

CASE REPORT

The occurrence of vascular displacement into intervertebral disc space following the compensated sagittal imbalance of the spine: a case report and review of literature

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Abstract

Background It is known that sagittal compensating mechanisms are created for counteracting sagittal imbalance problems; however, they can sometimes be associated with incidents which affect the plan of management.

Purpose The purpose of this study was to report a case of the occurrence of common iliac vessel displacement into the intervertebral disc space following one of the spinal compensatory mechanisms.

Material and methods The authors demonstrated this case by showing the patient history, physical examination, imaging studies, and treatment strategy as well as by reviewing some related literature.

Results An 81-year-old woman presented with a long history of low back pain with claudication. An upright plain radiograph and flexion–extension study demonstrated a progressive local thoracolumbar kyphosis and loss of lumbar lordosis with significant widening of the intervertebral disc space of L4–L5. An MRI scan and 3D volume rendering spiral computed tomography (3D-CT) revealed an abnormal content which was depicted as common iliac vessels inside the disc space of L4–L5. Consequently, a rare case of the occurrence of common iliac vessel displacement into the intervertebral disc space following one of the spinal compensatory mechanisms was reported.

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Conclusion The occurrence of vascular displacement into the intervertebral disc space related to lumbar hyperextension, as a compensating mechanism, is a rare incident but can occur. Consequently, when this mechanism presents with abnormal widening of the intervertebral disc space, especially at the low lumbar level, it should raise surgeon's concern about the probability of vascular injury when performing a disc procedure. Thorough investigation with imaging studies and selecting the optimum surgical treatment are warranted.

Keywords Vascular displacement · Compensatory mechanism · Sagittal imbalance · Spine · Intervertebral disc space

Introduction

In recent decades, a number of topics on spinal sagittal balance, which influence the management of spinal diseases, especially degenerative pathologies and spinal deformities, have been increased and focused. The compensatory mechanisms, which included reduction of thoracic kyphosis, intervertebral hyperextension, retrolisthesis, pelvic retroversion, knee flexion, and ankle extension [1], are thoroughly described in several published papers. These mechanisms are created for counteracting sagittal imbalance problems; however, they can sometimes be associated with incidents which affect the plan of management.

In this present study, we report an interesting case of common iliac vessel displacement into the intervertebral disc space related to one of the sagittal compensating mechanisms. We demonstrated this case by showing the patient history, physical examination, imaging studies, and

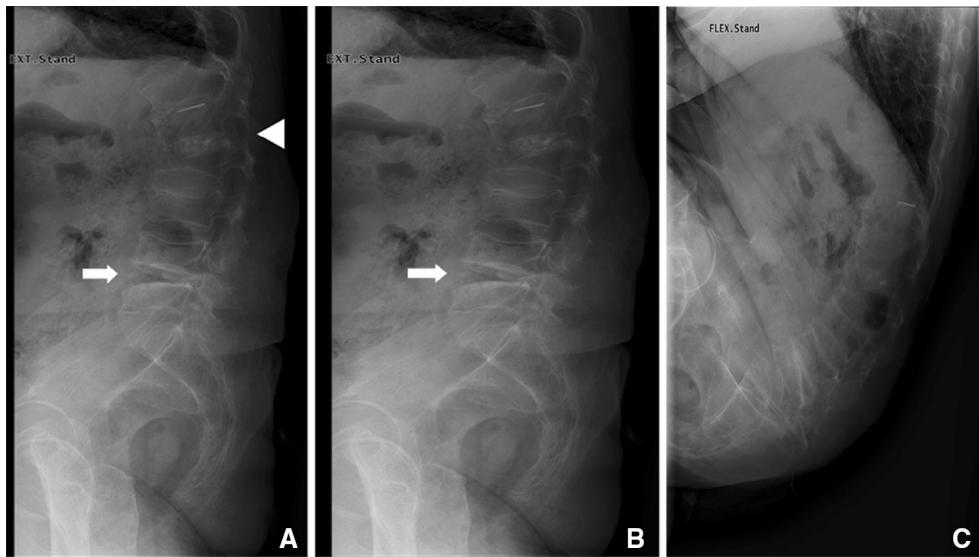


Fig. 1 **a** The upright plain radiograph showed local thoracolumbar kyphosis with losing of lumbar lordosis (white arrowhead) and significant widening of the L4–L5 intervertebral space (white arrow)

b and **c**. Dynamic flexion–extension radiograph showed angular instability through widening of the L4–L5 intervertebral disc space (white arrow)

