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Dynamic Stabilization of the Lumbar Spine using the Dynesys® System

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ABSTRACT

AIM: To present the clinical results in patients with minor instability with "Dynesys®" a soft spinal stabilization system.

MATERIAL and METHODS: A total of 83 patients were operated upon and the Dynesys® system was applied. Indications for surgery included painful degenerative disc disease, degenerative spondylolisthesis and lumbar canal stenosis.

RESULTS: The results for the Dynesys® system were satisfactory, and we have calculated the overall complication rate to be 20.4% (n=17), which is in agreement with the literature.

CONCLUSION: The Dynesys® dynamic stabilization system effectively protects lumbar motion and achieves lumbar stability in patients with lumbar spinal problems. Our clinical result support literature that Dynesys® system is a strong alternative to fusion and instrumentation system in patient with chronic instabilities.

KEYWORDS: Dynamic stabilization, Degenerative disc disease, Lumbar stenosis, Degenerative spondylolisthesis

INTRODUCTION

Posterolateral fixation with pedicle screws and rods has become the prominent intervention for the surgical treatment of spinal disorders such as spinal instability, degenerative disorders, vertebral fractures, malignancy, deformities and infections (2,3,6,27). One of the most important drawbacks of solid fixation and fusion is the decreased range of motion in the fused levels. In addition, adjacent segment degeneration (ASD) is another important postoperative complication (16,20). The dynamic neutralization system (Dynesys®, Zimmer CH) was designed as an alternative to spinal solid fixation in an effort to reduce ASD and maintain physiologic motion and function in select cases (15,16,22,26).

In this study, we present the clinical outcomes and complications of 83 patients who underwent surgery with the Dynesys® dynamic stabilization system (Zimmer Inc, Warsaw, IN, USA) and review the associated literature.

MATERIAL and METHODS

We retrospectively reviewed the cases of 83 patients with various spinal disorders who underwent surgery with the Dynesys® dynamic stabilization system between 2011 and 2016. Painful degenerative disc disease, degenerative spondylolisthesis and lumbar canal stenosis were indications for surgery. Radiologic and clinical follow-ups were documented separately. Patient demographic data, radiologic examinations and patient case notes were reviewed. The visual analog scale for leg pain (VAS-LP) and back pain (VAS-BP) and ODI were used to assess the pain levels and disability of the patients.

All patients received general anesthesia and were in the prone position for operations. The Dynesys® system was implanted either through a Wiltse approach or a midline incision. Prophylactic Cefuroxime was administered to all patients upon initiation of anesthesia and was continued during the following 48 hours. Patients were mobilized on the first

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postoperative day and discharged after 4 to 5 days. Clinical and radiological follow-ups were recorded at 6, 12 and 24 months after surgery. Imaging of an applied Dynesys® system is presented in Figure 1A-C.

RESULTS

The Dynesys® dynamic system was implanted in 83 consecutive patients between 2011 and 2016. There were 52 female patients and 31 male patients. The mean age was 52.5 (range between 21 and 85). Twenty-one patients underwent surgery due to instability and 45 patients were operated on due to discopathy. Seventeen patients had previous spine surgery. A total of 484 screws, 7 mm in diameter, were implanted. Mean clinical follow-up was 46 months (range between 32 and 90 months). Demographic data of patients are presented in Table I.

Table I: Demographic Data of Patients

Number of Patients	83	
Sex Ratio (women/men)	50/33	
Age at Operation	50.2 (21-85)	
Total Clinical Follow-up	46 months (32-90 months)	
Indications	Discopathy	45
	Instability	21
	Previous Surgery	17
Number of Segments	1	55
	2	10
	3	8
	4	2
	5+	8
Total Screws	484	

In our series, a significant clinical improvement was observed after surgery. Preoperative visual analog scales for back pain (VAS-BP) and leg pain (VAS-LP) were 7.6 ± 0.84 and 7.7 ± 0.85, respectively. VAS-BP was 2.5 ± 0.44 at the 6-month follow-up, 1.5 ± 0.32 at the 1-year follow-up and 1.5 ± 0.28 at 2-year follow-up. VAS-LP was 2.3 ± 0.42 at the 6-month follow-up, 1.5 ± 0.34 at the 1-year follow-up and 0.8 ± 0.22 at 2-year follow-up (Table II). Meanwhile, the ODI scores improved significantly after surgery at 24-month post-operation when compared to pre-operation. Preoperative ODI scores were 23.4 ± 9.9 before surgery. Six-month, 1-year and 2-year after surgery, ODI scores were 4.2 ± 2.2, 3.3 ± 1.2 and 2.9 ± 0.9, respectively (Table II).

