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Review Article

Lumbar spondylosis: Does conventional X-ray still play the role?

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Abstract

Lumbar spondylosis is a very common complaint of severe low back pain (LBP) or lumbar disc herniation, and patients are often diagnosed using radiological examination. Lumbar spondylosis is a degenerative process of the spine, but it can also result from various factors. It is often misdiagnosed as a degenerative process because it only involves the corpus vertebra, intervertebral disc, and osteoporosis of the spine. However, many other causes can lead to inappropriate treatment plans. The X-ray is believed to be a helpful tool in the initial imaging test of lumbar spondylosis diagnosis. However, further imaging tests with magnetic resonance imaging (MRI) or computed tomography (CT) scans are highly recommended. This should be noted by physicians working in rural primary and secondary healthcare facilities who might only have the X-ray to make a diagnosis of lumbar spondylosis. This article reviewed published studies comparing X-ray, CT scan, and MRI diagnosis data of patients with lumbar spondylosis. The analysis provides insight into the role of X-ray in diagnosing lumbar spondylosis.

Keywords: Lumbar spondylosis, LBP, diagnostic, X-ray, radiologic imaging

Introduction

Spondylosis is a degenerative disease in the spine, and it is often found in elderly patients or at least those who are over 40 years old (Kushchayev et al., 2018). Lumbar spondylosis is a disease of the lumbar spine with a wide spectrum (Konstantinou et al., 2015). It includes degeneration of the intervertebral discs, facet joints, formation of bone spurs (osteophytes), sclerosis of the vertebral corpus or endplates, and ligamentous hypertrophy (Debnath, 2021). In more serious stages, this can lead to a narrow gap between vertebrae or disc spaces, which can cause nerve interference and severe pain (Kushchayev et al., 2018).

Spondylosis can have various symptoms, such as back pain and stiffness (Chui et al., 2005). In some cases, it can also cause nerve compression, leading to numbness, tingling, and weakness in the arms or legs (Mir et al., 2021). Treatment for spondylosis may include medications, physical therapy, and, in some cases, surgery (Konstantinou et al., 2015). Based on its location, spondylosis can be divided into cervical spondylosis, thoraco-lumbar spondylosis and lumbar spondylosis, which is the most common one (Konstantinou et al., 2015). Lumbar spondylosis is a musculoskeletal problem and can lead to physical impairment in elderly patients (Brinjikji et al., 2015). It most commonly affects the L4-L5 and L5-S1 segments, and it is because of the central locations of the body axis (Oakley and Harrison, 2020).

Lumbar spondylosis is generally a degenerative process in the spine (Tsujimoto et al., 2016). It is characterized by osteophytosis of the end plates of the corpus vertebrae, which is often found in the anterior and lateral, but rarely in the posterior part of the corpus vertebrae. Lumbar spondylosis is also known as spondylosis deformans or vertebral osteoarthritis (OA) (Muraki et al., 2014). Pain complaints in patients with lumbar spondylosis are usually discogenic pain, but some patients could have radiculopathy pain (Sireesha, 2019). This is due to other

degenerative processes in the functional spinal unit, such as degeneration of the intervertebral disc, which can cause herniation of the nucleus pulposus or low back pain (LBP) because it involves the spinal cord (Debnath, 2021).

Lumbar spondylosis is a radiologic diagnosis, not a clinical diagnosis (Kushchayev et al., 2018). The degeneration process of the lumbar vertebrae can be symptomatic and asymptomatic (Dagenais, et al., 2014). Patients with lumbar spondylosis in the early stages usually do not complain of symptoms (asymptomatic), but in the advanced stages, patients will experience pain due to the continuous destruction process and usually accompanied by other degenerative processes in the functional spinal unit components. Therefore, patients will have various symptoms and clinical diagnoses (Dagenais et al., 2014; Mutmainna et al., 2014; Kushchayev et al., 2018).

