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Application of the Intraspine Interlaminar Dynamic Stabilization Device for the Treatment of Lumbar Disc Herniation in Young Patients: A Case Report

Yuan W[1] and Maoting Li M[2*]

[1]Department of Orthopedics, Fuxing Hospital, Capital medical University, China

[2]Department of Spine surgery, Aviation General Hospital of China Medical University, China

[*]Corresponding author:

Maoting Li,
Department of Spine surgery, Aviation General Hospital of China Medical University, No. 3 Anwai beiyuan Road, Chaoyang District, Beijing, 100012, China

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Keywords:

Lumbar disc herniation; Interlaminar device; Nonfusion fixation

1. Abstract

Degenerative lumbar diseases can be treated in several ways, including decompression alone, posterior lumbar interbody fusion, and nonfusion lumbar spinal surgery. The IntraSPINE (Cousin Biotech, Wervicq-Sud, France) is a new device for nonfusion lumbar spine surgery that is used as an alternative for the treatment of degenerative lumbar disease. Lumbar disc herniation (LDH) is a common disorder among adults with degenerated lumbar intervertebral discs. However, its occurrence in childhood and adolescence is much less frequent, mostly because children and adolescents tend to have a healthier lumbar spine than adults. However, the elimination of motion results in accelerated degeneration of the adjacent level, known as adjacent level disease. Motion-preserving surgical methods have been developed to overcome this complication. These methods include total disc replacement, laminoplasty, and the use of interspinous implants and dynamic posterior stabilization systems. The IntraSPINE has historically been indicated for young patients with conditions such as disc degeneration, lumbar instability, and zygapophyseal joint syndromes. Herein, we report the case of an 18-year-old young female patient with LDH on two levels treated by posterior decompression and IntraSPINE placement surgery. As a result, the young patient achieved good recovery, but mobility of the lower lumbar spine was preserved.

2. Introduction

Degenerative disc disease (DDD) is the major cause of low back pain, which places a considerable socioeconomic burden on the health system. Lumbar fusion is a traditional intervention applied in the treatment of degenerative lumbar disease [1]. Interbody fusion is recognized as the “gold standard” treatment for degenerative lumbar diseases, but spinal fusion surgery often incurs many complications, including donor area complications, morbidity, and adjacent segment disease [2]. A series of studies has shown that fusion surgery accelerates intervertebral disc degeneration near the area of spinal cord fusion [3-5]. To reduce the undesirable complications of rigid fixation, diverse motion-preserving devices have been developed. However, evidence to support the use of motion-preserving procedures for fusion in the lumbar spine is limited. In recent decades, lumbar interspinous nonfusion techniques have been developed as alternatives or adjuncts to traditional decompression and fusion in the treatment of degenerative lumbar diseases other than degenerative spondylolisthesis [6-7]. Interspinous process devices can reduce the compression of nerves, confer dynamic stability to adjacent levels, and reduce the incidence of complications related to lumbar fusion [8-9]. The Coflex, Wallis, and X-stop devices have been widely used in common and prevalent lumbar interspinous nonfusion techniques for many years. A variety of “minimally invasive” procedures have been introduced, including placement of the IntraSPINE device. This is a device with a unique interlaminar location, closer to the normal centre of rotation that may have mechanical advantages over traditional, more posteriorly placed interspinous implants by allowing more physiological movement without blocking extension. The core material of the IntraSPINE is flexible medical silica gel, and the surface material is polyester fibre, which can enlarge the foramina, relieve the pressure on facets and discs, and stabilize the spine without sacrificing its natural motion (Figure 1) [10]. In the report, we describe the case of a young patient with intervertebral disc herniation at L4/5 and L5/S1 who underwent treatment with the IntraSPINE device and fenestration. As a result, a good therapeutic effect was achieved in this young female while also preserving motor function.

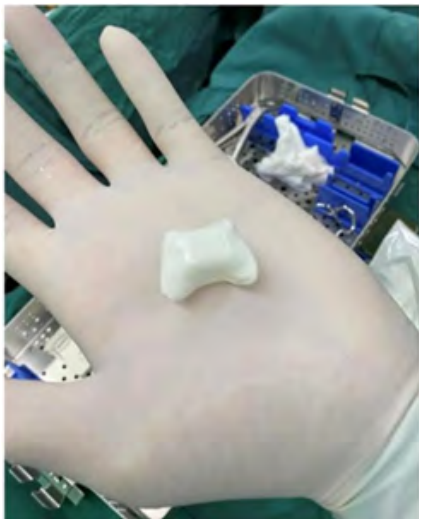

Figure 1: Appearance of IntraSPINE.

