Trends in Nonoperative Treatment Modalities Prior to Cervical Surgery and Impact on Patient-Derived Outcomes: Two-Year Analysis of 1522 Patients From the Prospective Spine Treatment Outcome Study

MICHAEL C. GERLING, MD, KRIS RADCLIFF, MD, ROBERT ISAACS, MD, KRISTINA BIANCO, BA, CYRUS M. JALAI, BA, NANCY J. WORLEY, BA, GREGORY W. POORMAN, BA, SAMANTHA R. HORN, OLIVIA J. BONO, BA, JOHN MOON, BS, PAUL M. ARNOLD, MD, ALEXANDER R. VACCARO, MD, PETER PASSIAS, MD

1Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, New York, 2Department of Orthopedic Surgery, Rothman Institute, Thomas Jefferson University, Philadelphia, Pennsylvania, 3Division of Neurosurgery, Duke University, Durham, North Carolina, 4Neurosurgery, University of Kansas Hospital, Kansas City, Kansas, 5NY Spine Institute/NYU Medical Center–Hospital for Joint Diseases, New York, New York

ABSTRACT

Background: Effects of nonoperative treatments on surgical outcomes for patients who failed conservative management for cervical spine pathologies remain unknown. The objective is to describe conservative modality use in patients indicated for surgery for degenerative cervical spine conditions and its impact on perioperative outcomes.

Methods: The current study comprises a retrospective review of a prospective multicenter database. A total of 1522 patients with 1- to 2-level degenerative cervical pathology who were undergoing surgical intervention were included. Outcome measures used were health-related quality-of-life scores, length of hospitalization, estimated blood loss, length of surgery, and return-to-work status at 2 weeks, 6 months, 1 year, and 2 years postoperatively. Patients were grouped by diagnosis (radiculopathy vs. myelopathy), then divided based on epidural injection(s), physical therapy (PT), or opioid use prior to enrollment. Univariate t-tests and \( \chi^2 \) tests were performed to determine differences between groups and impact on outcomes.

Results: Among 1319 radiculopathy patients, 25.7% received preoperative epidural injections, 35.3% received PT, and 35.5% received opioids. Radiculopathy patients who received epidurals and PT had higher 1-year postoperative return-to-work rates (\( P < .05 \)). Radiculopathy patients without preoperative PT had longer hospitalization times, whereas those who received PT had higher 36-Item Short Form Health Survey (SF-36) physical functioning and physical component scores, lower 2-year visual analog scale (VAS) neck/arm pain scores, and higher 2-year return-to-work incidence (\( P < .05 \)). Of myelopathy patients (\( n = 203 \)), 14.8% received epidural injections, 25.1% received opioids, and 41.5% received PT. Myelopathy patients with preoperative PT had worse VAS arm pain scores 2 years postoperatively (\( P < .05 \)). Patients receiving opioids were younger and had greater baseline–2-year Neck Disability Index improvement (\( P < .05 \)).

Conclusions: Radiculopathy patients receiving epidurals returned to work after 1 year more frequently. PT was associated with shorter hospitalizations, greater SF-36 bodily pain norm and physical component score improvements, and increased return-to-work rates after 1 and 2 years. No statistically significant nonoperative treatment was associated with return-to-work rate in myelopathy patients.

Clinical Relevance: These findings suggest certain preoperative conservative treatment modalities are associated with improved outcomes in radiculopathy patients.

INTRODUCTION

Nonoperative modalities are typically prescribed as the first method of conservative treatment of cervical pathologies, prior to elective cervical spine surgery.\(^1\) Nonoperative treatment has been shown to provide some benefits to these patients, but studies have been limited by small sample sizes, minimal follow-up data, and lack of control groups.\(^2\) Additionally, these studies examined the immediate and short-term effects of these interventions without long-term outcome data for patients who eventually undergo surgery. For example, Manchikanti et al.\(^8\) performed a randomized study
in which patients with chronic axial neck and radicular pain, attributed to cervical disc herniations, received cervical epidural injections with local anesthetic with or without corticosteroids. They reported that 72% of patients with just epidural and anesthetic and 68% of patients with additional corticosteroids reported significant improvement in both pain and functional ability, without providing further clinical information on patients who did not respond favorably at various time points. Similarly, in cases of cervical spondylotic myelopathy, reviews of nonoperative compared with operative treatment have been controversial, with specific concerns voiced by some authors on the benefit of delaying surgical decompression and the comparative efficacy of nonoperative treatment.

