Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Patient-Reported Outcomes After Anterior Cervical Discectomy and Fusion Plateau by 3 Months and Remain Stable Through 2 Years

Mitchell K. Ng

mitchng77@gmail.com

Rothman Orthopaedic Institute at Thomas Jefferson University

Morgan Hitchner

Rothman Orthopaedic Institute at Thomas Jefferson University

Yulia Lee

Rothman Orthopaedic Institute at Thomas Jefferson University

Gregorio Baek

Rothman Orthopaedic Institute at Thomas Jefferson University

Joshua Mathew

Rothman Orthopaedic Institute at Thomas Jefferson University

William A. Green

Rothman Orthopaedic Institute at Thomas Jefferson University

Yasmine K. Eichbaum

Rothman Orthopaedic Institute at Thomas Jefferson University

Divya Jain

Rothman Orthopaedic Institute at Thomas Jefferson University

Steven J. Banko

Rothman Orthopaedic Institute at Thomas Jefferson University

Saverio Esposito

Rothman Orthopaedic Institute at Thomas Jefferson University

Amrit Sandhu

Rothman Orthopaedic Institute at Thomas Jefferson University

Vijay A. Chhabra

Rothman Orthopaedic Institute at Thomas Jefferson University

Kathrynna Demetillo

Rothman Orthopaedic Institute at Thomas Jefferson University

Alec Giakas

Rothman Orthopaedic Institute at Thomas Jefferson University

Jonathan Dalton

Rothman Orthopaedic Institute at Thomas Jefferson University

Ali Farooqi
Rothman Orthopaedic Institute at Thomas Jefferson University
Emily Berthiaume
Rothman Orthopaedic Institute at Thomas Jefferson University
Jose A. Canseco
Rothman Orthopaedic Institute at Thomas Jefferson University
Alan S. Hilibrand
Rothman Orthopaedic Institute at Thomas Jefferson University
Alexander R. Vaccaro
Rothman Orthopaedic Institute at Thomas Jefferson University
Mark Kurd
Rothman Orthopaedic Institute at Thomas Jefferson University
Ian Kaye
Rothman Orthopaedic Institute at Thomas Jefferson University
Thomas Cha
Rothman Orthopaedic Institute at Thomas Jefferson University
Gregory D. Schroeder
Rothman Orthopaedic Institute at Thomas Jefferson University
Christopher K. Kepler
Rothman Orthopaedic Institute at Thomas Jefferson University

Research Article

Keywords: Anterior Cervical Discectomy and Fusion (ACDF), Patient-reported outcome measures (PROMs), Radiculopathy

Posted Date: July 23rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10350828/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Study Design:

Retrospective Cohort Study

Objective:

This study aims to: 1) describe the natural course of post-operative PROM data for up to 2 years; 2) determine where PROMs become relatively stable in the postoperative time frame; and 3) investigate whether 1-year PROMs accurately reflect 2-year outcomes following anterior discectomy and fusion (ACDF).

Summary of Background data:

Patient-reported outcome measures (PROMs) are the gold standard for assessing success in cervical spine surgery. While many registries and studies require 2-year follow-up, it remains unclear if clinical improvement plateaus earlier.

Methods:

A retrospective analysis was conducted on 132 patients undergoing ACDF for degenerative disease from 2020 to 2023. PROMs, including the Short Form-12 Physical and Mental Component Summaries (PCS, MCS), Visual Analog Scale (VAS) for neck and arm pain, and the modified Japanese Orthopaedic Association (mJOA) scale, were collected at baseline, 3, 6, and 24 months postoperatively. Post hoc comparisons were performed between 1 year and 2 year intervals to determine stability of long-term outcomes, with significance established at $P < 0.05$.

Results:

Significant improvements from baseline were observed across all PROMs starting at 3 months ($P < 0.001$) besides MCS which remained relatively stable. All PROMs displayed no significant differences starting from 3 months to 24 months ($P > 0.05$). Between 12-month and 24-month intervals, there were no statistically significant differences in PCS ($P = 0.996$), MCS ($P = 0.994$), VAS Neck ($P = 0.843$), VAS Arm ($P = 0.956$), or mJOA ($P = 0.964$).