3. Case Presentation

An 18-year-old Chinese woman first experienced low back pain and radicular pain in January 2020. The pain began spontaneously, worsened after long-term sedentary periods, and was accompanied by lumbar discomfort. Subsequently, she experienced right gluteal and right leg pain along with paraesthesia in her posterior right leg. She had received acupuncture treatment in other hospitals, but her symptoms had worsened during the most recent 6 months, especially when rolling over and moving out of bed. In addition, symptoms improved when lying flat. The patient was 164 cm tall and weighed 65 kg. Her body mass index (BMI) was 24.1 kg/m2, and there was no history of cigarette smoking or alcohol abuse and no other relevant medical history. On admission, she had a pain score of 6 on the visual analogue scale (VAS). Physical examination indicated right L4–S1 paraspinal muscle tenderness and L4–S1 percussive radicular pain, extending from the right gluteus to the back of the right leg and the sole of the ipsilateral foot. Muscle strength and tone appeared normal, and the patellar and ankle reflexes in both lower limbs were symmetrical. The Lasegue test result was 75° and 30° for the left and right leg, respectively. The straight-leg raising sign was positive in the right lower limb. The patient underwent lumbar magnetic resonance imaging (MRI) that revealed a large right-sided paracentral disc herniation in the L5/S1 intervertebral space, compressing the traversing S1 nerve root and resulting in spinal stenosis, consistent with her symptoms (Figure 2-3). After conservative treatment failed, surgery was performed with this patient in the prone position under general anaesthesia. A C-arm X-ray machine was used to confirm the targeted segments. After sterile surgical preparation, a midline skin incision was made on the index level. Periosteal muscle dissection was carried out to expose the interspinous space and both the cranial and caudal lamina. The lower two-thirds of the interspinous ligament were resected with a monopolar coagulator and pituitary forceps. The opposite laminar space could then be prepared for implantation using a monopolar and right-angled curette. The ligamentum flavum was partially preserved because this procedure was not intended to direct central decompression. The base of the spinous process should be cleaned before placing the nose part of the implant. Then, we removed the lower edge of the L5 vertebral plate and the upper edge of the S1 vertebral plate using a grinding drill and laminectomy forceps to expose the dura mater and nerve roots. Next, we carefully pulled open the dura mater with a nerve dissector and removed protruding intervertebral disc tissue with nucleus pulposus forceps. After the nucleus pulposus was partially cleared, the nerve roots were appropriately decompressed. Using trial implants, the surgeon decided on the size of the implant to be used. After insertion of the implant, large pituitary forceps were used to hold, push and pull the implant to confirm its secure placement (Figure 4). For this young patient, we selected a number 12 implant for L5/S1 and a number 10 implant for L4/5. However, we did not perform fenestration decompression in the L4-5 intervertebral space. The patient's lower back pain and radiating pain and numbness in the right leg improved remarkably postoperatively (Figure 5-6). After discharge from the hospital, patient was ordered to undergo regular re-examinations, wear a circumferential waist brace for protection for 3 months, and not perform excessive weight-bearing activities for 6 months.

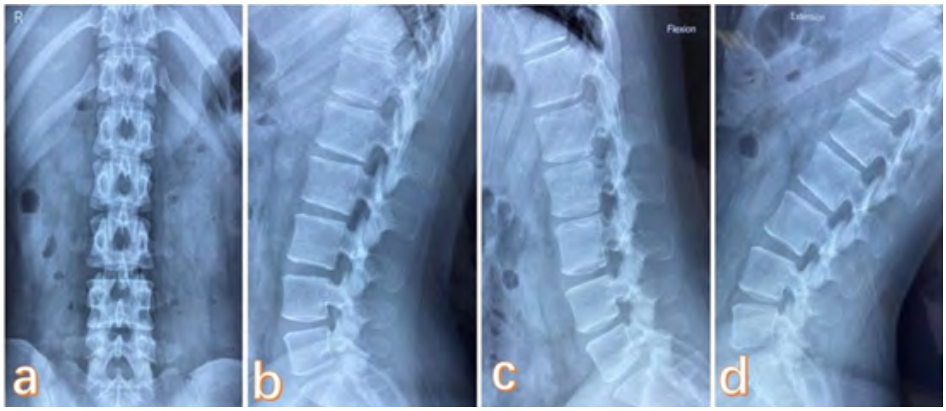

Figure 2: Preoperative X-ray and dynamic X-ray examination (a d).

