

Assessing the Impact of Preoperative Conservative Treatment Options Prior to Cervical Surgical Procedures: A Michigan Spine Surgery Improvement Collaborative (MSSIC) Study

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Introduction

- Cervical radiculopathy and myelopathy are prevalent conditions that significantly impair function and quality of life, most commonly resulting from degenerative cervical spine pathology causing spinal cord compression.¹⁻⁵
- While postoperative rehabilitation has been extensively studied, the role of preoperative conservative interventions remains controversial, with mixed evidence regarding their impact on surgical outcomes.⁶⁻⁷
- Initial management is typically nonoperative and includes physical therapy, oral medications, activity modification, and epidural steroid injections aimed at pain relief and functional improvement.
- When conservative treatment fails or neurological deficits progress, surgical intervention is indicated. **Anterior cervical discectomy and fusion (ACDF)** and **cervical total disc replacement (cTDR)** are well-established surgical options with high patient satisfaction.⁸⁻¹²
- With increasing emphasis on value-based care and outcome optimization, the effect of preoperative conservative management on postoperative complications, recovery, and patient satisfaction in cervical spine surgery remains incompletely understood.

Aims and Objectives

- To evaluate the association between preoperative conservative treatment and postoperative outcomes, including complications, recovery, and patient-reported function, in patients undergoing ACDF or cTDR.
- To identify clinical and demographic predictors of achieving meaningful postoperative improvement in neck pain following cervical spinal surgery.

Methods

- Retrospective cohort study of patients undergoing ACDF or cTDR (2017–2023) utilizing the MSSIC database
- Inclusion:** Age ≥18, primary ACDF or cTDR, ≤3 operative cervical levels
- Exclusion:** Trauma, revision surgery, >3 levels
- Cohort:** 13,404 patients; ACDF: 12,363; cTDR: 1,041
- Preoperative treatment groups:**
 - None (control)
 - PT/C (physical therapy ± chiropractic)
 - INJ (injections)
 - MTC (multiple/other treatments)
- Variables:**
 - Demographics

- Length of stay
- Comorbidities

- Outcomes:**
 - Patient Reported Outcomes Measurement Information System (PROMIS) Physical Function (baseline, 90 days)
 - MCID defined as ≥ +4.5
 - Depression screening via Patient Health Questionnaire (PHQ-2) (score ≥3)
- Statistics:**
 - Welch *t*-test, chi-square analysis
 - Multivariable GEE models for MCID neck pain
 - *Significance set at P < 0.05

Results

Study Cohort

- 13,404 patients, 52.1% female; mean age 55.5 ± 11.7 years
- Stratified by ACDF vs cTDR and preoperative conservative treatment

ACDF

- Preoperative treatment patients were younger, female, and had longer symptom duration (P < .001)
- Shorter hospital stay with preoperative treatment (<1.7 vs 2.15 days, P < .017)
- INJ and MTC cohorts had higher baseline anxiety/depression (P < .011)

Postoperative Outcomes

- Lower complication rates in treatment cohorts (P < .041)
- Reduced postoperative pain and weakness:
 - PT/C: less axial neck pain (7.2%, P = .039)
 - PT/C and INJ: less weakness (8.8%, 6.6%) vs control (10.5%)
- Lower 90-day readmissions:
 - PT/C 4.9%, MTC 4.3% vs control 7.9% (P < .001)

Functional & Disposition Outcomes

- More frequent home discharge and return to work in treatment cohorts (P < .014)
- Higher 90-day PROMIS PF in PT/C and MTC (P < .001); no MCID difference
- Lower postoperative depression in PT/C (P = .027)

cTDR

- No baseline demographic differences; longer symptom duration in treatment cohorts (P < .015)
- Shorter hospital stay in PT/C and MTC cohorts (<0.9 vs 1.5 days, P < .004)
- Fewer unplanned returns to OR in MTC cohort (0.2% vs 1.7%, P = .039)
- Discharge, satisfaction, PROMIS PF, and depression outcomes largely equivalent across cohorts

Multivariate Analysis (MCID – Neck Pain, 90 Days)

ACDF: Older age, white race, no painkillers at baseline, and osteoporosis ↑ MCID odds. Symptom duration ≥1 year and anxiety ↓ MCID odds. BMI effect statistically significant but clinically minimal
cTDR: Older age and white race ↑ MCID odds; hypertension ↓ MCID odds

