

## Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

**eTable 1: Radiologic evaluations of the MRIs**

Variable	Decompression alone	Fusion	p-value
	No (%)	No (%)	
No. of patients	256	72	
Stenosis levels <sup>a</sup>			
L1/L2	58 (22.7)	8 (11.1)	<b>0.046</b>
L2/L3	130 (50.8)	26 (36.1)	<b>0.039</b>
L3/L4	201 (78.5)	39 (54.2)	<b>&lt;0.001</b>
L4/L5	228 (89.1)	63 (87.5)	0.873
L5/S1	109 (42.6)	28 (38.9)	0.670
Stenotic levels <sup>a</sup>			<b>0.010</b>
0	2 (0.8)	1 (1.4)	
1	32 (12.5)	20 (27.8)	
2	68 (26.6)	20 (27.8)	
≥3	154 (60.2)	31 (43.1)	
Spondylolisthesis <sup>b</sup> , n levels (%)			
L1/L2	10 (3.9)	3 (4.2)	1
L2/L3	19 (7.4)	5 (6.9)	1
L3/L4	50 (19.5)	15 (20.8)	0.938
L4/L5	95 (37.1)	45 (62.5)	<b>&lt;0.001</b>
L5/S1	46 (18.0)	16 (22.2)	0.520

<sup>a</sup> at least one moderate grading in one of the following core parameters: compromise of the central zone, relation between fluid and cauda equina (Schizas classification), and nerve root compression in the lateral recesses

<sup>b</sup> Meyerding listhesis grade ≥1

**eTable 2: Cumulative incidence of revisions and 95% confidence intervals, including only patients with degenerative spondylolisthesis**

	<b>Decompression alone</b>		<b>Fusion</b>				
Time after index operation	Cumulative incidence, % (95% CI) <sup>a</sup>	No. at risk / of revisions <sup>b</sup>	Cumulative incidence, % (95% CI) <sup>a</sup>	No. at risk / of revisions <sup>b</sup>	Absolute risk difference, % (95% CI) <sup>a</sup>	Adj. absolute risk difference, % (95% CI) <sup>c,d</sup>	P value <sup>c</sup>
at index operation	n.a. (n.a.)	146 / 0	n.a. (n.a.)	57 / 0	n.a. (n.a.)	n.a. (n.a.)	n.a.
1 year	6.2 (2.2-10.0)	137 / 9	1.8 (0.0-5.1)	56 / 1	-4.4 (-9.6-0.8)	1.1 (-5.2-10.0)	0.763
2 years	9.6 (4.7-14.2)	132 / 14	10.5 (2.2-18.1)	51 / 6	0.9 (-8.4-10.2)	2.1 (-8.9-16.8)	0.750
3 years	11.0 (5.7-15.9)	26 / 16	10.5 (2.2-18.1)	8 / 6	-0.5 (-9.9-9.0)	2.3 (-9.7-18.0)	0.747

Abbreviations: adj., adjusted; CI, confidence interval

<sup>a</sup> Unadjusted estimates.

<sup>b</sup> Cumulative numbers of revisions.

<sup>c</sup> From fully adjusted multivariate Cox proportional hazards regression model (using the variables age, sex, body mass index (BMI) ( $\geq 25$  kg/m<sup>2</sup>), current smoker, civil risk (living alone, or living in a nursing/residential home while being single, divorced, or widowed), duration of symptoms ( $>6$  months), cumulative illness rating scale (CIRS), depression (Hospital Anxiety and Depression Scale (HADS) depression subscale  $\geq 8$  points), anxiety (HADS anxiety subscale  $\geq 8$  points), degenerative spondylolisthesis (Meyerding grade  $\geq 1$ ), stenotic levels ( $>1$  stenotic level), and number of decompressed levels).

<sup>d</sup> The 95% CIs were obtained by the adjusted bootstrap percentile method from 2000 bootstrap iterations.