Conclusions:

Patient reported recovery following ACDF stabilizes by one year postoperatively with the largest change in scores occurring from preoperative to 3 month time points. These findings suggest that 1-year PROMs are a reliable proxy for 2-year outcomes, potentially allowing for streamlined follow-up protocols and reduced institutional questionnaire burden.

Introduction

Anterior cervical discectomy and fusion (ACDF) remains a commonly performed operation for cervical degenerative disease, and is considered gold standard for managing patients with radiculopathy and/or myelopathy who fail nonoperative management.[1,2] As spine surgery has become increasingly outcomes-driven overall, patient-reported outcome measures (PROMs) play an important role in assessing procedural success or not, quantifying changes in pain, disability, neurologic function, and overall functional status.[3,4]

Despite the ubiquity of PROMs as primary and/or secondary outcome measures, the ideal postoperative end timepoint that most meaningfully reflects long-term recovery after ACDF remains unclear.[5,6] Many studies (e.g. prospective clinical trials, retrospective single institution, national database) emphasize 1- to 2-year follow-up as a benchmark endpoint. It is important to be note that prolonged PROM collection is not only resource-intensive, but also increasingly limited by patient attrition over time.[7–9] This is particularly relevant in retrospective clinical research, where requiring complete longitudinal PROM data may substantially reduce the analyzable cohort.[10,11] To this end, being able to determine whether earlier postoperative PROMs is predictive of later outcomes has practical implications for both study design and/or real-world outcomes tracking.[12,13]

Prior work in orthopedic surgery suggests the majority of improvement in patient-reported pain/function often occurs early after surgery, followed by relative stabilization.[7,14] If a similar trajectory is present after ACDF at the single-institution level, then 1-year PROMs may provide a clinically useful estimate of 2-year recovery for selected outcomes studies.[15–17] Such a finding would be meaningful, not only for patient education but also since later follow-up often adds logistical burden while yielding comparatively limited incremental information regarding pain relief/functional recovery.[7,9,10]

To this end, the purpose of the present study was to evaluate postoperative PROM trajectories following ACDF by: 1) assessing changes in PROMs from baseline to 3 months, 6 months, 1 year, and 2 years postoperatively; 2) identifying the time point where postoperative improvement plateaued; and 3) examining whether 1-year PROMs were representative of 2-year outcomes. Given the consistent improvements typically provided by ACDF, we hypothesized greatest improvement would occur in the early postoperative period and that PROMs would remain largely stable between 1 and 2 years.

Methods

This study utilized a retrospective observational design to evaluate clinical outcomes in patients treated for degenerative cervical spondylosis. The study protocol was reviewed and approved by the Institutional Review Board. Patients were identified from a surgical database covering a period from January 2020 to July 2023. All included patients underwent an anterior cervical discectomy and fusion (ACDF) procedure performed by a team of fellowship trained orthopaedic surgeons at a single institution.

Patients were eligible for inclusion if they presented with degenerative cervical conditions such as radiculopathy or myelopathy, underwent a primary ACDF procedure, and had complete patient-reported

outcome measures (PROMs) available for the preoperative baseline and postoperative intervals at 3 months, 6 months, 1 year, and 2 years. Patients were excluded if the surgery was for trauma, malignancy, or active infection, it was a revision surgery, the surgery was through a posterior cervical approach, and if there was insufficient follow-up data during the 24-month postoperative interval.

Primary outcomes were assessed using a battery of validated PROMs designed to capture physical function, mental health, pain levels, and neurological status. These included the SF-12 Physical and Mental Component Summaries (PCS, MCS) to evaluate the overall health-related quality of life. The Visual Analog Scale (VAS) for Neck and Arm pain was utilized to quantify the intensity of localized and radiating pain. Finally, the Modified Japanese Orthopaedic Association (mJOA) scale aided in assessing the functional status and severity of myelopathy. Data points were collected at a preoperative baseline and postoperative intervals at 3 months, 6 months, 12 months, and 24 months.