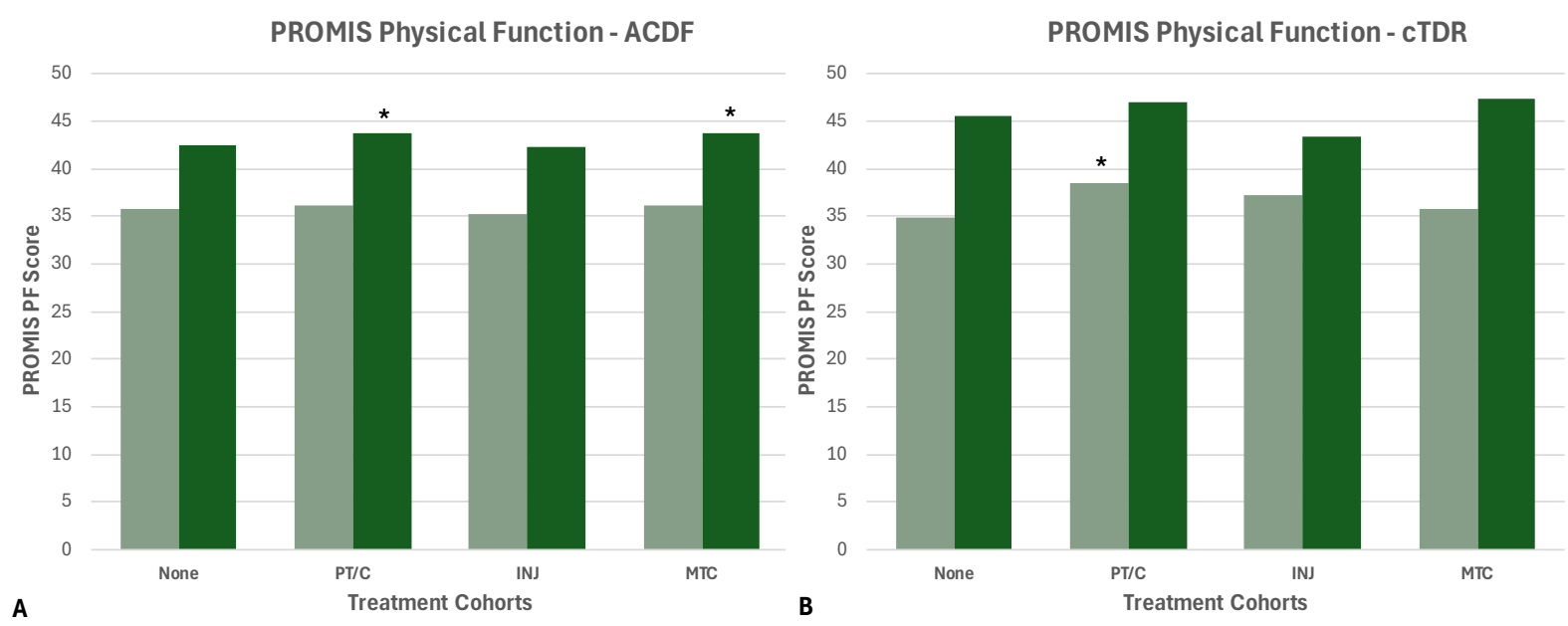


Figure 1. Baseline and 90-day postoperative PROMIS Physical Function questionnaire, a 0-100 scale with average of 50 and SD of 10, in ACDF (A) and cTDR (B).