**eTable 3: Multivariable Cox proportional hazards regression model**

Covariate	Hazard ratio (95% CI)	P value
Fusion (type of index operation)	1.40 (0.63-3.13)	0.409
Age (centered)	0.98 (0.94-1.02)	0.377
Female	0.82 (0.39-1.70)	0.593
BMI ( $\geq 25$ kg/m <sup>2</sup> )	1.18 (0.56-2.53)	0.662
Civil risk <sup>a</sup>	0.90 (0.41-1.98)	0.788
Current smoker	0.65 (0.24-1.76)	0.395
Duration of symptoms (>6 months)	0.45 (0.22-0.91)	<b>0.026</b>
CIRS (centered)	1.04 (0.95-1.14)	0.418
Depression	2.32 (1.02-5.29)	<b>0.046</b>
Anxiety	1.62 (0.73-3.61)	0.236
Degenerative spondylolisthesis (Meyerding Grade $\geq$ I)	0.77 (0.39-1.51)	0.446
Number of stenotic levels (>1 level)	0.92 (0.34-2.49)	0.863
2 Decompressed levels	1.48 (0.65-3.37)	0.355
3 Decompressed levels	1.82 (0.71-4.67)	0.214

Overall tests: likelihood ratio test  $p=0.09$

Abbreviations: BMI, body mass index; CI, confidence interval; CIRS, Cumulative Illness Rating Scale

<sup>a</sup> Living alone, or single/divorced/widowed and living in a nursing/residential home

**eTable 4: Mixed-effects models for the outcomes SSM symptoms, SSM function, and EQ-5D-3L SI**

**A) SSM symptoms**

	<b>Estimate</b>	<b>Lower 95% CI</b>	<b>Upper 95% CI</b>	<b>p-value</b>
(Intercept)	2.731	2.497	2.965	<b>0.000</b>
Cumulative number of total operations	0.171	0.047	0.295	<b>0.007</b>
Fusion (type of index operation)	-0.1	-0.258	0.057	0.214
Age (centered)	0.007	-0.002	0.015	0.112
Female	0.227	0.089	0.364	<b>0.001</b>
BMI ( $\geq 25\text{kg/m}^2$ )	0.185	0.054	0.315	<b>0.006</b>
Civil risk	-0.023	-0.169	0.124	0.760
Duration of symptoms (>6 months)	0.129	-0.02	0.277	0.090
CIRS (centered)	0.031	0.015	0.048	<b>0.000</b>
Current smoker	0.08	-0.092	0.253	0.364
Depression ( $\geq 8$ points)	0.367	0.184	0.55	<b>0.000</b>
Anxiety ( $\geq 8$ points)	0.189	0.018	0.36	<b>0.031</b>
Degenerative spondylolisthesis (Meyerding Grade $\geq 1$ )	-0.067	-0.198	0.063	0.312
Number of stenotic levels (>1 level)	0.03	-0.149	0.21	0.742
2 decompressed levels	-0.026	-0.169	0.116	0.716
3 decompressed levels	0.04	-0.146	0.225	0.677
Follow-up 12 months	-1.216	-1.367	-1.064	<b>0.000</b>
Follow-up 24 months	-1.203	-1.361	-1.044	<b>0.000</b>
Follow-up 36 months	-1.21	-1.372	-1.048	<b>0.000</b>

## B) SSM function

	Estimate	Lower 95% CI	Upper 95% CI	p-value
(Intercept)	2.037	1.848	2.226	<b>0.000</b>
Cumulative number of total operations	0.068	-0.036	0.172	0.198
Fusion (type of index operation)	-0.125	-0.252	0.002	0.055
Age (centered)	0.007	0.001	0.014	<b>0.032</b>
Female	0.213	0.102	0.324	<b>0.000</b>
BMI ( $\geq 25\text{kg/m}^2$ )	0.192	0.088	0.297	<b>0.000</b>
Civil risk	-0.03	-0.148	0.088	0.624
Duration of symptoms (>6 months)	0.002	-0.117	0.122	0.970
CIRS	0.016	0.003	0.03	<b>0.015</b>
Current smoker	0.055	-0.084	0.194	0.440
Depression ( $\geq 8$ points)	0.399	0.251	0.546	<b>0.000</b>
Anxiety ( $\geq 8$ points)	0.025	-0.112	0.163	0.718
Degenerative spondylolisthesis (Meyerding Grade $\geq 1$ )	-0.061	-0.166	0.044	0.258
Number of stenotic levels (>1 level)	-0.046	-0.19	0.099	0.536
2 decompressed levels	0.007	-0.108	0.122	0.908
3 decompressed levels	0.012	-0.138	0.161	0.878
Follow-up 12 months	-0.816	-0.944	-0.689	<b>0.000</b>
Follow-up 24 months	-0.798	-0.931	-0.665	<b>0.000</b>
Follow-up 36 months	-0.774	-0.91	-0.638	<b>0.000</b>