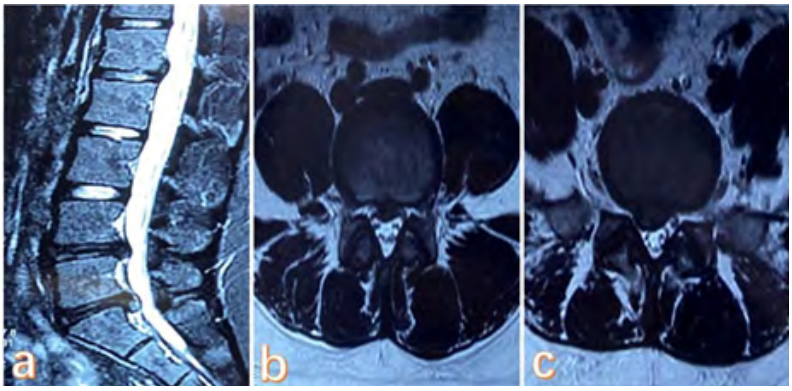

Figure 3: Preoperative magnetic resonance imaging (a-c). b L4-5 level. c L5-S1 level.

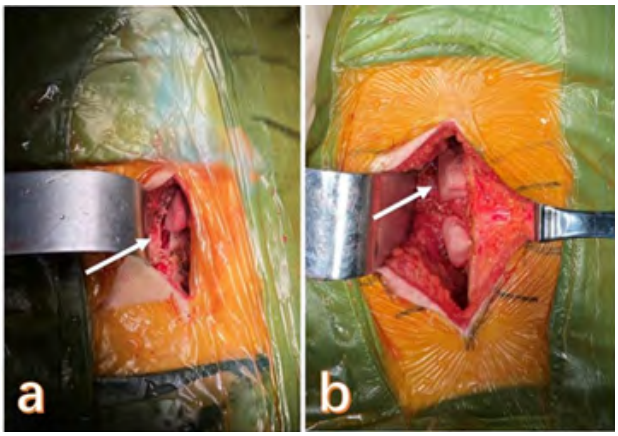

Figure 4: Intraoperative image (a-b). a The arrow indicates removed partially vertebral plate. b The white arrow indicates the location of the IntraSPINE.

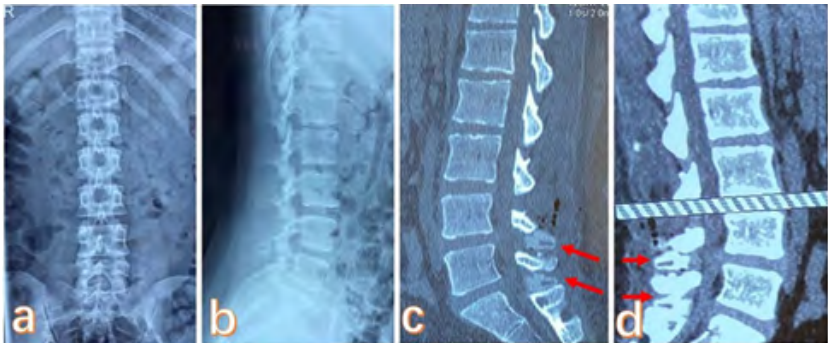

Figure 5: Postoperative (a-b) X-ray and (c-d) computed tomography (CT) examination. c-d Sagittal CT. The red arrow indicates the location of the IntraSPINE.

