Acta Orthop. Belg., 2012, **78**, 97-103

ORIGINAL STUDY

Dynesys dynamic stabilization : less good outcome than lumbar fusion at 4-year follow-up

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Dynamic semirigid stabilization of the lumbar spine was introduced in 1994 in an attempt to overcome the drawbacks of fusion. It is supposed to preserve motion at the treated levels, while avoiding hypermobility and thus spondylosis at the adjacent levels. Although the early reports showed promising results, the long term effects are still debated. We retrospectively compared outcomes of Dynesys dynamic stabilization with those of the traditional fusion technique. Thirty-two patients who had undergone Dynesys between 2004 and 2006 (group 1) were compared to 32 patients who had been treated with fusion between 2005 and 2006 (group 2). VAS for back and leg pain, and ODI improved significantly in both groups ($p < 0.001$). These scores were all better in the fusion group, and even significantly so as far as VAS for back pain was concerned ($p = 0.014$). Similarly, more patients were satisfied or very satisfied after fusion than after Dynesys : 87.5% versus 68.8% ($p = 0.04$). Interestingly, in the Dynesys group scatter plot graphs showed a positive correlation between older age and improvement in the two VAS scores and in ODI. Dynamic stabilization with Dynesys remains controversial. Older patients are relatively more satisfied about it, probably because of their low level of demands.

Keywords : lumbar spondylosis ; Dynesys ; dynamic semirigid stabilization ; lumbar fusion ; retrospective ; mid-term follow-up.

INTRODUCTION

Abnormal load transmission across the spine is a common cause of back pain and may result in disc degeneration and facet joint osteoarthritis (*16*). Both rigid and dynamic spinal stabilization procedures have been adopted to treat pain arising from spinal instability. Dynamic stabilization was introduced in 1994 as a motion preserving device in an attempt to overcome the disadvantages of fusion, provide sufficient stability, and above all preserve motion at

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No benefits or funds were received in support of this study. The authors report no conflict of interests.

the treated segment (*21*), so minimizing adjacent hypermobility and degeneration (*11,15*). Mobile stabilization was considered to be less invasive than fusion, making it an attractive option. Several studies have shown promising results from dynamic stabilization. Stoll *et al* (*23*) noted results which were comparable to those obtained by conventional procedures in a multicenter prospective study on 83 consecutive cases. Bordes-Monmeneu *et al* (*1*) reported good results in 94 Dynesys cases after 14-24 months, with only one complication of screw malpositioning. The protagonists of dynamic stabilization claim that, when compared to conventional rigid spinal fusion, dynamic stabilization offers less morbidity by being less invasive (*13,23*), while it preserves the physiological range of motion (*10,23*), so that it does not induce hypermobility and spondylosis at adjacent levels (*4,7,10*). Other reports were less enthusiastic. Cakir *et al* (*3*) obtained flexion-extension radiographs before and after Dynesys instrumentation L4L5, and compared the results with those noted after fusion. Although Dynesys preserved the global range of motion, the adjacent level movements were similar to those after fusion : in other words Dynesys did not protect against hypermobility at the adjacent levels. Moreover, disc degeneration of the bridged and adjacent segments still progressed. Of course (*11*), it is difficult to know whether this progression was due to natural disease progression or to the stabilization itself. Also Liu *et al* (*14*) found that the adjacent level was adversely affected, showing greater range of movement, annulus stress and facet loading. In a human cadaveric study, Niosi *et al* (*17*) similarly showed that Dynesys significantly increased peak facet contact forces in flexion and lateral bending. In a series of 21 patients with a 4-year follow-up, Kim *et al* (*10*) reported that after Dynesys, motion at the treated level was preserved in only 8% of the patients, while adjacent segment degeneration occurred in up to 47%. A few studies showed an increased rate of screw loosening (*5,12,14*).

The aim of this retrospective study was to compare the 4-year outcomes of two groups of patients who underwent either dynamic stabilization or conventional lumbar fusion by a single surgeon.

