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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

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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 χ^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.

Cervical Spine

Keywords: cervical spine surgery, outcomes, nonoperative treatment, epidural injections, physical therapy, opioids

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.[2–7] 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

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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.[8] 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.[9–11]

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[12] in 2013 and one by Passias et al[13] 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).[14] 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).

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

	No Epi	Epi	*P* Value
No. (%)	980 (74.3)	339 (25.7)	
Male, %	39.6	39.9	.920
Female, %	60.4	60.1	.920
Smoker, %	32.1	28.7	.256
Previous cervical surgery, %	13.2	18.0	.066
Age, y	50.41	49.53	.192
BMI	28.41	28.49	.855
	No PT	**PT**	***P* Value**
No. (%)	853 (64.7)	466 (35.3)	
Male, %	39.4	40.2	.783
Female, %	60.6	59.8	.783
Smoker, %	33.9	26.3	.006*
Previous cervical surgery, %	16.2	14.2	.418
Age, y	50.85	48.94	.002*
BMI	28.39	28.49	.814
	No Opioids	**Opioids**	***P* Value**
No. (%)	851 (64.5)	468 (35.5)	
Male, %	39.8	39.6	.958
Female, %	60.2	60.4	.958
Smoker, %	29.8	33.6	.172
Previous cervical surgery, %	13.4	16.4	.243
Age, y	50.66	49.32	.032*
BMI	38.63	28.34	.537

Abbreviations: BMI, body mass index; Epi, epidural injection; PT, physical therapy.
*Indicates statistical significance to $P < .050$.

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

	No Epi	Epi	*P* Value
No. (%)	173 (85.2)	30 (14.8)	
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
	No PT	**PT**	***P* Value**
No. (%)	150 (73.9)	53 (26.1)	
Male, %	58.1	50.9	.367
Female, %	41.9	49.1	.367
Smoker, %	26.4	21.6	.495
Previous cervical surgery, %	5.3	18.0	.023
Age, y	50.85	48.97	.002
BMI	28.39	28.49	.817
	No Opioids	**Opioids**	***P* Value**
No. (%)	152 (74.9)	51 (25.1)	
Male, %	53.3	64.7	.157
Female, %	46.7	35.3	.157
Smoker, %	24.7	26.5	.794
Previous cervical surgery, %	10.5	10.2	.954
Age, y	58.72	54.42	.019
BMI	29.15	30.07	.422

Abbreviations: BMI, body mass index; Epi, epidural injection; PT, physical therapy.
*Indicates statistical significance to $P < .050$.

Statistical Methods

Statistical analysis was performed using SPSS (v20, IBM, Armonk, New York). Independent sample *t*-tests were performed for continuous variables, and χ^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.

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 ESIs were similar with regard to preoperative health-related quality-of-life

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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
	No Opioids	**Opioids**	***P* Value**
SF-36 physical functioning norm	36.22	35.62	.305
SF-36 bodily pain norm	31.74	30.55	.010*
SF-36 PCS	34.92	34.66	.626
NDI	22.74	23.99	.054
VAS neck pain	6.87	7.19	.021*
VAS arm pain	6.20	6.67	.003*

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 5. Two-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	39.10	38.53	.652
SF-36 bodily pain norm	38.37	38.05	.781
SF-36 PCS	38.46	38.15	.795
NDI	16.86	17.26	.745
VAS neck pain	4.41	4.18	.451
VAS arm pain	3.61	3.52	.781
	No PT	**PT**	***P* Value**
SF-36 physical functioning norm	37.98	40.85	.011*
SF-36 bodily pain norm	37.64	39.56	.072*
SF-36 PCS	37.53	40.03	.024*
NDI	17.66	15.57	.062*
VAS neck pain	4.63	3.83	.004*
VAS arm pain	3.85	3.07	.007*
	No Opioids	**Opioids**	***P* Value**
SF-36 physical functioning norm	39.35	38.19	.307
SF-36 bodily pain norm	38.92	37.09	.085
SF-36 PCS	38.79	37.61	.286
NDI	16.72	17.41	.538
VAS neck pain	4.34	4.40	.839
VAS arm pain	3.73	3.30	.142

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, $P = .270$; SF-36 physical functioning, 36.06 vs. 35.98, $P = .900$; SF-36 bodily pain, 30.92 vs. 31.44, $P = .317$; Table 3).

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	4.16	.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 $P < .050$.

