Supplemental Online Content

Ghogawala Z, Terrin N, Dunbar MR, et al. Effect of ventral vs dorsal spinal surgery on patient-reported physical functioning in patients with cervical spondylotic myelopathy: a randomized clinical trial. *JAMA*. Published March 9, 2021. doi:10.1001/jama.2021.1233

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

eTable 1. CSM-S Trial Enrollment by Site and Strategy

Site (Principal Investigator)	Dorsal Laminoplasty	Dorsal Fusion	Ventral Fusion	Total
Lahey Hospital & Medical Center (Ghogawala)	6	13	12	31
Rutgers, The State University of New Jersey (Heary)	0	7	4	11
University of Utah Hospital (Bisson)	6	2	7	15
Cleveland Clinic Foundation (Benzel)	0	7	3	10
Thomas Jefferson University Hospital (Harrop)	2	6	4	12
University of Pittsburgh Medical Center (Kanter)	1	11	10	22
Washington University School of Medicine (Riew)	4	1	2	7
MetroHealth Medical Center (Steinmetz)	0	1	0	1
Medical College of Wisconsin (Wang)	0	3	3	6
Toronto Western Hospital, University Health Network (Fehlings)	0	5	5	10
Hospital for Special Surgery, New York City (Albert)	6	2	2	10
Emory University School of Medicine (Heller)	1	0	1	2
University of California, San Francisco (Mummaneni)	2	7	7	16
Columbia University Medical Center (Riew)	0	1	1	2
University of Kansas Medical Center (Arnold)	0	3	5	8
Total Patients	28	69	66	163

eTable 2. Baseline Characteristics of Patients by Actual Treatment Groups

	Dorsal Laminoplasty	Dorsal Fusion	Ventral Fusion
	n=28	n=69	n=66
Age, mean (SD)[a]	62.3 (8.9)	62.7 (8.7)	61.9 (7.4)
Sex			
Male	13 (46)	37 (54)	30 (45)
Female	15 (54)	32 (46)	36 (55)
Race			
White	27 (96)	57 (83)	55 (83)
Black	0	6 (9)	7 (11)
Asian	1 (4)	2 (3)	2 (3)
American Indian	0	2 (3)	2 (3)
Not provided	0	2 (3)	0
Hispanic ethnicity	1 (4)	3 (4)	2 (3)
Baseline work status			
Working full-time	12 (43)	26 (38)	19 (29)
Retired	7 (25)	22 (32)	14 (21)
Not working, unable to work	5 (18)	14 (20)	16 (24)
Not working, but able to work	4 (14)	2 (3)	9 (14)
Working part-time	0	3 (4)	8 (12)
ASA[b]			
1 (healthy)	0	1 (1.5)	0
2 (mild systemic disease)	12 (43)	33 (48)	32 (48.5)
3 (significant systemic disease)	15 (53.5)	34 (49)	32 (48.5)
Number of stenotic levels, mean (SD)	2.8 (0.6)	2.9 (0.8)	2.7 (0.7)
Number of stenotic levels			
1	0	2 (3)	1 (1.5)
2	9 (32)	19 (27)	23 (35)
3	17 (61)	37 (54)	34 (51.5)
4	2 (7)	9 (13)	8 (12)
5	0	2 (3)	0
Neck Disability Index[c], mean (SD)	33.0 (18.6)	37.3 (20.9)	37.3 (19.5)
SF-36 Mental Component Summary[d], mean (SD)	48.8 (8.9)	46.0 (13.2)	45.3 (12.1)
SF-36 Physical Component Summary[d], mean (SD)	36.7 (10.9)	37.1 (9.4)	37.8 (9.0)
Modified Japanese Orthopedic Association[e], mean (SD)	12.5 (2.6)	11.9 (2.1)	12.3 (2.7)
EuroQoL-5 Dimensions[f], mean (SD)	0.64 (0.22)	0.60 (0.21)	0.63 (0.22)
EuroQoL-5 Dimensions Visual Analog Scale[f], mean (SD)	65.2 (21.0)	61.1 (22.7)	62.8 (20.1)

[a]Data are presented as n (%) unless otherwise noted.
[b]The American Society of Anesthesiologists (ASA) classification is used to assess a patient's physical health and co-morbidities in order to predict perioperative risk prior to surgery; I=normal/healthy, II=mild systemic disease, III=significant systemic disease, IV=systemic disease that is life threatening (excluded from study).[1]
[c]Neck Disability Index, range 0-100, with lower scores representing less disability. A typical patient with moderate neck pain and disability would have a score between 20-40.
[d]SF-36 Mental Component Summary and Physical Component Summary scores range from 0-100, with higher scores representing better quality of life. A typical patient with cervical myelopathy who is being recommended surgery would have a score between 30-40.
[e]Modified Japanese Orthopedic Association, range 0-17, with higher scores representing less dysfunction from myelopathy. A typical patient with moderate cervical myelopathy has a mJOA score between 12 and 14. Many other surgical studies show that patients with cervical myelopathy have mJOA scores in this range.[2]
[f]EuroQol-5 Dimensions (EQ-5D), 0 indicates death and 1 represents a perfect health state. For EQ-5D Visual Analogy Scale, patients represent their health state on a scale from 0-100, with higher scores representing better health. EQ-5D scores between 0.6 and 0.7 represent a moderate but significant reduction in overall health-related quality of life.

eTable 3. Comparison of 1- and 2-Year Change in SF-36 Physical Component Summary Score