Continuous variables were expressed as means with standard deviations while categorical data was expressed as cell counts and percentages. Changes in PROMs over time were evaluated using repeated measures analysis to identify the timepoint at which significant clinical improvement plateaued. Post hoc comparisons between 12-month and 24-month intervals were performed to determine the stability of long-term outcomes. Significance was established at $P < 0.05$.

Results

428 patients were identified to have ACDF surgery at our institution from January 2020 to July 2023. After exclusion criteria was applied, the final cohort consisted of 132 patients with a mean age of 60.2 years. Further demographic data included race (86.4% White, 5.3% Black), smoking status (12.2% active smokers), and comorbidities such as diabetes (19.7%), and osteoporosis (13.6%) (Table 1).

Table 1
Demographics; CCI= Charlson Comorbidity Index, BMI= body mass index

Age	**Total Data**
	N = 132
	60.2 (10.1)
Race:	
White	114 (86.4%)
Black	7 (5.30%)
Other	3 (2.27%)
Unknown	8 (6.06%)
Male	68 (51.5%)
Smoker:	
No	50 (38.2%)
Yes	16 (12.2%)
Former	31 (23.7%)
Unknown	34 (26.0%)
CCI	2.66 (1.56)
Osteoporosis	18 (13.6%)
Diabetes	26 (19.7%)
BMI	30.0 (5.89)

All patients underwent ACDF with an average of 2.28 levels fused. The mean operative time was 117 minutes, with an average estimated blood loss (EBL) of 33.0 mL and a hospital stay of 0.76 days (Table 2). Postoperative complications were infrequent, including 30-day readmission rate of 3.03%, a 90-day readmission rate of 5.3%, and a revision rate of 5.3%. Non-union was reported in 3.03% of cases, and persistent radiculopathy was noted in 19.7% (Table 3).

Table 2
Peri-Operative Characteristics; EBL= estimated blood loss

Length of Stay	**Total Data**
	N = 132
	0.76 (0.85)
Operative Time	117 (49.0)
EBL (mL)	33.0 (23.2)
Levels Fused	2.28 (0.78)

Table 3
Post-Operative Complications; ED= Emergency Department, DVT/PE= deep vein thrombosis/ pulmonary embolism, SSI=surgical site infection

30 Day Readmission	**Total Data**
	N = 132
	4 (3.03%)
90 Day Readmission	7 (5.30%)
Post-operative revision	7 (5.30%)
Non-Union	4 (3.03%)
Persistent Radiculopathy	26 (19.7%)
Follow Up (days)	520 (529)
Relevant ED visit	11 (8.33%)
DVT/PE	1 (0.76%)
Pseudoarthrosis	3 (2.27%)
Wound Dehiscence	0 (0%)
SSI	0 (0%)
Hematoma	2 (1.52%)
Hardware Failure	1 (0.76%)

Primary outcomes were assessed through PCS and MCS of the SF-12, VAS for neck pain and arm pain, and the mJOA scale for functional myelopathy assessment. Data were analyzed at preoperative baseline, and four postoperative intervals at 3, 6, 12, and 24 months. PCS scores improved significantly from a preoperative mean of 35.1 to 38.3 at 3 months ($P < 0.001$). PCS scores showed no differences in

comparisons from the 3-month timepoint to 24 months ($P > 0.05$). MCS scores displayed no significant difference in scores from preoperative to 24 months postoperative ($P > 0.05$). VAS Neck and VAS Arm scores showed rapid decline, decreasing from 5.49 and 5.81 (preoperative) to 2.81 and 2.64 at 3 months, respectively ($P < 0.001$). These scores displayed no further significant changes in the 3-month to 24-month postoperative period ($P > 0.05$). The mJOA scale improved from 14.4 (preoperative) to 16.0 at 3 months ($P < 0.001$) and similarly remained significantly stable from 3 months to 24 months postoperative ($P > 0.05$) (Table 4, Fig. 1).