Patient Demographics						
Anterior Cervical Discectomy and Fusion		None (n=3384)	Physical Therapy/Chiropractic (n=232)	P-value	Injection (n=839)	P-value
Patients Age, (y)		3384	232	<0.001*	839	<0.001*
N		3384	232		839	
Mean (SD) [range]		58.6 (11.95) [19.9, 93.3]	57.0 (11.60) [21.8, 88.3]		56.9 (11.01) [26.5, 86.0]	
BMI, (kg/m ²)		3384	232	0.92	839	1.00†
N		3384	232		839	
Mean (SD) [range]		30.6 (7.34) [12.7, 75.7]	30.6 (7.46) [12.8, 80.6]		30.6 (7.29) [12.2, 62.0]	
Gender, N (%)				<0.001*		<0.001*
Male		1621 (53.8%)	1141 (48.9%)		391 (46.6%)	
Female		1563 (46.2%)	1181 (51.1%)		448 (53.4%)	
Race/Ethnicity, n (%)				<0.001*		0.08†
White		2057 (60.2%)	1536 (64.3%)		563 (64.8%)	
Unknown/Refused		46 (1.3%)	27 (1.1%)		64 (7.6%)	
Black or African American		348 (10.3%)	174 (7.5%)		68 (8.0%)	
Asian		14 (0.4%)	19 (0.8%)		3 (0.3%)	
Hispanic or Latino		34 (1.3%)	29 (1.2%)		12 (1.4%)	
American Indian		30 (1.2%)	11 (0.5%)		6 (0.7%)	
Native Hawaiian/Pacific Islander		4 (0.2%)	0 (0.0%)		1 (0.2%)	
B-Racial/Multi-Racial		30 (1.2%)	29 (1.2%)		7 (1.1%)	
Missing		616	510		175	
Duration of Symptoms, N (%)				<0.001*		<0.001*
< 3 months		972 (28.7%)	291 (12.5%)		94 (11.2%)	
3 months - 1 year		1056 (31.2%)	323 (13.9%)		217 (25.8%)	
> 1 year		1366 (40.1%)	1216 (52.2%)		528 (63.0%)	
Length of stay, (d)				<0.001*		<0.001*
N		3384	232		839	
Mean (SD) [range]		2.5 (1.33) [0.0, 63.0]	1.5 (1.77) [0.0, 2.0]		1.4 (1.34) [0.0, 1.4]	
Number of Levels, n (%)				0.619†		0.008†
1		1481 (43.8%)	991 (42.5%)		356 (42.4%)	
2		1237 (36.6%)	931 (39.9%)		349 (41.6%)	
3		666 (19.7%)	410 (17.6%)		136 (16.0%)	
ASA Grade (Per Anesthesia Operative Report)				<0.001*		0.017†
1		33 (1.0%)	40 (1.7%)		7 (0.8%)	
2		1308 (38.7%)	1040 (44.8%)		394 (46.9%)	
3		1942 (57.4%)	1214 (52.1%)		428 (50.8%)	
4		101 (3.0%)	51 (2.2%)		12 (1.4%)	
Cervical Total Disc Replacement						
Anterior Cervical Discectomy and Fusion		None (n=177)	Physical Therapy/Chiropractic (n=201)	P-value	Injection (n=67)	P-value
Patients Age, (y)		177	201	0.22†	67	0.11†
N		177	201		67	
Mean (SD) [range]		45.9 (11.85) [25.7, 77.8]	48.4 (11.67) [22.7, 79.6]		49.7 (12.16) [20.4, 81.4]	
BMI, (kg/m ²)		177	201	0.20†	67	0.49†
N		177	201		67	
Mean (SD) [range]		28.0 (7.72) [0.2, 65.0]	29.9 (7.01) [0.4, 56.5]		29.6 (8.09) [0.3, 49.5]	
Gender, n (%)				0.43†		0.36†
Male		90 (50.8%)	93 (46.3%)		29 (43.3%)	
Female		87 (49.2%)	108 (53.7%)		38 (56.7%)	
Race/Ethnicity, n (%)				0.029†		0.67†
White		101 (78.3%)	136 (68.3%)		42 (64.0%)	
Unknown/Refused		1 (0.6%)	0 (0.0%)		0 (0.0%)	
Black or African American		2 (1.1%)	10 (5.0%)		9 (13.0%)	
Asian		2 (1.1%)	2 (1.0%)		1 (1.5%)	
Hispanic or Latino		2 (1.1%)	5 (2.5%)		1 (1.5%)	
American Indian		0 (0.0%)	0 (0.0%)		0 (0.0%)	
B-Racial/Multi-Racial		3 (2.3%)	0 (0.0%)		0 (0.0%)	
Missing		46	47		17	
Duration of Symptoms, n (%)				<0.001*		0.015†
< 3 months		57 (32.0%)	26 (12.7%)		12 (18.0%)	
3 months - 1 year		52 (28.8%)	89 (44.0%)		19 (28.3%)	
> 1 year		68 (38.5%)	86 (42.3%)		26 (39.7%)	
Length of stay, (d)				0.004†		1.00†
N		177	201		67	
Mean (SD) [range]		1.5 (2.57) [0.0, 2.0]	0.9 (0.96) [0.0, 4.0]		1.2 (1.40) [0.0, 4.0]	
Number of Levels, n (%)				0.15†		0.72†
1		126 (71.2%)	140 (69.7%)		46 (68.7%)	
2		46 (26.0%)	60 (29.8%)		11 (16.4%)	
3		5 (2.8%)	7 (3.5%)		1 (1.5%)	
ASA Grade (Per Anesthesia Operative Report)				0.37†		0.88†
1		11 (6.2%)	7 (3.5%)		3 (4.5%)	
2		110 (62.1%)	131 (65.2%)		44 (65.7%)	
3		56 (31.6%)	61 (30.3%)		20 (29.9%)	
4		0 (0.0%)	2 (1.0%)		0 (0.0%)	