Spondylosis is a nonspecific term usually used to describe hypertrophic changes in the end plates (osteophytes) and facet joints (Pate et al., 1988; Kushchayev et al., 2018). There are three types of true degenerative osteophytes: traction osteophytes, claw osteophytes, and wraparound bumper osteophytes. Traction osteophytes are bone structures that protrude horizontally at the anterior part of the vertebral corpus (Figure 1a) (Kushchayev et al., 2018). It has been recognized since 1956 (Pate et al., 1988). This type of osteophyte is identified by its anterior location and emphasized radiographic characteristic that allow it to be more recognizable than the claw osteophytes. The identification of traction osteophytes is an indicator of spinal instability, notably when it occurs at the L4 to L5 spinal level. The development of traction osteophytes indicates unique changes in the outer part of annulus fibrous (Pate et al., 1988; Kushchayev et al., 2018).

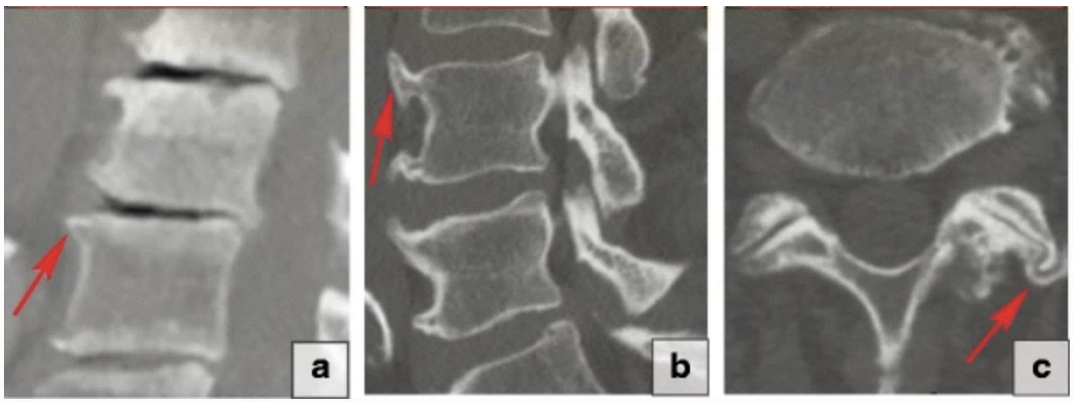

Figure 1. Three types of osteophytes related to the degenerative spine: (a) traction osteophytes (red arrow); (b) claw osteophytes (red arrow); and (c) bone window axial slices: osteophytes at the left facet joints are visible (red arrow) (Kushchayev *et al.,* 2018).

Claw osteophytes have a claw-like shape that protrudes horizontally at the anterior and toward the intervertebral disc, parallel to the vertebral body and opposite the disc (Figure 1b). Traction and claw osteophytes are often found side by side on the same vertebral edge and can be associated with horizontal instability. These osteophytes result from increased flexibility between the vertebral bodies and the production of inhomogeneous mechanical stresses at the annulus fibrosus and vertebral body edges, with sclerotic or hyperplastic changes occurring at the vertebral body edges (Kushchayev *et al.*, 2018; Sireesha, 2019). Bumper sheath osteophytes are usually found along the capsular insertion of the facet joint and are believed to be associated with facet joint instability (Figure 1c).

Anatomy of the vertebrae

The lumbar vertebrae have a larger corpus than the thoracic and cervical vertebrae, and its structure has a kidney-like shape (Dagenais et al., 2014). The characteristics of the lumbar vertebrae are that they have a posteriorly pointed pedicel, a thick lamina, a triangular vertebral foramen, a longer and slender transverse process than the cervical vertebrae, a posteriorly short, flat, and rectangular spinous process, a medially faced superior articular, and a laterally pointed inferior articular facet. The lumbar vertebrae have a transverse process with no foraminal transverse, and they also have no facet articular associated with the costae (Figure 2) (Ranga et al., 2016).