MATERIALS AND METHODS

Thirty-two consecutive patients underwent dynamic lumbar spine stabilization with Dynesys between 2004 and 2006, and were available for follow-up (group 1 : Dynesys group). These patients were compared to another group of 32 consecutive patients who were treated with conventional methods of lumbar fusion (group 2 : fusion group) between 2005 and 2006. The groups correlated well as to age, gender, indication (Table I), preoperative VAS and Oswestry Disability Index (ODI) (Table II). Patients with fractures, bone loss and scoliosis were not considered for dynamic stabilization.

All operations were primary procedures, performed by a single experienced spinal surgeon (BO). A standard mid-line posterior approach was used. Only Dynesys instrumentation was used for dynamic stabilization (Zimmer, Inc., Warsaw, IN, USA). The pedicle screws were positioned at the conventional (Magerl) site, and their position was checked with an image intensifier. Decompression, where indicated, was performed during the same session by undercutting laminae. Bone graft substitutes were used for fusion procedures. Preoperatively, patients were assessed using a Visual Analogue Scale (VAS) for back and leg pain and the Oswestry Disability Index (ODI). Besides, all patients underwent physical examination, radiographs and Magnetic Resonance (MR) imaging.

Postoperatively, all patients were assessed clinically and radiographically. Data were collected in a cross-sectional manner. At final follow-up a questionnaire was mailed to all the patients. It consisted of VAS for leg and back pain, ODI, and overall satisfaction (very satisfied, satisfied, not satisfied).

Statistical computation

Parametric tests were used as the data had a relatively acceptable normal distribution according to histograms and quantile plot graphs. An unpaired Student's t test was used to compare improvement in group 1 and 2, while a paired t test was used to assess the difference between pre- and postoperative scores. Fisher's exact test was used for analysis of the categorical data. Multiple linear regression analysis was performed to assess the effect of age, operation type and gender on the main primary outcome (i.e. improvement in ODI). A scatter plot assessed the correlation between VAS and ODI on the one hand, and age on the other hand. A p-value of less than 0.05 was considered significant for all statistical tests.

Table I. — Good comparability of both groups

	Dynesys (group 1)	Fusion (group 2)	p-value
Mean age at operation (SD)	40.6 (6.46)	46.5 (10.7)	0.23$
Sex (males/females)	19/13	15/17	0.45*
Prolapsed disc	18	14	0.45*
Spinal stenosis with spondylolisthesis	4	6	0.73*
Spinal stenosis without spondylolisthesis	7	6	1.0*
Degenerative disease	3	6	0.47*

* = Fisher's exact test, $ = independent Student's t-test, SD = standard deviation.

Table II. — Outcomes : means and standard deviations (SD) for pre and post-operative score ; percentages

		Group 1	Group 2	
VAS leg score	Pre-op	8 (1.55)	7.44 (1.29)	
	Post op	5.47 (2.36)	3.56 (2.59)	
	P value*	< 0.001*	< 0.001*	
VAS back score	Pre-op	7.22 (1.39)	8 (1.16)	
	Post op	4.91 (2.44)	3.97 (2.39)	
	P value*	< 0.001*	< 0.001*	
ODI score	Pre-op	73.37 (14.02)	77.75 (9.28)	
	Post op	56.06 (20.02)	49.56 (20.99)	
	P value*	< 0.001*	< 0.001*	
Improvement in scores				P value£
Improvement in ODI score		17.31 (19.57)	28.19 (23.94)	0.051
Improvement in leg VAS		2.53 (2.72)	3.88 (2.88)	0.600
Improvement in back VAS		2.31 (2.73)	4.03 (2.68)	0.014
Overall satisfaction				
Very satisfied and satisfied		22 (68.8%)	28 (87.5%)	0.01$
Not satisfied and dissatisfied		10 (31.2%)	4 (22.5%)	

* = paired Student t test, £ = unpaired Student t test, $ = Fisher's exact test.

