The Spine Journal 19 (2019) 1809–1815

Clinical Study

The discrepancy between functional outcome and self-reported health status after surgery for degenerative cervical myelopathy

Lindsay A. Tetreault, PhD[a,b], Mary P. Zhu[c], Rachel M. Howard, HBSc[b], Fatimah Sorefan-Mangou, BSc[b], Alpesh A. Patel, MD[d], Gregory D. Schroeder, MD[e], Eric M. Massicotte, MD, MSc, MBA[a], Jetan H. Bhadiwala, MD[a], Michael G. Fehlings, MD, PhD[a], Jefferson R. Wilson, MD, PhD[c,f,*]

[a] *Division of Neurosurgery, Department of Surgery, Toronto Western Hospital, 399 Bathurst Street, Toronto, Canada M5T 2S8*
[b] *Graduate Entry Medicine, University College Cork, College Rd, University College, Cork T12 K8AF Ireland*
[c] *Division of Neurosurgery, Department of Surgery, St. Michael's Hospital, 30 Bond Street, Toronto, Canada M5W 1W8*
[d] *Department of Orthopedic Surgery, Feinberg School of Medicine, Northwestern University, 420 E Superior Street, Chicago, IL 60611, USA*
[e] *Department of Orthopedic Surgery, Rothman Institute, Thomas Jefferson University Hospital, 925 Chestnut Street, Philadelphia, PA 19107, USA*
[f] *Li Ka Shing Knowledge Institute, St. Michael's Hospital, 209 Victoria Street, Toronto, Canada M5B 1T8*

Received 29 January 2019; revised 25 April 2019; accepted 30 June 2019

Abstract

INTRODUCTION: Surgery for degenerative cervical myelopathy has shown not only to halt neurologic deterioration, but also to improve functional impairments. Despite these improvements, some patients may be dissatisfied with their outcomes. This study aims to (1) investigate discrepancies between postoperative clinical measures and self-reported health status, and (2) identify important predictors of such discrepancies.

METHODS: Four hundred and seventy-nine surgical patients were prospectively enrolled in the CSM-International study at 16 global sites. At 1-year post-op, patients rated their general health status compared with their immediate preoperative status (much better, somewhat better, the same, somewhat worse, much worse). Descriptive analyses were conducted to evaluate the agreement between achieving a clinically important improvement (MCID) in function (modified Japanese Orthopedic Association [mJOA] scale) and self-reported health status. Agreement was defined as achieving the MCID on the mJOA and reporting general health as somewhat better or much better, whereas disagreement was defined as achieving MCID on the mJOA and reporting general health as the same, somewhat worse or much worse. Logistic regression analysis was used to determine factors that influence agreement between self-report of health status and functional outcomes.

RESULTS: A total of 395 patients had complete follow-up data at 1-year and were included in this analysis. Based on patient self-reports, 56 (14.2%) were somewhat or much worse than a year ago, 80 (20.2%) patients were the same and 259 (65.6%) patients were somewhat or much better. Thirty percent of patients who reported being somewhat or much worse were found to achieve the MCID on the mJOA; 57.5% of patients who indicated their health status were the

FDA device/drug status: Not applicable.

Author Disclosures**:** ***LAT:*** Nothing to disclose. ***MPZ:*** Nothing to disclose. ***RMH:*** Nothing to disclose. ***FSM:*** Nothing to disclose. ***GDS:*** Consulting: Stryker (C), Zimmer (C), Medtronic (C), Advanced Medical (C); Speaking and/or Teaching Arrangements: AOSPine (C); Research Support (Investigator Salary, Staff/Materials): AOSPine (C); Grants: Medtronic (C). ***EMM:*** Speaking and/or Teaching Arrangements: AOSpine North America (none); Fellowship Support: Medtronic (none). ***JHB:*** Nothing to disclose. ***MGF:*** Consulting: Fortuna Fix (B). ***JRW:*** Consulting: Stryker Canada (C).

* Corresponding author. Division of Neurosurgery, Department of Surgery, St. Michael's Hospital, 30 Bond Street, Toronto, Ontario, Canada M5W 1W8. Tel.: (416) 864-5920.

