

# Short term outcome of posterior dynamic stabilization system in degenerative lumbar diseases

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## ABSTRACT

**Background:** Decompression and fusion is considered as the 'gold standard' for the treatment of degenerative lumbar diseases, however, many disadvantages have been reported in several studies, recently like donor site pain, pseudoarthrosis, nonunion, screw loosening, instrumentation failure, infection, adjacent segment disease (ASDis) and degeneration. Dynamic neutralization system (Dynesys) avoids many of these disadvantages. This system is made up of pedicle screws, polyethylene terephthalate cords, and polycarbonate urethane spacers to stabilize the functional spinal unit and preserve the adjacent motion after surgeries. This was a retrospective cohort study to compare the effect of Dynesys for treating degenerative lumbar diseases with posterior lumbar interbody fusion (PLIF) based on short term followup.

**Materials and Methods:** Seventy five consecutive patients of lumbar degenerative disease operated between October 2010 and November 2012 were studied with a minimum followup of 2 years. Patients were divided into two groups according to the different surgeries. 30 patients underwent decompression and implantation of Dynesys in two levels ( $n = 29$ ) or three levels ( $n = 1$ ) and 45 patients underwent PLIF in two levels ( $n = 39$ ) or three levels ( $n = 6$ ). Clinical and radiographic outcomes between two groups were reviewed.

**Results:** Thirty patients (male:17, female:13) with a mean age of  $55.96 \pm 7.68$  years were included in Dynesys group and the PLIF group included 45 patients (male:21, female:24) with a mean age of  $54.69 \pm 3.26$  years. The average followup in Dynesys group and PLIF group was  $2.22 \pm 0.43$  year (range 2-3.5 year) and  $2.17 \pm 0.76$  year (range 2-3 year), respectively. Dynesys group showed a shorter operation time ( $141.06 \pm 11.36$  min vs.  $176.98 \pm 6.72$  min,  $P < 0.001$ ) and less intraoperative blood loss ( $386.76 \pm 19.44$  ml vs.  $430.11 \pm 24.72$  ml,  $P < 0.001$ ). For Dynesys group, visual analogue scale (VAS) for back and leg pain improved from  $6.87 \pm 0.80$  to  $2.92 \pm 0.18$  and  $6.99 \pm 0.81$  to  $3.25 \pm 0.37$ , (both  $P < 0.001$ ) and for PLIF, VAS for back and leg pain also improved significantly ( $6.97 \pm 0.84$ – $3.19 \pm 0.19$  and  $7.26 \pm 0.76$ – $3.56 \pm 0.38$ , both  $P < 0.001$ ). Significant improvement was found at final followup in both groups in Oswestry disability index (ODI) score (both  $P < 0.001$ ). Besides, Dynesys group showed a greater improvement in ODI and VAS back and leg pain scores compared with the PLIF group ( $P < 0.001$ ,  $P = 0.009$  and  $P = 0.031$ , respectively). For radiological, height of the operated level was found increased in both groups (both  $P < 0.001$ ), but there was no difference between two groups ( $P = 0.93$ ). For range of motion (ROM) of operated level, significant decrease was found in both groups ( $P < 0.001$ ), but Dynesys showed a higher preservation of motion at the operative levels ( $P < 0.001$ ). However, no significant difference was found in the percentage change of ROM of adjacent levels between Dynesys and PLIF ( $0.74 \pm 8.92\%$  vs.  $0.92 \pm 4.52\%$ ,  $P = 0.91$ ). Some patients suffered from degeneration of adjacent intervertebral disc at final followup, but there was no significant difference in adjacent intervertebral disc degeneration between two groups ( $P = 0.71$ ). Moreover, there were no differences in complications between Dynesys and PLIF ( $P = 0.90$ ), although the incidence of complication in Dynesys was lower than PLIF (16.67% vs. 17.78%).

**Conclusion:** Dynamic stabilization system treating lumbar degenerative disease showed clinical benefits with motion preservation of the operated segments, but does not have the significant advantage on motion preservation at adjacent segments, to avoid the degeneration of adjacent intervertebral disk.