### C) EQ-5D-3L SI

	Estimate	Lower 95% CI	Upper 95% CI	p-value
(Intercept)	0.628	0.554	0.703	<b>0.000</b>
Cumulative number of total operations	-0.061	-0.105	-0.017	<b>0.007</b>
Fusion (type of index operation)	0.029	-0.021	0.079	0.251
Age (centered)	-0.001	-0.004	0.001	0.321
Female	-0.098	-0.142	-0.055	<b>0.000</b>
BMI ( $\geq 25\text{kg/m}^2$ )	-0.062	-0.103	-0.02	<b>0.004</b>
Civil risk	0.047	0.001	0.094	<b>0.046</b>
Duration of symptoms (>6 months)	-0.02	-0.067	0.027	0.396
CIRS	-0.01	-0.015	-0.005	<b>0.000</b>
Current smoker	-0.023	-0.078	0.032	0.413
Depression ( $\geq 8$ points)	-0.172	-0.23	-0.114	<b>0.000</b>
Anxiety ( $\geq 8$ points)	-0.031	-0.085	0.023	0.258
Degenerative spondylolisthesis (Meyerding Grade $\geq 1$ )	0.036	-0.006	0.077	0.093
Number of stenotic levels (>1 level)	-0.012	-0.069	0.045	0.677
2 decompressed levels	-0.006	-0.051	0.039	0.805
3 decompressed levels	-0.037	-0.096	0.021	0.213
Follow-up 12 months	0.334	0.279	0.389	<b>0.000</b>
Follow-up 24 months	0.329	0.272	0.386	<b>0.000</b>
Follow-up 36 months	0.316	0.258	0.375	<b>0.000</b>

**eTable 5: Sensitivity analysis: baseline characteristics of the included patients**

Variable	All	Decompression alone	Fusion	p-value
	No (%)	No (%)	No (%)	
No. of patients	396	309	87	
Age, years, median (IQR)	74.0 [67.0, 79.0]	75.0 [68.0, 80.0]	70.0 [64.0, 74.0]	<b>&lt;0.001</b>
Female	200 (50.5)	157 (50.8)	43 (49.4)	0.915
BMI, kg/m <sup>2</sup> , median (IQR)	26.7 [24.0, 30.0]	26.4 [24.0, 30.2]	27.4 [24.0, 28.7]	0.605
BMI ≥25, kg/m <sup>2</sup>	263 (66.4)	202 (65.4)	61 (70.1)	0.485
Civil Risk <sup>a</sup>	134 (33.8)	112 (36.2)	22 (25.3)	0.075
Compulsory education	102 (25.8)	84 (27.2)	18 (20.7)	0.278
CIRS, median (IQR)	9.0 [7.0, 12.0]	9.0 [7.0, 12.0]	8.0 [6.0, 11.5]	<b>0.039</b>
Diabetes mellitus	41 (10.4)	37 (12.0)	4 (4.6)	0.073
Current smoker	58 (14.6)	40 (12.9)	18 (20.7)	0.102
Back pain	340 (85.9)	263 (85.1)	77 (88.5)	0.530
Buttocks pain	308 (77.8)	243 (78.6)	65 (74.7)	0.527
Leg pain	359 (90.7)	284 (91.9)	75 (86.2)	0.160
Problem getting better or worse in the last 3 months				0.218
Getting better	23 (5.8)	21 (6.8)	2 (2.3)	
Staying about the same	63 (15.9)	52 (16.8)	11 (12.6)	
Getting worse	308 (77.8)	234 (75.7)	74 (85.1)	
Don't know	2 (0.5)	2 (0.6)	0 (0.0)	
Duration of symptoms >6 months	299 (75.5)	226 (73.1)	73 (83.9)	0.055
HADS depression (≥8 points)	70 (17.7)	59 (19.1)	11 (12.6)	0.217
HADS anxiety (≥8 points)	80 (20.2)	55 (17.8)	25 (28.7)	<b>0.036</b>
SSM symptoms, median (IQR) <sup>b</sup>	3.1 [2.7, 3.6]	3.1 [2.7, 3.6]	3.1 [2.8, 3.4]	0.893
SSM function, median (IQR) <sup>c</sup>	2.2 [1.8, 2.8]	2.2 [1.8, 2.8]	2.2 [1.8, 2.6]	0.141
EQ-5D-3L SI, median (IQR) <sup>d</sup>	0.6 [0.2, 0.7]	0.6 [0.2, 0.7]	0.6 [0.4, 0.7]	0.979

Abbreviations: BMI, body mass index; CIRS, Cumulative Illness Rating Scale; IQR, interquartile range

<sup>a</sup> Living alone, or single/divorced/widowed and living in a nursing/residential home.