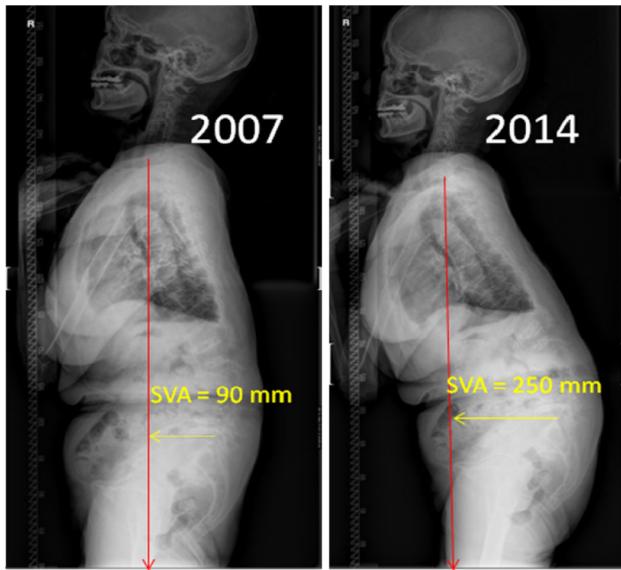


Fig. 2 The comparison of the progressive sagittal imbalance from the long standing radiographic images between year 2007 and 2014 (SVA sagittal vertebral axis)

treatment strategy as well as reviewing some related literature.

Case report

An 81-year-old woman presented with a 20-year long history of low back pain with claudication. Her symptoms, which included claudication and stooping posture, had



Fig. 3 Sagittal CT image showed the defect of pars interarticularis of L4 (white arrow) and abnormal intradiscal structure (white arrowhead)

progressively deteriorated over the last 10 years. Before she was referred to our clinic, she was treated only by conservative means. She had no previous history of trauma or spinal surgery. On examination, significant tenderness at the low back area as well as local thoracolumbar junctional kyphosis was demonstrated. Although she could stand in an erect position compensated by hip extension and knee flexion, the stooping posture was gradually unveiled when she was asked to take a short walk. No neurological deficit was detected. The subject was investigated through several imaging studies. As a result, the abnormal findings were demonstrated by an upright plain radiograph and dynamic

flexion–extension study (Fig. 1). A comparison between the 2007 and 2014 standard full-length 36-in. plain radiographs supported the diagnosis of progressive of sagittal imbalance (Fig. 2). Interestingly, the obtained sagittal reformatted CT image showed widening of the L4–L5 intervertebral disc space filled with abnormal content, which was depicted as common iliac vessels further

delineated by an MRI scan and 3D volume rendering spiral computed tomography (3D-CT) (Figs. 3, 4, 5).

At surgery, the subject was positioned prone on a standard open Jackson table. After checking the spinal alignment via fluoroscopic guidance, pedicular screw fixation from L3 to S1 in combination with bilateral iliac screw fixation was performed. Posterior and posterolateral