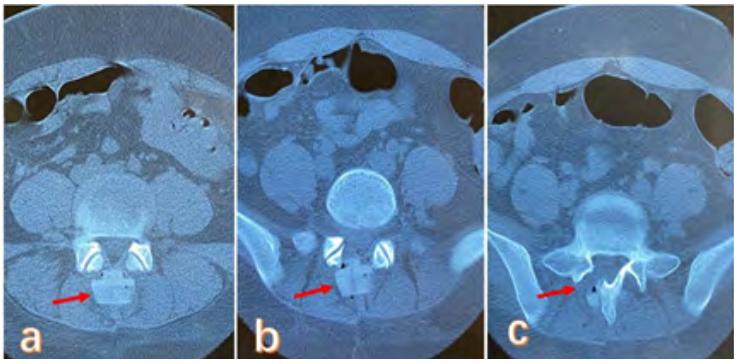

Figure 6: Postoperative (a c) computed tomography (CT). a Axial CT at the L4-5 level showed that the location of the IntraSPINE was suitable (red arrow). b Axial CT at the L5-S1 level showed that the location of the IntraSPINE was suitable (red arrow). c Red arrow indicates the location of fenestration decompression at the L5-S1 level.

4. Discussion

Spinal fusion is the gold standard for the treatment of degenerative lumbar diseases, but this method affects the activity of intervertebral joints, causes spinal segment movement disorder, increases the stress on adjacent segments of fused vertebrae, and accelerates the degeneration of adjacent segments [11]. An increasing number of studies [12] have shown that a high fusion rate does not necessarily represent the rate of treatment success, and among cases in which good fusion is achieved, there are still some patients whose symptoms have not improved. Additionally, the development of adjacent segmental lesions as a late complication after interbody fusion is another difficulty that spinal surgeons must face. During clinical follow-up, the degree of pain relief is sometimes not completely related to the fusion rate. Some patients with pseudoarthrosis or who even undergo nail or rod removal experience some relief. Therefore, scientists have gradually realized that while stopping segmental movement can relieve low back pain, the stability of the active segment may play an important role in controlling pain. In this research context, nonfusion technology began to receive attention, and dynamic stability (also known as soft stability) emerged, defined as a stable system that preserves beneficial movement and intersegmental load transmission of the vertebral joints without vertebral segmental fusion [13].

Posterior fusion by means of transpedicular screws is not free from complications and has been the focus of recent studies on biomechanics that could help to clarify the aetiology of the adjacent segment disease observed in patients submitted to this kind of surgical treatment. A wide range of nonfusion techniques have been proposed in the last decade, mainly consisting of anterior nonfusion techniques, such as artificial disc replacement (ADR) and prosthetic disc nucleus (PD) implantation, and posterior nonfusion techniques, such as the use of interspinous and transpedicular dynamic stabilization systems. In particular, interspinous devices are frequently used in cases of mild canal or foraminal stenosis, with or without decompression, to provide spinal stabilization while still allowing motion at the instrumented level. Several studies have reported the biomechanical behaviour of such implants through in vitro flexibility tests [14]. Despite their different designs, they show similar stabilizing effects and pressure reductions under extension while leaving flexion, lateral bending and torsion amplitudes almost unaffected. Usually implanted through a minimally invasive approach, these devices have been made using various materials and designs. The aim of interspinous spacers is to preserve motion while unloading the facet joints and increase central canal and neuroforaminal dimensions by either flexing the spinal segment or blocking extension. Interspinous implants can provide good clinical outcomes but are more reliable when combined with direct decompression [15].

Failures can occur due to local bone resorption leading to loss of constraint or spinous process fracture over distraction, which may lead to segmental kyphosis with a negative impact on sagittal balance and the physiological axes of rotation [16]. In contrast to interspinous spacers, the IntraSPINE is a new kind of interlaminar device that can significantly improve the functional status of patients with chronic low back pain [17]. The IntraSPINE, with its unique interlaminar location closer to the normal centre of rotation, has shown mechanical advantages in laboratory tests over a traditional, more posteriorly placed interspinous implant by allowing more physiological movement without blocking extension. Furthermore, this new device, with a core of medical silicone and an outer shell of pure polyethylene terephthalate (PET), has material properties very suitable for spinal applications. The fundamental feature of the IntraSPINE is the difference in the compression ratio between the anterior and posterior parts of the device: the anterior part is rigid, designed precisely to reproduce the inferior border of the superior laminae and the superior border of the inferior laminae, is able to distract and reopen the neuroforamen; in contrast, the posterior part is compressible and does not restrict spinous process movement. The major advantage of the device is the possibility of more anterior implantation in the “interlaminar” space, thus allowing better decompression and correction of physiological lordosis. A small-sample study showed that the IntraSPINE was able to reduce the load on adjacent levels compared with interspinous spacers [18].