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;

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Table 6. 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 functioning norm	3.43	3.26	.857
Change in SF-36 bodily pain norm	6.04	7.12	.347
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 functioning norm	2.91	4.27	.094
Change in SF-36 bodily pain norm	5.53	7.77	.038*
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 functioning norm	3.54	3.09	.597
Change in SF-36 bodily pain norm	6.59	5.80	.447
Change in SF-36 PCS	37.91	36.43	.186
Change in NDI	21.91	23.00	.053
Change in VAS neck pain	2.43	2.48	.856
Change in VAS arm pain	2.52	2.80	.400

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 $P < .050$.

$P < .05$), and PCS (39.94 vs. 37.55; $P < .05$) scores, and lower VAS arm pain (3.22 vs. 3.80; $P = .018$) scores (Table 4). At 2 years postoperatively, PT patients had higher SF-36 physical functioning norm (40.85 vs. 37.98; $P < .05$) and PCS (40.03 vs. 37.53; $P < .05$) scores, and lower VAS neck (3.83 vs. 4.64; $P = .004$) and arm pain (3.07 vs. 3.85; $P = .007$) scores (Table 6). PT patients had greater improvements in SF-36 bodily pain norm (7.77 vs. 5.53; $P < .05$), PCS (38.98 vs. 36.54; $P < .05$), and VAS neck pain (2.87 vs. 2.22; $P = .018$) scores (Table 6). A larger percentage of PT patients returned to work after 1 year (60.8% vs. 51.5%; $P < .05$) and 2 years (59.0% vs. 46.3%; $P < .05$) following surgery (Table 7).

Table 7. Return to work for myelopathy patients based on pretreatment type.

	No Epi	Epi	*P* Value
After 1 y, %	52.1	63.2	.028*
	No PT	**PT**	***P* Value**
After 1 y, %	51.5	60.8	.038*
After 2 y, %	46.3	59.0	.013*

Abbreviations: Epi, epidural injection; PT, physical therapy.
*Indicates statistical significance to $P < .050$.

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

	No PT	PT	*P* Value
LOH, hr	39.48	33.03	.001*
	No Opioids	**Opioids**	***P* Value**
LOS, min	28.14	25.79	.020*
LOH, hr	38.79	34.33	.043*
EBL, cm^3	102.62	136.84	.034*

Abbreviation: PT, physical therapy.
*Indicates statistical significance to $P < .050$.

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,

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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
	No Opioids	**Opioids**	***P* Value**
SF-36 physical functioning norm	34.63	33.67	.578
SF-36 bodily pain norm	34.23	30.89	.023*
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.
*Indicates statistical significance to $P < .050$.

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 12).

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	38.87	37.30	.743
SF-36 bodily pain norm	39.12	33.61	.247
SF-36 PCS	38.84	37.93	.845
NDI	14.15	15.22	.787
VAS neck pain	3.80	4.29	.658
VAS arm pain	3.05	2.57	.523
	No PT	**PT**	***P* Value**
SF-36 physical functioning norm	39.27	36.65	.408
SF-36 bodily pain norm	39.44	35.74	.242
SF-36 PCS	39.52	35.71	.317
NDI	14.29	14.05	.928
VAS neck pain	3.73	4.29	.457
VAS arm pain	3.08	2.78	.712
	No Opioids	**Opioids**	***P* Value**
SF-36 physical functioning norm	39.03	37.92	.699
SF-36 bodily pain norm	39.07	37.65	.625
SF-36 PCS	38.96	68.21	.789
NDI	14.06	14.75	.777
VAS neck pain	3.79	3.96	.791
VAS arm pain	3.26	2.29	.182

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.

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	.468
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 Opioids	**Opioids**	***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

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 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 Opioids	**Opioids**	***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 $P < .050$.

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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.[9,15] 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[16] reported their belief that patients with cervical spondylotic myelopathy never regain neurologic function. Rao[17] 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).[18] 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.[19–24] In the current study, the difference in baseline functioning, age, and smoking history between those patients receiving PT and those who did not could account for some of the postoperative differences observed. These factors could influence surgical outcomes independently of the use of PT. The decision to proceed with PT is likely complex and is reflective of physician biases, clinical symptoms, and patient beliefs and biases. These factors are also likely to affect patient perceived outcomes after surgical intervention.

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

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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 preoperatively. 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 analgesics, anti-inflammatories, and education/counseling.[25] 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 preoperatively 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 differences 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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