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Predictive Factors of Postoperative Dysphagia in Single-Level Anterior Cervical Discectomy and Fusion

Avani S. Vaishnav, MBBS[*], **Philip Saville, MD**[*], **Steven McAnany, MD**[*], **Dil Patel, BA**[*], **Brittany Haws, MD**[‡], **Benjamin Khechen, BA**[‡], **Kern Singh, MD**[‡], **Catherine Himo Gang, MPH**[*], **Sheeraz A. Qureshi, MD, MBA**[*,†]

[*]Hospital for Special Surgery, New York, New York;

[†]Weill Cornell Medical College, New York, New York;

[‡]Midwest Orthopedics at Rush, Chicago, IL.

Abstract

Study Design.—Retrospective review of prospectively collected data.

Objective.—To investigate if zero profile devices offer an advantage over traditional plate/cage constructs for dysphagia rates in single level anterior cervical discectomy and fusion (ACDF).

Summary of Background Data.—Dysphagia rates following ACDF have been reported to be as high as 83%, most cases are self-limiting, but chronic dysphagia can continue in up to 35% of patients. Zero profile devices were developed to limit dysphagia, and other plate specific complications, however the literature is currently divided regarding their efficacy.

Methods.—Dysphagia was assessed by swallowing quality of life (SWAL-QOL) scores preoperatively, at 6 weeks and 12 weeks. Patient reported outcome measures (PROMs) including visual analog scale (VAS) and Neck Disability Index (NDI) were collected preoperatively, at 6 weeks and at 6 months. Univariate and multivariate regression analysis was conducted with SWAL-QOL score as the dependent variable.

Results.—Sixty-four patients were included, 41 received a zero profile device, and 23 received plate-graft construct. Both groups were similar regarding patient demographics, except operative time, with the zero-profile group having a shorter procedure time than the cage-plate group (44.88 ± 6 54 vs. 54.43 ± 14.71 min, $P = 0.001$). At all timepoints dysphagia rates were similar between the groups. Regression analysis confirmed preoperative SWAL-QOL and operative time were the only significant variables. PROMs were also similar between groups at all time points, except VAS neck at 6 months, which was lower in the plate-graft group (1.05 ± 1.48 vs. 3.43 ± 3.21, $P = 0.007$).

Conclusion.—Operative time and preoperative SWAL-QOL scores are predictive of dysphagia in single level ACDF. Zero profile devices had a significantly shorter operative time, and may provide a benefit in dysphagia rates in this regard.

Address correspondence and reprint requests to Sheeraz A. Qureshi, MD, MBA, 535 E. 70th St., New York, NY 10017; qureshis@HSS.EDU.

Level of Evidence: 3

Keywords

anterior approach; anterior cervical discectomy and fusion; cervical; complication; deglutition; dysphagia; fusion; methylprednisolone; minimally invasive spine surgery; plate; procedure time; risk factor; steroid; swallowing

Anterior cervical discectomy and fusion (ACDF), first described by Smith and Robinson,[1] and Cloward[2] in 1958, is considered the gold-standard surgical treatment for single and multi-level cervical degenerative disc disease because it results in improved clinical and radiographic outcomes.[3–6]

Reported rates for Dysphagia following ACDF range from 2% to 83%,[6–15] with rates likely linked to how closely authors screen for postoperative dysphagia. Reassuringly the vast majority of cases are self-limiting, and resolve by 3 months.[6] Prolonged dysphagia can present significant health and nutritional risks to patients. Chronic dysphagia rates are reported in the range of 3% to 35%.[9,15–17]

The use of titanium plates in ACDF is common and several authors have shown improved clinical outcomes,[18] stability,[19] fusion rates,[3,19,20] and restoration of lordosis[19] as well as the prevention of graft dislodgement.[19] Despite the relative safety and efficacy of anterior cervical plates, plate-specific complications such as loss of fixation,[16,21] soft-tissue injury,[22–24] adjacent level ossification disease, and dysphagia[7,9,17] have been reported. Stand-alone zero-profile devices, which can be implanted entirely within the intervertebral space, are being used more frequently to mitigate some of these complications.

The role of zero profile devices in the reduction of postoperative dysphagia has not been fully elucidated with some studies reporting an increased incidence of dysphagia with the use of anterior cervical plates compared with zero-profile devices,[25–28] while others showing no difference.[9,16,29]

The purpose of this study was to determine what variables, if any, impacted the rates of postoperative dysphagia in patients undergoing single-level ACDF and determine if zero-profile devices provided any benefit in this regard.