A subset of patients will not achieve optimal improvement with nonsurgical interventions and ultimately will proceed to surgery. Indeed, the indications for nonoperative treatment modality use based on their effect on the relative rate of surgical intervention and postoperative clinical outcomes are not known. Previous studies, including a report by Karpova et al in 2013 and one by Passias et al in 2015, have evaluated factors associated with cervical spine surgical outcomes. However, few studies have sought to analyze associations of nonoperative treatment modalities prior to cervical surgery on surgical outcomes. This is particularly relevant because the cost of treatments for cervical degenerative conditions, both nonoperative and operative, are substantial, and the use of both modalities without sustained effect would affect cost-reduction initiatives in addition to delaying inevitable surgical intervention.

The purpose of this study was to investigate recent trends in the preoperative treatment modalities administered to patients who eventually go on to surgery. We further aimed to determine whether specific nonoperative treatment modalities prior to surgery are associated with operative data (length of hospitalization, length of surgery, and estimated blood loss), patient-reported outcomes, and the rate at which patients return to work.

MATERIALS AND METHODS

Data Source

The Prospective Spine Treatment Outcomes Study (ProSTOS) database is a part of the Association for Collaborative Spinal Research and consists of data that were prospectively collected at multiple centers from a total of 2221 patients with cervical pathology. Of those patients, 1818 underwent spinal surgery, and 403 were nonoperative patients. Inclusion criteria for the database were patients with degenerative cervical pathology indicated for and who subsequently underwent 1- or 2-level surgery and who had less than or equal to grade 1 spondylolisthesis (Meyerding classification). Patients who were included were at least 18 years of age. Patients with grade 2 or higher spondylolisthesis and patients who were imprisoned, mentally incompetent, unable to complete the follow-up and data collection schedule, or potentially unable to give informed consent, or who were institutionalized in a nonvoluntary and/or dependent residence (including hospitals, group homes, etc.), were excluded.

Patient Population

This study is a retrospective review of a prospectively collected multicenter database. Patients who underwent cervical surgery and had a diagnosis of either degenerative disease or myelopathy were included in this analysis. Patients whose specific diagnosis was not provided (257 patients; 14%) were excluded from analysis because a diagnosis was necessary for cohort stratification. Patients who belonged to sites with <10% follow-up at 2 years following surgery (39 patients; 2.15%) were removed from analysis in order to address concerns regarding poor patient follow-up negatively affecting results.

Analysis Variables

Patients belonged to 1 of 2 cohorts based on diagnosis: degenerative disease, including radiculopathy (1319 patients), or myelopathy (203 patients). Within each cohort, patients were subdivided according to the nonoperative modality they received prior to surgery: epidural injection(s), physical therapy (PT), or opioids. Primary outcome measures were 36-Item Short Form Health Survey (SF-36) physical component score (PCS), Neck Disability Index (NDI) score, and visual analog scale (VAS) score for arm and neck pain. Secondary outcome measures included SF-36 physical functioning norm and SF-36 bodily pain norm scores, length of hospitalization, and return-to-work status (at 2 weeks, 6 months, 1 year, and 2 years postoperatively).
Statistical analysis was performed using SPSS (v20, IBM, Armonk, New York). Independent sample t-tests were performed for continuous variables, and $\chi^2$ tests were performed for categoric variables to investigate differences in patient characteristics. Continuous variables are presented as means, and categoric variables are presented as percentages. Changes in SF-36 were calculated as 2-year–baseline, whereas change in NDI was calculated as baseline–2-year, in order to standardize for differences in scoring techniques. A positive coefficient corresponded to an improvement in scores, whereas a negative coefficient corresponded to a worsening in scores (compared with baseline) from the time of surgery to 2 years postoperatively.

RESULTS

A total of 1522 patients were included in analysis. Average follow-up rates at 2 years postoperatively were as follows: 47.2% for SF-36 PCS, bodily pain, and physical functioning; 47.4% for NDI; and 45.5% for VAS arm and 45.9% for VAS neck outcome scores. Mean duration of symptoms was 78.49 weeks (range, 0–936 weeks). A total of 1319 patients had a diagnosis of degenerative cervical disease, which included radiculopathy, and 203 patients had a diagnosis of myelopathy. Preoperatively 34.1% underwent PT, 34.1% received opioids, and 24.2% received epidural injections. A total of 788 patients (51.8%) did not undergo any of the 3 nonoperative treatments considered preoperatively, whereas 276 patients (18.1%) underwent only 1 of the 3 nonoperative modalities, and 458 (30.1%) underwent more than 1. Both cohorts of patients (radiculopathy and myelopathy) displayed improvements relative to baseline in HRQOL scores at 2 years after surgery, although these trends were not significant with respect to diagnosis: NDI (5.95 vs. 7.00), SF-36 PCS (3.94 vs. 3.40), SF-36 physical functioning (3.38 vs. 2.10), SF-36 bodily pain (6.31 vs. 6.77), VAS neck (2.45 vs. 2.41), and VAS arm (2.62 vs. 1.78) were all insignificant ($P > .05$).