Table 4
PROMs; PCS= physical component summary, MCS= mental component summary, VAS= visual analog scale, mJOA= modified Japanese Orthopaedic Association

Total Data N = 132	**Pre Op**	**3 Months**	**6 Months**	**12 Months**	**24 Months**	**P value**	**3 vs. 6 months P value**	**6 vs 12 months P value**	**12 vs 24 months P value**
PCS	35.1 (8.80)	38.3 (9.95)	39.7 (11.0)	40.2 (10.9)	40.8 (11.7)	**< 0.001**	0.829	0.994	0.996
MCS	49.7 (10.3)	51.5 (11.2)	52.5 (10.5)	51.1 (10.7)	51.6 (10.2)	0.286	0.937	0.818	0.994
VAS Neck	5.49 (2.75)	2.81 (2.25)	2.67 (2.28)	2.52 (2.51)	2.85 (2.59)	**< 0.001**	0.989	0.986	0.843
VAS Arm	5.81 (2.89)	2.64 (2.81)	2.64 (3.08)	2.52 (2.86)	2.79 (3.09)	**< 0.001**	1.000	0.998	0.956
mJOA	14.4 (2.98)	16.0 (2.09)	16.1 (2.21)	15.6 (2.58)	15.8 (2.39)	**< 0.001**	1.000	0.464	0.964

Comparing the 12-month and 24-month follow-up periods revealed no statistically significant changes in any measured PROMs. PCS scores slightly shifted from 40.2 to 40.8 ($P = 0.996$), and mJOA scores moved from 15.6 to 15.8 ($P = 0.964$). VAS pain scores for the neck and arm also remained stable ($P = 0.843$ and $P = 0.956$), confirming that the clinical benefits achieved at one year are maintained through the second postoperative year (Table 4, Fig. 1).

Discussion

In this retrospective single-institution cohort of 132 patients undergoing ACDF, we found that most measurable recovery occurred relatively early after surgery. By the first postoperative interval at 3 months, PCS improved from 35.1 preoperatively to 38.3, VAS neck pain from 5.49 to 2.81, VAS arm pain from 5.81 to 2.64, and mJOA from 14.4 to 16.0. Thereafter, PROMs remained largely stable from 6 months through 2 years, with no significant differences between 12- and 24-month values for any PROMs (PCS, MCS, VAS neck, VAS arm, or mJOA). Overall, our findings suggest that ACDF recovery follows an early-improvement, late-maintenance pattern and that 1-year PROMs may potentially reflect 2-year patient-reported status.

First, as expected, we found patients undergoing ACDF demonstrated significant early improvement in in nearly all PROM domains (pain, physical function, and neurologic status). This pattern is consistent with the broader ACDF literature, where the largest gains are typically seen within the first 3 to 6 months after surgery. One retrospective review of 614 patients with cervical degenerative myelopathy undergoing either ACDF or cervical disc arthroplasty (CDA) found that most patients experienced improvement in PROMs starting at 3 months through 12-month follow-up especially in NDI and NRS.[18]A prospective randomized clinical trial of 133 patients undergoing ACDF found improvements in NDI, VAS by 6 weeks which persisted throughout follow-up, with no changes in NDI or VAS at 24 months or 60 months.[19]

When considering this study's second aim, we found the magnitude of early improvement in the current cohort was clinically intuitive, with VAS arm pain decreasing by more than 3 points and VAS neck pain decreasing by nearly 2.7 points by 3 months. Similarly, a systematic review and pooled analysis of ACDF data from 3,271 patients demonstrated rapid early postoperative improvement, with mean neck disability and pain scores improving substantially within the first postoperative quarter.[19–23] Of note, the lack of clear MCS change is also not entirely unexpected, as in general mental health scores are often less procedure-sensitive and may be influenced and/or confounded by broader psychosocial factors.[24–26] Overall, our findings suggest that postoperative recovery is nonlinear, with the majority of benefit occurring early.