	Dorsal	Ventral	Estimated between-group difference in mean change (95% CI)[b]	p-value[b]
	n=97	n=60		
Mean at baseline (SD)	37.6 (9.9)	37.6 (8.9)	-	-
Mean at one year (SD)[a]	n=95 44.0 (10.5)	n=60 43.5 (10.7)	-	-
One-year mean change from baseline (SD)	6.2 (10.2)	5.9 (8.2)	0.3 (-2.6, 3.1)	0.859
Mean at two years (SD)[a]	n=79 43.6 (10.8)	n=51 43.4 (10.5)	-	-
Two-year mean change from baseline (SD)	6.0 (11.0)	5.2 (7.9)	1.1 (-1.9, 4.2)	0.458

[a]Some patients did not have data following baseline and are therefore not included in models.
[b]Estimated difference and p-values from linear mixed effects models adjusted for baseline values and clustering by surgeon.

eTable 4. Primary Analysis, Secondary Outcomes: Mixed Effects Model Comparisons of 1- and 2-Year Change in Outcome Scores by Randomized Groups

	Dorsal	Ventral	Estimated between-group difference in mean change (95% CI)[b]	p-value[b]
Neck Disability Index[a]	n=97	n=60		
Mean at baseline (SD)	35.4 (20.5)	38.1 (19.1)	-	-
Mean at one year (SD)	n=95 22.5 (20.3)	n=60 22.9 (20.1)	-	-
One-year mean change from baseline (SD)	-12.2 (17.9)	-15.1 (16.5)	1.6 (-3.6, 6.8)	0.54
Mean at two years (SD)	n=79 22.1 (21.3)	n=51 20.4 (20.2)	-	-
Two-year mean change from baseline (SD)	-13.0 (17.4)	-14.9 (18.1)	2.1 (-3.3, 7.4)	0.46
EuroQoL-5 Dimensions[a]	n=97	n=60		
Mean at baseline (SD)	0.61 (0.21)	0.64 (0.21)	-	-
Mean at one year (SD)	n=95 0.76 (0.19)	n=59 0.77 (0.21)	-	-
One-year mean change from baseline (SD)	0.15 (0.20)	0.13 (0.21)	0.00 (-0.05, 0.06)	0.97
Mean at two years (SD)	n=79 0.78 (0.19)	n=51 0.78 (0.20)	-	-
Two-year mean change from baseline (SD)	0.16 (0.22)	0.12 (0.23)	0.02 (-0.04, 0.08)	0.48
Modified Japanese Orthopedic Association[a]	n=91	n=60		
Mean at baseline (SD)	12.2 (2.3)	12.2 (2.7)	-	-
Mean at one year (SD)	14.2 (2.5)	14.5 (2.6)	-	-
One-year mean change from baseline (SD)	2.0 (2.9)	2.4 (2.9)	-0.4 (-1.1, 0.4)	0.37
Post-Op SVA[a]	n=78	n=49		
Mean (SD)	26.7 (13.3)	23.2 (11.8)	3.5 (-1.0, 8.1)	0.13

[a]Some patients did not have data following baseline and are therefore not included in models.
[b]Estimated difference and p-values from linear mixed effects models adjusted for baseline values and clustering by surgeon.

eTable 5. Cumulative Health Resource Utilization Over 1-Year Between Ventral and Dorsal Approach

	Dorsal	Ventral	Difference (95% Confidence Interval)	p-value
All Data N (%)	n=100	n=63		
Diagnostic Testing (any)	77 (77.0)	52 (82.5)	5.5 (-6.9, 18.0)	0.40
MRI	43 (43.0)	28 (44.4)	1.4 (-14.2, 17.1)	0.86
CT	16 (16.0)	11 (17.5)	1.5 (-10.4, 13.3)	0.81
X-ray	64 (64.0)	50 (79.4)	15.4 (1.6, 29.1)	0.04
Physical Therapy (any utilization)	52 (52.0)	34 (54.0)	2.0 (-13.8, 17.7)	0.81
Ongoing[a] Physical Therapy	15 (15.0)	11 (17.5)	2.5 (-9.2, 14.2)	0.68
Opioid Use (any)	57 (57.0)	29 (46.0)	-11.0 (-26.6, 4.7)	0.17
Ongoing[a] Opioids	11 (11.0)	6 (9.5)	-1.4 (-11.0, 8.0)	0.76
Physician Appointments (any)	31 (31.0)	17 (27.0)	-4.0 (-18.2, 10.2)	0.58

[a]Ongoing indicates active use of health resources 1 year after surgery.

eTable 6. Baseline Characteristics of Dorsal Laminoplasty and Dorsal Fusion Patients Treated by Surgeons Who Performed Both Procedures[a]

	Dorsal Laminoplasty	Dorsal Fusion
	n=27 (47)	n=31 (53)
Age, mean (SD)[b]	62.4 (9.1)	62.9 (7.5)
Sex		
Male	12 (44)	16 (52)
Female	15 (56)	15 (48)
Race		
White	26 (96)	29 (94)
Black	0	1 (3)
Asian	1 (4)	0
American Indian	0	1 (3)
Hispanic ethnicity	0	1 (3)
Baseline work status	n=27	n=30
Working full-time	12 (44)	14 (47)
Retired	7 (26)	8 (27)
Not working, unable to work	4 (15)	5 (17)
Not working, but able to work	4 (15)	0
Working part-time	0	3 (10)
ASA[c]	n=26	n=31
I (healthy)	0	1 (3)
II (mild systemic disease)	12 (46)	19 (61)
III (significant systemic disease)	14 (54)	11 (35)
Number of stenotic levels, mean (SD)	2.8 (0.6)	2.8 (0.8)
Number of stenotic levels		
1	0	2 (6)
2	8 (30)	8 (26)
3	17 (63)	15 (48)
4	2 (7)	6 (19)
Neck Disability Index[d], mean (SD)	32.3 (18.7)	36.3 (18.9)
SF-36 Mental Component Summary[e], mean (SD)	49.2 (8.8)	46.0 (10.5)
SF-36 Physical Component Summary[e], mean (SD)	37.0 (10.9)	39.0 (9.4)
Modified Japanese Orthopedic Association[f], mean (SD)	12.5 (2.7)	12.0 (2.1)
EuroQoL-5 Dimensions[g], mean (SD)	0.65 (0.22)	0.62 (0.21)
EuroQoL-5 Dimensions Visual Analog Scale[g], mean (SD)	66.5 (20.2)	61.3 (22.7)

[a]8/24 CSM-S spine surgeons treated patients for either dorsal laminoplasty or dorsal fusion in the trial, representing 27 and 31 enrolled patients, respectively, in each of the dorsal approaches. One spine surgeon performing laminoplasty moved institutions during the course of the trial and enrolled patients at both sites.