Patient demographics for radiculopathy and myelopathy cohorts are presented in Tables 1 and 2.

### Table 1. Demographic data for radiculopathy patients based on preoperative treatment type.

| Treatment Type | No Epi | Epi | P Value |
|----------------|--------|-----|---------|
| No. (%)        | 980 (74.3) | 339 (25.7) | .920 |
| Male, %        | 39.6 | 39.9 | .783 |
| Female, %      | 60.4 | 60.1 | .783 |
| Smoker, %      | 32.1 | 28.7 | .006* |
| Previous cervical surgery, % | 13.2 | 18.0 | .418 |
| Age, y         | 50.41 | 49.53 | .814 |
| BMI            | 28.41 | 28.49 | .537 |

### Table 2. Demographic data for myelopathy patients based on preoperative treatment type.

| Treatment Type | No Epi | Epi | P Value |
|----------------|--------|-----|---------|
| No. (%)        | 173 (85.2) | 30 (14.8) | .987 |
| Male, %        | 56.1 | 56.7 | .957 |
| Female, %      | 43.9 | 43.4 | .957 |
| Smoker, %      | 24.0 | 32.1 | .355 |
| Previous cervical surgery, % | 10.4 | 10.3 | .991 |
| Age, y         | 58.09 | 55.16 | .190 |
| BMI            | 28.78 | 31.60 | .079 |

### Statistical Methods

Statistical analysis was performed using SPSS (v20, IBM, Armonk, New York). Independent sample $t$-tests were performed for continuous variables, and $\chi^2$ tests were performed for categoric variables to investigate differences in patient characteristics. Continuous variables are presented as means, and categoric variables are presented as percentages. Changes in SF-36 were calculated as 2-year–baseline, whereas change in NDI was calculated as baseline–2-year, in order to standardize for differences in scoring techniques. A positive coefficient corresponded to an improvement in scores, whereas a negative coefficient corresponded to a worsening in scores (compared with baseline) from the time of surgery to 2 years postoperatively.

### RESULTS

A total of 1522 patients were included in analysis. Average follow-up rates at 2 years postoperatively were as follows: 47.2% for SF-36 PCS, bodily pain, and physical functioning; 47.4% for NDI; and 45.5% for VAS arm and 45.9% for VAS neck outcome scores. Mean duration of symptoms was 78.49 weeks (range, 0–936 weeks). A total of 1319 patients had a diagnosis of degenerative cervical disease, which included radiculopathy, and 203 patients had a diagnosis of myelopathy. Preoperatively 34.1% underwent PT, 34.1% received opioids, and 24.2% received epidural injections. A total of 788 patients (51.8%) did not undergo any of the 3 nonoperative treatments considered preoperatively, whereas 276 patients (18.1%) underwent only 1 of the 3 nonoperative modalities, and 458 (30.1%) underwent more than 1. Both cohorts of patients (radiculopathy and myelopathy) displayed improvements relative to baseline in HRQOL scores at 2 years after surgery, although these trends were not significant with respect to diagnosis: NDI (5.95 vs. 7.00), SF-36 PCS (3.94 vs. 3.40), SF-36 physical functioning (3.38 vs. 2.10), SF-36 bodily pain (6.31 vs. 6.77), VAS neck (2.45 vs. 2.41), and VAS arm (2.62 vs. 1.78) were all insignificant ($P > .05$).