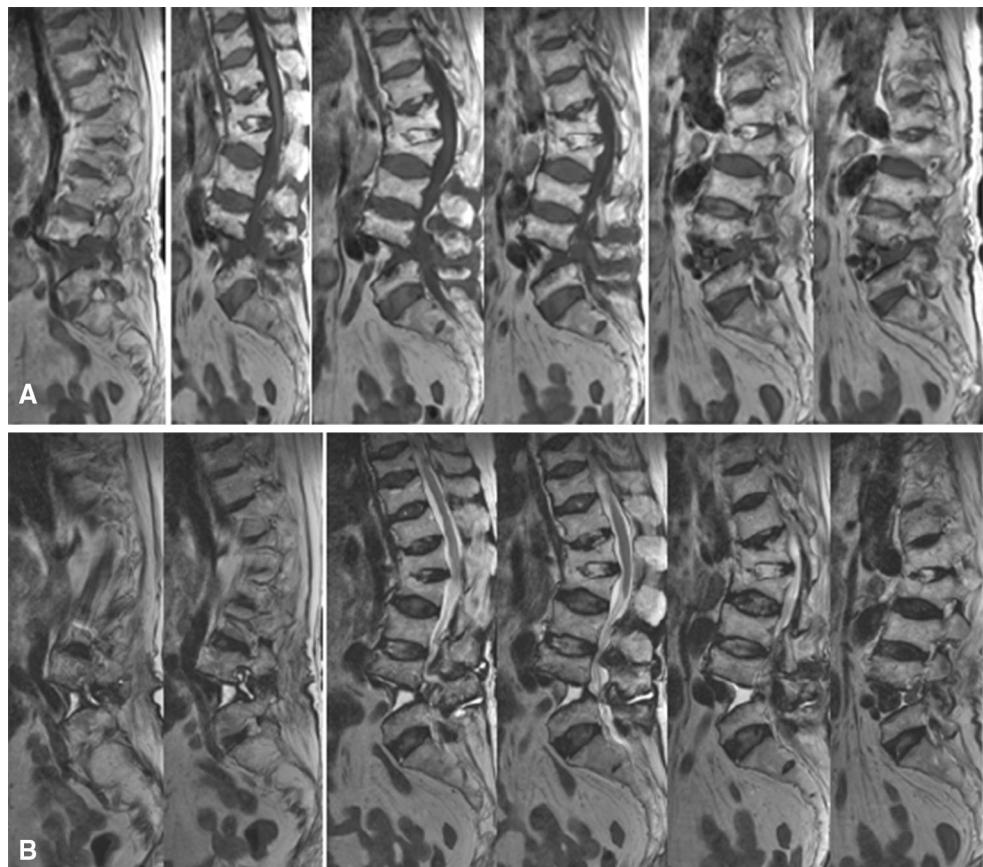
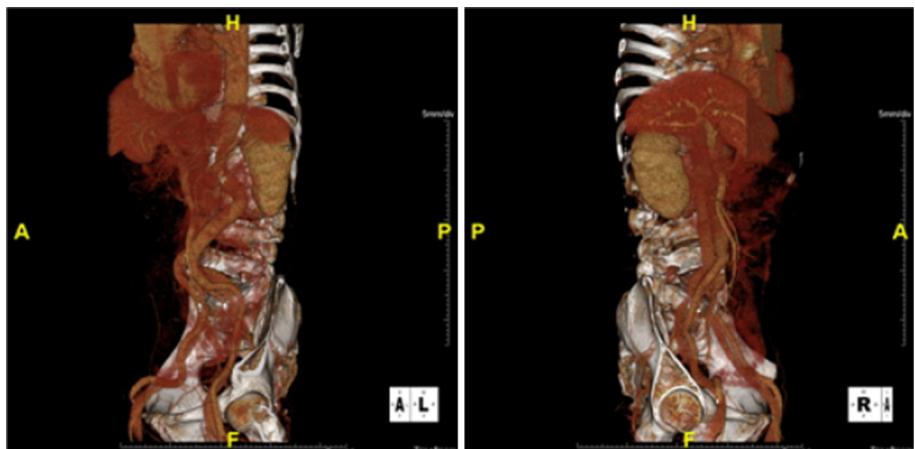


Fig. 4 Sagittal T1- (a) and T2-weighted MRI (b) showed common iliac vein displacement into the L4–L5 intervertebral disc space from left to right

Fig. 5 3D volume rendering spiral CT showed an atypical positioning of iliac vessels



fusion followed by posterior decompression of L4–5 and insertion of hyperlordotic rods relied on meticulous placing of local autograft, allograft material, and demineralized bone matrix. Finally, gentle compression of the rods was performed bilaterally. Although the objective of spinopelvic parameters was not achieved [1] (Fig. 6), intra-operative radiographs demonstrated an acceptable alignment (Fig. 7). At the 6-month follow-up, the subject's symptom gradually improved with the ability to walk in an erect position, though not in an economy state but independently without gait aids.



