Review Article

The renewed role of interspinous devices: the InSpan system—a narrative review on surgical indications

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Background and Objective: Interspinous devices have evolved from simple distraction spacers to interlaminar fixation systems capable of promoting fusion and stability. Early distraction-only implants were associated with high failure and reoperation rates, leading surgeons to abandon this technology. The InSpan system represents a new generation of posterior, interlaminar fixation devices designed to provide indirect decompression and interlaminar fusion. The goal of this review is to define practical, evidence-based indications and contraindications for the InSpan system within the context of interlaminar fixation, and to position this strategy among decompression alone and pedicle-based fusions.

Methods: This narrative review synthesizes evidence on interspinous and interlaminar fixation devices, with focus on the InSpan system. A search of PubMed/MEDLINE, Embase, and Cochrane Library databases up to November 2025 using the MeSH terms "interspinous device", "interlaminar fixation", "InSpan", "lumbar spinal stenosis", "spondylolisthesis", and "disc herniation" identified studies evaluating device design, kinematic behavior, clinical outcomes, and complications. Emphasis was placed on data informing practical surgical indications, contraindications, and patient selection criteria for InSpan.

Key Content and Findings: Available biomechanical studies suggest that InSpan provides meaningful flexion-extension control and serves as an effective scaffold for interlaminar fusion, while avoiding pedicle violation and preserving the posterior structures. Clinical series report sustained improvements in pain and disability scores, low revision and complication rates, and radiographic evidence of fusion in selected patients. The most promising indications include: (I) recurrent lumbar disc herniation after microdiscectomy with segmental micromotion or disc height loss; (II) single-level lumbar spinal stenosis with low-grade spondylolisthesis or mild instability in patients at elevated risk for pedicle-screw fusion; and (III) foraminal or far-lateral stenosis where preservation of foraminal height is critical. Severe instability, high-grade spondylolisthesis, deformity, and multilevel disease remain better suited to conventional fusion constructs.

Conclusions: Interlaminar fixation devices appear to occupy a valuable niche between decompression alone and pedicle-based fusion, particularly in single-level degenerative pathology and fragile patients. When combined with decompression, InSpan can provide indirect decompression and interlaminar fusion with reduced surgical morbidity. Nevertheless, current evidence is largely limited, and high-quality randomized and long-term studies are needed to refine indications, durability, and cost-effectiveness.

Keywords: Spinal fusion; InSpan; interspinous device (ISD); interlaminar fixation; surgical indications

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Introduction

Interspinous devices (ISDs) were first introduced more than two decades ago to provide a minimally invasive alternative for the management of lumbar spinal stenosis and neurogenic claudication by limiting spinal extension and indirectly enlarging the spinal canal and foramina to allow for decompression of neural elements (1). Early designs, including X-STOP, DIAM, Wallis, and Superion, initially demonstrated encouraging short-term improvements; however, long-term follow-up demonstrated high revision rates, implant migration, and spinous process fractures, which led to their gradual discontinuation (2-4).

More recent iterations of interspinous implants—including interspinous process fixation and interlaminar fixation systems—have been developed to provide indirect distraction while also adding posterior stabilization and facilitating fusion when combined with direct decompression (e.g., microscopic, endoscopic, or unilateral-approach bilateral decompression techniques). Within this broader category, the InSpan system is an interlaminar fixation construct that anchors against the lamina rather than acting solely as a spacer between spinous process tips (5).

The goal of this review is to define practical, evidence-based indications and contraindications for the InSpan system within the broader context of interspinous and interlaminar fixation, and to position this strategy among decompression alone, endoscopy, and pedicle-based fusion. We present this article in accordance with the Narrative Review reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-2025-1-232/rc).

Methods

This is a narrative review based on a targeted search of the PubMed/MEDLINE, Embase, and Cochrane Library databases up to November 2025 using combinations of the MeSH terms “interspinous device”, “interlaminar fixation”, “InSpan”, “lumbar spinal stenosis”, “spondylolisthesis”, and “disc herniation”. Additional references were identified from the bibliography of key articles and relevant device-specific publications. Priority was given to prospective studies, randomized controlled trials, biomechanical investigations, and series with at least 2-year follow-up. Because of the heterogeneity of study designs and outcomes, no formal meta-analysis was performed (*Table 1*, Table S1).