Of note, these lack of differences persisted between 1- and 2-year PROMs, supporting the perspective that 1-year outcomes may be representative of 2-year results after ACDF. This question is especially relevant because longer-term PROM collection is resource-intensive and oftentimes undermined by attrition/loss-to-follow-up. In the present study, 428 ACDF patients were identified, but only 132 had complete PROM data through 2 years, meaning that nearly 70% of the potentially eligible surgical population was not captured in the final longitudinal analysis. That issue is not unique to this study and reflects a broader challenge in spine outcomes research. From a practical standpoint, if outcomes are stable by 1 year, extending surveillance to 2 years may offer limited incremental value, especially for studies that are mainly focused on symptom relief and/or patient functional improvement. Our data does not prove total equivalence between 1- and 2-year results, but they do support the conclusion that 1-year PROMs or even shorter may serve as a reasonable endpoint for selected retrospective ACDF studies.

This study has several potential limitations. As a retrospective, single-institution study, there is the risk for selection/attrition bias and overall lack of external validity/generalizability. In addition, as a PROM-focused study we did not capture other potentially relevant long-term outcomes such as radiographic fusion, adjacent segment pathology, and/or late reoperation.[27,28] Furthermore, the apparent late PROM stabilization noted may partly reflect survivorship or ceiling effects, as patients with worse outcomes/complications may be less likely to complete long-term follow-up or vice versa. Nonetheless, this study has several important strengths, including longitudinal assessment of multiple validated PROMs across five time points in a uniform institutional ACDF cohort, with direct considerations when designing the follow-up of future spine outcome studies.

Conclusion

In our cohort of 132 patients undergoing ACDF who had a complete set of 2 year PROMs, we found that patient-reported recovery after ACDF occurs early, with reported improvement evident by 3 months maintained through 2 years postoperatively. PROMs remained largely stable after the early postoperative period, with no significant differences between 1- and 2-year outcomes across all measured domains (PCS, MCS, VAS neck, VAS arm, mJOA). Overall, our findings suggest that 1-year PROMs or perhaps earlier may serve as a practical endpoint for selected retrospective ACDF studies.

Declarations

Author Contribution

M.K.N. Conceptualization, Writing – original draft, Writing – review & editingM.H. Conceptualization, Writing – original draft, Writing – review & editingY.L. Conceptualization, Writing – original draft, Writing – review & editingG. B. Conceptualization, Writing – original draft, Writing – review & editingJ.M. Conceptualization, Writing – original draft, Writing – review & editingW.A. G. Conceptualization, Writing – original draft, Writing – review & editingY.K. E. Conceptualization, Writing – original draft, Writing – review & editingD.J. Conceptualization, Writing – original draft, Writing – review & editingS.B. Conceptualization, Writing – original draft, Writing – review & editingS.E. Conceptualization, Writing – original draft, Writing – review & editingA.S. Conceptualization, Writing – original draft, Writing – review & editingV.A.C. Conceptualization, Writing – original draft, Writing – review & editingK.D. Conceptualization, Writing – original draft, Writing – review & editingA.G. Conceptualization, Writing – original draft, Writing – review & editingJ.D. Conceptualization, Writing – original draft, Writing – review & editingA.F. Conceptualization, Writing – original draft, Writing – review & editingE.B. Conceptualization, Writing – original draft, Writing – review & editingJ.A. C. Conceptualization, Writing – review & editing, SupervisionA.S. H. Conceptualization, Writing – review & editing, SupervisionA.R.V. Conceptualization, Writing – review & editing, SupervisionM. K. Conceptualization, Writing – review & editing, SupervisionI. K. Conceptualization, Writing – review & editing, SupervisionT. C. Conceptualization, Writing – review & editing, SupervisionG.D.S. Conceptualization, Writing – review & editing, SupervisionC.K.K. Conceptualization, Writing – review & editing, Supervision

Data Availability

All data utilized in this study is available upon reasonable request.