Table 1. Patient demographics, stratified by treatment cohort and operative procedure (ACDF or cTDR).

Postoperative Complications, n (%)						
Anterior Cervical Discectomy and Fusion		None (n=3384)	Physical Therapy/Chiropractic (n=232)	P-value	Injection (n=839)	P-value
Any complications		499 (14.7%)	231 (9.9%)	<0.001*	100 (11.9%)	0.001*
Neck Pain (back/neck pain)		296 (8.8%)	169 (7.2%)	0.038	71 (8.5%)	0.81
Deep Vein Thrombosis		17 (0.5%)	7 (0.3%)	0.34	2 (0.2%)	0.40
Pulmonary Embolism		16 (0.5%)	3 (0.1%)	0.047	1 (0.1%)	0.22
Myocardial Infarction		10 (0.3%)	6 (0.3%)	0.17	1 (0.1%)	0.15
Ischa		9 (0.3%)	3 (0.1%)	1.00	1 (0.1%)	1.00
Wound dehiscence		10 (0.3%)	2 (0.1%)	0.14	1 (0.1%)	0.70
Myelopathy		10 (0.3%)	6 (0.3%)	1.00	1 (0.1%)	0.70
Neurogenic Bowel or Bladder Dysfunction		0 (0.0%)	5 (0.2%)	0.17	1 (0.1%)	0.20
A new neuro deficit (CVA) with confirmation of stroke on MRI or CT		1 (0.0%)	1 (0.0%)	0.035	1 (0.1%)	0.48
Weakness		356 (10.5%)	20 (8.6%)	0.038	95 (11.3%)	<0.001*
Patient died within 90 days of Surgery?		21 (0.6%)	6 (0.3%)	0.08	1 (0.1%)	0.10
Was there an unplanned return to the OR on this admission?		27 (0.8%)	6 (0.3%)	0.015	5 (0.8%)	0.70
Was the patient re-admitted to the hospital within 90 days of surgery?		289 (7.3%)	115 (4.9%)	<0.001*	52 (6.2%)	0.10
Did the patient return to the OR after discharge and within 90 days of surgery?		169 (5.0%)	72 (3.1%)	0.001	42 (5.0%)	1.00
Cervical Total Disc Replacement						
Anterior Cervical Discectomy and Fusion		None (n=177)	Physical Therapy/Chiropractic (n=201)	P-value	Injection (n=67)	P-value
Any complications		12 (6.8%)	10 (5.0%)	0.60	2 (3.0%)	0.36
Neck Pain (back/neck pain)		17 (9.6%)	10 (5.0%)	0.12	2 (3.0%)	0.15
Deep Vein Thrombosis		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Pulmonary Embolism		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Myocardial Infarction		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Ischa		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Wound dehiscence		2 (1.1%)	0 (0.0%)	0.20	0 (0.0%)	1.00
Myelopathy		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Neurogenic Bowel or Bladder Dysfunction		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
A new neuro deficit (CVA) with confirmation of stroke on MRI or CT		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Weakness		9 (5.1%)	11 (5.5%)	1.00	1 (1.5%)	0.29
Patient died within 90 days of Surgery?		0 (0.0%)	0 (0.0%)	-	0 (0.0%)	-
Was there an unplanned return to the OR on this admission?		3 (1.7%)	2 (1.0%)	0.67	1 (1.5%)	1.00
Was the patient re-admitted to the hospital within 90 days of surgery?		3 (1.7%)	3 (1.5%)	1.00	1 (1.5%)	1.00
Did the patient return to the OR after discharge and within 90 days of surgery?		4 (2.3%)	3 (1.5%)	0.71	0 (0.0%)	0.56

Table 2. Postoperative complications, stratified by treatment cohort and operative procedure (ACDF or cTDR).

