SEMI-DYNAMIC STABILIZATION VERSUS POSTERIOR INTERLUMINAR SILICONE DEVICE FOR SINGLE-LEVEL DEGENERATIVE LUMBAR DISEASE: A RETROSPECTIVE COMPARATIVE COHORT FROM VIETNAM

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ABSTRACT

Introduction: Dynamic stabilization is a surgical option for degenerative lumbar disease with instability or a risk of postoperative instability. In Vietnam, the semi-dynamic B-Dyn device and the interluminar silicone Intraspine® device are commonly used, yet head-to-head data are scarce. This study aims to compare clinical outcomes, segmental mobility, and complications between B-Dyn and Intraspine® in single-level degenerative lumbar disease. **Materials and Methods:** We retrospectively reviewed patients with single-level lumbar disc herniation and/or lumbar spinal stenosis with segmental instability or a risk of postoperative instability who underwent surgery from January 2018 to December 2021. Outcomes included the Visual Analog Scale (VAS) for low back and radicular pain (preoperative and last follow-up), the Oswestry Disability Index (ODI) (preoperative and last follow-up), and segmental range of motion at the treated level (preoperative and last follow-up). Segmental range of motion (ROM) was measured on dynamic flexion–extension lateral radiographs as the change in the intervertebral angle at the treated level. Complications and reoperations were extracted from medical records. **Results:** Twenty-eight patients received B-Dyn and 30 received Intraspine®; age was similar (42.68±9.01 vs 43.93±9.02 years; p=0.598). Both groups showed marked pain reduction by the last follow-up. Low back pain improvement was greater with B-Dyn (5.25±1.08) than with Intraspine® (4.37±1.54; p=0.014), while radicular pain improvement was comparable (5.89±0.96 vs 5.43±2.16; p=0.296). ODI improved in both groups and tended to be higher with B-Dyn (61.57±17.09) than with Intraspine® (52.80±24.92; p=0.122). Segmental ROM changed from 3.50±1.91 to 3.14±1.53 with B-Dyn and from 3.20±1.92 to 3.03±1.96 with Intraspine®. Intraspine® had two infections and two recurrent disc herniations requiring reoperation; no complications occurred with B-Dyn. **Conclusion:** Both devices provided substantial postoperative improvement. B-Dyn achieved greater low back pain improvement, while functional recovery was similar; complications and reoperations occurred only with Intraspine®.

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I. INTRODUCTION

Degenerative lumbar disease, particularly lumbar disc herniation and lumbar spinal stenosis, is a common cause of persistent low back pain, radicular symptoms, and functional limitation in adult patients. When conservative treatment fails, surgical intervention is often required to achieve neural decompression and improve quality of life. However, in patients with segmental instability or those at risk of postoperative instability after decompression, the choice of surgical strategy remains challenging. In routine spine practice, the surgeon is not only expected to relieve symptoms, but also to maintain mechanical stability and preserve as much physiological motion as possible (1).

Lumbar fusion has traditionally been used to address instability, but this approach is associated with the loss of motion at the treated segment and may increase biomechanical stress at adjacent levels. Over time, this may contribute to adjacent segment degeneration or adjacent segment disease, which remains a major concern after rigid fixation (2)(3). For this reason, motion-preserving techniques have attracted increasing interest as a potential alternative in selected patients with degenerative lumbar disorders.

Among these techniques, pedicle or rod-based dynamic stabilization systems were developed to control abnormal motion without completely abolishing segmental mobility. Recent evidence suggests that dynamic stabilization may provide satisfactory medium- and long-term clinical and radiological outcomes, while potentially preserving more physiological biomechanics than fusion in carefully selected cases (4). Interspinous devices represent another motion-preserving option and offer a less invasive posterior approach. Nevertheless, their safety and effectiveness remain controversial, as recent systematic review

evidence has shown that the clinical benefit of interspinous implants is not always consistent and that complication or reoperation rates may still be of concern (5).

In our clinical setting, both the B-Dyn semi-dynamic stabilization system and the Intraspine® posterior interspinous silicone implant have been used in patients with single-level degenerative lumbar disease associated with instability or a risk of postoperative instability. However, direct comparative data between these two motion-preserving strategies remain limited. Therefore, the present study aimed to compare clinical outcomes, segmental range of motion, and complications between B-Dyn and Intraspine® in the surgical treatment of single-level degenerative lumbar disease.

II. MATERIALS AND METHODS

2.1. Study design and setting

This study was designed as a retrospective comparative cohort study conducted at 108 Military Central Hospital, Hanoi, Vietnam. We reviewed consecutive patients with single-level degenerative lumbar disease who underwent decompression and motion-preserving stabilization between January 2018 and December 2021. The objective was to compare clinical outcomes, segmental mobility, and complications between semi-dynamic Rod-based stabilization using the B-Dyn system and posterior interluminar silicone implantation using the Intraspine® device.