References

1. Mastrokostas PG, Said M, Yusupov D et al (2025) Trends in Anterior Cervical Discectomy and Fusion: Medicare Projections Through 2060. Global Spine J Published online. 10.1177/21925682251405773

2. Anderson M, Thingvold A, Kroymann T et al (2026) Is Anterior Cervical Decompression and Fusion Still Considered the Gold-Standard Treatment Option Relative to Anterior Cervical Disc Replacement for the Treatment of Symptomatic Disc Herniation in the Nonspondylotic Cervical Spine? *Clin Spine Surg*. Published online Febr 16. 10.1097/BSD.0000000000002040
3. Mastrokostas PG, Schwartz LB, Berglas E et al (2025) Single-level anterior cervical discectomy and fusion is associated with higher nonroutine discharge rates compared to cervical disc arthroplasty in obese patients. J Craniovertebr Junction Spine 16(2):205–211. 10.4103/jcvjs.jcvjs_108_25
4. Kornberg J, Høy K, Andersen MØ, Pedersen CF, Carreon LY (2026) Outcome and complications after two-level Anterior Cervical Discectomy and Fusion (ACDF) with or without plating. A propensity matched cohort study. Brain Spine 6(4):105961. 10.1016/j.bas.2026.105961
5. Lee TJ, Thomas AA, Grandhi NR et al (2020) Cost-effectiveness Applications of Patient-reported Outcome Measures (PROMs) in Spine Surgery. Clin Spine Surg 33(4):140–145. 10.1097/BSD.0000000000000982
6. Karamian BA, Minetos PD, Levy HA et al (2022) The Effect of Anterior Cervical Discectomy and Fusion Procedure Duration on Patient-Reported Outcome Measures. World Neurosurg 164(7):e548–e556. 10.1016/j.wneu.2022.05.016
7. Jayakumar P, Bozic K (2023) Journal of the American Academy of Orthopaedic Surgeons Patient-Reported Outcome Measurements (PROMs) Special Issue: The Value of PROMs in Orthopaedic Surgery. J Am Acad Orthop Surg 31(20):1048–1056. 10.5435/JAAOS-D-23-00500
8. Wilson I, Bohm E, Lübbeke A et al (2019) Orthopaedic registries with patient-reported outcome measures. EFORT Open Rev 4(6):357–367. 10.1302/2058-5241.4.180080
9. Canfield M, Savoy L, Cote MP, Halawi MJ (2020) Patient-reported outcome measures in total joint arthroplasty: defining the optimal collection window. Arthroplast Today 6(1):62–67. 10.1016/j.artd.2019.10.003
10. Levy HA, Karamian BA, Pezzulo J et al (2023) Do Patient Outcomes Predict Loss to Long-Term Follow-Up After Spine Surgery? World Neurosurg 170(2):e301–e312. 10.1016/j.wneu.2022.11.006
11. Narayanan R, Ezeonu T, Heard JC et al (2024) One-year patient reported outcomes after single-level lumbar fusion at orthopedic specialty hospital compared to tertiary referral center. Spine J 24(12):2297–2304. 10.1016/j.spinee.2024.08.024
12. Somerson JS, Bartush KC, Shroff JB, Bhandari M, Zelle BA (2016) Loss to follow-up in orthopaedic clinical trials: a systematic review. *International Orthopaedics 2016 40:11*. ;40(11):2213–2219. 10.1007/s00264-016-3212-5
13. Geere JH, Hunter PR, Marjoram T, Cook AJ, Rai AS Loss to follow-up after lumbar decompressive surgery: effect of collection method and perioperative factors on patient-reported outcome measures. *European Spine Journal* (2025). Published online August 30, 2025:1–9. doi:. Published online August 30, 2025:1–9. 10.1007/s00586-025-09254-5
14. Chen DA, Vaishnav AS, Louie PK et al (2020) Patient Reported Outcomes in Patients Who Stop Following Up: Are They Doing Better or Worse Than the Patients That Come Back? Spine (Phila Pa 1976) 45(20):1435–1442. 10.1097/BRS.0000000000003543