No reoperations were required in the postoperative period due to screw malposition. Our screw-loosening rate was 6% (n=5) and breakage rate was 3.6% (n=3). We also found ASD in 4.8% of patients (n=4). No reoperations were required due to ASD. In this study, the infection rate was 5.9% (n=5). All the patients who had postoperative infections had instrumentation of five levels or more. The infection rate was 0% (n=75) in cases involving four or fewer segments. The reoperation rate was 8.4% (n=7). Three patients underwent reoperation due to screw breakage and four due to operation site infection. In our study, the overall complication rate was 20.4% (n=17).

Table II: VAS and ODI Scores of the Patients

	Preoperative	Postoperative 6 Months	Postoperative 12 Months	Postoperative 24 Months
VAS-BP	7.6 ± 0.84	2.5 ± 0.44	1.5 ± 0.32	1.5 ± 0.28
VAS-LP	7.6 ± 0.84	2.3 ± 0.42	1.5 ± 0.34	0.8 ± 0.22
ODI	23.4 ± 9.9	4.2 ± 2.2	3.3 ± 1.2	2.9 ± 0.9

VAS: *Visual analogue scale,* ***ODI:*** *Oswestry disability index,* ***BP:*** *Back pain,* ***LP:*** *Leg pain.*

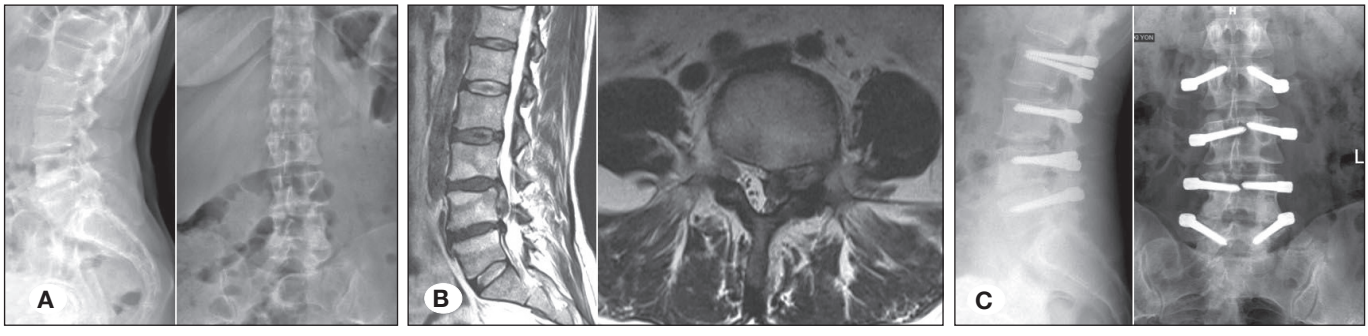

Figure 1: 46-year-old female was admitted to our clinic with complaints of back and left leg pain. X-rays reveal apparent calcification at the L3-4 and L4-5 levels **(A)**. MR scans reveal a large L4-5 disc herniation with Modic degeneration on both levels **(B)**. Dynamic stabilization was performed on these levels **(C)**.

DISCUSSION

Dynamic stabilization systems (DSS) have been developed to permit restricted motion across a functional spinal unit. Additionally, the theory behind DSS is to reduce loading of the facet joints and to preserve the operated segment kinematics. Dubois et al. were the first to present the Dynesys® dynamic stabilization system (8,11). The Dynesys® Spinal System (Zimmer Spine, Minneapolis, MN, USA) is a dynamic transpedicular screw-based fixation system with elastic interconnection parts; it involves restoration of the biomechanics of the posterior annulus and facet joints, thus allowing for the reconstitution of the natural balance between the posterior muscular structures and the intervertebral disc (24). It was shown that progression of minor deformities secondary to spinal stenosis with degenerative scoliosis, and early degenerative spondylolisthesis could be treated with the Dynesys® system (28). Surgeons typically use the Dynesys® system as a single level implant; however, up to 4 segments can be treated (23,29). In our study, 10 patients underwent stabilization of 4 or more segments with Dynesys®.