The laminar implant is positioned close to the centre of rotation to provide elasticity for the spinous ligament tissue. Similar to the Wallis system, the interspinous ligament must be removed during the procedure and placed in the interlaminar space in compression mode to counteract the compression between the upper and lower spinous processes during lumbar flexion and extension, thus maintaining the fixation position. The advantages of this system are that it does not involve facet joints, does little damage to the posterior column structure, retains the motor function of the responsible segments of the lumbar spine, and avoids excessive compensatory activities and stress concentration in adjacent segments. Interlaminar decompression increases the capacity of the spinal and nerve root canals and the height of the intervertebral disc, reduces the pressure load on the posterior annulus and facet joints, and delays the degeneration of the vertebral body. Encouraging results of using the IntraSPINE for the treatment of DDD at the L5–S1 segment have been reported by Caspar et al, [19]. Additionally, Guizzardi and Morichi [20] verified the efficacy of the IntraSPINE in stopping or reversing the progressive cascade associated with disc degeneration.

In this study, the postoperative clinical symptoms of this patient were obviously alleviated, and the VAS score and Oswestry Disability Index (ODI) were significantly improved compared with those before surgery. In terms of the surgical operation, while ensuring the decompression effect, the as little as possible of the lamina should be removed to protect the facet joints because excessive laminar removal will affect the stability of the lumbar spine, which is not conducive to preserving the posterior structure of the lumbar spine and affects the stability and efficacy of prosthesis implantation. Regarding IntraSPINE prosthesis selection, in our experience, it is best to try to select a large prosthesis that will not cause kyphosis.

Finally, but not in order of importance, the possibility of implanting this device (IntraSPINE) in a fast and easy manner, without the necessity of a larger surgical incision or of a second operation, represents an another advantage for young patient that merits emphasis. In fact, major concerns associated with fusion procedures are the length of the surgical incision, the extensive trauma to the surrounding tissues, and the large amount of blood lost.

There is a large broad spectrum of available treatment options, including both conservative and surgical approaches. Novel strategies involving minimally invasive and motion-preserving techniques have emerged within the last decade, including IntraSPINE placement. Laboratory research has shown that the IntraSPINE can reduce the intradiscal pressure under flexion and extension. Furthermore, it preserves the range of motion under flexion and extension. In clinical practice, the absence of major complications, the minimal invasiveness of the surgical procedure and the good clinical results allow us to conclude that with correct patient selection, this method could serve as a “new arrow in the quiver” for the treatment of degenerative lumbar disease. While this is only the beginning of the journey to define the best treatment strategy for DDD, to date, in light of our clinical cases, we feel we can recommend the use of the IntraSPINE® as the first choice instead of more invasive surgeries, especially in the early stages of degenerative disease in order to slow the natural evolution, of course after failure of the mandatory attempt with conservative therapy.

5. Conclusion

The IntraSPINE interlaminar nonfusion elastic decompression device can be used to treat lumbar disc herniation, especially in young patients. Additionally, strict surgical indications and prudent surgical procedures are important factors affecting the outcome of surgery, especially the long-term outcome. However, there are still some shortcomings in this study. The long-term effects of the IntraSPINE on adjacent segmental degeneration and the degeneration and hydration of surgical segmental intervertebral discs need to be further explored and studied.