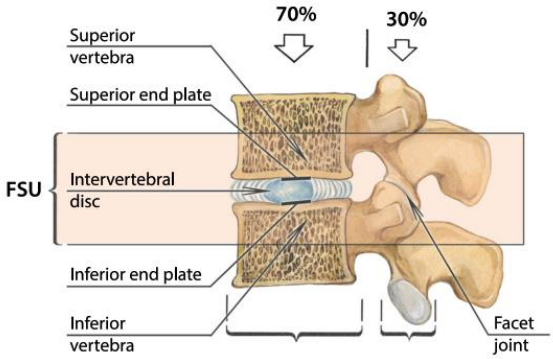

Figure 2. Functional spinal unit (FSU) or functional unit in the vertebra (Kushchayev et al., 2018).

Vertebrae are functional units that regulate the body's movement and support the body's weight. The corpus vertebrae and intervertebral discs support 70% of the body's load, while the facet joints regulate the rest 30% (Kushchayev et al., 2018). The FSU degeneration process will cause the patients to experience stability disorders in their bodies.

Epidemiology of lumbar spondylosis

The lumbar spondylosis cases of patients above 40 years in Japan were recorded using radiographic examination, with 37.9 million cases in 2012. Meanwhile, in the United States, the spondylosis cases were reported to be more than 80% of patients aged above 40 years. In another age group of 20–29 years, the spondylosis cases are currently 3% higher than before (Tsujimoto et al., 2016; Lee et al., 2017; Mir et al., 2021).

The Kellgren-Lawrence (KL) criteria was used in studies from Japan and Korea to classify lumbar spondylosis into four different levels. The results were that 76.7% of lumbar spondylosis patients had KL ≥ 2, while 38.8% had KL ≥ 3 (Tsujimoto et al., 2016). Spondylosis was present at L3/4, L4/5, and L5/S1, and it was also accompanied by LBP, body mass index (BMI), age, and spinal stiffness (Tsujimoto et al., 2016). Other studies have reported a clear prevalence of lumbar spondylosis, with 75.8% of cases showing KL>2 and 50.4% showing KL>3 (Muraki et al., 2014; Kushchayev et al., 2018; Sireesha, 2019; Oakley and Harrison, 2020).

The cases of lumbar spondylosis in Korea in 2006–2008 were 73% with KL grade ≥ 2, and 36.5% of lumbar spondylosis patients had LBP complaints (Yamada et al., 2022). At the same time, the incidence of lumbar spondylosis accompanied by LBP was highest in elderly women who were over 60 (Yamada et al., 2022).

Lumbar spondylosis is a degenerative process characterized by the intervertebral discs degeneration and osteophytes formation (Kushchayev et al., 2018). Lumbar spondylosis, or the degeneration process of the intervertebral disc, can cause stenosis,

vertebral instability and is associated with LBP symptoms and lower limb pain. Lumbar spondylosis and intervertebral disc degeneration are a single entity that can be caused by aging and repetitive trauma (degenerative disease affecting intervertebral discs, vertebrae, and facet joints. However, all literature sources have a unified definition of lumbar spondylosis as a degenerative-related process in the vertebrae (Chui et al., 2005; Muraki et al., 2014; Sireesha, 2019).

Some lumbar spondylosis patients are reported to be asymptomatic or showing no symptoms, and this can be for a long time without the patient's being aware of it. However, some patients report to have complaints of LBP (Tsujimoto et al., 2016). The results of the radiographic examination on women aged 20–80 years showed signs of age-related lumbar degeneration with no complaints of LBP (Tsujimoto et al., 2016). This indicates that patients with lumbar spondylosis can be symptomatic or asymptomatic. Studies also provided contradictory results regarding the relationship between vertebral degenerative events and the age of the patients (Mutmainna et al., 2014; Nouh, 2019; Yamada et al., 2022).

Pathophysiology of lumbar spondylosis

Due to aging, elderly patients will first experience impaired nutritional supply due to some changes in the bone matrix. The nutritional deficit causes a high amount of lactate, leading to a lower pH. Metabolic changes lead to cellular changes that result in the cartilage matrix (end plate) degradation and will eventually cause structural damages. The bone destruction will secrete inflammatory agents such as tumor necrosis factor (TNF-α), interleukin-1 (IL-1), IL-6, and prostaglandins (PGE). Proinflammatory cytokines, nitric dioxide, metabolic debris, increased lactic acid, and low pH will diffuse out of the disc and cause nociceptive to the outer annular fibers. As a result, the patient will experience discogenic pain (Pate et al., 1988; Muraki et al., 2014; Lee et al., 2017; Sireesha, 2019; Oakley and Harrison, 2020).