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## INTRODUCTION

There are many different surgical treatments for degenerative lumbar disease existing, among which, decompression and fusion surgery (such as, posterior lumbar interbody fusion, [PLIF]) is one of the most used therapies, which is considered as "gold standard."<sup>1</sup>

However, many disadvantages and complications of fusion surgery have been found in the treatment of degenerative conditions of the lumbar spine, including donor site pain, pseudoarthrosis, nonunion, screw loosening, instrumentation failure, infection, adjacent segment disease (ASDis) and degeneration,<sup>2-6</sup> interest has been given to therapies which could avoid these unwanted effects.

Dynamic neutralization system (Dynesys) designed by Dubois and Graf, was approved in the USA in 2009 to provide spinal alignment and stabilization in patients with radiculopathy and degenerative spondylolisthesis, spinal stenosis or the other stenosing lesion.<sup>7</sup> This system is made up of pedicle screws, polyethylene terephthalate cords, and polycarbonate urethane spacers to stabilize the functional spinal unit and preserve the adjacent motion after surgeries.<sup>8</sup> Many *in vitro* and biomechanical studies have shown that this system can restrain the amount of flexibility through polyethylene terephthalate cords and polycarbonate urethane spacers.<sup>9-11</sup> Contrary to PLIF, which may lead to a rigid connection of the operative level, this system is designed to stabilize the operated segment while allowing some mobility, therefore, it may preserve a better of lumbar mobility than PLIF.<sup>12</sup>

Many series have been reported positive results stating that patients treated with Dynesys system showed improvement in Oswestry disability index (ODI) scores and visual analogue scale (VAS) pain scores, as well as less blood loss, shorter recovery times than PLIF.<sup>13-17</sup> Moreover, motion preservation has also been reported in many researches,<sup>13,14,18-20</sup> in which many researchers believed that the Dynesys could reduce the loading across the intervertebral disk and posterior elements, which could relieve back and leg pain, limit adjacent segment degeneration (ASDeg), preserve motion and prevent ASDis. Besides, it could also slow down the degenerative process of adjacent intervertebral disc postoperatively.<sup>18,21</sup> However, recently, many published researches have reported the contradictory results, indicating that Dynesys may not have a significant advantage on outcomes (clinical measurements, motion preservation and adjacent disc protection).<sup>7,22-24</sup> This study reports the clinicoradiological outcomes in patients treated with Dynesys and explores whether the dynamic stabilization system have advantages on clinicoradiological outcomes compared with PLIF.

## MATERIALS AND METHODS

75 patients of degenerative lumbar diseases, who met the inclusion and exclusion criteria's and underwent surgical intervention between October 2010 and November 2012 constitutes the study. The inclusion criteria's were: Spinal

stenosis with or without Grade I spondylolisthesis with degenerative disc disease (DDD) (Pfirman Grade II-IV), recurrent herniated intervertebral disc with DDD (Pfirman Grade II-IV), failure of 3 months of conservative treatment or other degenerative lumbar diseases. Patients with scoliosis, infection, lateral translation, advanced disc collapse, greater than Grade I spondylolisthesis, fracture or tumor were excluded. Patients suffering from chronic diseases were also excluded, which might increase the operative risk were also excluded. Clinicoradiological outcomes were compared between the two groups preoperatively and at final followup. This study was approved by the Institutional Review Board of our hospital, all patients in the Dynesys group and PLIF group provided written informed consent for the study and surgery.

Dynamic neutralization system was implanted, according to the directions of the manufacture in 30 patients.<sup>8</sup> Meanwhile, in most cases, simple decompression, such as, laminotomy or interlaminar decompression, was performed, but, for cases of severe stenosis or far lateral stenosis, extensive decompression, including facetectomy was performed, followed by implantation with Dynesys. After surgery, patients who had received the implantation of Dynesys received a soft support brace (lumbar corset) for 3 months.

In the control group, PLIF was operated in a standard manner including decompression, fusion, cage insertion, extensive decompression or facetectomy were performed when required. Postoperatively, patients in the PLIF group received a hard plastic lumbar brace for 3 months.

All patients received preoperative and followup physical examinations, including ODI,<sup>25</sup> VAS scores for back pain and leg pain.<sup>26</sup> Operation time, blood loss, and complications were compared between the two groups.