2.2. Patient selection

Eligible patients were adults with single-level lumbar degenerative disease, including lumbar disc herniation and/or lumbar spinal stenosis, associated with segmental instability or considered at risk of postoperative instability after decompression. All included patients were treated surgically with posterior decompression followed by either B-Dyn semi-dynamic stabilization or Intraspine® interspinous silicone implantation.

Patients were excluded if they had multilevel lumbar disease, prior lumbar instrumentation at the index level, or incomplete clinical or radiographic follow-up data that prevented comparison of outcomes between the two treatment groups. A total of 58 patients met the study criteria, including 28 in the B-Dyn group and 30 in the Intraspine® group. The two groups were comparable in baseline age and sex distribution, while follow-up duration was longer in the Intraspine® group.

2.3. Surgical procedures

All patients underwent posterior decompression at the symptomatic lumbar level. The stabilization method was selected according to the segmental pathology, radiographic characteristics, and surgeon judgment at the time of surgery.

In the B-Dyn group, decompression was followed by implantation of a rod-based semi-dynamic stabilization system designed to limit excessive motion while preserving controlled movement at the treated segment. In the Intraspine® group, a posterior interspinous silicone implant was inserted after decompression to provide posterior support and reduce abnormal extension-related loading.

2.4. Outcome measures

Clinical and radiographic outcomes were collected from the medical records and follow-up documentation. The primary clinical variables were low back pain intensity, radicular pain intensity, and functional disability. Pain was assessed using the VAS for low back pain and radicular pain at three time points: preoperatively, early postoperatively, and at the last follow-up. Functional status was assessed using the ODI, and the final available postoperative ODI value was used for comparison with the preoperative score to calculate functional improvement.

Radiographic assessment focused on ROM at the treated level. ROM was measured on dynamic flexion–extension lateral radiographs as the change in the intervertebral angle at the operated segment. Measurements were recorded preoperatively and at the last follow-up.

For comparative analysis, the following derived variables were calculated for each patient: improvement in VAS low back pain, improvement in VAS radicular pain, and improvement in ODI, defined as the difference between the preoperative value and the final follow-up value. Follow-up duration was recorded in months from surgery to the last clinical assessment. This framework matches the Results section, which reports baseline characteristics, clinical improvement, preserved ROM, and complication/reoperation outcomes.

2.5. Complications and reoperations

Complications were identified through review of inpatient charts, follow-up records, and reoperation history. The analysis specifically recorded postoperative infection, recurrent disc herniation, and any event requiring reoperation. Complications were summarized descriptively for each treatment group. In the present cohort, complications and reoperations were observed only in the Intraspine® group.

2.6. Ethics

The study was approved by the Institutional Ethics Committee of 108 Military Central Hospital. Because of the retrospective design and the use of anonymized existing clinical data, the requirement for informed consent was waived. The study was conducted in accordance with the Declaration of Helsinki.

2.7. Statistical analysis

Statistical analysis was performed to compare baseline characteristics, clinical improvement, radiographic outcomes, and complications between the B-Dyn and Intraspine® groups. Continuous variables were summarized as mean ± standard deviation when approximately normally distributed, and as median with interquartile range (IQR) when distribution was skewed. Categorical variables were presented as counts and percentages.

Between-group comparisons of continuous variables were performed using the independent-samples t-test when assumptions of normality and variance homogeneity were acceptable; Welch's t-test was used when variances were unequal. For non-normally distributed continuous variables, the Mann–Whitney U test was applied. Categorical variables, including sex distribution and complications, were compared using the chi-square test or Fisher's exact test as appropriate. A two-sided p-value < 0.05 was considered statistically significant. This analytic approach is consistent with the current Results section, which reports p-values for age, sex, follow-up duration, and between-group differences in clinical improvement.

III. RESULTS

3.1. Patient characteristics

A total of 58 patients with single-level degenerative lumbar disease were included in the study, including 28 patients in the B-Dyn group and 30 patients in the Intraspine® group. The mean age was similar between groups (42.68 ± 9.01 years in the B-Dyn group vs 43.93 ± 9.02 years in the Intraspine® group; p = 0.598). Sex distribution was also comparable, with 16 males (57.1%) and 12 females (42.9%) in the B-Dyn group, compared with 18 males (60.0%) and 12 females (40.0%) in the Intraspine® group (p = 0.83). The duration of follow-up was longer in the Intraspine® group than in the B-Dyn group. Mean follow-up time was 54.8 ± 5.5 months in the B-Dyn group and 64.2 ± 18.6 months in the Intraspine® group. Median follow-up was 55.5 months (IQR 50.8–58.3) for B-Dyn and 67.0 months (IQR 60.0–75.5) for Intraspine®. This difference was statistically significant. Overall, the two groups were comparable in baseline demographic characteristics, while follow-up duration was significantly longer in the Intraspine® group (Table 1).

