

Supplementary Table S1. Criteria for substantial clinical benefit (SCB) in the clinical scores

| Clinical score | Criteria for substantial clinical benefit (SCB) in the clinical score |
|----------------|---|
| VAS-BP | 2.5-point net improvement or 41.4% percent improvement (Glassman et al.; 2008) |
| VAS-LP | 2.5-point net improvement or 38.8% percent improvement (Glassman et al.; 2008) |
| ODI | 18.8-point net improvement or 36.8% percent improvement (Glassman et al.; 2008) |
| JOABPEQ | 20-point net improvement (Kasai et al.; 2017) |

VAS-BP, visual analog scale for back pain; VAS-LP, visual analog scale for leg pain; ODI, Oswestry disability index; JOABPEQ, Japanese Orthopedic Association Back Pain Evaluation Questionnaire

1 Supplementary Table S2. Preoperative and one-year postoperative clinical scores stratified by the maximum grade of central stenosis

| Clinical scores | The maximum grade of central stenosis | | | | | | | |
|---|---------------------------------------|--------------------------|--------------|-------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | A (n=11) | | B (n=20) | | C (n=59) | | D (n=55) | |
| | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year |
| ODI | 38.4 ± 5.1 | 21.6 ± 5.7 | 37.3 ± 7.7 | 21.1 ± 7.4 | 34.6 ± 7.0 | 19.3 ± 7.0 | 34.8 ± 8.1 | 20.8 ± 7.8 |
| VAS BP | 7.6 ± 2.2 | 3.9 ± 2.7 | 6.3 ± 2.5 | 2.9 ± 2.7 | 6.9 ± 2.0 | 3.0 ± 2.4 | 6.3 ± 2.7 | 2.6 ± 2.3 |
| VAS LP | 8.5 ± 2.0 | 2.1 ± 2.0 | 7.7 ± 1.7 | 2.4 ± 3.2 | 7.5 ± 2.0 ^a | 1.7 ± 2.5 ^a | 7.9 ± 2.0 ^a | 1.4 ± 2.0 ^a |
| JOABPEQ LBP | 19.5 ± 25.0 | 67.5 ± 27.9 | 30.7 ± 29.8 | 77.1 ± 28.0 | 30.5 ± 25.7 | 71.4 ± 28.8 | 35.1 ± 28.8 | 79.5 ± 21.3 |
| JOABPEQ LF | 38.6 ± 30.3 ^b | 56.1 ± 32.1 ^b | 36.3 ± 35.0 | 65.0 ± 29.8 | 39.6 ± 31.4 | 57.1 ± 30.0 | 45.6 ± 29.7 | 56.8 ± 28.2 |
| JOABPEQ WA | 15.6 ± 17.4 | 73.4 ± 28.8 | 15.6 ± 21.7 | 80.7 ± 30.2 | 20.2 ± 20.2 ^a | 81.0 ± 29.9 ^a | 16.4 ± 15.7 ^a | 78.3 ± 30.0 ^a |
| JOABPEQ SLF | 14.0 ± 11.9 | 57.5 ± 30.8 | 14.0 ± 21.6 | 59.6 ± 28.7 | 22.6 ± 16.1 ^a | 63.7 ± 25.2 ^a | 23.0 ± 17.8 | 58.7 ± 29.8 |
| JOABPEQ MH | 29.9 ± 19.6 | 55.8 ± 23.8 | 29.9 ± 14.2 | 60.3 ± 20.9 | 41.2 ± 21.3 | 68.6 ± 18.1 | 38.4 ± 19.1 | 66.9 ± 21.4 |
| All scores are presented as mean ± standard deviation.; All preoperative scores showed significant improvement at 1-year postoperatively for paired <i>t</i> -tests or Wilcoxon signed rank tests ^a (<i>P</i> < 0.05) except JOABPEQ_LF in grade 0 of maximal central stenosis (<i>P</i> = 0.238) ^b . No significant difference in preoperative and postoperative scores for one-way ANOVA test or Kruskal-Wallis test is observed between four groups. | | | | | | | | |