E-mail addresses: wilsonjeff@smh.ca, jeffersonwilson7@gmail.com (J.R. Wilson).

https://doi.org/10.1016/j.spinee.2019.06.026

same as before surgery also exhibited clinically meaningful improvements in functional impairment. Based on multivariate analysis, there was an increased odds of observing an agreement between self-reports of health status and functional outcomes if the patient exhibited greater improvement in mJOA upper extremity motor function at 1-year (odds ratio [OR]: 1.41, 95% confidence interval [CI] 1.03−1.93, p=.033) and reduced odds of agreement with increased age (OR for every decade: 0.66, 95% CI 0.50−0.87, p=.0035) and increased bodily pain at 1-year (OR: 0.62, 95% CI 0.49−078, p<.0001).

CONCLUSIONS: There was a discrepancy between changes in mJOA and self-reports of health status in patients undergoing surgery for degenerative cervical myelopathy. Increased bodily pain at 1-year, smaller improvements in postoperative upper extremity score and increased age were associated with worsened or unchanged general health status, despite clinically significant improvements in overall postoperative function.

Keywords: Degenerative cervical myelopathy; Modified Japanese Orthopedic Association score; Outcomes; prediction; Surgery; Self-reported health status

Introduction

Degenerative cervical myelopathy (DCM) is a progressive degenerative spine disease and the most common cause of spinal cord dysfunction in adults worldwide [1,2]. Surgery is increasingly recommended as the preferred treatment strategy for patients with moderate to severe myelopathy, as it can halt neurologic deterioration and significantly improve functional impairment, disability and quality of life [3−7]. Despite studies documenting improvements with surgery, there continues to be heterogeneity observed in postoperative clinical outcomes. A number of patient and disease factors may underlie this heterogeneity, with older age, longer duration of preoperative symptoms, psychiatric comorbidity, and smoking found to lower individuals' likelihood of functional improvement after surgery [8−11].

In addition to observing differences in outcomes between patients, it is also possible to observe differences between separate outcomes in the same patient after surgery. Specifically, clinical experience suggests that despite most DCM patients experiencing subjective and objective improvement in functional outcome postoperatively, some may still be dissatisfied with their outcomes. Discrepancies between clinical measures and self-reported health status can be due to changes in patients' internal standards of measurement, values and/or conceptualization of quality of life. Understanding the patient variables underlying such discrepancy is important not only to aid in preoperative counseling and patient education, but also to identify targets of future research to help improve patient outcomes, satisfaction, and engagement after surgery for DCM.

This study aims to:

1. Evaluate discrepancies between clinical measures and self-reported health status in patients undergoing surgery for DCM.
2. Investigate whether certain factors can predict discrepancies between self-reported health status and clinical measures.

Materials and methods

Study design and participants

Between October 2007 and January 2011, 479 patients were prospectively enrolled in the AOSpine CSM-International study from 16 academic sites across North America, Asia, Europe, and Latin America. Patients were eligible to participate in this study if they satisfied the following inclusion criteria (1) referred for consultation to a site's neurosurgery or orthopedic surgery department; (2) 18 years of age or older; (3) presenting with symptomatic DCM with at least 1 clinical sign of myelopathy; (4) image evidence of cervical cord compression; and (5) no previous surgery. All sites were expected to enroll a minimum of 10 patients per year into the study. Patients were excluded if they were asymptomatic or if they had active infection, neoplastic disease, rheumatoid arthritis, ankylosing spondylitis, or concomitant lumbar stenosis.

At their respective sites, all patients underwent decompressive surgery of their cervical spine. The attending surgeon decided what approach to use, how many levels to decompress and whether or not to use instrumentation. Anterior surgeries included discectomy and/or corpectomy with or without fusion. Posterior techniques included laminectomy with or without fusion or laminoplasty. A minority of patients received a combined anterior and posterior surgery. Further details on the study protocol can be found within the publication of the primary analysis [12].

Data collection

Extensive data were collected at baseline, including demographic information, comorbidities, cause of myelopathy, and surgical characteristics. Patients were evaluated preoperatively and at 6-, 12-, and 24-months following surgery using a wide variety of assessment tools, including the mJOA, Nurick Grade, Neck Disability Index, and Short-Form-36 version 2 (SF-36v2).

Outcome measures

The modified Japanese Orthopedic Association (mJOA) is an 18-point investigator-administered, DCM-specific index that separately evaluates motor function of the upper and lower extremities, sensory function of the upper extremities, and sphincter function [13]. It consists of two dimensions, has moderate internal consistency, is responsive to change and demonstrates both convergent and divergent validity [14]. The MCID of the mJOA was recently established using distribution- and anchor-based methods and varies based on myelopathy severity: 1 point for mild myelopathy (mJOA=15–17), 2 points for moderate (mJOA=12–14), and 3 points for severe disease (mJOA<12) [15]. The reliability of the mJOA has not been rigorously evaluated.