Radiology diagnostic imaging

Radiographs of lumbar spondylosis usually show osteophytes and narrowed intervertebral discs. A study used the KL score to categorize the degree of vertebral degeneration, and the results showed no specific relationship between the degree of degenerative bone and the severity of pain in patients (Kushchayev et al., 2018). The KL criteria is the original and reliable system for determining the level of severity in knee joint osteoarthritis (Kushchayev et al., 2018; Nouh, 2019). It is also used to classify degenerative spine and has been modified to consider osteophyte formation and narrowing of the intervertebral disc (Kushchayev et al., 2018; Sireesha, 2019). The interpretation of the modified system is as follows: KL0: normal; KL1: minimal osteophytes; KL2: obvious osteophytes; KL3: narrowing of the intervertebral discs and osteophyte formation; KL4: visible sclerosis of the vertebrae, narrowing of the intervertebral discs, and prominent and extensive size osteophyte formation (Figure 3). Another assessment is the narrowing of the joint gap, including the assessment of the KL score (Tsujimoto et al., 2016; Kushchayev et al., 2018).

The radiologic examination is an essential step to determine the lumbar spondylosis (Chui et al., 2005). The initial imaging option for lumbar spondylosis cases is the X-ray, meanwhile the CT scan and MRI are used for subsequent evaluations (Ranga et al., 2016). MRI might be used for evaluation of patients with facet joint osteoarthritis or those with an early stage of degenerative disc disease (Ranga et al., 2016; Sayah et al., 2016). CT scan is a preferable imaging tool that can be used in patients with contraindications to MRI test (Dagenais et al., 2014; Sayah et al., 2016).