Table 1. Baseline characteristics of the study groups

Variable	B-Dyn group (n = 28)	Intraspine® group (n = 30)	p-value
Age (years), mean ± SD	42.68 ± 9.01	43.93 ± 9.02	0.598
Male, n (%)	16 (57.1)	18 (60.0)	0.830
Female, n (%)	12 (42.9)	12 (40.0)	0.830
Follow-up duration (months), mean ± SD	54.8 ± 5.5	64.2 ± 18.6	0.012*
Follow-up duration (months), median (IQR)	55.5 (50.8–58.3)	67.0 (60.0–75.5)	<0.001**
** Welch's t-test; ** Mann–Whitney U test*			

3.2. Clinical outcomes

Table 2 indicated that both groups showed marked postoperative improvement in pain and disability at the last follow-up. Improvement in low back pain was significantly greater in the B-Dyn group than in the Intraspine® group (5.25 ± 1.08 vs 4.37 ± 1.54, $p = 0.014$). Improvement in radicular pain was also observed in both groups, but the between-group difference was not statistically significant (5.89 ± 0.96 vs 5.43 ± 2.16, $p = 0.296$). Similarly, ODI improved in both

groups, with a numerically greater improvement in the B-Dyn group (61.57 ± 17.09 vs 52.80 ± 24.92), although this difference did not reach statistical significance (p = 0.122).

Table 2. Comparison of clinical improvement between the two groups

Outcome	B-Dyn Group	Intraspine® Gourp	*p*-value
Improvement in VAS low back pain	5.25 ± 1.08	4.37 ± 1.54	0.014
Improvement in VAS radicular pain	5.89 ± 0.96	5.43 ± 2.16	0.296
Improvement in ODI	61.57 ± 17.09	52.80 ± 24.92	0.122
Data are presented as mean ± standard deviation.			

3.3. Radiological outcomes

Segmental range of motion (ROM) at the treated level was largely preserved in both groups at the last follow-up. In the B-Dyn group, mean ROM changed from 3.50 ± 1.91 preoperatively to 3.14 ± 1.53 at the final follow-up. In the Intraspine® group, mean ROM changed from 3.20 ± 1.92 to 3.03 ± 1.96 over the same period (Table 3). These findings suggest that both motion-preserving strategies maintained residual segmental mobility after surgery.

Table 3. Segmental range of motion at the treated level

Segmental ROM (degrees)	B-Dyn Group	Intraspine® Group
Preoperative	3.50 ± 1.91	3.20 ± 1.92
Final follow-up	3.14 ± 1.53	3.03 ± 1.96
Data are presented as mean ± standard deviation.		

3.4. Complications and reoperations

Complications were observed only in the Intraspine® group (Table 4). Two patients developed postoperative infection, and two patients experienced recurrent disc herniation requiring reoperation. No complications or reoperations were recorded in the B-Dyn group during the follow-up period.

Table 4. Complications and reoperations

Variable	B-Dyn Group (n = 28)	Intraspine® Group (n = 30)
Postoperative infection	0	2
Recurrent disc herniation	0	2
Reoperation	0	4

IV. DISCUSSION

In the present study, both B-Dyn and Intraspine® were associated with meaningful postoperative improvement in patients with single-level degenerative lumbar disease. Low back pain, radicular pain, and disability improved in both groups, while segmental motion was largely preserved at final follow-up. However, B-Dyn was associated with greater improvement in low back pain, and all recorded complications and reoperations occurred in the Intraspine® group. From a clinical perspective, these findings suggest that although both motion-preserving strategies may offer symptomatic benefit after decompression, rod-based semi-dynamic stabilization may provide a more reliable balance between mechanical control and preservation of motion in appropriately selected patients.

This interpretation is consistent with the broader surgical literature on degenerative lumbar disease. Lumbar stenosis and disc degeneration often present with a mixture of axial pain, radicular symptoms, and functional disability, and decompression remains the essential step when neural compression is present. Yet decompression alone may be insufficient in patients with pre-existing segmental instability or in those at risk of postoperative instability. In such cases, the rationale for dynamic stabilization is attractive: to avoid the rigidity and biomechanical trade-offs of fusion while still controlling pathological motion. At the same time, the long-standing concern with rigid fusion has been the development of increased stress at adjacent levels, which may contribute to adjacent segment degeneration or symptomatic adjacent segment disease over time (6).