### Radiculopathy

### Epidural Injection Analysis

A total of 25.7% of patients received at least 1 epidural injection prior to enrollment. Cohorts that had and had not received ESIIs were similar with regard to preoperative health-related quality-of-life
Table 3. Baseline HRQOL scores (SF-36, NDI, VAS) for radiculopathy patients based on preoperative treatment type.

|                | No Epi | Epi  | P Value |
|----------------|--------|------|---------|
| SF-36 physical functioning norm | 35.98  | 36.03 | .900    |
| SF-36 bodily pain norm | 31.44  | 30.92 | .317    |
| SF-36 PCS | 34.67  | 35.23 | .344    |
| NDI | 22.91  | 24.03 | .104    |
| VAS neck pain | 6.94   | 7.12  | .262    |
| VAS arm pain | 6.33   | 6.52  | .270    |

|                | No PT | PT  | P Value |
|----------------|-------|-----|---------|
| SF-36 physical functioning norm | 35.46  | 36.96 | .011*   |
| SF-36 bodily pain norm | 31.21  | 31.47 | .589    |
| SF-36 PCS | 34.19  | 35.96 | .001*   |
| NDI | 23.05  | 23.48 | .497    |
| VAS neck pain | 6.99   | 6.98  | .952    |
| VAS arm pain | 6.40   | 6.33  | .659    |

Abbreviations: Epi, epidural injection; HRQOL, health-related quality of life; NDI, neck disability index; PCS, physical component score; PT, physical therapy; VAS, visual analog scale.

*Indicates statistical significance to P < .050.

Table 4. One-year follow-up HRQOL scores (SF-36, NDI, VAS) for radiculopathy patients based on preoperative treatment type.

|                | No Epi | Epi  | P Value |
|----------------|--------|------|---------|
| SF-36 physical functioning norm | 39.59  | 40.12 | .630    |
| SF-36 bodily pain norm | 38.16  | 38.04 | .917    |
| SF-36 PCS | 38.30  | 38.39 | .939    |
| NDI | 16.55  | 0.368 | .692    |
| VAS neck pain | 47.39  | 41.6   | .387    |
| VAS arm pain | 3.72   | 3.22  | .078    |

|                | No PT | PT  | P Value |
|----------------|-------|-----|---------|
| SF-36 physical functioning norm | 38.75  | 41.73 | .003*   |
| SF-36 bodily pain norm | 37.48  | 39.51 | .040*   |
| SF-36 PCS | 37.55  | 39.94 | .022*   |
| NDI | 16.61  | 0.373 | .821    |
| VAS neck pain | 4.48   | 4.04  | .063*   |
| VAS arm pain | 3.80   | 3.22  | .018*   |

|                | No Opioids | Opioids | P Value |
|----------------|------------|---------|---------|
| SF-36 physical functioning norm | 39.73  | 39.65  | .082    |
| SF-36 bodily pain norm | 38.17  | 38.05  | .899    |
| SF-36 PCS | 38.30  | 38.36  | .957    |
| NDI | 16.30  | 16.41  | .914    |
| VAS neck pain | 4.40   | 4.20   | .385    |
| VAS arm pain | 3.70   | 3.43   | .289    |

Abbreviations: Epi, epidural injection; HRQOL, health-related quality of life; NDI, neck disability index; PCS, physical component score; PT, physical therapy; VAS, visual analog scale.

*Indicates statistical significance to P < .050.

(HRQL) scores (SF-36 PCS, 35.32 vs. 34.67, P = .344; NDI, 24.03 vs. 22.91, P = .104; VAS neck pain, 7.12 vs. 6.94, P = .262; VAS arm pain: 6.52 vs. 6.33, P = .780; SF-36 physical functioning, 36.06 vs. 35.98, P = .900; SF-36 bodily pain, 30.92 vs. 31.44, P = .317; Table 3).

There were no statistically significant differences between the 2 cohorts in terms of HRQLs at 1 year (Table 4) and 2 years (Table 5) postoperatively and in change in HRQL scores from baseline to 2 years postoperatively (Table 6). A larger percentage of patients who received preoperative epidurals returned to work after 1 year postoperatively (63.2% vs. 52.1%; P < .05; Table 7).

PT Analysis
A total of 35.3% of radiculopathy patients underwent PT prior to enrollment. A larger percentage of patients who did not undergo PT were smokers (33.9% vs. 26.3%; P < .05; Table 1). Patients who did not undergo PT were older on average (50.85 vs. 48.97 years; P < .05; Table 1) and had a higher follow-up rate at 1 year postoperatively (54.6% vs. 47.4%; P < .05). PT patients had higher baseline SF-36 physical functioning norm (36.96 vs. 35.46; P < .05) and PCS (35.96 vs. 34.19; P < .05) scores (Table 3).