RESULTS

Both groups improved significantly after surgery : $p < 0.001$ (Table II). The fusion group performed better (Table II) than the Dynesys group as to VAS for back pain ($p = 0.014$), VAS for leg pain (not significantly), and ODI (not significantly). Also patients' satisfaction was better in the fusion group : 28 out of 32 (87.5%) fusion patients were satisfied or very satisfied, versus only 22 out of 32 (68.8%) in the Dynesys group ($p = 0.01$, Fisher's exact test).

Multiple linear regression analysis showed a significant relation between improvement in ODI and age ($p < 0.001$), but not between improvement in ODI and technique or gender (Table III). In the Dynesys group a scatter plot analysis showed a positive correlation between age and improvement of VAS for back and leg pain (Fig. 1), and between age

Table III. — ODI improvement as a function of technique, gender and age (multiple linear regression analysis)

Parameter	B	Std Error	95% Wald Confidence Interval		p value
			Lower	Upper	
(Intercept)	-25.353	13.0727	-50.975	0.269	0.052
Dynesys	-4.325	5.0115	-14.148	05.497	0.388
Fusion	0[a]	.	.	.	.
Females	-2.759	4.9043	-12.371	6.853	0.574
Males	0[a]	.	.	.	.
Age	1.184	.2782	0.639	1.729	< 0.001
(Scale)	360.542[b]	63.7354	254.967	509.834	

Dependent variable : ODI improvement.
Model : (Intercept), technique, gender, age.
a. Set to zero because this parameter is redundant.
b. Maximum likelihood estimate.

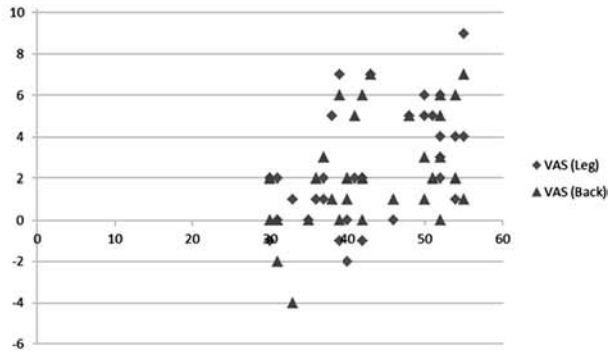

Fig. 1. — VAS scores for back and leg pain improved with age in the Dynesys group.

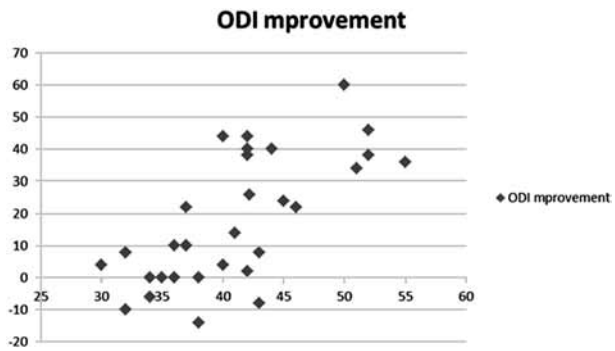

Fig. 2. — ODI improved with age in the Dynesys group

and improvement of ODI (Fig. 2). Such a relationship was not found for the fusion group.

Complications

Four Dynesys patients underwent revision surgery including decompression and fusion, owing to persistent symptoms (2 patients), malpositioning of screws (1 patient) and symptomatic screw loosening (1 patient). One patient developed foot drop postoperatively, which recovered spontaneously after 5 months. Five patients in the fusion group needed revision of the decompression and fusion, owing to persistent symptoms (2 patients) or to symptomatic screw loosening (3 patients, with evidence of nonunion in 2 of these).