<sup>b</sup> score range 1-4 (best-worst); higher scores indicate more pain.

<sup>c</sup> score range 1-5 (best-worst); higher scores indicate more disability.

<sup>d</sup> score range -0.53-1.00 (worst-best); higher scores indicate better quality of life.



**eTable 6: Sensitivity analysis: cumulative incidence of revisions and 95% confidence intervals**

	<b>Decompression alone</b>		<b>Fusion</b>				
Time after index operation	Cumulative incidence, % (95% CI) <sup>a</sup>	No. at risk / of revisions <sup>b</sup>	Cumulative incidence, % (95% CI) <sup>a</sup>	No. at risk / of revisions <sup>b</sup>	Absolute risk difference, % (95% CI) <sup>a</sup>	Adj. absolute risk difference, % (95% CI) <sup>c,d</sup>	P value <sup>c</sup>
at index operation	n.a. (n.a.)	309 / 0	n.a. (n.a.)	87 / 0	n.a. (n.a.)	n.a. (n.a.)	n.a.
1 year	5.1 (2.5-7.5)	269 / 15	3.6 (0.0-7.5)	79 / 3	-1.5 (-6.1-3.2)	2.5 (-1.4-9.4)	0.335
2 years	8.7 (5.4-11.8)	243 / 25	9.7 (3.1-15.9)	70 / 8	1.0 (-6.0-8.2)	4.5 (-2.6-15.4)	0.316
3 years	10.9 (7.2-14.5)	46 / 31	13.7 (5.8-20.9)	10 / 11	2.8 (-5.4-11.1)	5.7 (-3.2-18.5)	0.305

Abbreviations: adj., adjusted; CI, confidence interval

In the sensitivity analysis also the patients without a complete follow-up of three years were included in the analysis (see Figure 1), i.e., “no longer interested” (n = 39), “died” (n = 16), “excluded by study nurse” (n = 11), “referred to assisted living residences” (n = 2).

<sup>a</sup> Unadjusted estimates.

<sup>b</sup> Cumulative numbers of revisions.

<sup>c</sup> From fully adjusted multivariate Cox proportional hazards regression model (using the variables age, sex, body mass index (BMI) ( $\geq 25$  kg/m<sup>2</sup>), current smoker, civil risk (living alone, or living in a nursing/residential home while being single, divorced, or widowed), duration of symptoms (>6 months), cumulative illness rating scale (CIRS), depression (Hospital Anxiety and Depression Scale (HADS) depression subscale  $\geq 8$  points), anxiety (HADS anxiety subscale  $\geq 8$  points), degenerative spondylolisthesis (Meyerding grade  $\geq 1$ ), stenotic levels (>1 stenotic level), and number of decompressed levels).

<sup>d</sup> The 95% CIs were obtained by the adjusted bootstrap percentile method from 2000 bootstrap iterations.

**eTable 7: Sensitivity analysis: multivariable Cox proportional hazards regression model**

<b>Covariate</b>	<b>Hazard ratio (95% CI)</b>	<b>p-value</b>
Fusion (type of index operation)	1.62 (0.76-3.46)	0.213
Age (centered)	0.99 (0.95-1.03)	0.592
Female	0.83 (0.41-1.67)	0.593
BMI ( $\geq 25$ kg/m <sup>2</sup> )	1.04 (0.51-2.12)	0.915
Civil risk <sup>a</sup>	0.93 (0.44-1.95)	0.852
Current smoker	0.61 (0.22-1.67)	0.336
Duration of symptoms (>6 months)	0.41 (0.21-0.80)	<b>0.008</b>
CIRS (centered)	1.05 (0.97-1.14)	0.257
Depression	2.42 (1.09-5.37)	<b>0.030</b>
Anxiety	1.40 (0.64-3.06)	0.405
Degenerative spondylolisthesis (Meyerding Grade $\geq$ I)	0.79 (0.41-1.52)	0.486
Number of stenotic levels (>1 level)	0.93 (0.34-2.49)	0.878
2 Decompressed levels	1.47 (0.65-3.29)	0.354
3 Decompressed levels	2.22 (0.91-5.44)	0.081