In addition to the clinical outcomes, radiological outcome were also compared between these two groups. These radiographs were measured by two experienced spine surgeons in our department respectively, including average intervertebral space height anterior height (AH), range of motion (ROM) of the operated and adjacent segment level and degenerative changes on the intervertebral disk. Flexion and extension views were taken with the patients in the lateral position. The AH was measured by the following formula:  $AH = (\text{Ventral intervertebral space height} + \text{Central intervertebral space height} + \text{Dorsal intervertebral space height})/3$ . The segmental angulation at the level L3-L4 was measured from the upper vertebral end plate of L3 to the lower end plate of L4 and L4-L5 was measured from the upper vertebral end plate of L4 to the lower end plate of L5 and L5-S1 was analyzed from the lower end plate of L5 to the superior end plate of S1. The ROM was obtained by

the following formula: ROM = Angle (extension) – Angle (flexion). Patients were also required to receive the examination of magnetic resonance imaging (MRI) for the adjacent segments' intervertebral discs, both preoperatively and at final followup. Disc degeneration was graded on T2-weighted sagittal and axial images by using a five point scale according to the method of Pfirrmann.<sup>27</sup>

### Statistical analysis

Statistical analyses were performed using SPSS 19.0 statistics software (SPSS Inc., Chicago, IL). Independent two-sample *t*-test was used to compare the change of the variables between two groups. Paired *t*-tests in both groups were employed to analyze the results of improvement differences from baseline (preoperatively) to final followup. Categorical variables were compared by Chi-square, Fisher's exact test or Mann-Whitney U test. All statistical assessments were two sided and evaluated at the 0.05 level of significant difference. Descriptive statistics in the form of mean and standard deviation.

### RESULTS

Thirty patients (male:17, female:13) with a mean age of 55.96 ± 7.68 years were included in Dynesys group and the PLIF group included 45 patients (male:21, female:24) with a

mean age of 54.69 ± 3.26 years. Patients in Dynesys group were reviewed at a followup time of 2.22 ± 0.43 years (range 2-3.5 years) and the final followup time in PLIF group was 2.17 ± 0.76 years (range 2-3 years) [Table 1]. Preoperative diagnosis was degenerative lumbar spinal canal stenosis in 23 patients (30.67%) and 35 patients suffered from lumbar intervertebral disc herniation (46.67%) and 15 patients suffered from spinal stenosis with disc herniation (20%). Besides, two patients (2.67%) had undergone lumbar surgery before presenting to this institute. All the baseline characteristics were similar between two groups (all, *P* > 0.05).

There was significant difference in operation time (141.06 ± 11.36 min vs. 176.98 ± 6.72 min, *P* < 0.001) and blood loss (386.76 ± 19.44 ml vs. 430.11 ± 24.72 ml, *P* < 0.001) between two groups. Complications occurred in 30 patients in Dynesys group: Screw loosening (*n* = 4, 13.33%) and aggravated back and leg pain (*n* = 1, 3.33%). There were no wound infection and dural tears occurred. Eight complications occurred in PLIF group: Wound infection (*n* = 3, 6.67%), dural tears (*n* = 2, 4.44%), aggravated back and leg pain (*n* = 2, 4.44%) and screw loosening (*n* = 1, 2.22%). Although the percentage of the complications in PLIF group is higher than Dynesys group (*n* = 5, 17.78% vs. *n* = 8, 16.67%), there were

**Table 1: Clinical details of patients**

Patient demographics and characteristics	Dynesys group	PLIF group	<i>P</i>
Demographic data			
Cases <sup>c</sup>	30	45	
Age (years) <sup>a</sup>	55.96±7.68	54.69±3.26	0.41
Sex ratio (male/female) <sup>b</sup>	17 (56.67)/13 (43.33)	21 (46.67)/24 (53.33)	0.40
BMI (kg/m <sup>2</sup> ) <sup>a</sup>	24.57±0.19	25.14±0.31	0.08
Duration of symptom (months) <sup>a</sup>	10.21±1.55	10.06±2.40	0.80
Followup time (years) <sup>a</sup>	2.22±0.43	2.17±0.76	0.75
Baseline characteristics			
Distribution of levels treated			
L3-L4	1	2	
L4-L5	11	20	
L5-S1	14	17	0.57
L3-L5	3	2	
L4-S1	1	4	
Preoperative ODI <sup>a</sup>	71.93±5.17	72.82±5.72	0.49
Preoperative VAS scores for back pain <sup>a</sup>	6.87±0.80	6.97±0.84	0.64
Preoperative VAS scores for leg pain <sup>a</sup>	6.99±0.81	7.26±0.76	0.15
Preoperative height of the operated level (mm) <sup>a</sup>	8.20±0.79	8.13±0.84	0.76
Preoperative ROM of the operated level (°) <sup>a</sup>	8.25±0.86	8.11±0.82	0.49
Preoperative ROM of the adjacent segment (°)	8.15±0.79	8.39±0.78	0.21
Evaluation of the adjacent intervertebral disc <sup>b</sup>			
Grade I	0 (0)	0 (0)	0.46
Grade II	17 (56.57)	22 (48.89)	
Grade III	12 (40)	20 (44.44)	
Grade IV	1 (3.33)	3 (6.67)	
Grade V	0 (0)	0 (0)	