2 ODI, Oswestry disability index; VAS-BP, visual analog scale for back pain; VAS-LP, visual analog scale for leg pain; JOABPEQ, Japanese Orthopedic Association Back

3 Pain Evaluation Questionnaire; LBP, lower back pain; LF, lumbar function; WA, walking ability; SLF, social life function; MH, mental health

1 Supplementary Table S3. Preoperative and one-year postoperative clinical scores stratified by the existence of severe central stenosis

| Clinical scores | The maximum grade of central stenosis | | | |
|--|---------------------------------------|--------------------------|--------------------------|--------------------------|
| | A, B, or C (n = 90) | | D (n = 55) | |
| | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year |
| ODI | 35.6 ± 7.0 | 20.0 ± 7.0 | 34.8 ± 8.1 | 20.8 ± 7.8 |
| VAS BP | 6.8 ± 2.2 | 3.1 ± 2.5 | 6.3 ± 2.7 | 2.6 ± 2.3 |
| LP | 7.7 ± 1.9 ^a | 1.9 ± 2.6 ^a | 7.9 ± 2.0 ^a | 1.4 ± 2.0 ^a |
| JOABPEQ LBP | 29.2 ± 26.5 ^a | 72.2 ± 28.4 ^a | 35.1 ± 28.8 | 79.5 ± 21.3 |
| LF | 38.7 ± 31.7 | 58.7 ± 30.1 | 45.6 ± 29.7 | 56.8 ± 28.2 |
| WA | 19.3 ± 20.1 ^a | 80 ± 29.6 ^a | 16.4 ± 15.7 ^a | 78.3 ± 30.0 ^a |
| SLF | 21.1 ± 17.1 | 62.0 ± 26.5 | 23.0 ± 17.8 | 58.7 ± 29.8 |
| MH | 38.3 ± 20.0 | 65.2 ± 19.9 | 38.4 ± 19.1 | 66.9 ± 21.4 |
| All scores are presented as mean ± standard deviation. All preoperative scores showed significant improvement at 1-year postoperatively for paired <i>t</i> -tests or Wilcoxon signed rank tests ^a (<i>P</i> < 0.05). There is no significant difference in preoperative and postoperative scores for student <i>t</i> -test between two groups. | | | | |

2 ODI, Oswestry disability index; VAS-BP, visual analog scale for back pain; VAS-LP, visual analog scale for leg pain; JOABPEQ, Japanese Orthopedic Association Back

3 Pain Evaluation Questionnaire; LBP, lower back pain; LF, lumbar function; WA, walking ability; SLF, social life function; MH, mental health

1 Supplementary Table S4. Preoperative and one-year postoperative clinical scores stratified by the maximum grade of foraminal stenosis