One of the most important findings of our study is the significantly greater improvement in low back pain in the B-Dyn group. This difference is biologically plausible. Rod-based semi-dynamic systems provide fixation through the pedicle screws and posterior rods, allowing better control of multidirectional motion, including translational and rotational components that may contribute to mechanical back pain. By contrast, interspinous devices mainly act through the posterior column and primarily restrict extension; they may therefore be less effective in controlling more complex instability patterns. This distinction has also been reflected in the

literature on dynamic systems. In a multicenter randomized controlled trial, Meyer and colleagues reported that pedicle-based dynamic stabilization achieved clinical outcomes comparable to fusion while reducing surgical complexity, operative duration, and blood loss. Similarly, Zhou et al. reported that Dynesys dynamic stabilization yielded medium- and long-term clinical and radiographic outcomes comparable to fusion in degenerative lumbar disease (7).

The relatively similar improvement in radicular pain between groups in our study is also understandable from a pathophysiological standpoint. Radicular pain is primarily driven by neural compression, and both groups underwent decompression at the symptomatic level. Once adequate decompression has been achieved, the additional stabilizing implant may have less influence on leg pain than on axial back pain. The same logic may explain why ODI improved substantially in both groups but did not differ significantly between them. In other words, both implants may support functional recovery after decompression, but the rod-based construct may provide a clearer advantage in controlling the mechanical component of low back pain.

Another key issue in our cohort was safety. All complications and reoperations occurred in the Intraspine® group. Although our sample size is modest and caution is necessary when interpreting complication data, this pattern is difficult to ignore and is broadly consistent with published concerns regarding interspinous devices. In the 2024 systematic review and meta-analysis by Han et al., interspinous process devices showed no superiority over decompression surgery for pain or ODI improvement, and reoperation rates were significantly worse for the interspinous-device group (5). Likewise, the 5-year randomized trial by Schenck et al. showed that interspinous devices did not clearly outperform conventional decompression in long-term clinical recovery, despite their motion-preserving intent (8). More recently, Cebulla et al. reported that additional dorsal interspinous stabilization after decompression for degenerative lumbar spinal stenosis provided no clinical advantage and did not stabilize sagittal alignment (9). Taken together, these studies suggest that the theoretical appeal of interspinous implants does not necessarily translate into more dependable real-world performance.

The finding that segmental ROM was preserved in both groups is still clinically relevant. Motion preservation remains one of the central arguments for using non-fusion technologies, especially in younger or middle-aged patients with single-level disease. However, preserved ROM alone should not be considered sufficient evidence of success. The implant must also provide durable symptom relief and acceptable safety. This point is important because not all motion-preserving constructs behave the same way. Guan et al., in a 2023 systematic review of semi-rigid stabilization devices, noted that semi-rigid constructs may offer effective stabilization and motion preservation, but the evidence remains heterogeneous and not yet strong enough to claim superiority over rigid instrumentation (10). In parallel, more recent literature on dynamic stabilization also reminds us that unintended fusion, construct-related failure, and adjacent segment problems can still occur, meaning that dynamic systems reduce but do not eliminate the biomechanical challenges of lumbar surgery (11).

Our results should also be viewed in the context of contemporary evidence comparing surgical strategies for degenerative lumbar stenosis more broadly. A 2024 network meta-analysis by Chen et al. highlighted that multiple surgical options exist and that no single procedure is uniformly superior across all clinical contexts; effectiveness and safety remain highly dependent on indication, anatomy, and patient selection. This is particularly relevant to the present study. The practical question is not whether one technology is universally "better," but whether one construct is more suitable for a specific mechanical problem. Based on our data, B-Dyn appears to be the more dependable option when the goal is to combine decompression with motion-preserving stabilization in single-level disease with instability or risk of instability (12).

Several limitations should be acknowledged. First, this was a retrospective study with a relatively small sample size, which limits statistical power and increases susceptibility to selection bias. Second, implant selection was not randomized and may have been influenced by surgeon preference and case-specific anatomical

considerations. Third, the follow-up variables available in our dataset were focused on pain, ODI, ROM, and complications, without broader health-related quality-of-life instruments. Finally, our findings apply only to single-level degenerative lumbar disease and should not be generalized directly to multilevel degeneration, deformity, or revision settings. Even so, the study addresses a clinically relevant question for which direct head-to-head data remain limited.

V. CONCLUSIONS

In conclusion, both B-Dyn and Intraspine® provided postoperative clinical improvement while preserving residual segmental motion. However, the greater reduction in low back pain and the absence of recorded complications in the B-Dyn group suggest that pedicle-based semi-dynamic stabilization may offer a more reliable motion-preserving solution than posterior interspinous silicone implantation in selected patients with single-level degenerative lumbar disease. Future prospective comparative studies with larger cohorts and longer follow-up will be needed to determine whether this short- to mid-term advantage translates into better long-term durability and lower revision rates.

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