MATERIALS AND METHODS

A full Institutional review board (IRB) approval was obtained prior to collecting surgical data and an expedited IRB approval was obtained for the retrospective review and analysis of this data.

Study Design and Population

A retrospective review of prospectively collected data from a single surgeon surgical database was performed. The surgical database includes data on patient demographics, comorbidities, various intraoperative variables, and postoperative outcomes. This database was queried for patients who underwent single-level ACDF with either a traditional plate-graft construct or a zero-profile device. Patients with a history of previous otolaryngologic

surgery or other conditions that may cause neurogenic dysphagia, such as cerebrovascular disease, motor neuron disease, myopathies, psychiatric disorders, or thyroid disease and those who underwent revision surgery or combined anterior to posterior surgery, were excluded from the analysis.

Extracted Data

Selected patients were divided into two groups based on whether they received a plate-graft construct or zero-profile device, and baseline characteristic and operative data were compared. Postoperative dysphagia was compared between the plate-graft construct and zero-profile groups.

Patient data extracted for analysis include patient age at the time of surgery, sex, body mass index (BMI), smoking status, and the American Society of Anesthesiologists (ASA) classification. Surgical data analyzed include the type of implant used (plate-graft vs. zero-profile), estimated blood loss, procedure time (in min), and length of stay in the hospital (in h). Patient reported outcome measures (PROMs) collected preoperatively, and at 6 weeks and 6 months postoperatively include Neck Disability Index (NDI), visual analog scale (VAS) for neck pain and arm pain and Short Form-12 Physical Health Score (SF-12 PHS) and Mental Health Score (SF-12 MHS). In addition, any complications occurring during the index hospitalization were recorded.

The presence and severity of dysphagia was assessed preoperatively, and at 6 and 12 weeks postoperatively using the swallowing quality of life (SWAL-QOL) questionnaire.[25] The SWAL-QOL questionnaires contain 44-items divided into various domains. Each item is given a score from 1 to 5 (worse to best). Scoring in each domain is calculated by the sum of the scores for each item in that domain expressed as a percentage of the maximum possible domain score. In addition to the domain scores, a total SWAL-QOL can also be derived by summing each domain score and dividing by 10. The Frequency of Symptoms domain of the SWAL-QOL was used for this study, with the dysphagia rates being reported as the sum of the scores for each of the 14 items in this domain, expressed as a percentage of the maximum possible domain score of 70.

Statistical Analysis

Descriptive statistics were summarized using Fisher exact test for categorical variables and Independent Samples Student *t* test was used to compare means of continuous variables (Table 1).

Paired Samples Student *t* test was used to analyze the change in PROMs from the preoperative visit to the 6-month follow-up.

Individual linear regression analyses were conducted to predict 6 weeks SWAL-QOL scores based on the following patient demographics and comorbidities, preoperative PROMs, and intraoperative variables: age, sex, BMI, smoking status, ASA class, type of implant used (zero profile device vs. plate-graft construct), local application of steroid to the esophagus before closure, estimated blood loss, duration of the procedure, postoperative day zero (POD 0) pain scores, occurrence of in-hospital complications, length of hospital stay, and

preoperative PROMs (NDI, VAS arm pain, VAS neck pain, NDI, SF-12 MHS, and SF-12 PHS).

A multiple linear regression analysis was also performed with the 6-week SWAL-QOL scores as the dependent variable (Table 2).

Statistical significance was defined with a *P* value set at <0.05 and all *P* values were 2-tailed. All analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) version 25 (IBM Corp., Armonk, NY).

RESULTS

A total of 64 patients were included in this study, of which 23 received a plate-graft construct and 41 received a zero-profile device. There was no difference between the groups in terms of age (46.37 ± 8.4 vs. 48.58 ± 10.72, $P = 0.37$), body mass index (28.94 ± 5.13 vs. 30.45 ± 5.12, $P = 0.27$), or ASA classification ($P = 0.77$). The plate-graft group comprised 14 males (61%) and 9 females (39%), whereas the zero-profile group included 29 males (71%) and 12 females (29%). This difference did not reach significance ($P = 0.42$). The only significant difference in baseline characteristics between the two groups was smoking status, with five patients (21.7%) in the plate-graft group and two patients (4.9%) in the zero-profile group being smokers ($P = 0.04$).