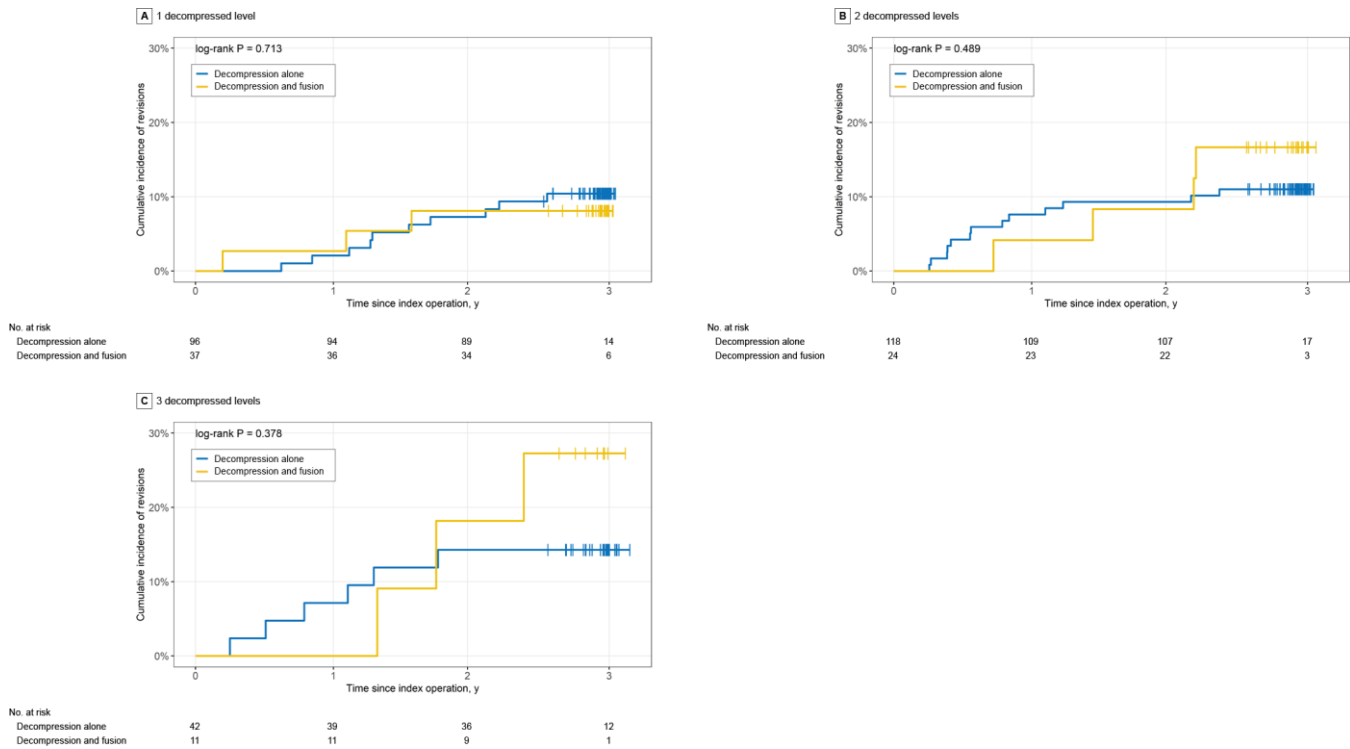
Overall tests: likelihood ratio test p=0.09

Abbreviations: BMI, body mass index; CI, confidence interval; CIRS, Cumulative Illness Rating Scale

In the sensitivity analysis also the following primarily excluded patients were included (see Figure 1): "no longer interested" (n = 39), "died" (n = 16), "excluded by study nurse" (n = 11), "referred to assisted living residences" (n = 2).

<sup>a</sup> Living alone, or single/divorced/widowed and living in a nursing/residential home

## eFigure: Cumulative incidence of revisions (Kaplan-Meier), stratified into number of decompressed levels



The date of the initial surgery was considered as the index date. Revision (event) is defined as a renewed operation on at least one level that was operated before (index level(s)) or on an adjacent segment after three months of the index operation.

Patients were stratified into number of decompressed levels, e.g., patients in the decompression alone group that underwent surgery only on 1 level were compared to patients in the fusion group that underwent surgery only on 1 level.