The SF-36v2 is a questionnaire that evaluates both physical and mental health and pain levels. It consists of eight subscales, namely vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health [16]. It has been validated in a DCM population, is responsive to change and has good test-retest reliability and internal consistency [17]. As part of the SF-36v2 questionnaire, patients are asked to rate their general health status compared with 1 year ago (before the surgery) as much better, somewhat better, the same, somewhat worse or much worse. This is known as the Health Transition question; this item has been previously validated and accurately describes the average clinical change in health status at a group level [18]. Patients are also asked to rate how much bodily pain they have experienced during the past 4 weeks as none, very mild, mild, moderate, severe or very severe.

Statistical analysis

SASv9.4 was used to conduct all analyses. Continuous variables were described using means, standard deviations, and ranges. Categorical variables were summarized using frequencies and percentages.

Descriptive analyses were conducted to evaluate the agreement between functional outcomes and patient self-reports of health status. Agreement was defined as achieving a MCID on the mJOA and self-reported health as somewhat better or much better. In contrast, disagreement was defined as achieving a MCID on the mJOA and self-reported health as the same, somewhat worse or much worse. Univariable logistic regression analyses were used to determine factors that influence agreement between self-reports of health status and functional outcomes. Variables that yielded a p value <.20 in univariable analysis were further examined in multivariable analysis. Collinearity was assessed by calculating tolerance. If two variables were collinear, the one that yielded a better model fit and had a larger effect size would be further explored in multivariable analysis. Multivariable logistic regression was used to create the final model and odds ratios (OR) with 95% confidence intervals (CI) were computed to quantify the estimate of effect. Variables were included in the final model if they were statistically significant ($p<.05$) and/or deemed clinically important based on existing literature.

Results

Participants and descriptive data

A total of 479 patients were enrolled in the AOSpine CSM-International study from 16 centers in four continents: Asia (n=150, 31.3%), Europe (n=126, 26.3%), North America (n=123, 25.7%), and Latin America (n=80, 16.7%). Eighty-four patients were excluded from this analysis because they had a preoperative mJOA score of 18 (n=8) or had missing SF-36v2 data at 1-year following surgery.

The study cohort consisted of 249 (63.0%) men and 146 (37.0%) women, with ages ranging from 21 to 87 (mean: 56.6±11.8) years. Based on the mJOA, 97 (24.6%) patients presented with mild, 161 (40.8%) with moderate and 137 (34.7%) with severe disease (mean: 12.4±2.8). The mean duration of symptoms was 28.6±36.0 (range: 0.25–240) months. The most common signs and symptoms were numb hands (89.1%), general weakness (81.0%), hyper-reflexia (80.0%), gait impairment (76.5%), and corticospinal distribution motor deficits (70.1%). One hundred and five (26.6%) patients were current smokers and 226 (57.2%) had concomitant disease. Based on the available data, it was unknown how many individuals quit smoking before surgery. The surgical approach was anterior in 223 (56.5%) patients, posterior in 162 (41.0%), and circumferential in 10 (2.5%). The mean operative duration was 179.4±84.0 (range: 45.0–495.0) minutes and the mean number of levels decompressed was 3.7±1.3 (range: 1–7). Table 1 summarizes the demographics and surgical characteristics of the patient population.

Summary of outcomes

Two hundred and sixty-three (66.6%) patients exhibited clinically meaningful improvements on the mJOA at 1-year following surgery (mean change in mJOA: 2.5±2.7). Of the 132 patients who failed to achieve a MCID, 47 (35.6%) exhibited an improvement less than the defined MCID, 38 (28.8%) stayed the same, and 47 (35.6%) deteriorated.

Based on patient self-reports, 259 (65.6%) patients were better than 1 year ago, 80 (20.2%) patients were the same and 56 (14.2%) patients were somewhat or much worse. Thirty percent (n=17) of patients who reported being somewhat or much worse achieved a MCID. Furthermore, 57.5% (n=46) of patients who indicated their health status was the same as 1-year ago also exhibited clinically meaningful improvements in their mJOA scores. In contrast, 13.5% (n=17) of patients who reported being much better than 1-year ago failed to achieve a MCID on the mJOA (Table 2).