Twelve (52.2%) patients in the plate-graft group and 17 (41.5%) patients in the zero-profile group received local application of steroid to the esophagus ($P = 0.41$). Although the mean estimated blood loss was less (27.32 ± 9.23 vs. 30.68 ± 13.21 mL, $P = 0.24$) and the mean length of stay was longer (11.97 ± 10.02 vs. 10.80 ± 9.09 h, $P = 0.65$) in the zero-profile group compared with the plate-graft group, neither of these differences were significant. The only parameter that was significantly different between the two groups was the duration of the procedure with the zero-profile group having a shorter procedure time than the cage-plate group (44.88 ± 6.54 vs. 54.43 ± 14.71 min, $P = 0.001$).

Both groups had a significant improvement in PROMs from preoperatively to 6 months in terms of NDI ($P<0.0001$ for the zero-profile group, $P = 0.001$ for the plate-graft group), VAS arm pain ($P<0.0001$ for the zero-profile group, P = 0.005 for the plate-graft group), VAS neck pain ($P<0.0001$ for the zero-profile group, $P<0.0001$ for the plate-graft group), SF-12 PHS ($P = 0.022$ for the zero-profile group, $P = 0.011$ for the plate-graft group), and SF-12 MHS ($P = 0.009$ for the zero-profile group, $P = 0.012$ for the plate-graft group). As seen in Table 3, there were no differences in any PROMs between the two groups at any time-point, except for VAS neck at 6 months, which was lower in the plate-graft group (1.05 ± 1.48 vs. 3.43 ± 3.21, $P = 0.007$). The dysphagia rates were also similar between those who received a zero-profile device and those who received a plate-graft construct at all time-points.

Individual linear regression analyses for each of the predictor variables showed a significant regression for estimated blood loss ($P = 0.047$), procedural time ($P = 0.028$), and preoperative Thus, greater blood loss, longer duration of surgery, and worse preoperative dysphagia were individually predictive of lower 6-week postoperative SWAL-QOL scores, which indicates worse postoperative dysphagia. In addition, preoperative SF-12 PHS

approached significance with higher preoperative SF-12 scores, which suggests better physical health was predictive of lower postoperative dysphagia (Table 4).

The results of the multiple linear regression analyses to predict 6-week postoperative SWAL-QOL scores showed a significant regression ($P < 0.0001$) with an R^2 of 0.604 and an adjusted R^2 of 0.564. The predictive factors included in this model were age ($P = 0.660$), sex (P 0.430), procedural time ($P = 0.004$), preoperative SF-12 PHS ($P = 0.232$) and preoperative SWAL-QOL ($P < 0.0001$). These results indicate that longer procedural time and worse preoperative dysphagia are significant predictors of postoperative dysphagia (Table 5).

Since a significant difference in procedure time was seen between those who received a plate-graft construct and those who received a zero-profile device, and procedure time was found to be a significant predictor of postoperative dysphagia, a regression was performed to examine and account for a potential interaction between the type of implant used and procedure time on postoperative dysphagia rates. This interaction was not significant ($P = 0.570$), thus indicating that procedure time was predictive of postoperative dysphagia in those who received a plate-graft construct and those who received a zero-profile device.

DISCUSSION

The results of our study show that patients receiving a plate-graft construct had a significantly longer procedure time, compared with those receiving a zero-profile device with no difference in other demographic and procedural factors except for smoking status. The longer procedural time is likely attributable to the greater tissue dissection and preparation required for the application of an anterior cervical plate. In addition, there were no differences in functional outcomes (assessed by the NDI), postoperative arm pain (assessed by VAS for arm pain), overall health (assessed by the SF-12), or dysphagia rates (assessed by the SWAL-QOL) preoperatively or at follow-up between patients who received a zero-profile device and those who received a plate-graft construct. Interestingly, the only PROM that was significant between the zero-profile device and the plate-graft construct was VAS neck pain at 6 months, which was lower in the plate-graft construct group. While the assessment of fusion was not the aim of this study, fusion is an important consideration and this difference in VAS neck pain at 6 months may represent delayed or reduced fusion rates in modern low-profile devices, a criticism leveled at the earlier iterations of these devices.

Although dysphagia following ACDF is transient in most cases, it is a common source of patient discomfort and dissatisfaction. In addition, persistent and severe dysphagia can result in serious medical complications and significant morbidity and possibly mortality.