Evolution from spacers to interlaminar fixation

Early devices and limitations

The first generation of interspinous process devices emerged in the early 2000s with the goal of offering a minimally invasive surgical alternative for lumbar spinal stenosis and neurogenic claudication. Devices such as X-STOP, DIAM, Aperius, Superion, and Wallis were designed to distract the spinous processes and maintain the lumbar spine in relative flexion, thereby widening the spinal canal and foramen and indirectly reducing neural compression. Early multicenter trials demonstrated short-term clinical improvement, particularly in elderly who were poor candidates for fusion (1,4,6).

However, the enthusiasm surrounding these devices diminished as long-term data accumulated showing that several biomechanical weaknesses resulted in treatment failure or complications. The distraction-based mechanism primarily limited extension but offered minimal resistance to flexion, lateral bending, and rotational forces. Because these devices relied solely on the cortical integrity of the spinous processes, they were prone to spinous process fractures, bone osteolysis, device loosening and spinous process anastomosis, particularly in osteoporotic patients (4-6). Furthermore, without rigid fixation, many patients developed progressive instability or recurrent initial-level stenosis or adjacent segment disease, often requiring conversion to instrumented fusion (2,3). Revision rates exceeded 25–30% at 2 to 5 years, significantly higher than decompression alone, attributed to inadequate fusion and resulting instability of the involved levels (3,5,7). Histological and radiographic analyses and imaging studies also revealed fibrous encapsulation rather than true osseous fusion around early devices, which explained the high incidence of recurrent symptoms and persistent back pain (6). Consequently, many first-generation devices were withdrawn from the market, and surgeons largely abandoned interspinous implants in favor of conventional decompression or minimally invasive transpedicular fixation. The lessons learned from this first era highlighted that distractive decompression alone was often insufficient, and that durable outcomes likely depend on adequate segmental stability and, when intended, successful

Table 1 The search strategy summary

Items	Specification
Date of search	Up to September 12th through November 20th, 2025
Databases and other sources searched	PubMed/MEDLINE, Embase, and Cochrane
	Additional references were identified from the bibliography of key articles and relevant device-specific publications
Search terms used	"Interspinous device", "interlaminar fixation", "InSpan", "lumbar spinal stenosis", "spondylolisthesis", and "disc herniation"
Timeframe	Due to the historical nature of the review literature available literature on ISDs was included up to November 2025
Inclusion and exclusion criteria	Inclusion was largely based on relevant literature about the topic in discussion. Priority was given to prospective studies, randomized controlled trials, biomechanical investigations, and series with at least two-year follow-up
	Individual case reports were excluded
	Editorials, commentaries, letters to the editor, expert opinion pieces without original patient/biomechanical data not included
	Conference abstracts/posters without an accessible full-text manuscript or with insufficient methodological/outcome detail did not meet inclusion criteria
	Duplicate publications (same cohort/data reported multiple times): the most complete and/or longest follow-up report retained; others excluded
	Literature in any language other than English or Spanish was excluded
Selection process	All authors revised the articles found in the search and came to a consensus on which articles should be included. Decisions were made based on relevance and statistical power of the articles. Outdated references were included based on their historic importance on the subject.
Additional considerations	Older and outdated studies are included in the review due to its narrative nature, mainly to illustrate the evolution of the topic in discussion

ISDs, interspinous devices.

biologic fusion of the treated level.

The InSpan system: design and evidence

Device characteristics

The InSpan system (InSpan LLC, Burlington, MA 01803, USA) is classified as a posterior, non-pedicle interlaminar fixation device. It is implanted directly against the lamina with plates that capture and couple the spinous processes, and it can serve as a scaffold for bone graft placement to facilitate posterior fusion between adjacent laminae and spinous processes (8,9). Its design aims to improve flexion-extension stability and may help maintain foraminal height and share load after decompression (10). Compared with earlier distraction-only ISDs, features such as laminar contact and locking screws are intended to reduce the risk of migration or loosening and to distribute forces across posterior elements rather than concentrating loads at the spinous process tips (9,11). If reoperation is required, the construct can be removed by reversing the locking mechanism.

Clinical outcomes and evidence

Published clinical series have reported mid- to long-term outcomes with InSpan used as a posterior fixation adjunct to decompression. Chin *et al.* [2020] evaluated 122 patients undergoing decompression with single-level (L4–L5) InSpan fixation, reporting mean operative time <60 minutes, discharge within 24 hours, and improvements in Visual Analog Scale (VAS) (from 8.1 to 1.5) and Oswestry Disability Index (ODI) (from 42.9 to 14.8) at 5 years; one reoperation was reported during follow-up (9). When applied to other spinal levels, Chin *et al.* [2023] published

a 5-year follow-up of 100 patients at L4–L5 and L5–S1 showing sustained improvements in pain and disability, with revision rates <5%, none of which were attributed to implant failure (10). Raikar *et al.* also published a case series with results that support the use of ISDs such as InSpan in the treatment of disc herniations, reducing pain as measured by validated scales (12). Biomechanical studies have reported increased flexion-extension stiffness compared with spacer-type ISDs and improved load transfer when combined with bone graft placed in the device hub (13,14). No warnings or recall notifications are reported in the referenced Food and Drug Administration (FDA) 510(k) summary for the device (15).