[b]Data are presented as n (%), unless otherwise noted. All baseline values/ scores were not different between groups at the time of enrollment (p>0.10).

[c] The American Society of Anesthesiologists (ASA) classification is used to assess a patient's physical health and co-morbidities in order to predict perioperative risk prior to surgery; I=normal/healthy, II=mild systemic disease, III=significant systemic disease, IV=systemic disease that is life threatening (excluded from study).[1]

[d]Neck Disability Index (NDI), range 0-100, with a lower score representing less disability. A typical patient with moderate neck pain and disability would have a score between 20-40.

[e]SF-36 Mental Component Summary (MCS) and Physical Component Summary (PCS) scores, range 0-100, with a mean population score of 50 and higher scores representing better quality of life. A typical patient with cervical myelopathy who is being recommended surgery would have a score between 30-40.

[f]Modified Japanese Orthopedic Association (mJOA), range 0-17, with higher scores representing less dysfunction from myelopathy. A typical patient with moderate cervical myelopathy has a mJOA score between 12 and 14. Many other surgical studies show that patients with cervical myelopathy have mJOA scores in this range.[2]

[g]EuroQol-5 Dimensions (EQ-5D), 0 indicates death and 1 represents a perfect health state. For EQ-5D Visual Analogy Scale, patients represent their health state on a scale from 0-100, with higher scores representing better health. EQ-5D scores between 0.6 and 0.7 represent a moderate but significant reduction in overall health-related quality of life.

eTable 7. Secondary Analysis, Primary Outcome: Mixed Effects Model Comparisons of 1- and 2-Year Change in Outcome Scores by Actual Treatment Groups

	Dorsal Laminoplasty	Dorsal Fusion	Ventral Fusion	Estimated between-group difference in mean change (95% CI)[b]	p-value [b]
SF-36 Physical Component Summary[a]	n=26	n=68	n=63		
Mean at baseline (SD)	37.3 (11.1)	37.3 (9.4)	38.1 (9.1)	-	-
Mean at one year (SD)	n=26 47.1 (9.7)	n=66 42.5 (10.4)	n=63 43.8 (10.9)	-	-
One-year mean change from baseline (SD)	9.8 (9.3)	5.0 (10.4)	5.7 (8.0)	DL vs VF: 3.88 (-0.17, 7.94) DL vs DF: 4.99 (0.95, 9.04) DF vs VF: -1.11 (-4.11, 1.88)	0.06 0.02 0.46
Mean at two years (SD)	n=21 48.3 (9.3)	n=55 41.5 (10.6)	n=54 43.8 (10.7)	-	-
Two-year mean change from baseline (SD)	9.7 (9.7)	4.5 (11.5)	5.3 (7.8)	DL vs VF: 5.08 (0.80, 9.37) DL vs DF: 5.82 (1.53, 10.1) DF vs VF: -0.74 (-3.88, 2.41)	0.02 0.01 0.65

[a]Some patients did not have data following baseline and are therefore not included in models.
[b]Estimated difference and p-values from linear mixed effects models adjusted for baseline values and clustering by surgeon.

eTable 8. Secondary Analysis, Secondary Outcomes: Mixed Effects Model Comparisons of 1- and 2-Year Change in Outcome Scores by Actual Treatment Groups

	Dorsal Laminoplasty	Dorsal Fusion	Ventral Fusion	Estimated between-group difference in mean change (95% CI) [b]	p-value [b]
Neck Disability Index[a]	n=26	n=68	n=63		
Mean at baseline (SD)	32.9 (18.3)	37.4 (21.0)	36.8 (19.5)	-	-
Mean at one year (SD)	n=26 15.2 (15.6)	n=66 26.0 (21.3)	n=63 22.2 (19.9)	-	-
One-year mean change from baseline (SD)	-17.7 (17.5)	-10.4 (18.0)	-14.6 (16.3)	DL vs VF: -4.48 (-11.7, 2.75) DL vs DF: -8.37 (-15.5, -1.20)	0.22 0.02
Mean at two years (SD)	n=21 16.7 (17.0)	n=55 24.4 (22.8)	n=54 20.2 (19.8)	-	-
Two-year mean change from baseline (SD)	-16.4 (14.9)	-12.0 (18.5)	-14.5 (17.8)	DL vs VF: -2.37 (-9.97, 5.23) DL vs DF: -5.61 (-13.2, 1.94)	0.54 0.15
EuroQoL-5 Dimensions[a]	n=26	n=68	n=63		
Mean at baseline (SD)	0.65 (0.22)	0.60 (0.21)	0.63 (0.21)	-	-
Mean at one year (SD)	n=26 0.84 (0.15)	n=66 0.73 (0.19)	n=62 0.77 (0.21)	-	-
One-year mean change from baseline (SD)	0.19 (0.22)	0.12 (0.19)	0.14 (0.21)	DL vs VF: 0.07 (-0.01, 0.14) DL vs DF: 0.11 (0.03, 0.19)	0.08 0.01
Mean at two years (SD)	n=21 0.87 (0.13)	n=55 0.75 (0.19)	n=54 0.77 (0.20)	-	-
Two-year mean change from baseline (SD)	0.20 (0.17)	0.14 (0.22)	0.12 (0.25)	DL vs VF: 0.12 (0.03, 0.20) DL vs DF: 0.12 (0.04, 0.21)	0.01 0.01
Modified Japanese Orthopedic Association[a]	n=26	n=62	n=63		
Mean at baseline (SD)	12.7 (2.6)	11.9 (2.1)	12.3 (2.7)	-	-
Mean at one year (SD)	15.1 (2.0)	13.8 (2.7)	14.5 (2.6)	-	-
One-year mean change from baseline (SD)	2.4 (2.7)	1.9 (3.0)	2.2 (2.9)	DL vs VF: 0.4 (-0.7, 1.5) DL vs DF: 1.0 (-0.1, 2.1)	0.43 0.07
Post-Op SVA[a]	n=20	n=55	n=52		
Mean (SD)	24.3 (13.4)	27.9 (12.8)	23.1 (12.3)	DL vs VF: 0.9 (-5.6, 7.5) DL vs DF: -3.8 (-10.3, 2.7)	0.78 0.25