The mobility of instrumented segments after DSS plays an important role in improving the quality of life (12,14,22,25,28). In this study, the majority of patients were satisfied with the results of the surgery. The patients were mobilized on the first postoperative day and discharged within 4 to 5 days. Moreover, patients displayed significant improvement in VAS and ODI score at 6-month, 1- and 2-year follow-ups.

Despite the advantages of the Dynesys® system, reoperation may be necessary due to several complications. An overall complication rate of 0% to 24% with the Dynesys® system has been reported (22,23,29). Our overall complication rate was comparable at 20.4% (n=17). The most common complications were screw breakage and loosening (21). Pham et al. recently presented a comprehensive review. They reported the overall screw loosening rate as 11.6% and breakage rate as 1.6% (21). In our study, loosening and screw breakage rates were as low as 6% and 3.6%, respectively. These rates suggest that the Dynesys® system minimizes the incidence of screw breakage by offering more flexibility than solid fixation. Reported reoperation rates secondary to complications range from 4.8% to 19% (12,21,28,29). Our reoperation rate was comparable at 8.4% (n=7).

One of the major complications associated with implant systems is postoperative surgical site infection. Post-operative infection cause chronic back pain, increased deformity, prolonged hospital stays, and higher hospital costs (4,7,13,18). Compared to the majority of posterior arthrodesis procedures, those involving Dynesys® frequently have a lower postoperative infection rate for the system is less invasive (5,21,22,28). Pham et al. reported an overall infection rate of 4.6% (21). Our overall surgical site infection rate was slightly higher at 5.9% (n=5). All of the five patients who developed postoperative infections had undergone five or more levels instrumentation. Lutz et al. reported a high rate of infection (22%) in patients with the Dynesys® system in the long-term follow-up period; however, they did not find any correlation between the operated level and infection rate in their Dynesys® series as we did in our study (17).

In our series, the infection rate was 0% (75 of 83 patients) in short levels (4 or less), whereas patients with long levels of instrumentation (5 or more) had a high infection rate of 62.5% (5 of 8 patients) (1).

It is assertive to suggest that dynamic systems, including Dynesys®, preserve spinal motion and create a suitable environment for spine physiology. We have previously reported that motion similar to that of a normal spine can be achieved when dynamic rods are used together with dynamic screws (9,19). In the literature, there are many clinical and experimental reports showing that the Dynesys® system is very effective for stabilizing the impaired motion segment in patients who have one or two affected lumbar segments. Complications typically occur when the system is used in three or more unstable segments. Preserving the motion and stabilizing the spine are the main objectives in dynamic systems; however, we cannot obtain these results in all patients. In patients with severely damaged stability, fusion risk after dynamic stabilization is higher than in patients with moderately damaged stability. In our own published experience, we found that if a dynamic system is used in cases of advanced degenerative disc disease, the degenerated disc proceeds to fusion under the control of the dynamic system, but rehydration has improved in patients with a less degenerate disc disease (30-32).

With a review of our previous clinical results along with the literature data, for select cases, the Dynesys® system can be claimed to be superior to fusion. First, it is a simple and easy system for surgeons to apply compared to fusion procedures. Second, in the cases of suboptimal results or complications with Dynesys®, it is possible to change the system and perform a fusion. On the contrary, once a fusion operation is performed, the result is permanent, and cannot be converted to a dynamic system. This is one of the most important advantages of all dynamic stabilization systems.

It should be noted that our study had some limitations. First, our study is retrospective with inherent design limitations. Second, our study had no control group, such as patients who underwent surgery with a different rigid or dynamic instrumentation system. We are therefore planning additional studies that aim to include control groups and larger patient numbers.

CONCLUSION

The Dynesys® dynamic stabilization system is effective in preserving lumbar motion and achieving lumbar stability in patients who have lumbar spinal problems. Moreover, motion preservation also reduces the risks of pseudoarthrosis and adjacent segment disease, which are unfortunately not rare after fusion surgery. Lumbar stabilization without fusion is particularly effective in cases involving up to two unstable segments.

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