References

1. Kos N, Gradisnik L, Velnar T. A brief Review of the Degenerative Intervertebral Disc Disease. Med Arch. 2019; 73(6): 421-4.
2. Overdevest G, Vleggeert-Lankamp C, Jacobs W, Thome C, Gunzburg R, Peul W. Effectiveness of posterior decompression techniques compared with conventional laminectomy for lumbar stenosis. Eur Spine J. 2015; 24 (10): 2244-63.
3. Rijsbergen MV, Rietbergen BV, Barthelemy V, Eltes P, Lazary A, Lacroix D, et al. Comparison of patient-specific computational models vs. clinical follow-up, for adjacent segment disc degeneration and bone remodeling after spinal fusion. PLoSONE. 2018; 13(8): e0200899.
4. Faizan A, Kiapour A, Kiapour AM, Goel VK. Biomechanical analysis of various footprints of transforaminal lumbar interbody fusion devices. J Spinal Disord Tech. 2014; 27(4): E118-E127.
5. Calvo-Echenique A, Cegonino J, Chueca R, Palomar AP. Standalone lumbar cage subsidence: a biomechanical sensitivity study of cage design and placement. Comput Method Program Biomed. 2018; 162: 211-9
6. Cai YF, Luo JQ, Huang JJ, Lian CJ, Zhou H, Yao H, et al. Interspinous spacers versus posterior lumbar interbody fusion for degenerative lumbar spinal diseases: a meta-analysis of prospective studies. Int Orthop. 2016; 40(6): 1135-42.
7. Hashimoto K, Aizawa T, Kanno H, Itoi E. Adjacent segment degeneration after fusion spinal surgerya systematic review. Int Orthop. 2019; 39(8): 1459-64.
8. Yeh KL, Wu SH, Wu SS. Application of the IntraSPINE® interlaminar device in patients with osteoporosis and spinal stenosis: two case reports. J Int Med Res. 2021; 49: 1-8.
9. Gelalis ID, Papadopoulos DV, Giannoulis DK, Tsantes AG, Korompilias AV. Spinal motion preservation surgery: indications and applications. Eur J Orthop Surg Traumatol. 2018; 28(3): 335-42.

10. Feng ST, Fan ZH, Ni JS, Yang Y, Fei Q. New combination of IntraSPINE device and posterior lumbar interbody fusion for rare skipped-level lumbar disc herniation: a case report and literature review. J Int Med Res. 2020; 48(8): 300060520949764.
11. Hashimoto K, Aizawa T, Kanno H, Itoi E. Adjacent segment degeneration after fusion spinal surgery-a systematic review. Int Orthop. 2019; 43(4): 987-93.
12. Pan AX, Hai Y, Yang JC, Zhou LJ, Chen XL, Guo H. Adjacent segment degeneration after lumbar spinal fusion compared with motion-preservation procedures: a meta-analysis. Eur Spine J. 2016; 25(5): 1522-32.
13. Asgari N, Sanjari MA, Esteki A. Local dynamic stability of the spine and its coordinated lower joints during repetitive Lifting: Effects of fatigue and chronic low back pain. Hum Mov Sci. 2017; 54: 339-46.
14. Fan W, Guo LX. The effect of non-fusion dynamic stabilization on biomechanical responses of the implanted lumbar spine during whole-body vibration. Comput Methods Programs Biomed. 2020; 192: 105441
15. Schenck CD, Terpstra SES, Moojen WA, Zwet EV, Peul W, Arts MP, et al. Interspinous process device versus conventional decompression for lumbar spinal stenosis: 5-year results of a randomized controlled trial. J Neurosurg Spine. 2021; 36(6): 909-17.
16. Davis R, Auerbach JD, Bae H, Errico TJ. Can low-grade spondylolisthesis be effectively treated by either coflex interlaminar stabilization or laminectomy and posterior spinal fusion? Two-year clinical and radiographic results from the randomized, prospective, multicenter US investigational device exemption trial. J Neurosurg Spine. 2013; 19: 174-84.
17. Bae J, Lee SM, Lee SH, Shin SH, Kim HJ, Kim KH. The likelihood of reaching substantial clinical benefit after an interlaminar dynamic spacer for chronic low back pain: a clinical and radiologic analysis of a prospective cohort. World Neurosurg. 2017; 101: 589-98.
18. Carrabs G, Sessa G, Oliva G, Magliulo M, Pipola AM, Silvestro A, et al. Intraspine interlaminar device: clinical, radiological, and safety results of a mini case series (10 cases). Global Spine J. 2015; 5: s-0035-1554605-s-0035.
19. Caspar A, Manuel CJ, Giancarlo G. The Intraspine® in the treatment of L5-S1 degenerative disc disease. Preliminary report. EC Orthopaedics. 2015; 2: 146-52.
20. Giancarlo G, Morichi R. Clinical results with IntraSPINE®. EC Orthopaedics. 2015; 2: 101-6.