15. Miller AK, Zakko P, Park DK et al (2024) Cervical disc arthroplasty versus anterior cervical discectomy and fusion: an analysis of the Michigan Spine Surgery Improvement Collaborative Database. Spine J 24(5):791–799. 10.1016/j.spinee.2023.12.004
16. Yakdan S, Benedict B, Botterbush K et al (2025) Randomized controlled trials comparing cervical disc arthroplasty and anterior cervical discectomy and fusion outcomes in degenerative spine disease: a systematic review and meta-analysis. J Neurosurg Spine 43(6):703–716. 10.3171/2025.4.SPINE241277
17. Hartman TJ, Nie JW, Khosla I et al (2024) Cervical Disk Replacement Versus Anterior Cervical Diskectomy and Fusion: Effect of Procedural Variant on Patients with a Prolonged Preoperative Duration of Symptoms from Disk Herniation. J Am Acad Orthop Surg 32(12):558–562. 10.5435/JAAOS-D-23-00655
18. Mjåset C, Zwart JA, Kolstad F, Solberg T, Grotle M (2022) Clinical improvement after surgery for degenerative cervical myelopathy; A comparison of Patient-Reported Outcome Measures during 12-month follow-up. PLoS ONE 17(3):e0264954. 10.1371/journal.pone.0264954
19. Coric D, Guyer RD, Nunley PD et al (2018) Prospective, randomized multicenter study of cervical arthroplasty versus anterior cervical discectomy and fusion: 5-year results with a metal-on-metal artificial disc. J Neurosurg Spine 28(3):252–261. 10.3171/2017.5.SPINE16824
20. Rossi V, Asher A, Peters D et al (2019) Outpatient anterior cervical discectomy and fusion in the ambulatory surgery center setting: safety assessment for the Medicare population. J Neurosurg Spine 32(3):360–365. 10.3171/2019.7.SPINE19480
21. Delamarter RB, Murrey D, Janssen ME et al (2010) Results at 24 months from the prospective, randomized, multicenter Investigational Device Exemption trial of ProDisc-C versus anterior cervical discectomy and fusion with 4-year follow-up and continued access patients. SAS J 4(4):122–128. 10.1016/j.esas.2010.09.001
22. Loumeau TP, Darden BV, Kesman TJ et al (2016) A RCT comparing 7-year clinical outcomes of one level symptomatic cervical disc disease (SCDD) following ProDisc-C total disc arthroplasty (TDA) versus anterior cervical discectomy and fusion (ACDF). Eur Spine J 25(7):2263–2270. 10.1007/s00586-016-4431-6
23. Berlin C, Ibrahim S, Mummaneni PV et al (2025) Are There Differences in 2-Year Outcomes Between Two-Level Anterior Cervical Diskectomy and Fusion Versus Single-Level Anterior Cervical Corpectomy and Fusion to Treat Cervical Myelopathy? A Quality Outcomes Database Study. Neurosurgery 97(5):1091–1099. 10.1227/neu.0000000000003518
24. Ng M, Mastrokostas L, Mastrokostas P et al Impact of mental health disorders and perioperative outcomes following anterior cervical discectomy and fusion (ACDF): a national inpatient analysis. *European Spine Journal* (2026). Published online January 20, 2026:1–9. doi:. Published online January 20, 2026:1–9. 10.1007/s00586-025-09728-6
25. COLANTONIO DF, Nassr A, FREEDMAN BA et al (2022) The Effect of Preoperative Mental Health Status on Outcomes After Anterior Cervical Discectomy and Fusion. Int J Spine Surg 16(2):233. 10.14444/8211

26. Parrish JM, Jenkins NW, Lynch CP et al (2021) Preoperative Physical Function Association With Mental Health Improvement After Anterior Cervical Discectomy and Fusion. Clin Spine Surg 34(10):E559–E565. 10.1097/BSD.0000000000001232
27. Gagnier JJ, Johnston BC (2019) Poor quality patient reported outcome measures bias effect estimates in orthopaedic randomized studies. J Clin Epidemiol 116(1):36–38. 10.1016/j.jclinepi.2019.07.012
28. Acosta J, Tang P, Regal S et al (2020) Investigating the Bias in Orthopaedic Patient-reported Outcome Measures by Mode of Administration: A Meta-analysis. J Am Acad Orthop Surg Glob Res Rev 4(12). 10.5435/JAAOSGlobal-D-20-00194