<sup>a</sup>Data are displayed as mean±SD, <sup>b</sup>Data are displayed as number (%), <sup>c</sup>Data are displayed as the number. SD=Standard deviation, BMI=Body mass index, ODI=Oswestry disability index, PLIF=Posterior lumbar interbody fusion, ROM=Range of motion, VAS=Visual analogue scale

no significant differences in complications between two groups ( $P = 0.90$ ) [Table 2].

Significant improvements in ODI and VAS scores for leg and back pain were found in both two groups at final followup [Dynesys group: Table 3, PLIF group: Table 4, all  $P < 0.001$ ]. Dynesys group showed better improvement in ODI and VAS back, and leg pain than PLIF and the differences of percentage changes between these two groups were significant (ODI:  $P < 0.001$ , VAS back pain:  $P = 0.009$  and VAS leg pain:  $P = 0.031$ ) [Table 5].

**Radiological outcomes**

Height of the operated level was significantly increased in both two groups at final followup compared with the preoperative disc height [Dynesys group: Table 3, PLIF group: Table 4, both,  $P < 0.001$ ], but the difference of percentage change of operated level height was not significant between two groups [Table 5,  $P = 0.93$ ]. Significant decrease of ROM at the operated level at final followup was also observed in both groups [Dynesys group: Table 3, PLIF group: Table 4, both,  $P < 0.001$ ], but ROM of the operated level in Dynesys group was greater than that in PLIF group ( $2.97 \pm 0.12^\circ$  vs.  $1.25 \pm 0.16^\circ$ ) and the percentage change at final followup was also significant ( $-63.56 \pm 4.66\%$  vs.  $-84.42 \pm 2.92\%$ ,  $P < 0.001$ ). The ROM of adjacent segment did not increase significantly in both Dynesys (from  $8.15 \pm 0.79^\circ$  to  $8.22 \pm 0.25^\circ$ ,  $P = 0.58$ ) and PLIF group (from  $8.39 \pm 0.78^\circ$  to  $8.44 \pm 0.59^\circ$ ,  $P = 0.32$ ) and there was no significant difference in percentage change of the adjacent segment's ROM between two groups ( $0.74 \pm 8.92$  vs.  $0.92 \pm 4.52$ ,  $P = 0.91$ ). According to preoperative MRI, in Dynesys group, 17 patients had Grade II degeneration, another 12 Grade III and 1 Grade IV and in PLIF group, 22 patients had Grade II degeneration, another 20 Grade III and 3 Grade IV. At final followup, in Dynesys group, 12 patients had Grade II, 15 patients Grade III and 3 patients Grade IV and in PLIF group, 20 patients had Grade II degeneration, another 21 Grade III, 4 had Grade IV. Although some patients in both groups underwent the degeneration of adjacent intervertebral disc, the difference between preoperative MRI and followup both groups was not significant [Tables 3 and 4]. In addition, the difference of disc degeneration at final followup between two groups was also not significant [Table 5,  $P = 0.71$ ] [Figure 1].

**DISCUSSION**

Degenerative lumbar diseases are a major cause of chronic back pain and are typically treated by fusion of the affected levels if conservative treatment fails. Former studies have reported that the radiographic rates

**Table 2: Comparability of the operation time, blood loss and complications between two groups**

Variables	Dynesys group	PLIF group	P
Operation time (min) <sup>a</sup>	141.06±11.36	176.98±6.72	<0.001
Blood loss in operation (ml) <sup>a</sup>	386.76±19.44	430.11±24.72	<0.001
Complications <sup>b</sup>	5 (16.67)	8 (17.78)	
Wound infection	0 (0)	3 (6.67)	0.90
Dural tear	0 (0)	2 (4.44)	
Aggravated back and leg pain	1 (3.33)	2 (4.44)	
Screw loosening	4 (13.33)	1 (2.22)	