Patients who did not undergo PT had longer hospitalizations (39.48 vs. 33.03 hours; P < .05; Table 8). At 1 year postoperatively, PT patients had higher SF-36 physical functioning norm (41.73 vs. 38.75; P < .05), bodily pain norm (39.51 vs. 37.48;
Changes in HRQOL scores (SF-36, NDI, VAS) from baseline to 2-year follow-up for radiculopathy patients based on preoperative treatment type.

|                          | No Epi | Epi   | P Value |
|--------------------------|--------|-------|---------|
| Change in SF-36 physical | 3.43   | 3.26  | .857    |
| functioning norm         |        |       |         |
| Change in SF-36 bodily    | 6.04   | 7.12  | .347    |
| pain norm                |        |       |         |
| Change in SF-36 PCS      | 37.47  | 37.17 | .807    |
| Change in NDI            | 21.91  | 23.04 | .103    |
| Change in VAS neck pain  | 2.37   | 2.69  | .291    |
| Change in VAS arm pain   | 2.59   | 2.69  | .776    |

|                          | No PT  | PT    | P Value |
|--------------------------|--------|-------|---------|
| Change in SF-36 physical  | 2.91   | 4.27  | .094    |
| functioning norm         |        |       |         |
| Change in SF-36 bodily    | 5.53   | 7.77  | .038*   |
| pain norm                |        |       |         |
| Change in SF-36 PCS      | 36.54  | 38.98 | .029*   |
| Change in NDI            | 22.05  | 22.49 | .491    |
| Change in VAS neck pain  | 2.22   | 2.87  | .018*   |
| Change in VAS arm pain   | 2.46   | 2.91  | .162    |

|                          | No Opioids | Opioids | P Value |
|--------------------------|------------|---------|---------|
| Change in SF-36 physical  | 3.54       | 3.09    | .597    |
| functioning norm         |            |         |         |
| Change in SF-36 bodily    | 6.59       | 5.80    | .447    |
| pain norm                |            |         |         |
| Change in SF-36 PCS      | 37.91      | 36.43   | .186    |
| Change in NDI            | 21.91      | 23.00   | .53     |
| Change in VAS neck pain  | 2.43       | 2.48    | .856    |
| Change in VAS arm pain   | 2.52       | 2.80    | .400    |

Table 8. Significant outcome variables (length of hospitalization [LOH], length of surgery [LOS], and estimated blood loss [EBL]) for radiculopathy patients based on preoperative treatment type.

|                          | No PT     | PT      | P Value |
|--------------------------|-----------|---------|---------|
| LOH, hr                  | 39.48     | 33.03   | .001*   |
| EBL, cm³                 | 102.62    | 136.84  | .034*   |

*Indicates statistical significance to P < .05.

Opioids Analysis
A total of 35.5% of patients received opioids. Patients who did not receive opioids were older (50.66 vs. 49.32 years; P < .05; Table 1) and had a higher follow-up rate at 1 year postoperatively (55.5% vs. 45.9%; P < .05). At baseline, patients who did not receive opioids had higher SF-36 bodily pain norm scores (31.74 vs. 30.55; P < .05) as well as lower VAS neck pain (6.87 vs. 7.19; P = .021) and arm pain (6.20 vs. 6.67; P = .003) scores (Table 3). Patients who received opioids had shorter hospitalizations (34.33 hours vs. 38.79 hours; P < .05; Table 8).

Myelopathy
A total of 203 patients had a diagnosis of myelopathy.

Epidural Injection Analysis
A total of 14.8% of myelopathic patients received epidurals preoperatively. Patients undergoing epidural injections had lower follow-up rates at 1 year postoperatively (26.7% vs. 56.6%; P < .05). There were no significant differences between patients who received and those who did not receive epidurals in terms of HRQLs preoperatively (Table 9) and postoperatively (Tables 10 and 11), or in terms of HRQL changes from baseline to postoperatively (P < .05; Table 12).

PT Analysis
PT patients were younger (48.97 vs. 50.85 years; P < .05; Table 2) and had lower rates of follow-up at 1 year postoperatively (39.6% vs. 56.7%; P < .05; Table 10). At 2 years postoperatively, patients who received PT had worse VAS arm pain scores (4.19 vs. 2.69; P = .046; Table 11).