| | | The maximum grade of foraminal stenosis | | | | | | | |
|---|-----|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | | 0 (n=16) | | 1 (n=29) | | 2 (n=26) | | 3 (n=74) | |
| Clinical scores | | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year |
| ODI | | 35.1 ± 9.6 | 19.0 ± 5.3 | 35.5 ± 6.8 | 19.5 ± 7.0 | 34.4 ± 7.3 | 18.2 ± 6.3 | 35.6 ± 7.3 | 21.7 ± 8.0 |
| VAS | LBP | 6.4 ± 2.6 | 2.7 ± 2.3 | 6.5 ± 2.3 | 2.7 ± 2.3 | 6.4 ± 2.5 | 2.8 ± 2.4 | 6.9 ± 2.3 | 3.1 ± 2.6 |
| | LP | 8.1 ± 1.5 | 2.1 ± 2.4 | 7.4 ± 2.5 ^a | 2.0 ± 2.8 ^a | 7.9 ± 1.9 | 1.3 ± 1.7 | 7.8 ± 1.8 ^a | 1.7 ± 2.5 ^a |
| JOABPEQ | LBP | 29.5 ± 22.4 ^a | 75.9 ± 23.2 ^a | 32.0 ± 28.5 | 76.4 ± 30.1 | 43.4 ± 33.0 | 78.0 ± 25.6 | 27.4 ± 25.1 | 73.2 ± 25.5 |
| | LF | 44.8 ± 34.8 ^b | 62.0 ± 31.8 ^b | 40.5 ± 28.9 | 68.7 ± 26.8 | 40.7 ± 33.3 | 61.2 ± 26.6 | 41.1 ± 30.8 ^a | 51.8 ± 29.6 ^a |
| | WA | 22.8 ± 18.5 | 93.3 ± 12.9 | 18.7 ± 21.5 ^a | 85.2 ± 23.9 ^a | 17.9 ± 22.1 ^a | 83.5 ± 22.0 ^a | 17.1 ± 16.1 ^a | 72.6 ± 34.8 ^a |
| | SLF | 19.1 ± 15.4 | 71.0 ± 22.9 | 22.0 ± 20.8 | 66.5 ± 24.6 | 22.5 ± 15.9 | 58.0 ± 27.4 | 22.0 ± 17.1 ^a | 57.3 ± 29.5 ^a |
| | MH | 39.2 ± 14.6 | 66.4 ± 23.3 | 34.7 ± 22.0 | 69.0 ± 19.7 | 43.1 ± 22.8 | 65.5 ± 20.6 | 37.8 ± 18.4 | 64.6 ± 20.2 |
| <p>All scores are presented as mean ± standard deviation. All preoperative scores showed significant improvement at 1-year postoperatively for paired <i>t</i>-tests or Wilcoxon signed rank tests^a (<i>P</i> < 0.05) except JOABPEQ_LF in grade 0 of maximal foraminal stenosis (<i>P</i> = 0.105)^b. There is no significant difference in preoperative and postoperative scores for a one-way ANOVA test or Kruskal-Wallis test between four groups.</p> | | | | | | | | | |

2 ODI, Oswestry disability index; VAS-BP, visual analog scale for back pain; VAS-LP, visual analog scale for leg pain; JOABPEQ, Japanese Orthopedic Association Back

3 Pain Evaluation Questionnaire; LBP, lower back pain; LF, lumbar function; WA, walking ability; SLF, social life function; MH, mental health

1 Supplementary Table S5. Preoperative and one-year postoperative clinical scores stratified by the existence of severe foraminal stenosis

| Clinical scores | The maximum grade of foraminal stenosis | | | |
|---|---|----------------------------|--------------------------|----------------------------|
| | 0, 1, or 2 (n = 71) | | 3 (n = 74) | |
| | Preoperative | Postoperative 1-year | Preoperative | Postoperative 1-year |
| ODI | 35.0 ± 7.6 | 18.9 ± 6.3 ^b | 35.6 ± 7.3 | 21.7 ± 8.0 ^b |
| VAS BP | 6.4 ± 2.4 | 2.7 ± 2.3 | 6.8 ± 2.3 | 3.1 ± 2.6 |
| LP | 7.8 ± 2.1 ^a | 1.7 ± 2.3 ^a | 7.8 ± 1.8 ^a | 1.7 ± 2.5 ^a |
| JOABPEQ LBP | 35.6 ± 29.3 ^a | 76.9 ± 26.7 ^a | 27.4 ± 25.1 | 73.2 ± 25.5 |
| LF | 41.6 ± 31.5 | 64.4 ± 27.7 ^b | 41.1 ± 30.8 ^a | 51.8 ± 29.6 ^{a,b} |
| WA | 19.3 ± 20.9 ^a | 86.4 ± 21.3 ^{a,b} | 17.1 ± 16.1 ^a | 72.6 ± 34.8 ^{a,b} |
| SLF | 21.5 ± 17.8 | 64.4 ± 25.5 | 22.0 ± 17.1 ^a | 57.3 ± 29.5 ^a |
| MH | 38.8 ± 20.9 | 67.1 ± 20.6 | 37.8 ± 18.4 | 64.6 ± 20.2 |
| All scores are presented as mean ± standard deviation. All preoperative scores showed significant improvement at 1-year postoperatively for paired <i>t</i> -tests or Wilcoxon signed rank tests ^a (<i>P</i> < 0.05). Group with severe foraminal stenosis showed a significantly higher ODI (<i>P</i> =0.024), lesser lumbar function score, and walking ability score in JOABPEQ (<i>P</i> =0.009 and 0.004, respectively) at 1-year postoperative for student <i>t</i> -test. ^b | | | | |