<sup>a</sup>Data are displayed as mean±SD, <sup>b</sup>Data are displayed as number (%). SD=Standard deviation, PLIF=Posterior lumbar interbody fusion

**Table 3: ODI, VAS scores for back pain and leg pain, the height of the operated level, the ROM of the operated level and adjacent segments, degeneration of the adjacent intervertebral disc at preoperative and final followup in Dynesys group**

Variables	Preoperative	Final followup	P
Oswestry disability index <sup>a</sup>	71.93±5.17	32.63±2.22	<0.001
VAS scores for back pain <sup>a</sup>	6.87±0.80	2.92±0.18	<0.001
VAS scores for leg pain <sup>a</sup>	6.99±0.81	3.25±0.37	<0.001
Height of the operated level (mm) <sup>a</sup>	8.20±0.79	10.24±0.89	<0.001
ROM of the operated level (°) <sup>a</sup>	8.25±0.86	2.97±0.12	<0.001
ROM of the adjacent segment (°) <sup>a</sup>	8.15±0.79	8.22±0.25	0.58
Evaluation of the adjacent intervertebral disc <sup>b</sup>			
Grade I	0	0	16
Grade II	17	12	
Grade III	12	15	
Grade IV	1	3	
Grade V	0	0	

<sup>a</sup>Data are displayed as mean±SD, <sup>b</sup>Data are displayed as number. SD=Standard deviation, ODI=Oswestry disability index, VAS=Visual analogue scale, ROM=Range of motion

**Table 4: ODI, VAS scores for back pain and leg pain, the height of the operated level, the ROM of the operated level and adjacent segments, degeneration of the adjacent intervertebral disc at preoperative and final followup in PLIF group**

Variables	Preoperative	Final followup	P
Oswestry disability index <sup>a</sup>	72.82±5.72	39.07±2.65	<0.001
VAS scores for back pain <sup>a</sup>	6.97±0.84	3.19±0.19	<0.001
VAS scores for leg pain <sup>a</sup>	7.26±0.76	3.56±0.38	<0.001
Height of the operated level <sup>a</sup>	8.13±0.84	10.16±0.80	<0.001
ROM of the operated level <sup>a</sup>	8.11±0.82	1.25±0.16	<0.001
ROM of the adjacent segment <sup>a</sup>	8.39±0.78	8.44±0.59	0.32
Evaluation of the adjacent intervertebral disc <sup>b</sup>			
Grade I	0	0	0.63
Grade II	22	20	
Grade III	20	21	
Grade IV	3	4	
Grade V	0	0	

<sup>a</sup>Data are displayed as mean±SD, <sup>b</sup>Data are displayed as number. SD=Standard deviation, ODI=Oswestry disability index, ROM=Range of motion, PLIF=Posterior lumbar interbody fusion, VAS=Visual analogue scale

of fusion could be > 95% but the successful clinical outcomes have been reported in only 70% of cases.<sup>6</sup>





**Figure 1:** Preoperative radiographs anteroposterior (a) and lateral (b) views of a 60-year-old male with disc herniation in L3-L4 and L4-L5 showing degenerative changes in lumbosacral area (c) Preoperative magnetic resonance imaging (MRI) T2W sagittal cut showing the disc herniation in L3-L4 and L4-L5. (d) Preoperative MRI T2W axial image showing Grade II degeneration of the disc in L3-L4. (e and f) Postoperative radiographs with dynamic neutralization system. (g) Postoperative MRI image showing no significant degenerative changes in intervertebral disc

**Table 5: Comparability of the percentage changes of ODI, VAS scores for back pain and leg pain, height of the operated level, ROM of the operated level and adjacent segments at final followup and degeneration of the adjacent intervertebral disc between two groups**

Variables	Dynesys group	PLIF group	P
Oswestry disability index (%) <sup>a</sup>	-54.39±4.69	-45.97±6.16	<0.001
VAS scores for back pain (%) <sup>a</sup>	-56.97±5.54	-52.19±8.64	0.009
VAS scores for leg pain (%) <sup>a</sup>	-53.36±4.06	-50.49±6.34	0.031
Height of the operated level (%) <sup>a</sup>	25.37±8.61	25.55±9.71	0.93
ROM of the operated level (%) <sup>a</sup>	-63.56±4.66	-84.42±2.92	<0.001
ROM of the adjacent segment (%) <sup>a</sup>	0.74±8.92	0.92±4.52	0.91
Evaluation of the adjacent intervertebral disc <sup>b</sup>			
Grade I	0	0	0.71
Grade II	12	20	
Grade III	15	21	
Grade IV	3	4	
Grade V	0	0	