Opioids Analysis
Patients who received opioids were younger (54.42 vs. 58.72 years; P < .05; Table 2). At baseline,
Table 9. Baseline HRQOL scores (SF-36, NDI, VAS) for myelopathy patients based on preoperative treatment type.

|                      | No Epi | Epi | P Value |
|----------------------|--------|-----|---------|
| SF-36 physical functioning norm | 34.17  | 35.64 | .405    |
| SF-36 bodily pain norm     | 33.50  | 32.82 | .704    |
| SF-36 PCS               | 34.70  | 35.66 | .457    |
| NDI                   | 20.31  | 22.63 | .305    |
| VAS neck pain          | 6.27   | 6.50  | .670    |
| VAS arm pain           | 5.77   | 6.17  | .494    |

|                      | No PT | PT | P Value |
|----------------------|-------|----|---------|
| SF-36 physical functioning norm | 34.30  | 34.64 | .845    |
| SF-36 bodily pain norm     | 33.57  | 32.90 | .646    |
| SF-36 PCS               | 34.63  | 35.46 | .582    |
| NDI                   | 20.38  | 21.44 | .525    |
| VAS neck pain          | 6.31   | 6.29  | .975    |
| VAS arm pain           | 5.80   | 5.94  | .769    |

Table 10. One-year follow-up HRQOL scores (SF-36, NDI, VAS) for myelopathy patients based on preoperative treatment type.

|                      | No Epi | Epi | P Value |
|----------------------|--------|-----|---------|
| SF-36 physical functioning norm | 34.63  | 33.67 | .578    |
| SF-36 bodily pain norm     | 34.23  | 30.89 | .022*   |
| SF-36 PCS               | 35.04  | 34.27 | .614    |
| NDI                   | 19.73  | 23.42 | .047*   |
| VAS neck pain          | 6.14   | 6.81  | .132    |
| VAS arm pain           | 5.64   | 6.43  | .106    |

|                      | No PT | PT | P Value |
|----------------------|-------|----|---------|
| SF-36 physical functioning norm | 34.63  | 33.67 | .578    |
| SF-36 bodily pain norm     | 34.23  | 30.89 | .022*   |
| SF-36 PCS               | 35.04  | 34.27 | .614    |
| NDI                   | 19.73  | 23.42 | .047*   |
| VAS neck pain          | 6.14   | 6.81  | .132    |
| VAS arm pain           | 5.64   | 6.43  | .106    |

Abbreviations: Epi, epidural injection; HRQOL, health-related quality of life; NDI, neck disability index; PCS, physical component score; PT, physical therapy; VAS, visual analog scale.

patients who received opioids had lower SF-36 bodily pain norm (30.89 vs. 34.23; \( P < .05 \)) and higher NDI (23.42 vs. 19.73; \( P < .05 \)) scores (Table 9). Patients who received opioids had greater improvement in NDI scores from baseline to 2 years postoperatively (22.42 vs. 18.73; \( P < .05 \)).

Table 11. Two-year follow-up HRQOL scores (SF-36, NDI, VAS) for myelopathy patients based on preoperative treatment type.

|                      | No Epi | Epi | P Value |
|----------------------|--------|-----|---------|
| SF-36 physical functioning norm | 36.18  | 37.32 | .752    |
| SF-36 bodily pain norm     | 37.84  | 36.23 | .691    |
| SF-36 PCS               | 35.36  | 38.29 | .648    |
| NDI                   | 13.09  | 16.50 | .342    |
| VAS neck pain          | 3.81   | 3.90  | .916    |
| VAS arm pain           | 3.00   | 3.40  | .695    |

|                      | No PT | PT | P Value |
|----------------------|-------|----|---------|
| SF-36 physical functioning norm | 36.52  | 35.69 | .765    |
| SF-36 bodily pain norm     | 38.74  | 34.19 | .072    |
| SF-36 PCS               | 36.06  | 34.65 | .646    |
| NDI                   | 12.97  | 15.10 | .426    |
| VAS neck pain          | 3.69   | 4.24  | .390    |
| VAS arm pain           | 2.69   | 4.19  | .046*   |

|                      | No Epi | Epi | P Value |
|----------------------|--------|-----|---------|
| SF-36 physical functioning norm | 36.56  | 35.50 | .705    |
| SF-36 bodily pain norm     | 37.61  | 37.75 | .966    |
| SF-36 PCS               | 35.68  | 35.85 | .955    |
| NDI                   | 13.60  | 13.00 | .850    |
| VAS neck pain          | 3.83   | 3.80  | .968    |
| VAS arm pain           | 2.97   | 3.32  | .662    |

|                      | No PT | PT | P Value |
|----------------------|-------|----|---------|
| SF-36 physical functioning norm | 36.67  | 33.17 | .050    |
| SF-36 bodily pain norm     | 37.61  | 37.75 | .966    |
| SF-36 PCS               | 35.68  | 35.85 | .955    |
| NDI                   | 13.60  | 13.00 | .850    |
| VAS neck pain          | 3.83   | 3.80  | .968    |
| VAS arm pain           | 2.97   | 3.32  | .662    |

Abbreviations: Epi, epidural injection; HRQOL, health-related quality of life; NDI, neck disability index; PCS, physical component score; PT, physical therapy; VAS, visual analog scale.