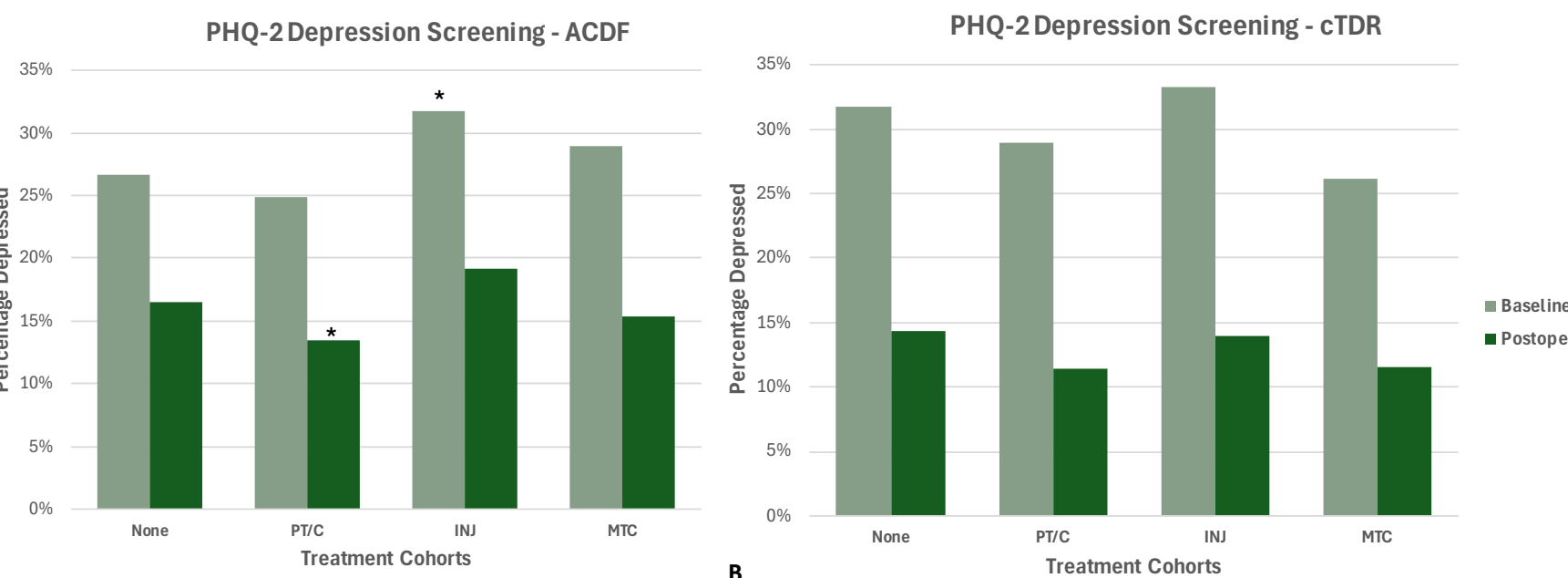


Figure 2. Baseline and 90-day postoperative PHQ-2 questionnaire in ACDF (A) and cTDR (B).