<sup>a</sup>Data are displayed as mean±SD, <sup>b</sup>Data are displayed as number. SD=Standard deviation, ODI=Oswestry disability index, ROM=Range of motion, PLIF=Posterior lumbar interbody fusion, VAS=Visual analogue scale

Besides, many complications have been reported after the surgery, therefore, nonfusion stabilization, such as Dynesys, has been designed by researchers to prevent these degenerative complications. Many researches have shown great improvement of clinical and radiographic outcomes in patients with degenerative lumbar diseases using Dynesys but results of some studies<sup>7,22,27,28</sup> were inconsistent with former researches. Our results are comparable with those above, in addition, we also

compare the change of adjacent intervertebral disc degeneration between two groups.

Many studies<sup>24,29-34</sup> have reported positive results of the Dynesys, while some reports have indicated that results are no better than those obtained with typical fusion. Haddad *et al.*<sup>28</sup> conducted a retrospective study, who studied 32 patients treated with Dynesys and 32 patients with fusion and found that ODI and VAS scores were all better in the fusion group. Similarly, more patients were very much satisfied after fusion than after Dynesys: 87.5% vs. 68.8% ( $P = 0.04$ ). Grob *et al.*<sup>22</sup> conducted a retrospective study that involved 31 consecutive patients instrumented with Dynesys over the preceding 40 months, finding that 6 of 31 (19%) patients had required or were scheduled for further surgical intervention and they believed these results provide no support for the notion that semi-rigid fixation of the lumbar spine results in better patient-oriented outcomes than those typical of fusion. In our study, ODI and VAS scores for leg and back pain improved in both groups at final followup compared with preoperative scores, indicating that both methods were effective for the treatment of degenerative lumbar diseases, and we also found that the improvement of ODI and VAS scores for leg and back pain were better in Dynesys than PLIF group, suggesting that Dynesys might provide better results of these scores. We contribute this improvement to the biomechanics of the Dynesys, which is a load-sharing device that results in less stiffness than PLIF and may provide immediate stabilization of the diseased segment, and neutralizes the

abnormal forces caused by the pathological bony and soft tissue changes.<sup>13,35,36</sup>

For perioperative variables, our results showed less operation time and blood loss in Dynesys than PLIF, which was consistent with many studies.<sup>13,29,35,37</sup> We attribute these results to the procedure of the Dynesys, in which endplate preparation and insertion of an interbody device or bone grafting are not needed, and less blood loss may result from the less bone and soft tissue dissection and insertion of an interbody device.

One major concern for the Dynesys is the high occurrence rate of screw loosening. Sapkas *et al.*<sup>33</sup> studied 114 patients underwent a Dynesys and found that at final followup, 22 patients (20.6%) were diagnosed as screw loosening, and 3 patients (2.8%) with screw loosening underwent rigid spine arthrodesis. Ko *et al.*<sup>38</sup> conducted a retrospective study to evaluate the incidence of screw loosening and its effect on clinical outcomes and they reported that there were loose screws in 14 of 71 patients (19.7%), for a rate of 4.6%/screw (17 of 368 screws). However, they believed that the loosening of screws has no adverse effect on clinical improvement. In our study, screw loosening were happened in four patients in Dynesys group (13.33%), and 1 out of 45 patients suffered dural tears in PLIF (2.22%), giving a total rate of 6.67%, however, no revision surgeries were required. According to our experience, this higher incidence of screw loosening might mainly be caused by inaccurate implantation of screws or the increased ROM after surgery. Besides, two dural tear that happened in the levels of cage placement were observed in PLIF group while none occurred in Dynesys group. This mainly due to the interbody cage insertion in the procedure of PLIF. We also found that the incidence of wound infection in PLIF was higher than that in Dynesys and it may be attributed to the less operation time in Dynesys, which may reduce the exposure of the wounds as well as the invasion of bacteria. Our data showed no significant differences in complications between two groups, although the percentage of the complications in PLIF group was higher than Dynesys group. The relatively small sample size may be the reason.