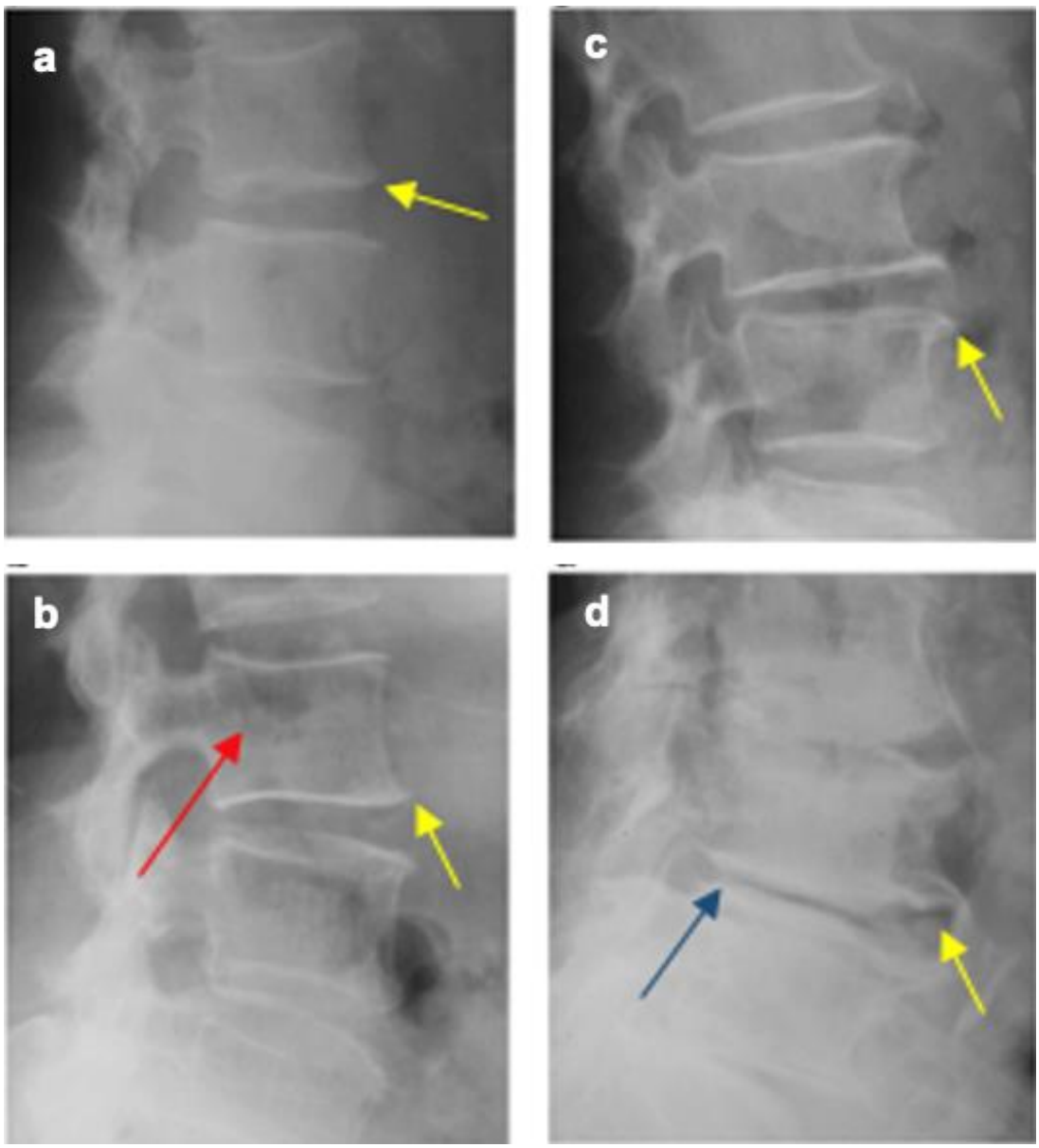

Figure 3. Interpretation of the Kellgren-Lawrence grading on X-ray. (a) KL-1: no osteophyte visible; (b) KL-2: osteophyte visible; (c) KL-3: osteophyte and narrowing of the intervertebral disc (blue arrow) visible; (d) KL-4: prominent osteophyte, associated with narrowed intervertebral disc, and sclerotic (red arrow). Yellow arrows indicate osteophytes (Tsujimoto et al., 2016).

X-ray examination

X-ray examination is a conventional tool that can be used to assess osteophytosis in the vertebral body. Sometimes, the imaging of lumbar spondylosis is misdiagnosed as another spinal degenerative disorder (Muraki et al., 2014). This condition is described as experiencing back pain, radiating to legs or pain during movement. The radiographic results of an elderly woman with back pain can be seen in Figure 4a and 4b. The X-ray from another patient also showed osteophytes, narrowed intervertebral discs, and sclerosis (Figure 4c and 4d). Sclerosis is a process of fibrous tissue compaction that can begin with the destruction of bone tissue. This is characterized by changes in the density of the spine, which become translucent on X-ray images (Kushchayev et al., 2018; Sireesha, 2019).

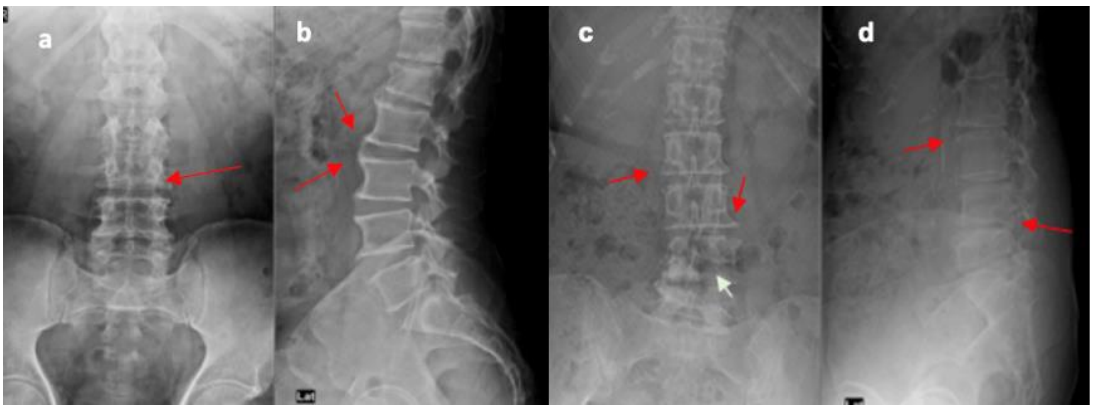

Figure 4. Projection of lumbar vertebra showing osteophytes and narrowing of the intervertebral discs from different lumbar spondylosis (Sireesha, 2019).