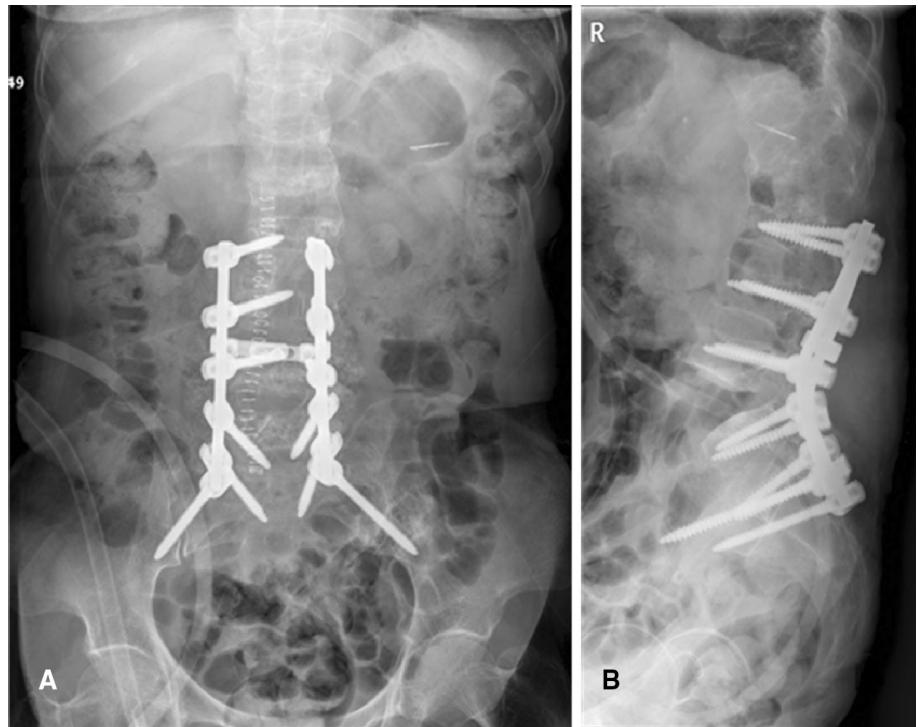
Fig. 6 Lateral pelvis radiograph showed the pelvic tilt (*PT*) which remained upper normal limit, indicating under correction

Discussion

Since Itoi initially described the compensatory mechanism for counteracting progressive kyphosis in osteoporotic patients in 1991 [2], it has been widely discussed in several published papers relating to the sagittal balance of the spine. The compensatory mechanisms, which appear in the spine, pelvis around the hip joint, and lower extremities, occur independently and to different degrees depending on the severity of spinal imbalance [3]. Theoretically, these mechanisms aim to make the subject, who developed the process of progressive sagittal imbalance, stand in an erect position with horizontal gaze. Despite their objective being to alleviate the spinal sagittal imbalance symptoms, they can create a lot of problems themselves. Specifically, in a case such as decreased lumbar lordosis due to degenerative disc disease, the initial compensatory mechanism to restore the sagittal vertical axis is pelvic retroversion [4, 5]; however, at the same time the posterior spinal muscles, which act as the posterior tension band, take an action to ameliorate lumbar hypolordosis by creating adjacent hyperextension. As such, the posture as described can cause overstrain to the muscles in the back leading to fatigue and then distribute more stress to the facet joints [5].