Contrary to PLIF, which leads to a solid connection of the operative levels and may increase the incidence of ASDis and ASDeg, Dynesys was designed to protect the motion of both operated and adjacent segments, which can stabilize the index level, while the flexible cords and spacers allow a limited ROM.<sup>13,35</sup> Yang and Jiang<sup>27</sup> reported 14 patients undergoing Dynesys with 18 patients undergoing PLIF, and they found that ROM of operated segment in PLIF group was significantly decreased at final followup while no significant decrease was observed in Dynesys group. ROM of adjacent segment in PLIF group increased significantly

from  $7.0 \pm 1.6^\circ$  to  $8.7 \pm 0.4^\circ$  ( $P = 0.042$ ), while ROM of adjacent segment was decreased (from  $7.3 \pm 1.8^\circ$  to  $7.2 \pm 0.7^\circ$ , no significant difference,  $P = 0.108$ ). A meta-analysis<sup>21</sup> including 31 articles was performed to investigate whether conclusions can be made with regard to the isolated posterior dynamic stabilization (PDS) procedure in reducing the risk of ASDeg and ASDis suggested that relative success of the PDS procedure in protecting against ASDeg and ASDis. But, Schaeren *et al.*<sup>39</sup> reported that at 4 years followup, 47% of the 26 patients (mean age, 71 years) treated with Dynesys showed some degeneration at adjacent levels. Cakir *et al.*'s<sup>23</sup> retrospective study suggested that monosegmental PDS with Dynesys has no effect on adjacent segment mobility compared with monosegmental fusion.

In our study, ROM of operated level was significantly decreased in both groups, but Dynesys could maintain some ROM because of its biological design. According to the biomechanics of Dynesys, Dynesys should have a significant advantage on motion preservation of the adjacent segments and the difference in adjacent ROM between Dynesys and PLIF should be significant, but our results suggested that no significant difference was found in ROM of adjacent segment although ROM of adjacent segment was increased in both groups insignificantly. We contribute these results to the insufficient followup time because the significant difference in ROM of adjacent levels could be observed at least 7 years after surgery. Besides, we found that the height of the operated level was significantly increased in both two groups at final followup compared with the preoperative disc height, but the difference of the percentage change of the operated level height was not significant between two groups. We contributed the mechanism and implantation of Dynesys, and the interbody cage insertion in the procedure of PLIF to the significant increase of disc height in Dynesys group and PLIF group, respectively. Contrary to our results, Beastall *et al.*'s<sup>12</sup> retrospective study suggested that mean anterior disc height at the instrumented level reduced by 0.7 mm following insertion of the Dynesys ( $P = 0.027$ ) and mean posterior disc height was not significant reduced and Yu *et al.*<sup>13</sup> reported a statistically significant decrease in the percentage change of total anterior disc height at both the operated and L1-S1 levels at 3 years postoperatively in the Dynesys group. Therefore, the change of intervertebral discs' height after Dynesys implantation need to be confirmed by further studies. In theory, mechanical stress on adjacent levels imposed by Dynesys may slow down the degeneration of adjacent intervertebral disc, as was shown in Putzier *et al.*<sup>40</sup> and Reyes-Sánchez *et al.*'s<sup>18</sup> studies. However, in our study, although we did observe degenerative changes on adjacent discs in some patients, overall, no significant degenerative changes of adjacent discs were observed in both groups. Some significant

degenerative changes on adjacent discs may result from natural procedure of disc degeneration and insignificant difference between preoperative and final followup in both groups may be attributed to the short-term followup time.

The limitations of the study are firstly, although the mean followup time in Dynesys group is  $2.22 \pm 0.43$  years and  $2.17 \pm 0.76$  years in PLIF group, much longer followup is needed to determine the long term radiographic and clinical results of Dynesys. Secondly, small patient numbers may be the reason for the insignificant incidence of complications, ROM of adjacent segments and degenerative changes on adjacent discs. Thirdly, the data are from a single medical center, so further randomized controlled trial in multiple medical center should be conducted. Besides, since there was no blinding, a bias can contribute varying clinical outcomes in two groups.

## CONCLUSION

This study indicated that the clinical results of Dynesys showed better improvement compared with PLIF in a short followup. Implantation of Dynesys is less invasive than PLIF, such as less operation time and less blood loss and effectively improves the ODI and VAS for back and leg pain, stabilizes the unstable spine and protects the mobility of operated level, but no advantages on protection of ROM of adjacent segments and adjacent discs' degeneration have been observed in short term followup.

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