Computed tomography scan (CT scan)

The CT scan can be used as a follow-up imaging option after an X-ray examination, especially when MRI modalities are unavailable (Pate et al., 1988; Tallroth, 1998; Mutmainna et al., 2014; Kushchayev et al., 2018). It can also be used to evaluate degenerative changes in the intervertebral discs that may be invisible on an X-ray examination. It can assess the presence of minimal osteophytes, annular protrusions, calcifications, and the presence of gas in the intervertebral disc or the so-called vacuum phenomenon (Figure 5). Furthermore, CT scans can demonstrate abnormalities in the facet joints that are challenging to identify with X-rays (Tallroth, 1998).

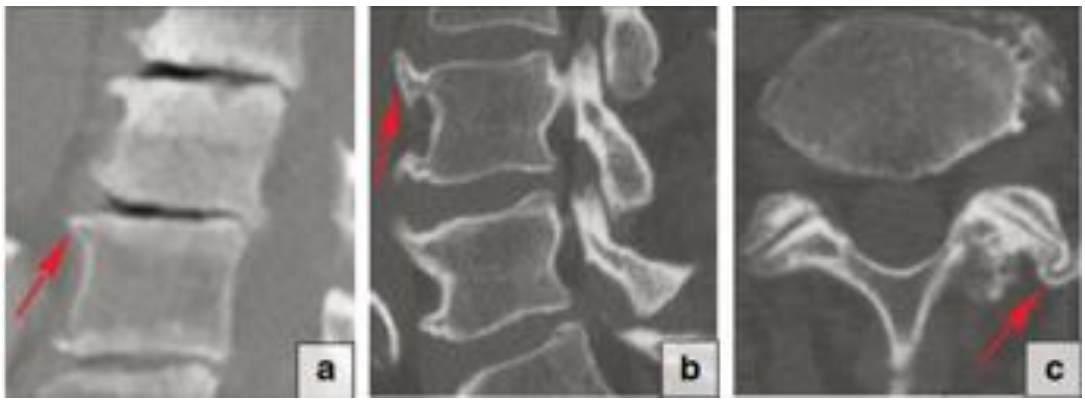

Figure 5. Bone window CT scan results. (a) Osteophytes and vacuum phenomenon appear. (b) with bone window technique in sagittal plane: osteophytes appear with claw-like appearance. (c) Axial slice of bone window CT scan: osteophytes appear in left facet joints (Kushchayev *et al.*, 2018).

Magnetic resonance imaging (MRI)

MRI is the gold standard for imaging patients with degenerative vertebrae, even without contrast agents (Sayah *et al.*, 2016; Kushchayev *et al.*, 2018). The MRI protocols consist of sagittal T1-weighted, sagittal T2-weighted, sagittal short tau inversion recovery (STIR), axial T2-weighted, and axial T1-weighted (Figure 6). MRI has a few disadvantages; for example, it takes a huge amount of time (20 minutes on average), is relatively expensive and is not always available in all health facilities. However, an MRI is believed to be better than a CT scan to evaluate spondylosis because it can assess morphological abnormalities of the intervertebral disc and annulus. MRI can also assess narrowing or neural foraminal stenosis, which usually gives clinical complaints in the form of severe pain in patients. It is also an excellent tool for assessing soft tissue structures around the vertebrae, changes or

abnormalities in the myelum, and the evaluation of bone density (Sayah et al., 2016; Mir et al., 2021).

