surveys of providers. All patients should be free of pain during sports-related activities, have full range of motion and be without neurologic deficit before returning to play. Patients who undergo lumbar spine fusion are generally recommended to abstain from noncontact sports for 6 months and contact sports for 1 year. Many surgeons recommend never returning to collision sports, such as hockey and football. We recommend using shared decision-making between the doctor and patient and emphasizing that reinjury may risk permanent neurologic deficit. Following the period of rest, physical therapy regimens should focus on hamstring stretching, lumbodorsal fascia stretching, and core strengthening. Adhering to recommended return to play guidelines balances minimizing time away from physical activity while also minimizing risk of reinjury.

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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