Table 1
Patient baseline demographic information on 395 patients enrolled in the AOSpine CSM-international study at 16 international sites

Characteristic (n=395)	Summary
Baseline severity score (mJOA)	12.4±2.8
Mild (mJOA≥15)	97 (24.6%)
Moderate (mJOA = 12-14)	161 (40.8%)
Severe (mJOA<12)	137 (34.7%)
Age (years)	56.6±11.8
Gender (%)	249 (63.0%) M
Duration of symptoms (months)	28.6±36.0
Current smoker (%)	105 (26.6%)
Comorbidities (%)	226 (57.2%)
Symptoms (presence, %)	
Numb hands	352 (89.1%)
Clumsy hands	285 (72.2%)
Impaired gait	302 (76.5%)
Bilateral arm paresthesia	235 (59.5%)
L'Hermitte's phenomena	88 (22.3%)
General weakness	320 (81.0%)
Signs (presence, %)	
Corticospinal motor deficits	277 (70.1%)
Atrophy of intrinsic hand muscles	133 (33.7%)
Hyper-reflexia	316 (80.0%)
Positive Hoffman's sign	241 (61.0%)
Upgoing plantar responses	154 (39.0%)
Lower limb spasticity	204 (51.6%)
Broad-based unstable gait	252 (63.8%)
Surgical approach (%)	
Anterior	223 (56.5%)
Posterior	162 (41.0%)
Anterior and Posterior	10 (2.5%)
Operative duration (min)	179.4±84.0
Number of levels decompressed	3.7±1.3

mJOA, modified Japanese Orthopedic Association.

Univariable analysis

Of the patients who achieved a MCID on the mJOA (n=263), there was an agreement between self-reported health status and functional improvements in 200 (75.75%). Based on univariate analysis, there was an increased likelihood of observing a discrepancy between functional outcomes and self-reported health status if the patient was older (OR for every decade: 0.73, 95% CI 0.57−0.93, p=.012), had more bodily pain at 1-year postoperative (OR: 0.64, 95% CI 0.51−0.79, p<.0001) or exhibited less improvement in pain scores from baseline (OR: 0.74, 95% CI 0.61−0.89, p=.0013). Compared with North American patients, those treated surgically in Latin America were more likely to demonstrate an agreement between self-reported health status and mJOA scores (OR: 2.53, 95% CI 0.94−6.82, p=.066); however, this relationship did not reach statistical significance. There were no other differences in the outcome of interest among regions.

There was also an increased likelihood of observing a disagreement between self-reports and functional gains if the patient exhibited less improvement in mJOA upper extremity motor scores (OR: 1.30, 95% CI 0.98−1.73, p=.071), was a current smoker (OR: 0.57, 95% CI 0.30−1.07, p=.082) and achieved lower total mJOA scores at 1-year (OR 1.13, 95% CI 0.98−1.30, p=.087). Although these associations did not reach statistical significance, they were still evaluated in multivariate analysis given that p<.20. The following factors were not significant predictors of the outcome of interest: other subscores of the mJOA, preoperative bodily pain, gender, comorbidities, duration of symptoms, surgical approach, operative duration, and number of levels decompressed. Table 3 summarizes the results from univariate analysis.

Table 2
A summary of self-reports of health status and functional outcomes

	Achieved a MCID (n=263)	Did not achieve a MCID (n=132)
Much better (n=126)	109 (86.5%)	17 (13.5%)
Somewhat better (n=133)	91 (68.4%)	42 (31.6%)
Same (n=80)	46 (57.5%)	34 (42.5%)
Somewhat worse (n=44)	14 (31.8%)	30 (68.2%)
Much worse (n=12)	3 (25%)	9 (75.0%)

MCID, minimum clinically important difference.

Multivariable analysis

The final model consisted of three statistically significant predictors: change in upper extremity motor function (OR: 1.41, 95% CI 1.03−1.93, p=.033), age (OR for every decade: 0.66, 95% CI 0.50−0.87, p=.0035) and bodily pain over the last 4-weeks at 1-year postoperative (OR: 0.62, 95% CI 0.49−0.78, p=<.0001).