Evidence-based surgical indications and patient selection

Drawing from the limitations reported with early distraction-only ISDs and from available data on interspinous/interlaminar fixation systems, the literature supports a set of potential indications in carefully selected patients. InSpan and similar fixation systems are generally described as adjuncts to direct decompression of the neural elements. Based on published studies and expert opinion, commonly proposed indications include:

Recurrent disc herniation after previous microdiscectomy with mild segmental instability or micromotion

Lumbar disc herniation and its surgical treatment inherently alter spinal biomechanics and may predispose to segmental instability. As reported in the literature, following discectomy, reherniation rates may be as high as 27%, reoperation rates up to 21%, and persistent symptoms up to 38%, depending on the degree of annular defect (16). The main risk factors for recurrent disc herniation—large annular defects and limited disc removal at the index surgery—both accelerate disc-height loss, a problem that can be mitigated by the InSpan system (13,14,17).

The benefits of combining an ISD with microdiscectomy—whether performed through open or endoscopic approaches—have been documented in the literature. In a prospective cohort study of 383 patients, the addition of an interspinous system resulted in hospital length of stay, complication rates, and VAS and ODI scores that were comparable to those of standalone discectomy, while achieving greater average disc height and a lower rate of reoperation due to instability compared with open or endoscopic discectomy alone (18). Other studies have supported these findings, reporting reduced pain medication use, faster return to work, and higher overall patient satisfaction in ISD-treated cohorts (19). Additional series comparing ISDs with posterior lumbar interbody fusion (PLIF) with pedicle screws in the setting of lumbar disc herniation have shown shorter hospital stays and lower in-hospital costs with ISDs, with no significant differences in complication, readmission, or reoperation rates (20).

Interlaminar fixation may be considered in selected patients undergoing microdiscectomy—whether traditional, tubular, or endoscopic—when there is concern for postoperative micromotion, recurrent symptoms, or progressive loss of disc height. Although these procedures are effective for symptom relief, they do not restore stability after partial removal of the intervertebral disc and are associated with progressive loss of disc height, a problem that is further accentuated in the setting of recurrent herniation (21). In this context, a posterior fixation strategy intended to promote osseous fusion (including ISDs such as InSpan) has been reported as one approach to address segmental instability-related pain and well as minimizing recurrent herniation risks in appropriately selected patients (6,8,9).

Single-level lumbar spinal stenosis at L4–L5 or L5–S1 with low-grade (Grade I) spondylolisthesis or minor instability, particularly in geriatric or high-risk patients who are unfit for full fusion

Pedicle screw fixation has long been the standard method for achieving lumbar stability and fusion. Nevertheless, in elderly patients with degenerative disease its efficacy is challenged by reduced bone mineral density, lower fusion rates, and higher complication profiles, with reported rates of screw loosening ranging from 10% to 60% and osteoporosis figures approaching the upper limit in single-level degenerative cases (22-24). Even when radiographic fusion is achieved, many patients continue to experience persistent low back pain, attributed to muscle denervation, scarring, and altered biomechanics of adjacent segments.

In contrast, interlaminar fixation devices such as InSpan can provide posterior stabilization without the need for pedicle instrumentation. By anchoring to the spinous processes and laminae, they may reduce the extent of muscle dissection and preserve posterior elements, with potential reductions in blood loss and operative time (9,10,14,25,26). Studies have demonstrated that, although

interlaminar fusion does not match the rotational rigidity of pedicle screws, it provides flexion-extension control that may be sufficient to facilitate interlaminar fusion in single-level degenerative pathology, with symptom relief comparable to PLIF as measured by VAS and ODI scores in appropriately selected patients, providing added benefits such as of shorter operative times, less estimated blood loss and less perioperative complications (22,27,28). Other reported benefits of an ISD strategy include comparable osseous fusion and a narrower increase in mobility of adjacent segments when compared with PLIF, which may translate to reduced rates of adjacent segment disease and reoperation (28).