[a]Some patients did not have data following baseline and are therefore not included in models.
[b]Estimated difference and p-values from linear mixed effects models adjusted for baseline values and clustering by surgeon.
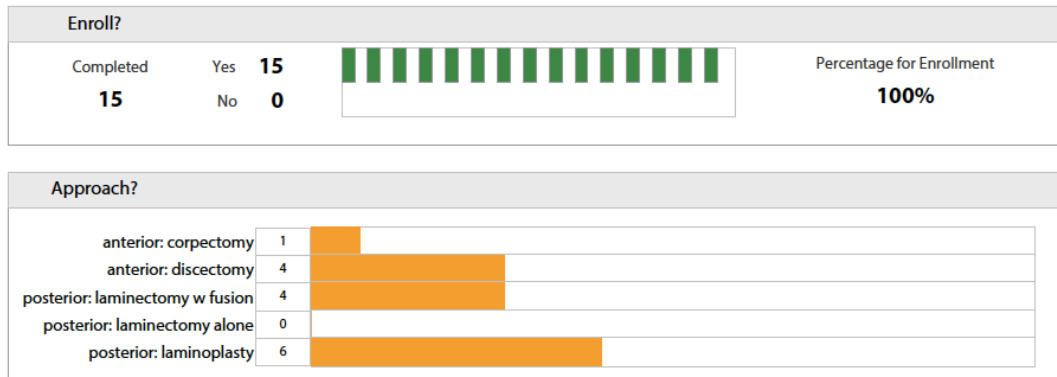
At year 1, dorsal laminoplasty was associated with significant greater mean change in EQ-5D compared to dorsal fusion (estimated mean change, 0.21 vs. 0.10; estimated mean difference, 0.11 [95% CI, 0.03, 0.19]; P=0.007), but not ventral fusion patients (estimated mean change, 0.21 vs. 0.14; estimated mean difference, 0.07 [95% CI, -0.01, 0.15]; P=0.08. At year 2, dorsal laminoplasty was associated with significantly greater mean change in EQ-5D compared to both dorsal fusion patients (estimated mean change, 0.24 vs. 0.12; estimated mean difference, 0.12 [95% CI, 0.04, 0.21]; P=0.005) and ventral fusion patients (estimated mean change, 0.24 vs. 0.12; estimated mean difference, 0.12, [95% CI 0.03, 0.20]; P=0.006). No other significant differences in three other pre-specified outcomes were observed between groups at 2-years post-operatively.

eTable 9. Cumulative Health Resource Utilization Over 1-Year Varied by Actual Treatment Groups

	Dorsal Laminoplasty	Dorsal Fusion	Ventral Fusion	Difference (95% Confidence Interval)	p-value
All Data N (%)	n=28	n=69	n=66		
Diagnostic Testing (any)	17 (60.7)	60 (87.0)	52 (78.8)	DL vs VF: 18.1 (-2.5, 38.7) DL vs DF: 26.2 (6.5, 46.0)	0.02
MRI	11 (39.3)	32 (46.4)	28 (42.4)	DL vs VF: 3.1 (-18.5, 24.8) DL vs DF: 7.1 (-14.5, 28.7)	0.79
CT	4 (14.3)	11 (15.9)	12 (18.2)	DL vs VF: 3.9 (-12.1, 19.9) DL vs DF: 1.7 (-13.9, 17.2)	0.88
X-ray	13 (46.4)	51 (73.9)	50 (75.8)	DL vs VF: 29.3 (8.2, 50.5) DL vs DF: 27.5 (6.3, 48.7)	0.01
Physical Therapy (any utilization)	13 (46.4)	39 (56.5)	34 (51.5)	DL vs VF: 5.1 (-17.0, 27.1) DL vs DF: 10.1 (-11.8, 32.0)	0.64
Ongoing[a] Physical Therapy	0 (0.0)	15 (21.7)	11 (16.7)	DL vs VF: 16.7 (7.7, 25.7) DL vs DF: 21.7 (12.0, 31.4)	0.03
Opioid Use (any)	11 (39.3)	45 (65.2)	30 (45.5)	DL vs VF: 6.2 (-15.5, 27.9) DL vs DF: 25.9 (4.6, 47.2)	0.02
Ongoing[a] Opioids	0 (0.0)	11 (15.9)	6 (9.1)	DL vs VF: 9.1 (2.2, 16.0) DL vs DF: 15.9 (7.3, 24.6)	0.06
Physician Appointments (any)	6 (21.4)	26 (37.7)	16 (24.2)	DL vs VF: 2.8 (-15.6, 21.2) DL vs DF: 16.3 (-2.7, 35.3)	0.14

[a]Ongoing indicates active use of health resources 1 year after surgery.

eFigure 1. Spinal Experts Review Polling Results

Enroll?