2 ODI, Oswestry disability index; VAS-BP, visual analog scale for back pain; VAS-LP, visual analog scale for leg pain; JOABPEQ, Japanese Orthopedic Association Back

3 Pain Evaluation Questionnaire; LBP, lower back pain; LF, lumbar function; WA, walking ability; SLF, social life function; MH, mental health

- 1 Supplementary Table S6. Univariate and multivariate logistic regression analyses on achieving substantial clinical
 2 benefit (SCB) in Oswestry disability index (ODI) 1 year postoperatively.

| | Univariate analysis | | Multivariate analysis | |
|--|---------------------|----------------|-------------------------|----------------|
| | Odds ratio (95% CI) | <i>P</i> value | Odds ratio (95% CI) | <i>P</i> value |
| Age (years) | 0.92 (0.87–0.97) | 0.001 | 0.92 (0.88-0.98) | 0.004 |
| Sex (male) | 0.84 (0.41–1.74) | 0.645 | | |
| BMI | 1.00 (0.95–1.05) | 0.976 | | |
| Preoperative diagnosis | | 0.007 | | 0.040 |
| Degenerative spondylolisthesis ^a | 3.22 (1.55–6.69) | 0.002 | 2.68 (1.23-5.84) | 0.013 |
| Adjacent segment disease ^a | 1.47 (0.35–6.12) | 0.599 | 1.15 (0.25-5.40) | 0.856 |
| Previous operation history in index surgical level | 0.48 (0.20–1.18) | 0.111 | | 0.240 |
| Open posterior fusion | 0.26 (0.08–0.93) | 0.037 | | 0.124 |
| The number of surgical level | | 0.120 | | 0.307 |
| 2 ^b | 0.70 (0.32–1.49) | 0.349 | | |
| 3 ^b | 0.37 (0.14–0.96) | 0.041 | | |
| Maximum grade of central stenosis | | 0.686 | | |
| Grade B ^c | 1.02 (0.23–4.47) | 0.981 | | |
| Grade C ^c | 1.75 (0.48–6.48) | 0.399 | | |
| Grade D ^c | 1.35 (0.37–4.98) | 0.653 | | |
| Severe central stenosis | 0.94 (0.47–1.87) | 0.855 | | |
| Maximum grade of foraminal stenosis | | 0.316 | | |
| Grade 1 ^c | 1.19 (0.31–4.53) | 0.795 | | |
| Grade 2 ^c | 1.02 (0.27–3.93) | 0.974 | | |
| Grade 3 ^c | 0.57 (0.18–1.79) | 0.331 | | |
| Severe foraminal stenosis | 0.52 (0.26–1.04) | 0.063 | | 0.547 |
| Foraminal osteophyte of SAP | 0.15 (0.04–0.57) | 0.006 | 0.20 (0.05-0.81) | 0.024 |
| Endplate lesion | | 0.453 | | |
| Soft tissue buckling | 1.50 (0.72–3.11) | 0.281 | | |
| Bony spur | 0.76 (0.14–4.19) | 0.753 | | |
| Instability | 3.37 (1.66–6.82) | 0.001 | | 0.420 |
| Decreased disc height | | 0.257 | | |
| Only in standing | 5.89 (0.68–50.75) | 0.107 | | |
| Always | 1.02 (0.49–2.13) | 0.964 | | |
| Facet cyst | 0.78 (0.17–3.63) | 0.753 | | |
| Sequestered disc | 0.62 (0.23–1.63) | 0.330 | | |

| | | | | |
|---|------------------|-------|--|--|
| Cage subsidence | 0.92 (0.44–1.90) | 0.819 | | |
| Postoperative radiating pain | 0.88 (0.24–3.28) | 0.852 | | |
| Postoperative infection | 0.89 (0.14–5.48) | 0.897 | | |
| ^a Odds compared to spinal stenosis without spondylolisthesis, ^b Odds compared to single level, ^c Odds compared to grade A or 0 | | | | |