Clinically, InSpan has been shown to achieve pain relief and functional improvement comparable to single-level pedicle screw fusion, with fewer perioperative complications, particularly in older adults (9,10,22). Studies analyzing fusion rates with ISDs have shown osseous fusion in 84% to 87% of patients undergoing single-level decompressive surgery with an interspinous implant, often including fusion across the facet joints, with only 0.7–5.4% demonstrating increased postoperative spinal instability (29,30). Furthermore, a meta-analysis on ISD use for degenerative lumbar disease that included six randomized controlled trials found that, compared with decompression alone, decompression plus an ISD resulted in better VAS back and leg pain scores as well, improved overall functional status and less reported treatment failures, further supporting the stabilizing role of these devices (31).

Recognizing the limitations of systems such as InSpan is equally important for appropriate patient selection and optimal outcomes. Candidates not suited for an ISD include those with instability greater than Grade II or >3 mm translation/>10° angulation, as well as patients with severe facet arthropathy, deformity, or osteoporosis with thin spinous processes (22,32). Caution is also warranted at L5–S1, where spinous morphology and biomechanical load increase risk of implant loosening (25,33).

Extreme lateral or foraminal herniations requiring decompression with preservation of foraminal height

Foraminal stenosis produces neurogenic pain in the affected nerve root, and surgical decompression has long been considered the gold-standard treatment. Beyond direct neural decompression, foraminal height itself has been recognized as an important determinant of symptom relief (1). The effect of ISDs on foraminal dimensions has been documented in multiple studies, which consistently show that implantation of an ISD increases foraminal area, height, and width without adversely affecting foraminal dimensions at adjacent levels (34). These biomechanical changes have been shown to persist in the upright position during both flexion and extension (35). In cases of isolated foraminal stenosis, ISDs have demonstrated promising clinical results, with reductions in VAS pain scores, improvements in ODI disability indices, and better SF-36 health-related quality-of-life scores (36).

In recent years, endoscopic lumbar decompression has revolutionized the management of spinal stenosis and herniated discs by providing direct neural decompression through tubular or full-endoscopic approaches. These techniques minimize muscle trauma, reduce hospital stay, and allow faster recovery compared with open surgery (37). For purely compressive pathologies without radiographic or clinical instability, endoscopy alone remains the gold standard because of its minimal invasiveness and excellent visualization (38).

However, in the context of foraminal stenosis, an interlaminar fixation adjunct may be considered when decompression requires partial facet resection or when there is concern for postoperative micromotion and progressive foraminal collapse. Following decompression—particularly when facet joint resection is required—dynamic loading may lead to micromotion, loss of foraminal height, or recurrent radicular pain, issues that decompression alone (open or endoscopic) may not address when instability is present. When used after decompression, an ISD/interlaminar fixation system such as InSpan can provide segmental stabilization and may help maintain foraminal height without the morbidity associated with pedicle screw instrumentation (9,10,25). In this setting, decompression and interlaminar fixation can be viewed as complementary components across the minimally invasive treatment spectrum rather than competing strategies.

Technical considerations and surgical pearls

Based on the surgical techniques employed in studies that have led to promising results, technical consideration that might yield good surgical outcomes can be identified. Direct decompression (laminectomy, flavectomy, or foraminotomy) should always be performed before implant insertion, and the implant size must be selected to restore foraminal height without causing over-distraction (9). Use at L5–S1 should be avoided unless the S1 spinous process is robust, and the

device should not be employed in multilevel disease or in the presence of gross instability (9,10). Placement of bone graft material between the laminae may enhance fusion success, and early postoperative mobilization is encouraged.

Discussion

The evolution of interspinous process technology mirrors the ongoing search for less invasive yet biomechanically stable options for lumbar degenerative disease. The early generation of distraction-type devices, such as the X-STOP and DIAM, aimed primarily to reduce lumbar extension and enlarge the spinal canal indirectly. While initial outcomes were satisfactory, the lack of rigid fixation and the reliance solely on posterior element integrity often resulted in micromotion, subsidence, or device migration, leading to loss of correction and high revision rates (2-4,6-8). The ensuing skepticism caused many surgeons to abandon these devices and return to traditional decompression or fusion procedures. Recently, interspinous fixation and fusion techniques have been utilized for many years in conjunction with direct decompression, including microscopic, endoscopic, unilateral-approach and bilateral decompression strategies, using multiple devices with interspinous and interlaminar constructs. In this context, interlaminar fixation systems represent an evolution of established posterior fixation concepts rather than a new principle. Instead of serving merely as a spacer, the InSpan device acts as a posterior stabilization and fusion platform positioned flush against the lamina, which allows for the placement of bone graft material to support biological fusion (9,10,14,25,39,40). These design refinements may improve mechanical stability and broaden the potential clinical indications for selected patients. Biomechanical testing has demonstrated increased stiffness in flexion-extension and comparable stiffness in lateral bending relative to dynamic interspinous spacers (10,39). Although its rotational stability remains lower than that achieved with pedicle screw constructs, the balance between stabilization and a less extensive posterior approach may make it an option for cases of mild instability or revision after prior discectomy. Clinically, prospective series have reported durable results at up to 5 years with low reoperation rates when used after appropriate decompression (9,10,25). Nevertheless, the evidence base is still limited. Most available studies are single-center or retrospective with relatively small cohorts, and there are no large randomized controlled trials directly comparing InSpan with pedicle screw fixation or minimally invasive decompression alone. Additionally, cost-effectiveness analyses and long-term evaluations beyond 5 years are lacking. Therefore, while reported outcomes are encouraging, adoption should remain cautious and data driven.