While the etiology of postoperative dysphagia has not been clearly established, previous reports have attributed this to numerous factors. In previous reports, female sex,[7,26] age more than 60 years,[13] smoking status,[30] prior cervical surgery,[30] surgical approach,[14] greater number of levels operated,[7,9,12,16] use of rhBMP-2,[31,32] duration of surgery,[33] and postoperative soft-tissue edema[10,12] have been shown to be associated with an increased incidence of dysphagia. In addition, some studies have reported an increased incidence of

dysphagia with the use of anterior cervical plates compared with zero-profile devices[25–28] while others found no difference.[9,16,29] A few studies have shown that the size and type of plate[11] can also impact the incidence of dysphagia. Some authors have also demonstrated that preoperative tracheal retraction exercise[34] can reduce postoperative dysphagia. Local application of steroids at the time of surgery has also shown varying results[35] with some studies showing benefit of this practice.[8,36,37]

The results of our study indicate that procedural time, estimated blood loss, and preoperative SWAL-QOL are individually significant predictors of postoperative dysphagia with preoperative SF-12 approaching statistical significance. The multiple regression model confirmed these findings with sex and preoperative SWAL-QOL being significant variables in the model.

A longer procedural time was shown to be predictive of increased postoperative dysphagia which is in concordance with previous studies.[22] Longer procedural time may indicate more soft-tissue dissection and/or longer retraction resulting in greater postoperative inflammation and edema, which have been shown to be associated the increased dysphagia.[10,12] Since the plate-graft constructs in our study on average had significantly longer procedural times compared with the zero-profile devices, it may be inferred that procedure time being predictive of postoperative dysphagia also means that the use of a plate-graft construct may be predictive of postoperative dysphagia. However, this association between the type of implant and postoperative dysphagia was not directly demonstrable in our study. It is possible that our study was not adequately powered to detect this underlying association. Rather, the findings of our study indicate that a longer procedure time in both plate-graft constructs and zero-profile devices is predictive of greater postoperative dysphagia, as evidenced by the regression for the interaction between procedure times and type of implant being non-significant. With this in mind, standardized protocols to optimize work flow in the operating room, especially during times of soft tissue retraction may be beneficial in reducing the rates and/or severity of postoperative dysphagia.

Estimated blood loss, which was independently significant, was not included in the multiple regression, because it was not significant once other factors were controlled for using multiple regressions. This may be due to the fact that longer surgical times were associated with greater blood loss, and thus, controlling for procedural time resulted in estimated blood loss no longer being a significant predictor of postoperative dysphagia.

Our results also demonstrate that preoperative SWAL-QOL was a significant predictor of postoperative SWAL-QOL in the individual regression as well as multiple linear regressions. To our knowledge, this is the first report to show an association between preoperative dysphagia and postoperative dysphagia in patients undergoing ACDF. This finding is particularly relevant clinically because it enables clinicians to identify preoperatively those patients who are at an increased risk of postoperative dysphagia and counsel them appropriately. In addition, it may aid in more precise preoperative planning to mitigate or reduce the severity of postoperative dysphagia in these patients.

Another factor that approached significance was the preoperative SF-12 PHS score. A larger sample size may have found this association to be significant. A higher preoperative SF-12 PHS score signifies better physical health which was predictive of lower postoperative dysphagia. This may be attributable to the fact that overall physical health and function may allow for faster tissue healing and quicker recovery postsurgery, and thus reducing the severity of symptomatic dysphagia at 6 weeks. This finding has important clinical implications; it allows clinicians to preoperatively identify those at an increased risk of postoperative dysphagia and not only provide appropriate counseling, but also optimize the overall physical health status of a patient prior to surgery.

Surprisingly, the reduced tissue dissection and reduced anterior spinal mass following the use of a stand-alone zero-profile device did not result in improved dysphagia rates. The current literature is conflicted in this regard with some studies showing an increased incidence of dysphagia with the use of anterior cervical plates compared with zero-profile devices,[25–28] and others showing no difference.[9,16,29] Given that our study included 64 patients, all whom underwent single-level ACDF, it is possible that our study may not have been adequately powered to detect a significant difference between these implants or that a benefit for these devices may be more apparent in multi-level cases which would require more tissue dissection and result in a greater anterior spinal mass from the anterior cervical plate. It is also possible that the zero-profile device may have been beneficial in the early postoperative period when the soft-tissue inflammation and edema would have been the greatest, but this difference was not captured with our dysphagia evaluation performed at 6 weeks.