DISCUSSION

Less good outcome after Dynesys

"Dynamic stabilization or conventional fusion ?" : this is the eternal question after spinal decompression surgery. The current mid-term study is rather reserved about dynamic stabilization, in accordance with several other reports (*9,24*). The original indications for Dynesys were "conditions of instability with local lumbar pain as well as radicular pain

Table IV. — Review of the English language literature : Dynesys results improve with increasing age

Author	Mean age	Number of patients	Average FU (months)	Screw loosening	Type of study	Conclusions
Present study 2012	42.8	32	48	1/32	Retrospective Comparative	Outcome better in the elderly
Grob 2005	50	31/50	24	2/31	Retrospective not comparative	No support that semirigid fixation provides better patient oriented outcomes
Bothmann 2008	56	40/54	16	7/40	Prospective	Midterm results are highly comparable to fusion procedures
Welch 2007	56.3	101	12	1/101	Prospective clinical	Early results are promising
Stoll 2002	58	83	38.1	7/83	Prospective multicenter	Good results
Würgler-Hauri 2008	58	36/37	12	NA	Prospective	Microsurgical decompression and Dynesys. Does not show advantages in outcome.
Ko 2010	59.2	71	NA	14/71	Retrospective	Screw loosening more common in the elderly : 19.7% and 4.6% per screw.
Di Silvestre 2010	68.5	29	NA	0/29	Retrospective not comparative	Good results in the elderly with degenerative scoliosis.
Schaeren 2008	71	19/26	52	3/19	Prospective clinical	Patient satisfaction excellent : 95% would have the same procedure again.
Schanke 2006	71	26	24	3/19	Prospective clinical	It maintains enough stability.

FU = Follow up.

and/or deficit" (*23*). Some authors have suggested that it should not be used for patients with progressive instability or spondylolisthesis (*2,9,18*).

Which type of dynamic stabilization ?

Choosing the right device for dynamic stabilization depends on the surgeon's individual preference. Sangiorgio *et al* (*20*) conducted a biomechanical study comparing three different dynamic devices. They concluded that each excelled in different areas. For example, PercuDyn (Interventional Spine, Inc., Irvine, CA, USA) was most effective at preventing hyperextension, whilst Isobar (Scientx, Guyancourt, France) was the only device to stabilize the anterior column. FlexPLUS (SpineVision SA, Paris, France) was found superior in preserving the lordosis of instrumented segments while minimizing the compensatory lordosis at the cranial adjacent segment (*25*). The specific characteristics of dynamic stabilization devices should be determined through further biomechanical and clinical studies (*8*).

Influence of age

Dynamic stabilization was designed to prevent the long term adverse effects of fusion, such as decreased range of motion at the treated level, and adjacent segment hypermobility and thus degeneration. Theoretically, it is therefore more logical to use this system in younger patients in an attempt to preserve the biomechanics of the spine. This would increase the longevity of the construct and decrease the chance of degeneration in the adjacent segment. But the question if patient's age might be a factor in

predicting the outcome after Dynesys is still a matter of debate. Some studies confirm the conclusion of the current study that it works better in older patients (*6,19,22*). A review of the literature shows better results with increasing age (Table III). Its minimal invasiveness, implicating less morbidity, is probably at the origin of this finding (*6*). In fact, one would expect more problems in the elderly, because osteoporosis means screw loosening, more frequently than in youngsters. But screw loosening is not always symptomatic (*12*). Moreover, older patients have a lower level of demands, which in theory would make pain control more sustainable. All these factors might explain why older patients had better results.

Limitations and strengths

The current study had some limitations, mainly by being retrospective and by lacking interim follow-ups. Furthermore, randomization would have made the findings more trustworthy, but randomized studies were not found in the literature. A strength was the comparability among groups as to demographics, surgical indications, and preoperative VAS and ODI scores. However, the main strength stemmed from the fact that all operations were performed by the same surgeon. Finally, the average follow-up period of 48 months surpassed most other Dynesys studies.

Acknowledgement

The authors wish to thank Ms Suzie Cro for her advice and supervision with regards to the statistical analysis.

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