From a practical standpoint, InSpan may occupy a therapeutic niche for selected patients by providing posterior stabilization without pedicle-based instrumentation. This option may be relevant for elderly or medically fragile patients, those with low-grade spondylolisthesis, or recurrent disc herniation after prior decompression. It may also be considered in cases of foraminal or extraforaminal pathology where maintaining foraminal height is important to reduce the risk of recurrent nerve root compression. However, in patients with gross instability (Grade II or higher), deformity, or multi-level disease, pedicle screw fixation remains the gold standard (22,33). When compared with endoscopic decompression, interlaminar fixation should be viewed as complementary rather than competitive: endoscopic or minimally invasive decompression addresses neural compression, whereas fixation may be considered when there is concern for postoperative motion or collapse. Both modalities can therefore coexist within a minimally invasive algorithm—decompression alone for purely compressive disease and decompression plus interlaminar fixation for selected cases where stabilization is desired (9,10,14,25).

Future research should focus on multicenter randomized comparisons between InSpan-assisted fusion, minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF), and endoscopic decompression alone. Such studies would clarify the cost-benefit ratio, ideal indications, and long-term radiological fusion rates. Additionally, biomechanical studies investigating hybrid constructs that combine interlaminar fixation with cortical screw or facet stabilization could further refine surgical strategies for early degenerative instability.

Conclusions

Interlaminar fixation devices such as InSpan may fill a therapeutic niche between decompression alone and pedicle-screw fusion for carefully selected patients with degenerative lumbar disease. Available biomechanical and clinical data suggest that, when combined with adequate decompression, InSpan can provide flexion-extension stability, promote interlaminar fusion, and improve pain and disability with lower surgical morbidity in single-level

pathology. The most suitable candidates are patients with recurrent disc herniation, low-grade spondylolisthesis or minor instability, and foraminal or far-lateral stenosis in whom preservation or restoration of foraminal height is important and pedicle-based constructs are undesirable or high risk. In contrast, severe instability, deformity, and multilevel disease remain better treated with conventional fusion. Further prospective, comparative, and long-term studies are required to refine patient selection, confirm durability of outcomes, and clarify cost-effectiveness of interlaminar fixation strategies.

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Footnote

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-2025-1-232/rc

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Supplementary

Table S1 Example detailed search strategy (PubMed/MEDLINE)

Step	Search query (PubMed syntax)	Limits/filters	Records retrieved (n)
1	("interspinous device"[Title/Abstract] OR "interlaminar fixation"[Title/Abstract] OR "interlaminar stabilization"[Title/Abstract] OR "interspinous process device"[Title/Abstract] OR InSpan[Title/Abstract])	None	–
2	("lumbar spinal stenosis"[Title/Abstract] OR "Spinal Stenosis"[MeSH Terms] OR spondylolisthesis[Title/Abstract] OR "Spondylolisthesis"[MeSH Terms] OR "disc herniation"[Title/Abstract] OR "Intervertebral Disc Displacement"[MeSH Terms])	None	–
3	(lumbar[Title/Abstract] OR "Lumbar Vertebrae"[MeSH Terms])	None	–
4	#1 AND #2 AND #3	None	–
5	#4	Humans; English; publication date: database inception to 30 Nov 2025 (pdat)	–

Database platform: PubMed (National Library of Medicine). Search conducted through November 2025 (last searched: November 2025). The above search string is provided as an example of the detailed search strategy for one database, as requested by the editor. Additional references were identified by screening bibliographies of key articles and device-specific publications. During screening, priority was given to prospective studies, randomized controlled trials, biomechanical investigations, and clinical series with ≥2-year follow-up (as described in the Methods).

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