Based on the OR, the likelihood of achieving agreement between patient self-reports of health status and functional outcomes (1) is 1.41 times higher for every 1-point improvement in upper extremity motor scores (from baseline to 1-year); (2) decreases by 34% for every 10-year increase in age; and (3) decreases by 38% for every category increase in bodily pain over the last 4-weeks at 1-year postoperative (eg, from mild to moderate) (Table 4).

Discussion

The primary objective of this study was to evaluate the discrepancy between clinical measures and self-reported health status in patients undergoing surgery for DCM. Based on our results, 32% of patients who reported being somewhat or much worse 1-year following surgery achieved clinically significant improvements on the mJOA.

Discrepancies between clinical measures and self-reported health status can be explained by changes in patients' internal standards of measurement, values and/or conceptualization of quality of life. Response shift theory suggests that changes in an individual's health status may initiate behavioral, cognitive, and affective processes that can cause reconceptualization, reprioritization and/or recalibration of a patient's self-reported quality of life [19]. As a result of response shift, a patient's perceived outcome may be better or worse than that

Table 3
Factors influencing the likelihood of agreement between self-reported health status and functional outcomes: results of univariable analysis

Characteristic	Agreement between self-reports and functional outcomes	Disagreement between self-reports and functional outcomes	Odds Ratio (95% CI)	p Value
Postoperative mJOA scores at 1-year	16.2±1.9	15.7±2.0	1.13 (0.98–1.30)	.087
Change in upper extremity motor function on the mJOA*	1.3±1.2	1.0±0.9	1.30 (0.98–1.73)	.071
Change in lower extremity motor function on the mJOA*	1.6±1.3	1.4±1.4	1.12 (0.90–1.40)	.30
Change in sensory function of the upper extremity on the mJOA*	0.7±0.6	0.6±0.7	1.13 (0.74–1.73)	.58
Change in sphincter function on the mJOA*	0.3±0.7	0.3±0.6	0.91 (0.60–1.38)	.66
Preoperative bodily pain†	3.9±1.4	3.9±1.5	0.98 (0.80–1.20)	.81
Bodily pain at-1-year postoperative†	2.6±1.3	3.4±1.4	0.64 (0.51–0.79)	<.0001
Change in bodily pain*,†	−1.3±1.6	−0.5±1.5	0.74 (0.61–0.89)	.0013
Preoperative mJOA score	12.3±2.9	12.3±2.4	1.00 (0.90–1.11)	.99
Gender (ref=women)	61.2% M	58.7% M	1.08 (0.60–1.92)	.80
Age (every 10 years)	54.2±11.7	58.8±11.4	0.73 (0.57–0.93)	.012
Comorbidities (ref=no-comorbidities)	54.6% Y	57.1% Y	0.94 (0.53–1.66)	.82
Current smoker (ref=nonsmokers)	20.9% Y	31.8% Y	0.57 (0.30–1.07)	.082
Duration of symptoms (months)	28.8±39.5	26.8±28.2	1.00 (0.99–1.01)	.73
Region (ref=North America)	86.0% LA	14.0% LA	2.53 (0.94–6.82)	.066
	68.9% E	31.1% E	0.91 (0.41–2.02)	.82
	79.2% AP	20.8% AP	1.56 (0.78–3.12)	.21
	70.9% NA	29.1% NA	N/A	N/A
Surgical approach (ref=posterior)	61.3% Anterior	54.1% Anterior	1.35 (0.75–2.41)	.32
Operative duration (mins)	184.4±86.3	175.8±88.1	1.00 (1.00–1.00)	.53
Number of levels decompressed	3.6±1.3	3.8±1.3	0.90 (0.72–1.12)	.34

mJOA, modified Japanese Orthopedic Association; CI, confidence interval.

* Change in scores from baseline to 1-year postoperative

† Bodily pain at 1-year was extracted from the SF-36 questionnaire: "How much bodily pain have you had during the past 4-weeks?" None, very mild, mild, moderate, severe.

predicted by objective criteria. This process occurs after treatment and is detected in cases where patients are required to self-report their outcomes [20]. Response shift may also impact the validity of other measurements of disability and quality of life and affect the assessment of the cost-effectiveness of various treatments [21].

The presence of response shift has been evaluated in several other fields including cancer, stroke, epilepsy, multiple sclerosis, and lumbar spine surgery [22–29]. Recalibration is a component of response shift and is important to consider when conducting a longitudinal study with self-reported outcomes. Specifically, patients may retrospectively underestimate or overestimate their baseline level of impairment due to changes in their expectations or awareness. For example, in patients undergoing lumbar spine surgery, Finkelstein et al. concluded that patients who report resolution of their leg or back pain after surgery most commonly overestimate their preoperative disability after the fact [30]. Such overestimation has been associated with increased patient satisfaction following treatment. Although the patients in our study may have changed their perception of their impairment over time, we were unable to directly assess a response shift using the available data.