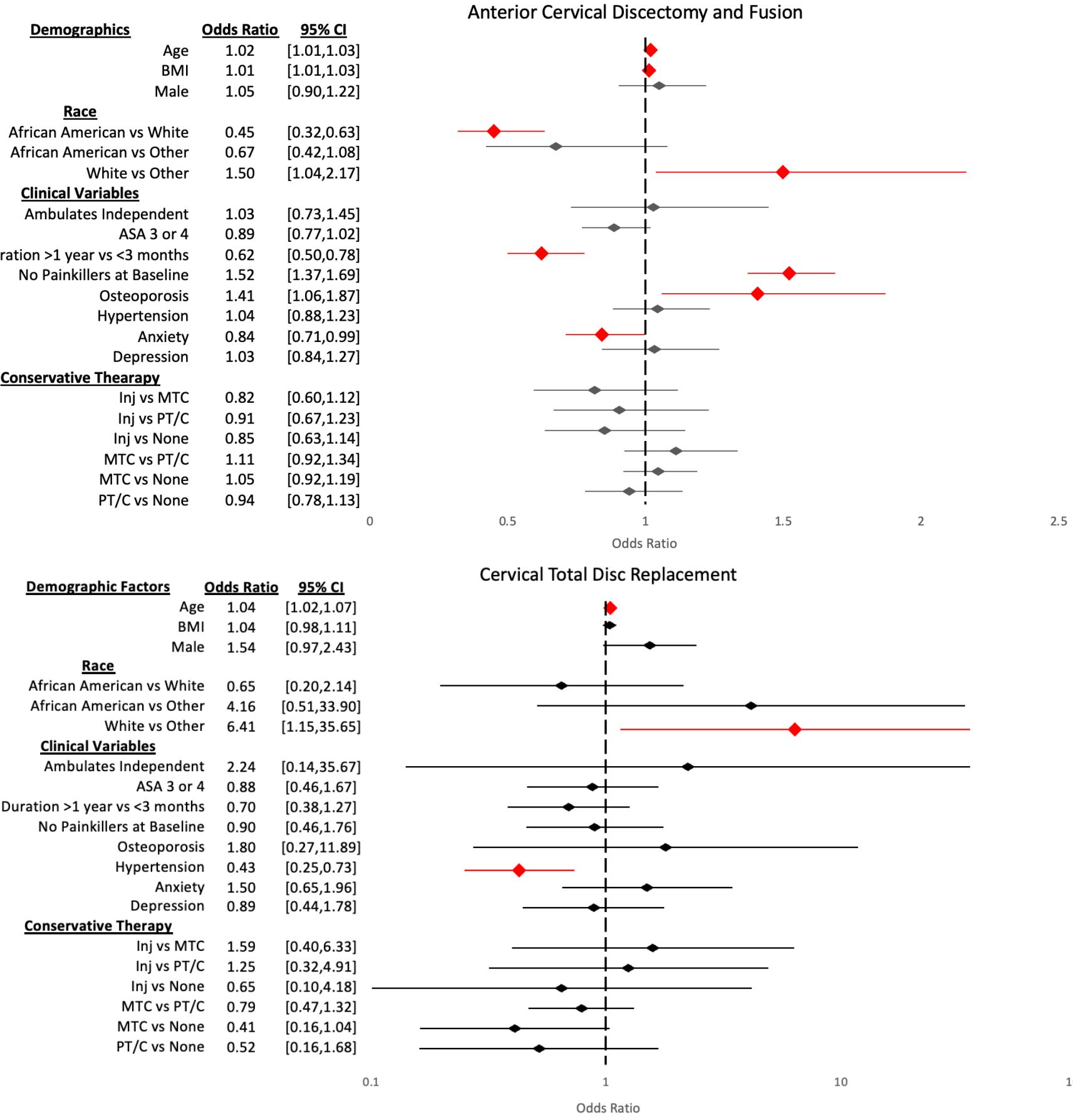


Figure 3. Multivariable analysis for ACDF and cTDR for achieving MCID in neck pain at 90-days postoperative. Further subcategorized based upon patient characteristics, health history, and preoperative treatment cohorts.

Conclusions

- Preoperative conservative treatment in ACDF patients is associated with younger age, fewer comorbidities, longer symptom duration, fewer postoperative complications, higher rates of home discharge and return-to-work, improved physical function, and lower depression.
- In cTDR patients, preoperative conservative care was linked to shorter hospital stays and longer symptom duration, with no other significant differences.
- Multivariate analysis identified age, BMI, osteoporosis, symptom duration, and anxiety as significant predictors of achieving MCID in neck pain at 90 days.
- Preoperative management had no significant impact upon reaching MCID in neck pain for ACDF or cTDR.
- Future studies with standardized preoperative protocols are needed to clarify benefits, optimize outcomes, and reduce patient costs.

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