*Indicates statistical significance to \( P < .05 \).

Table 12. Changes in HRQOL scores (SF-36, NDI, VAS) from baseline to 2-year follow-up for myelopathy patients based on preoperative treatment type.

|                      | No Epi | Epi | P Value |
|----------------------|--------|-----|---------|
| Change in SF-36 physical functioning norm | 1.88   | 1.68  | .964    |
| Change in SF-36 bodily pain norm     | 4.21   | 1.94  | .625    |
| Change in SF-36 PCS               | 34.07  | 37.04 | .478    |
| Change in NDI                   | 19.31  | 21.63 | .305    |
| Change in VAS neck pain          | 2.76   | 1.40  | .164    |
| Change in VAS arm pain           | 2.72   | 2.00  | .560    |

|                      | No PT | PT | P Value |
|----------------------|-------|----|---------|
| Change in SF-36 physical functioning norm | 1.71   | 2.35  | .736    |
| Change in SF-36 bodily pain norm     | 4.57   | 1.96  | .450    |
| Change in SF-36 PCS               | 34.73  | 33.35 | .657    |
| Change in NDI                   | 19.38  | 20.44 | .525    |
| Change in VAS neck pain          | 2.94   | 1.50  | .051    |
| Change in VAS arm pain           | 3.03   | 1.35  | .071    |

|                      | No Epi | Epi | P Value |
|----------------------|--------|-----|---------|
| Change in SF-36 physical functioning norm | 1.53   | 2.98  | .456    |
| Change in SF-36 bodily pain norm     | 2.81   | 7.92  | .144    |
| Change in SF-36 PCS               | 34.35  | 34.60 | .936    |
| Change in NDI                   | 18.73  | 22.72 | .047*   |
| Change in VAS neck pain          | 2.60   | 2.63  | .964    |
| Change in VAS arm pain           | 2.60   | 2.78  | .853    |

Abbreviations: Epi, epidural injection; HRQOL, health-related quality of life; NDI, neck disability index; PCS, physical component score; PT, physical therapy; VAS, visual analog scale.

*Indicates statistical significance to \( P < .05 \).
DISCUSSION

The primary goal of nonsurgical treatments in patients with radiculopathy or myelopathy is to reduce symptoms and eliminate the need for surgical intervention. In the current study, more than one third of patients who underwent cervical surgery had undergone preoperative epidural injection and/or PT. The utility of these modalities that introduce added costs and delay the ultimate decision to proceed with surgery is brought to question. Additional research needs to focus on defining patients in whom these treatments are unlikely to be effective and therefore could be eliminated from the care pathway.

This study aimed to investigate the effects of nonoperative treatment modalities received preoperatively on the outcomes of cervical surgery patients postoperatively. Myelopathy patients from this database were not associated with benefits from nonoperative treatment modalities following surgical intervention, which is consistent with prior studies. In contrast, for patients with degenerative nonmyelopathic cervical pathology, including radiculopathy, certain nonoperative treatment modalities were associated with benefits. Specifically, epidurals were associated with a higher percentage of patients returning to work at 1 year but not 2 years postoperatively, and PT was associated with shorter hospitalizations, greater improvements in SF-36 bodily pain norm and PCS scores, and a higher percentage of patients returning to work after 1 year and 2 years postoperatively. Opioid use did not alter outcomes.

Cervical radiculopathy patients are thought to have better prognosis than cervical spondylotic myelopathy patients. Clarke and Robinson reported their belief that patients with cervical spondylotic myelopathy never regain neurologic function. Rao reported in his review of cervical radiculopathy and myelopathy that myelopathic patients have little likelihood of improving and often continue to decline. Preoperative epidural steroid injections were not associated with benefits in cervical spondylotic myelopathy patients but were associated with radiculopathy patients returning to work more rapidly after surgery. This raises the question as to whether preoperative epidural steroid injections have some type of effect on postoperative outcomes or whether patients selected for or willing to undergo epidural steroid injections in the treatment of radiculopathy are more likely to have a favorable surgical outcome.