Completed	Yes	**15**		Percentage for Enrollment
15	No	**0**		**100%**

Approach?

anterior: corpectomy	1	
anterior: discectomy	4	
posterior: laminectomy w fusion	4	
posterior: laminectomy alone	0	
posterior: laminoplasty	6	

eFigure 1. A summary of expert panel review is shown for 1 patient in this trial. In this case, 15 experts voted in favor or randomization with 5 votes for a ventral surgery, 4 votes for dorsal laminectomy and fusion, and 6 votes for laminoplasty. Clinical equipoise was met and the patient consented to randomization.

eFigure 2. Surgical Strategies for Cervical Spondylotic Myelopathy
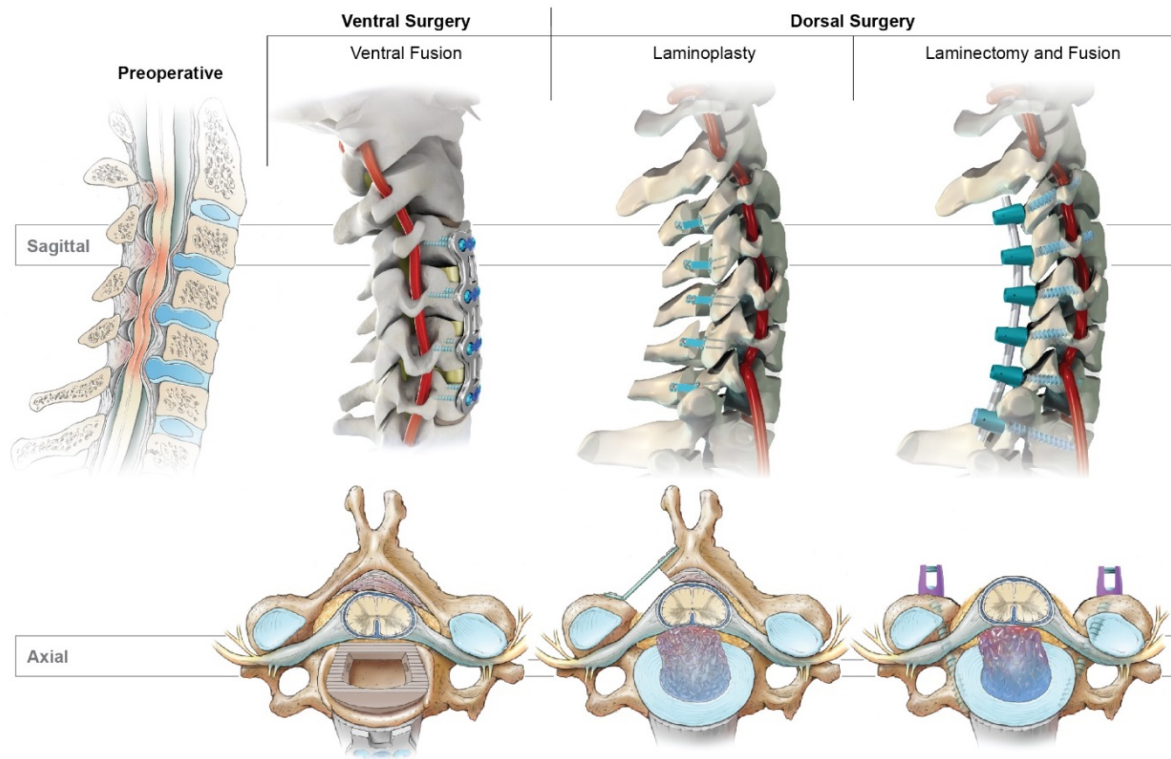
eFigure 2. A sagittal cross-section image is shown in the upper left, with evidence for spinal cord compression at multiple levels from cervical spondylosis, followed by schematics for each of the surgical approaches, ventral fusion, dorsal laminoplasty, and dorsal laminectomy and fusion. Below each surgical approach, an axial image is shown that demonstrates how the spinal cord is decompressed. In the ventral fusion example, the disc is removed and replaced with a bone graft or cage device. For laminoplasty, the disc remains, but the lamina is opened on one side and held open with a plate. For dorsal laminectomy and fusion, the lamina is removed to decompress the spinal cord and then screws and rods are placed to hold the spine in proper alignment so that the bones will fuse together.