1 ODI, Oswestry disability index; BMI, body mass index; CI, confidence interval; SAP, superior articular plate

- 1 Supplementary Table S7. Univariate and multivariate logistic regression analyses on achieving substantial clinical
 2 benefit (SCB) in the walking ability score in JOABPEQ 1 year postoperatively.

| | Univariate analysis | | Multivariate analysis | |
|--|---------------------|------------------|-------------------------|----------------|
| | Odds ratio (95% CI) | <i>P</i> value | Odds ratio (95% CI) | <i>P</i> value |
| Age (years) | 0.96 (0.90–1.03) | 0.211 | | |
| Sex (male) | 1.30 (0.44–3.87) | 0.634 | | |
| BMI | 1.02 (0.94–1.120) | 0.678 | | |
| Preoperative diagnosis | | 0.216 | | |
| Degenerative spondylolisthesis ^a | 1.04 (0.35–3.05) | 0.948 | | |
| Adjacent segment disease ^a | 0.27 (0.05–1.39) | 0.118 | | |
| Previous operation history in index surgical level | 0.14 (0.05–0.40) | <0.001 | 0.15 (0.05-0.45) | 0.001 |
| Open posterior fusion | 0.17 (0.05–0.59) | 0.006 | | 0.344 |
| The number of surgical level | | 0.754 | | |
| 2 ^b | 0.97 (0.34–2.74) | 0.951 | | |
| 3 ^b | 1.77 (0.36–8.74) | 0.481 | | |
| Maximum grade of central stenosis | | 0.877 | | |
| Grade B ^c | 0.57 (0.05–6.21) | 0.642 | | |
| Grade C ^c | 0.56 (0.06–4.89) | 0.596 | | |
| Grade D ^c | 0.82 (0.09–7.55) | 0.858 | | |
| Severe central stenosis | 1.38 (0.49–3.87) | 0.542 | | |
| Maximum grade of foraminal stenosis | | 0.130 | | 0.478 |
| Grade 1 ^c | | 0.268 | | |
| Grade 2 ^c | | 0.794 | | |
| Grade 3 ^c | | 0.034 | | |
| Severe foraminal stenosis | 0.33 (0.11–0.96) | 0.041 | | 0.415 |
| Foraminal osteophyte of SAP | 0.19 (0.06–0.66) | 0.009 | 0.22 (0.06-0.86) | 0.030 |
| Endplate lesion | | 0.355 | | |
| Soft tissue buckling | 0.39 (0.11–1.43) | 0.155 | | |
| Bony spur | 0.37 (0.03–4.22) | 0.420 | | |
| Instability | 1.46 (0.56–3.86) | 0.442 | | |
| Decreased disc height | | 0.354 | | |
| Only in standing | 0.30 (0.04–2.10) | 0.225 | | |
| Always | 0.42 (0.11–1.54) | 0.190 | | |
| Facet cyst | 0.18 (0.04–0.85) | 0.031 | | 0.115 |
| Sequestered disc | 0.78 (0.20–2.96) | 0.710 | | |

| | | | | |
|---|------------------|-------|--|-------|
| Cage subsidence | 0.43 (0.16–1.14) | 0.090 | | 0.191 |
| Postoperative radiating pain | 0.58 (0.11–2.94) | 0.508 | | |
| Postoperative infection | 0.59 (0.06–5.58) | 0.645 | | |
| ^a Odds compared to spinal stenosis without spondylolisthesis, ^b Odds compared to single level, ^c Odds compared to grade A or 0 | | | | |

1 ODI, Oswestry disability index; BMI, body mass index; CI, confidence interval; SAP, superior articular plate