The clinical importance of these findings is further emphasized by the current health care cost crisis. Eliminating potentially unnecessary and increasingly costly nonoperative treatments would be one avenue to help address this issue. For example, spinal epidural rates have increased by 121.2% from 1997 to 2006, resulting in a 21.8% annual increase in Medicare expenditures ($743.78 million). The findings from this study could be used in conjunction with future studies on cost-effectiveness that analyze the difference in effect of epidurals on postoperative outcomes in patients with cervical radiculopathy and myelopathy.

Our results revealed that patients who underwent PT preoperatively and who had radiculopathy diagnoses had shorter lengths of hospitalization as well as better SF-36 physical functioning norm and PCS scores at 2 years postoperatively. PT patients also had greater improvement on average in SF-36 bodily pain norm and PCS from preoperatively to 2 years postoperatively compared with patients who did not undergo PT preoperatively. A higher percentage of PT patients with radiculopathy also returned to work at 1 and 2 years postoperatively. For radiculopathy patients, PT prior to surgery, in general, has been associated with beneficial effects on postoperative patient outcomes.

Another explanation for our findings could be that patients receiving comprehensive treatment prior to surgery may represent a better conditioned or better selected population. There could be some selection bias in our database. It should also be noted that the preoperative PT cohort also had higher average baseline SF-36 physical functioning norm and PCS scores. This could be a limitation of this analysis, because perhaps patients in the preoperative PT group were in better health to begin with compared with the group that did not.
perform preoperative PT. Patients who performed
PT preoperatively improved from that therapy even
before surgery. Myelopathy patients who underwent
PT preoperatively had worse (higher) VAS arm pain
scores at 2 years postoperatively (P < .05).

Our results did not reveal any differences in 2-
year postoperative HRQL scores, changes in HRQL
scores from baseline to 2 years postoperatively, or
differences in return to work between patients who
took and those who did not take opioids for both
radiculopathy and myelopathic diagnoses. The only
exception to this was that myelopathic patients had
a greater improvement in NDI from baseline to 2
years postoperatively if they took opioids preoper-
atively. This result is likely confounded by the
finding that patients who took opioids started out
with worse NDI scores at baseline, making opioid
consumption likely not a causative finding in the
greater improvement in scores observed after
surgery.

In the Spine Patient Outcomes Research Trial
(SPORT) disc herniation trial, which revealed more
improvement in lumbar patients after surgery
compared with conservative care, surgical patients
recorded any preoperative conservative care they
took, which included PT, epidurals, opioid analge-
sics, anti-inflammatories, and education/counsel-
ing. Different patients received different
variations of this care, similar to our study. With
the apparent benefits of preoperative PT on
postoperative patient outcomes and not everyone
participating in such treatment (34% in our study
and 67% in SPORT), surgeons should question the
adequacy of current preoperative care. In the
SPORT study, 42% received epidurals (24% in
ours) and 40% received opioids (34% in ours). In
our current setting of cost savings in health care,
future studies should be oriented towards assessing
the use of these nonoperative treatments preopera-
tively on postoperative outcomes in cervical spine
patients. Furthermore, studies should look into
ways to better define which patients are most
appropriate for preoperative nonoperative care
based on diagnosis.

This study has some limitations. First, there was a
low rate of complete follow-up compared with other
studies. To address this issue, sites with the worst
follow-up were removed from this analysis. Second,
when categorizing patients based on preoperative
nonoperative treatment modalities, the dosage/amount and duration of those treatments were
unknown. As a result, patients in each nonoperative
treatment modality group, such as epidural use,
were not standardized. Finally, there were differ-
ences in baseline characteristics between the groups,
complicating statistical inferences that can be made.
This limitation is mitigated by our large sample size.

**CONCLUSION**

This study will guide physicians in developing
optimal treatment algorithms for patients with
cervical pathology and to guide future research on
the efficacy of nonoperative treatment strategies
prior to cervical spine surgery. In patients with
cervical radiculopathy, epidural steroid use was
associated with earlier return to work after surgery.
PT was associated with shorter hospitalizations,
greater improvements in SF-36 bodily pain norm
and PCS scores, and lower VAS neck and arm pain
scores at 2 years postoperatively, and a larger
percentage of PT patients returned to work after 1
year and 2 years postoperatively.

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**Corresponding Author:** Peter G. Passias, MD, NY Spine Institute/NYU Medical Center—
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Hospital for Joint Diseases, 301 East 17th Street, New York, NY 10003. Phone: (646) 794-8640; Fax: (646) 602-6927; Email: Peter.Passias@nyumc.org.

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