Figures

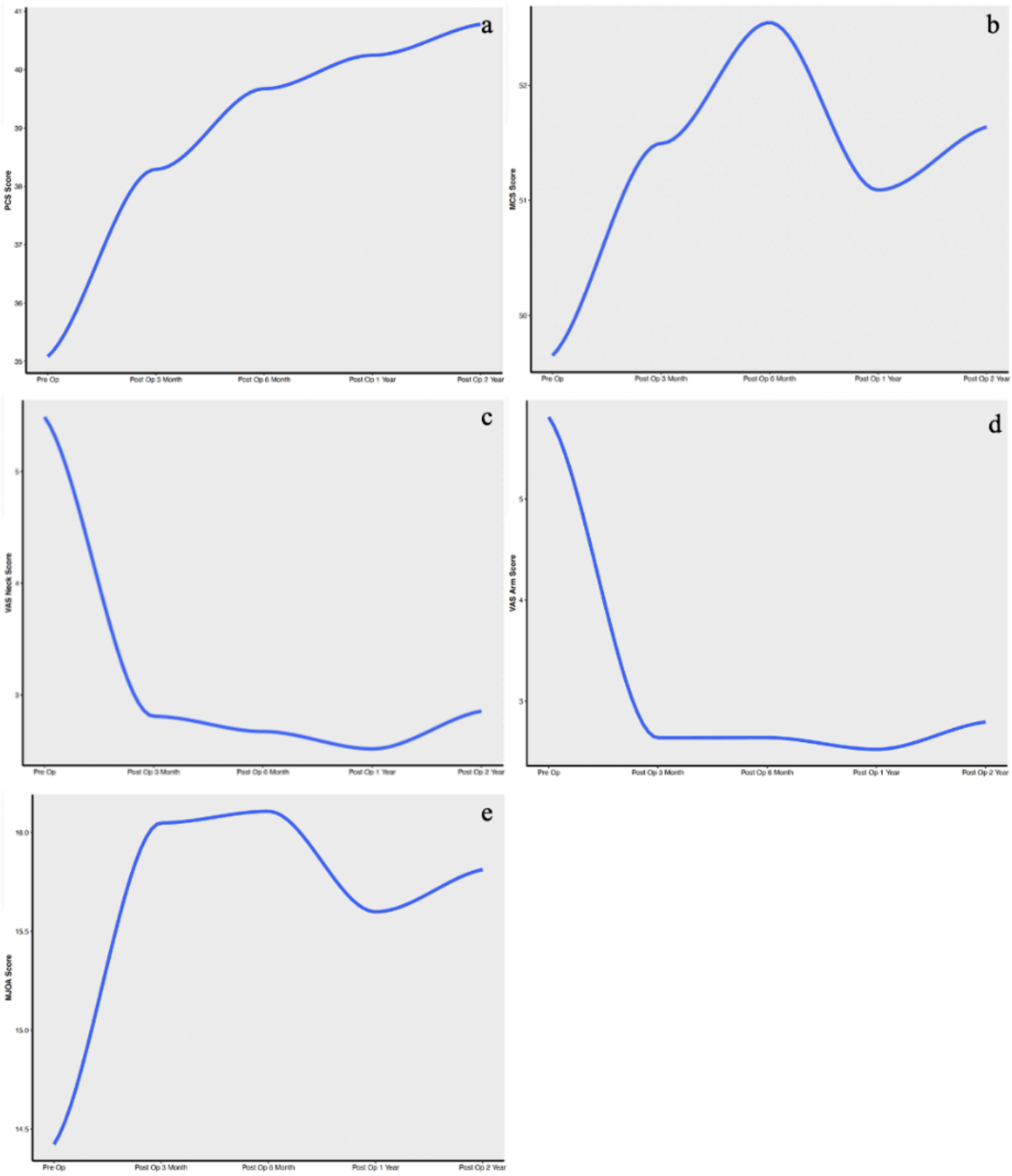

Figure 1

Average PROM scores over time. (a) PCS, (b) MCS, (c) VAS Neck, (d) VAS Arm, (e) mJOA