eFigure 3. Return to Work

A. Ventral vs. dorsal
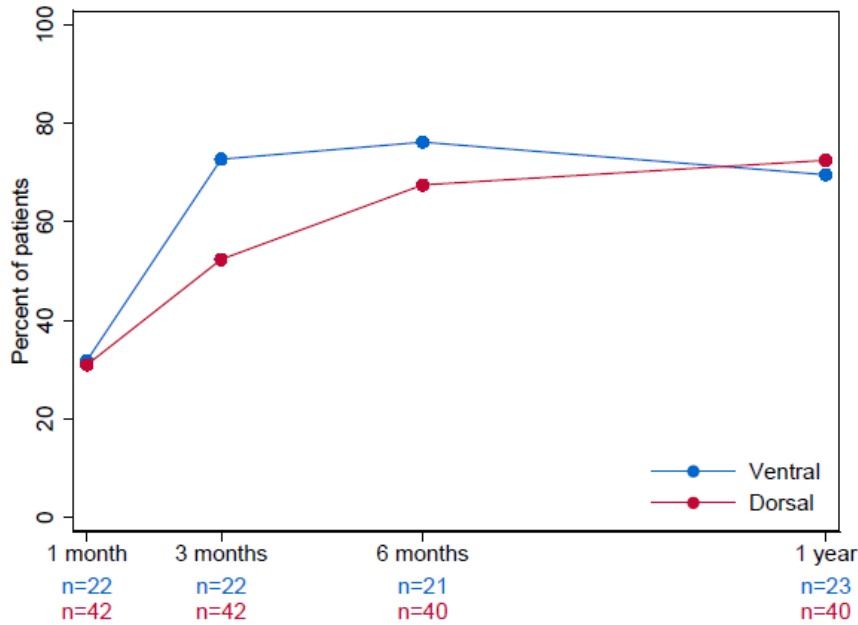
B. Actual treatment groups
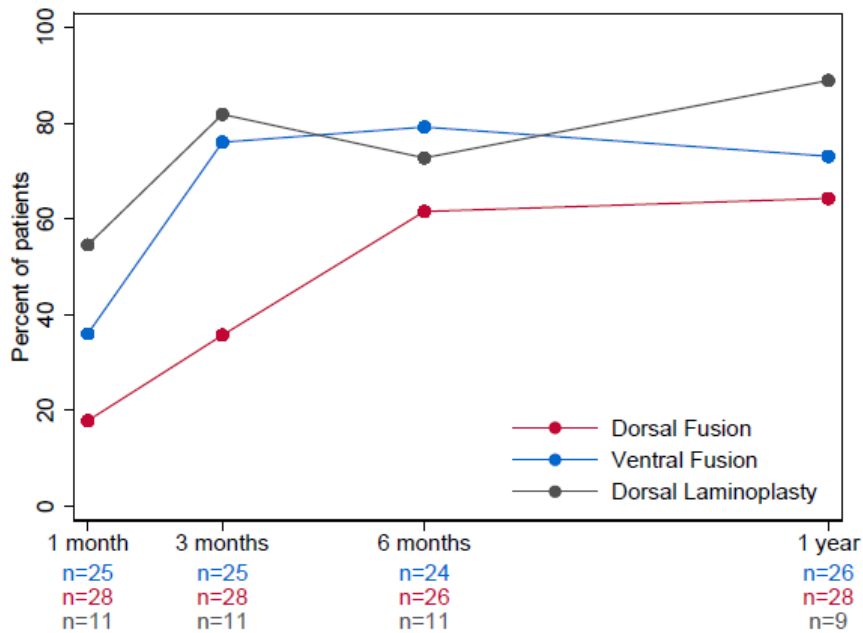
eFigure 3. Proportions of patients in each group who had returned to work are shown at 1, 3, 6, and 12 months after surgery. (B) At 1-year, the proportion of patients who returned to work did not significantly differ depending upon surgical strategy (dorsal laminoplasty, 88.9% [95% CI, 51.7%, 99.7%]; dorsal fusion, 64.3% [95% CI, 44.1%, 81.4%]; ventral fusion, 73.1% [95% CI, 52.2%, 88.4%]; (P=0.35).

eFigure 4. Secondary Analysis, Primary Outcome
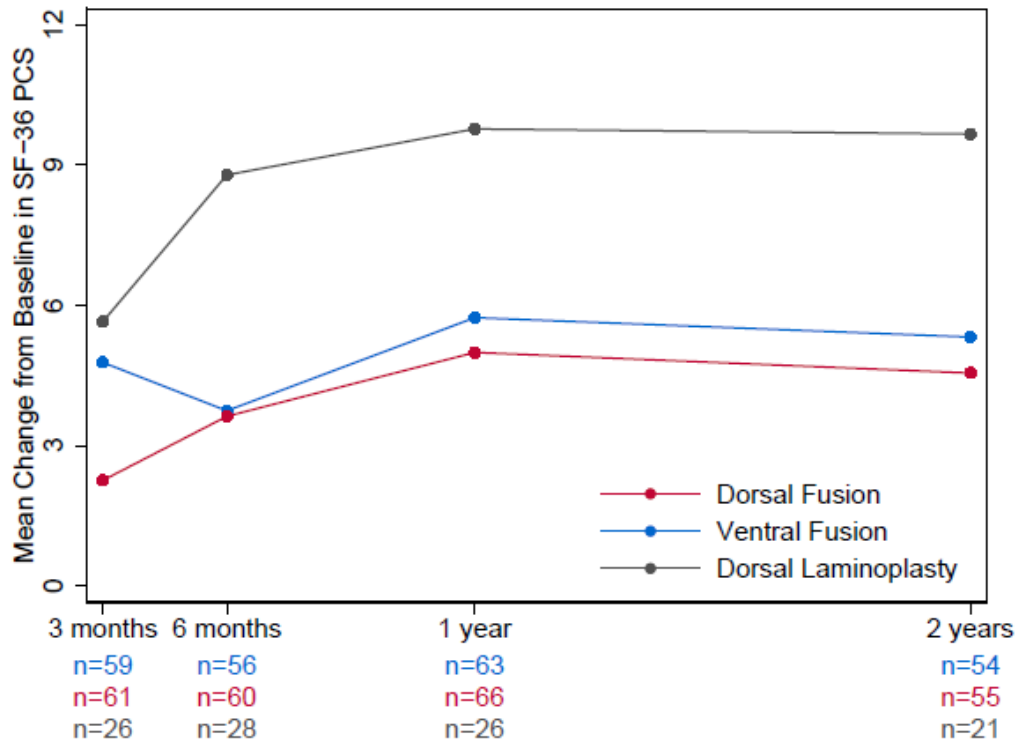
eFigure 4. Trajectory of change in SF-36 PCS by actual treatment groups.

eAppendix. Outcome Assessment Documents

Note: The EuroQol 5 Dimensions document is not included herein because of copyright constraints.