Table 4
Factors influencing the likelihood of agreement between self-reported health status and functional outcomes: results of multivariate analysis

Characteristic	Odds Ratio (95% CI)	p Value
Change in upper extremity motor function	1.41 (1.03–1.93)	.033
Age (ever 10 years)	0.66 (0.50–0.87)	.0035
Bodily pain over the last 4-weeks at 1-year postoperative	0.62 (0.49–0.78)	≤.0001

CI, confidence interval.

A second objective of this study was to investigate whether certain factors can predict a discrepancy between self-reported health status and clinical measures. Based on our results, there was an increased likelihood of observing a discrepancy between functional outcomes and self-reported health status if the patient was older, exhibited less improvement in upper extremity motor function and reported more bodily pain at 1-year. This information can be used by surgeons to manage patient expectations with respect to upper extremity function and bodily pain after surgery and counsel concerned patients regarding treatment options.

Several studies have reported that older age is associated with worse functional, disability, and quality of life outcomes following surgery for DCM. In our study, patients who were older were more likely to exhibit disagreement between self-reported health status and clinical measures. Potential explanations for this discrepancy include (1)

elderly patients have reduced physiological reserves and may be less tolerant of surgery than younger patients [31]; (2) increased age is associated with a higher risk of complications in the perioperative and postoperative period; and (3) the elderly are more like to experience comorbidities unrelated to their current diagnosis [32]. All of these factors may skew patients' perception of their health status.

The discrepancy between clinical measures and self-reported health status may also be explained by disease components not covered by the mJOA, including pain. Persistent postoperative neck and bodily pain may significantly impact a patient's quality of life and result in a lower self-reported health status. Since pain outcomes are not captured by the mJOA, patients with residual pain may exhibit improved functional and neurological impairment postoperatively but may continue to be dissatisfied with their surgical results. Furthermore, patients who exhibited greater improvements in bodily pain from preoperative levels were more likely to agree with their functional improvements. In contrast, preoperative pain scores did not influence the outcome of interest, highlighting that current levels of pain and degree of improvement following surgery are more important predictors of treatment satisfaction.

Finally, patients who exhibited less improvement in their upper extremity motor function were more likely to report either no improvement or regression of their health status despite achieving a MCID on the mOA scale. Upper extremity weakness and loss of dexterity are cardinal symptoms of DCM and contribute significantly to the functional impairment experienced by these patients [33]. In patients with cervical spinal cord injury, improvements in arm and hand function is the most important as small gains in these domains can enhance their ability to perform simple activities of daily living [34]. According to Anderson, 48.7% of individuals with cervical spinal cord injury reported that gaining arm and hand function would significantly improve their quality of life and prioritized this over walking and trunk stability [35]. This current study supports this finding in a DCM population as patients with less improvement in their upper extremity motor score were more likely to be dissatisfied with their outcomes following surgery.

Strengths and limitations

This large multicenter prospective study represents the first study to analyze discrepancies between clinical measures and self-reported health status in patients treated surgically for DCM. This study also has certain limitations. First, retrospective assessment of health status after surgery may be affected by recall bias. This method, however, has been used frequently to evaluate the interpretability of outcome measures and likely represents the best method available for our study question. Second, 15.9% (n=76) of patients were lost to follow-up at 1-year. However, it is likely that patients lost to follow-up did not systematically differed from those retained in a way that would bias outcomes. Finally, we were unable to evaluate whether our results would be similar at 2-years follow-up due to the specific frame of reference (1-year time period) used within the Health Transition Item of the SF-36v2.

Conclusions

Although the majority of patients experience improvements in functional status after surgery for DCM, a significant proportion remain dissatisfied with their outcome. Older age, increased bodily pain at 1-year, and reduced improvement in upper extremity motor function were associated with worsened or unchanged general health status, in spite of clinically significant improvements in overall postoperative function. These results can be used by clinicians to manage patient expectations with respect to recovery across the care pathway, aid preoperative patient education, and provide a focus for future research on improving patient outcomes and satisfaction after surgery for DCM.

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