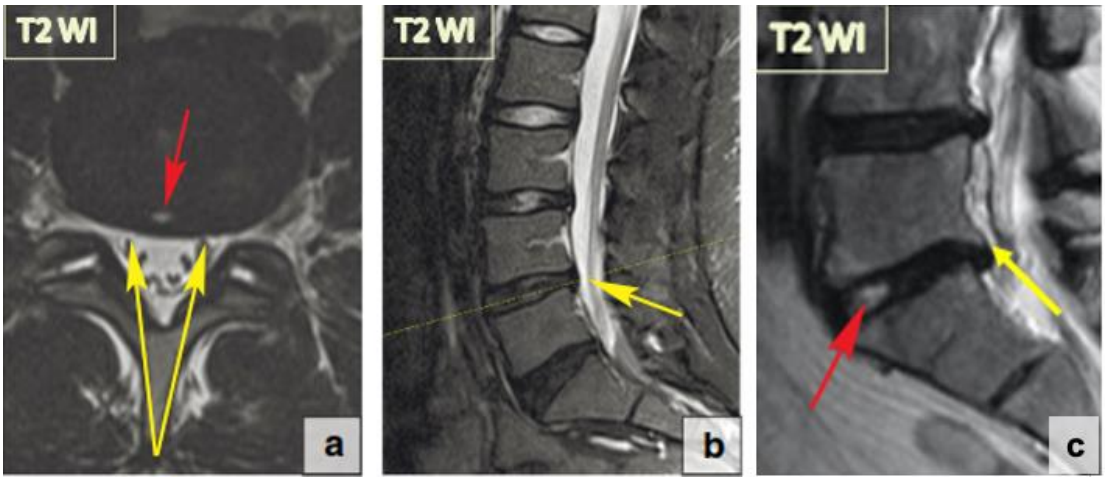

Figure 6. The results of MRI examination. (a) Transverse plane, T2WI sequence; (b) sagittal section, T2WI sequence. The protruding intervertebral discs are clearly indicated by the yellow arrows. Furthermore, the red arrow shows the hyperintensity in the posterior L4-L5 discs that is similar to the annulus fibrosus (Kushchayev et al., 2018). (c) Sagittal plane of T2WI sequence showing fluid-filled discs at L5-S1 (due to aging), and yellow arrows indicate osteophytes (Kushchayev et al., 2018).

Procedure management

The procedure management of lumbar spondylosis patients is either non-operative or operative. Non-operative therapy aims to relieve pain, improve the patient's quality of life, and allow them to work and perform activities as they normally do. Non-operative therapy includes pain medications, physical exercise, and cognitive behavioral therapy (CBT) (Chui et al., 2005; Konstantinou et al., 2015).

Surgical therapy is an option for spondylosis patients who have demonstrated spinal fusion or arthrodesis. The total disc arthroplasty can be used on patients without contraindications, where the problematic spinal component is replaced with a prothesis (Pate et al., 1988; Dagenais et al., 2014; Muraki et al., 2014; Ranga et al., 2016).

Conclusions

Lumbar spondylosis is a degenerative bone disorder characterized by osteophyte formation that can be seen on X-ray radiographs. Radiologic imaging is still the gold standard for diagnosing lumbar spondylosis. The basic diagnosis of spondylosis depends on radiological diagnosis. The use of X-ray as an initial imaging modality is strongly recommended. MRI is the recommended examination for advanced imaging. However, in the absence of MRI facilities, CT scans may be used. X-ray examination remains an important part of lumbar spondylosis diagnosis.

Authors' contributions

Conceptualization: TMY, IZ, DS, and RI; Data curation: TMY, IZ, DS, and RI; Formal analysis: TMY, IZ, DS, and RI; Investigation: TMY, IZ, DS, and RI; Methodology: TMY, IZ, DS, and RI; Project administration: TMY, IZ, DS, and RI; Resources: TMY, IZ, DS, and RI; Supervision: TMY, IZ, DS, and RI; Validation: TMY, IZ, DS, and RI; Writing-original draft preparation: TMY, IZ, DS, and RI; Writing-review and editing: TMY, IZ, DS, and RI.

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Ethical approval

Not applicable.

Conflict of interest

There is no conflict of interest reported by the authors.

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