36-Item Short Form (SF-36) Health Survey (Version 2)
The physical component summary (PCS) score, derived from the 36-Item Short Form (SF-36) Health Survey (Version 2) was the primary outcome. The range of the SF-36 PCS is between 0 and 100, where higher scores represent better physical functioning.[3]

Your Health and Well-Being

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. *Thank you for completing this survey!*

For each of the following questions, please mark an ⊠ in the one box that best describes your answer.

1. In general, would you say your health is:

Excellent	Very good	Good	Fair	Poor
▼	▼	▼	▼	▼
☐₁	☐₂	☐₃	☐₄	☐₅

2. <u>Compared to one year ago</u>, how would you rate your health in general <u>now</u>?

Much better now than one year ago	Somewhat better now than one year ago	About the same as one year ago	Somewhat worse now than one year ago	Much worse now than one year ago
▼	▼	▼	▼	▼
☐₁	☐₂	☐₃	☐₄	☐₅

3. **The following questions are about activities you might do during a typical day. Does <u>your health now limit you</u> in these activities? If so, how much?**

		Yes, limited a lot ▼	Yes, limited a little ▼	No, not limited at all ▼
a	<u>Vigorous activities</u>, such as running, lifting heavy objects, participating in strenuous sports	☐ 1	☐ 2	☐ 3
b	<u>Moderate activities</u>, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	☐ 1	☐ 2	☐ 3
c	Lifting or carrying groceries	☐ 1	☐ 2	☐ 3
d	Climbing <u>several</u> flights of stairs	☐ 1	☐ 2	☐ 3
e	Climbing <u>one</u> flight of stairs	☐ 1	☐ 2	☐ 3
f	Bending, kneeling, or stooping	☐ 1	☐ 2	☐ 3
g	Walking <u>more than a mile</u>	☐ 1	☐ 2	☐ 3
h	Walking <u>several hundred yards</u>	☐ 1	☐ 2	☐ 3
i	Walking <u>one hundred yards</u>	☐ 1	☐ 2	☐ 3
j	Bathing or dressing yourself	☐ 1	☐ 2	☐ 3

4. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u>?

	All of the time ▼	Most of the time ▼	Some of the time ▼	A little of the time ▼	None of the time ▼
a Cut down on the <u>amount of time</u> you spent on work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b <u>Accomplished less</u> than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Were limited in the <u>kind</u> of work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d Had <u>difficulty</u> performing the work or other activities (for example, it took extra effort)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

5. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of any emotional problems</u> (such as feeling depressed or anxious)?

	All of the time ▼	Most of the time ▼	Some of the time ▼	A little of the time ▼	None of the time ▼
a Cut down on the <u>amount of time</u> you spent on work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b <u>Accomplished less</u> than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Did work or other activities <u>less carefully than usual</u>	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

6. **During the** <u>**past 4 weeks**</u>**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?**

Not at all	Slightly	Moderately	Quite a bit	Extremely
▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

7. **How much** <u>**bodily**</u> **pain have you had during the** <u>**past 4 weeks**</u>**?**

None	Very mild	Mild	Moderate	Severe	Very severe
▼	▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

8. **During the** <u>**past 4 weeks**</u>**, how much did** <u>**pain**</u> **interfere with your normal work (including both work outside the home and housework)?**

Not at all	A little bit	Moderately	Quite a bit	Extremely
▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

9. **These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks…**

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Did you feel full of life?	□ 1	□ 2	□ 3	□ 4	□ 5
b Have you been very nervous?	□ 1	□ 2	□ 3	□ 4	□ 5
c Have you felt so down in the dumps that nothing could cheer you up?	□ 1	□ 2	□ 3	□ 4	□ 5
d Have you felt calm and peaceful?	□ 1	□ 2	□ 3	□ 4	□ 5
e Did you have a lot of energy?	□ 1	□ 2	□ 3	□ 4	□ 5
f Have you felt downhearted and depressed?	□ 1	□ 2	□ 3	□ 4	□ 5
g Did you feel worn out?	□ 1	□ 2	□ 3	□ 4	□ 5
h Have you been happy?	□ 1	□ 2	□ 3	□ 4	□ 5
i Did you feel tired?	□ 1	□ 2	□ 3	□ 4	□ 5

10. **During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?**

All of the time	Most of the time	Some of the time	A little of the time	None of the time
□ 1	□ 2	□ 3	□ 4	□ 5

11. How TRUE or FALSE is each of the following statements for you?

		Definitely true ▼	Mostly true ▼	Don't know ▼	Mostly false ▼	Definitely false ▼
a	I seem to get sick a little easier than other people	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b	I am as healthy as anybody I know	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c	I expect my health to get worse	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d	My health is excellent	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Thank you for completing these questions!

Neck Disability Index (NDI)

The Neck Disability Index (NDI) measures how neck pain affects the patients' ability to manage in everyday life. Each section is scored on a scale of 0 to 5, where 0 = "no pain" and 5 = "worst imaginable pain." The summed total range is between 0 and 100, with a lower score representing less disability.[4]

Please Read: This questionnaire is designed to enable us to understand how much your neck pain has affected your ability to manage everyday activities. Please answer each Section by circling the **ONE CHOICE** that most applies to you. We realize that you may feel that more than one statement may relate to you, but Please **just circle the one choice** which closely describes your problem *right now.*

SECTION 1--Pain Intensity
A. I have no pain at the moment
B. The pain is mild at the moment.
C. The pain comes and goes and is moderate.
D. The pain is moderate and does not vary much.
E. The pain is severe but comes and goes.
F. The pain is severe and does not vary much.