In this present report, the authors demonstrated a rare case of the displacement of common iliac vessels into the intervertebral disc space following the compensatory

Fig. 7 Immediate postoperative antero-posterior (a) and lateral (b) radiographic images



lumbar hyperextension state. Lumbar hyperextension, especially at the upper level, is thought to be one of the compensatory mechanisms which usually occur to counteract anterior shifting of axis gravity [3, 6]. To our current knowledge, there is only one previous report regarding the herniation of common iliac vessels into a lumbar intervertebral disc space but it was an incidental finding on an imaging study (MRI) [7] and not described as a relationship to the compensatory mechanism. In addition, although there is another report about abdominal pseudoaneurysm of aorta protrusion into the L3–L4 disc space, it related to the intra-operative injury during disc surgery [8]. Of note, our reported case was not a contingent event. After follow-up radiographic studies, the authors noticed that the subject gradually developed a widening of the L4–L5 intervertebral disc space, which compensated for the progressive local thoracolumbar kyphosis. In addition, the appearance of isthmic lysis of L4 can be further explained by the aggravation of the lumbar hyperextension state (Fig. 3). With regard to the anatomical knowledge of the anterior longitudinal ligament (ALL) and anterior outer part of the anulus fibrosus (AF), the authors might hypothesize that attenuation or distraction of these protecting ligaments can lead the abdominal draping vessels penetrate into intervertebral disc space.

The primary goal of surgical management in the presented case is to stabilize the very unstable spine due to circumferential structural disruption of the lower lumbar segment (ALL, AF plus pars interarticularis lysis of L4), whereas the secondary goal is to do some good for correcting the sagittal alignment. However, for the plan of surgical management, vascular injury is the largest concern. The occurrence of abdominal vascular injury during the spine operation is quite infrequent ranging from 0.03 to 0.17 % [9–14]. In contrast, the mortality rate ranges from 15 to 100 % depending on the prompt of diagnosis, type of vascular injury, and the emergence of intervention [12]. The lumbar hyperextension in the state of extremis, which distracted and split the anterior longitudinal ligament and outer anulus fibrosus, can be one risk factor for the incident of vascular injury during disc surgical procedures, specifically posterior lumbar interbody fusion (PLIF). Although the rate of vascular injury during lumbar disc procedure in the cases with typical abdominal vessels is only 0.01 % as reported by Papadoulas et al. [13], the prevalence rate should be raised by this reported incident. Interestingly, all of the reports about vascular injuries including arteriovenous fistula, laceration of one or multiple vessels, or pseudoaneurysm during lumbar disc procedures mostly occurred at the L4–L5 disc space [15]. As such, the presented case had two identifiable risk factors which are the lumbar hyperextension state and the most frequent operative area of vascular injury during lumbar disc procedure.

Although the study by Liu et al. [16] revealed that PLIF has more favorable outcomes than posterior lumbar fusion (PLF) in achieving spinal fusion, the presented subject demonstrated acceptable postoperative images with gradual improvement of clinical symptoms. Furthermore, from the biomechanical standpoint, imaging showed that after corrective surgery the axis of gravity was shifted to the posterior direction far from the axis of the vertebral column, so performing PLIF may not have yielded any benefit of anterior support and better area of fusion. With regard to her age (81 years old), to correct sagittal imbalance to a shape of perfect alignment, which needs some osteotomy procedures such as a pedicular subtraction osteotomy combined with extended instrumentation, might present more risk to the patient than benefit. Sometimes it is better to keep a compensated balance than to obtain the ideal one with excessive risk [17]. Consequently, the authors decided to perform instrumented PLF with respect to the parameters indicated to the compensated alignment to avoid the occurrence of major vessel injury and other complications which might occur following aggressive procedures. Of note, however, one major pitfall was occurred and should be demonstrated in this report. As shown in a postoperative imaging (Fig. 7b), the upper end of instrumented vertebra should not end at the apex of kyphosis. It is agreed that such an improper ending of upper posterior instrumentation increases the risk of a failed surgery [18, 19].

Conclusion

The occurrence of vascular displacement into the intervertebral disc space related to lumbar hyperextension, as a compensating mechanism, is a rare incident but can occur. Consequently, when this compensatory mechanism presents with abnormal widening of the intervertebral disc space, especially at the low lumbar level, it should raise surgeons' concern about the probability of vascular injury during performing a disc procedure. Thorough investigation with imaging studies and selecting the optimum surgical treatment are warranted.

Compliance with ethical standards

Conflict of interest None of the authors has any potential conflict of interest.

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