SECTION 2--Personal Care (Washing, Dressing etc.)
A. I can look after myself without causing extra pain.
B. I can look after myself normally but it causes extra pain.
C. It is painful to look after myself and I am slow and careful.
D. I need some help, but manage most of my personal care.
E. I need help every day in most aspects of self-care.
F. I do not get dressed, I wash with difficulty and stay in bed.

SECTION 3--Lifting
A. I can lift heavy weights without extra pain.
B. I can lift heavy weights, but it causes extra pain.
C. Pain prevents me from lifting heavy weights off the floor but I can if they are conveniently positioned, for example on a table.
D. Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.
E. I can lift very light weights.
F. I cannot lift or carry anything at all.

SECTION 4 --Reading
A. I can read as much as I want to with no pain in my neck.
B. I can read as much as I want with slight pain in my neck.
C. I can read as much as I want with moderate pain in my neck.
D. I cannot read as much as I want because of moderate pain in my neck.
E. I cannot read as much as I want because of severe pain in my neck.
F. I cannot read at all.

SECTION 5--Headache
A. I have no headaches at all.
B. I have slight headaches which come infrequently.
C. I have moderate headaches which come in-frequently.
D. I have moderate headaches which come frequently.
E. I have severe headaches which come frequently.
F. I have headaches almost all the time.

SECTION 6 -- Concentration
A. I can concentrate fully when I want to with no difficulty.
B. I can concentrate fully when I want to with slight difficulty.
C. I have a fair degree of difficulty in concentrating when I want to.
D. I have a lot of difficulty in concentrating when I want to.
E. I have a great deal of difficulty in concentrating when I want to.
F. I cannot concentrate at all.

SECTION 7--Work
A. I can do as much work as I want to.
B. I can only do my usual work, but no more.
C. I can do most of my usual work, but no more.
D. I cannot do my usual work.
E. I can hardly do any work at all.
F. I cannot do any work at all.

SECTION 8--Driving
A. I can drive my car without neck pain.
B. I can drive my car as long as I want with slight pain in my neck.
C. I can drive my car as long as I want with moderate pain in my neck.
D. I cannot drive my car as long as I want because of moderate pain in my neck.
E. I can hardly drive my car at all because of severe pain in my neck.
F. I cannot drive my car at all.

SECTION 9--Sleeping
A. I have no trouble sleeping
B. My sleep is slightly disturbed (less than 1 hour sleepless).
C. My sleep is mildly disturbed (1-2 hours sleepless).
D. My sleep is moderately disturbed (2-3 hours sleepless).
E. My sleep is greatly disturbed (3-5 hours sleepless).
F. My sleep is completely disturbed (5-7 hours sleepless).

SECTION 10--Recreation
A. I am able engage in all recreational activities with no pain in my neck at all.
B. I am able engage in all recreational activities with some pain in my neck.
C. I am able engage in most, but not all recreational activities because of pain in my neck.
D. I am able engage in a few of my usual recreational activities because of pain in my neck.
E. I can hardly do any recreational activities because of pain in my neck.
F. I cannot do any recreational activities all all.

Subject ID:_____ Visit:_____

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DISABILITY INDEX SCORE: %_____

Modified Japanese Orthopedic Association (mJOA) Scale

The modified Japanese Orthopedic Association (mJOA) score is used to evaluate the functional status of patients with degenerative cervical myelopathy. Each section is summed to obtain a score (range = 0-17), with a higher score representing less dysfunction from myelopathy.[5] A typical patient with moderate cervical myelopathy has a mJOA score between 12 and 14. Many other surgical studies show that patients with cervical myelopathy have mJOA scores in this range.[2]

mJOA Scale

mJOA: _____ (0-17)

Motor, arms
0	Unable to feed oneself
1	Unable to use a knife and fork, able to eat with spoon
2	Able to use knife and fork with much difficulty
3	Able to use knife and fork with slight difficulty
4	No deficit

Motor, legs
0	Unable to walk
1	Can walk on flat floor with a walking aid
2	Can walk up or down stairs with a handrail
3	Lack of stability and smooth gait
4	No deficit

Sensation, arms
0	Severe sensory loss or pain
1	Mild sensory loss
2	No deficit

Sensation, legs
0	Severe sensory loss or pain
1	Mild sensory loss
2	No deficit

Sensation, trunk
0	Severe sensory loss or pain
1	Mild sensory loss
2	No deficit

Bladder function
0	Unable to void
1	Marked difficulty with micturation (retention)
2	Difficulty in micturation (frequency, hesitation)
3	No deficit

CSM-S Trial Investigators

The participating sites and investigators of the CSM-S Trial included:

Lahey Hospital & Medical Center – Zoher Ghogawala, MD, Subu N. Magge, MD,
   Robert G. Whitmore, MD
Rutgers New Jersey Medical School – Robert F. Heary, MD
University of Utah – Erica F. Bisson, MD
Cleveland Clinic Foundation – Edward C. Benzel, MD, Michael P. Steinmetz, MD[a]
Thomas Jefferson University – James Harrop, MD
Washington University School of Medicine – K. Daniel Riew, MD[b]
MetroHealth – Michael P. Steinmetz, MD
Medical College of Wisconsin – Marjorie C. Wang, MD, MPH
University of Pittsburgh Medical Center – Adam Kanter, MD
University of California San Francisco – Praveen V. Mummaneni, MD
University Health Network – Michael G. Fehlings, MD, PhD
Hospital for Special Surgery – Todd J. Albert, MD
Kansas University Medical Center – Paul M. Arnold, MD
Columbia University – K. Daniel Riew, MD
Emory University – John G. Heller, MD

[a]Michael P. Steinmetz, MD moved from MetroHealth to Cleveland Clinic Foundation
[b]K. Daniel Riew, MD moved from Washington University School of Medicine to Columbia University

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