The administration of topical corticosteroids is a controversial practice with mixed results in the literature.[8,23,24] In our study we did not see any significant benefit of local steroid application at 6 weeks. While it is possible that benefit was seen at 0 to 6 weeks, it is important to counter this against any potential wound and metabolic complications. It is also possible that the anti-inflammatory benefits were limited in these single-level fusions. Inclusion of multi-level surgeries might have revealed some benefit.

Limitations

This study was a retrospective review of prospectively collected data, and thus, selection bias cannot be completely eliminated. The criteria for selection of a zero-profile device *versus* plate-graft construct with regard to local steroid application could not be elucidated from retrospective analysis of the data.

A major limitation of our study is the lack of postoperative dysphagia data before the 6-week follow-up. It is possible that demographic factors and operative interventions affected dysphagia rates in the early postoperative period, but was not captured with our dysphagia evaluation process. However, the decision to assess for dysphagia at 6 weeks was made, because in our opinion, this is more clinically significant than early postoperative dysphagia which is usually mild and self-limiting in a majority cases. In contrast, swallowing problems that persist beyond 6 weeks can present a more challenging treatment conundrum with risks of malnutrition and weight loss.

The results of the multiple regression, which showed an R^2 of 0.604 and an adjusted R^2 of 0.564, indicate that only 55% to 60% of the variability in dysphagia rates is explained by the variables in this model. Thus, although the factors elucidated in our analysis are predictive of postoperative dysphagia, a significant portion of the variability in dysphagia rates remains unexplained and may be attributable either to other factors that were not included in the study, or to the lack of adequate sample size to clarify these associations. Despite this limitation, our study identifies several factors not previously reported that predict postoperative dysphagia, and hence should be an important consideration in preoperative planning and patient-counseling.

Additionally, only studying single-level surgeries may have limited the benefits observed from stand-alone devices or corticosteroid use that may be more apparent in multilevel surgeries.

A further limitation is that the patients included in our study cohort may not be representative of all patients undergoing this surgical procedure. Patients included in the study were limited to those with degenerative conditions of the cervical spine who underwent minimally invasive single-level ACDF with a plate-graft construct or a zero-profile device, and hence these findings may not be applicable to other populations.

Additionally, objective evaluation of dysphagia was not performed which may have recognized dysphagia that was not subjectively apparent to patients. However, in our opinion, patient-centric subjective dysphagia evaluation using validated PRO tools is more relevant in the clinical setting as a guide to the need for further evaluation and management of persistent postoperative dysphagia.

CONCLUSION

The results of our study indicate that longer procedural time and worse preoperative dysphagia are predictive of increased postoperative dysphagia in single-level ACDF. Preoperative physical health, as assessed by the SF-12 PHS, though not significant was also included in the predictive model. Other demographic and operative parameters including smoking status, BMI, type of implant and local application of steroid to the esophagus were not related to dysphagia at 6 weeks. Based on these results, patients that are at an increased risk of postoperative dysphagia should be identified preoperatively and counseled, and work-flow in the operating room should be optimized to reduce tissue retraction times. Additionally, while there was no benefit of steroid application, there were also no complications related to its use. Larger studies are warranted to further study the predictive factors elucidated in this study, as well as identify other contributory factors, which can be used to reduce postoperative discomfort and optimize patient care.

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Key Points

- Zero profile devices were developed to limit dysphagia, and other plate specific complications, however, the literature is currently divided regarding their efficacy.
- Operative time and preoperative SWAL-QOL scores are predictive of dysphagia in single level ACDF.
- Zero profile devices had a significantly shorter operative time, and may provide a benefit in dysphagia rates in this regard.

TABLE 1.

Demographics and Preoperative Variables

	Zero-Profile Device	Plate-Graft Construct	*P*-Value
Number of cases (n)	41	23	
Age (in yrs)	48.58 ± 10.72	46.37 ± 8.4	0.37
Gender			0.42
Male	29 (71%)	14 (61%)	
Female	12 (29%)	9 (39%)	
Body mass index (BMI), in kg/m^2	30.45 ± 5.12	28.94 ± 5.13	0.27
Current smoker (within 1 yr)	2 (4.9%)	5 (21.7%)	0.04
ASA classification			0.77
Class 1	5	2	
Class 2	22	14	
Class 3	2	2	

TABLE 2.

Operative and Postoperative Factors

	Zero-Profile Device	Plate-Graft Construct	*P*-Value
Procedure time (in min)	44.88 ± 6.54	54.43 ± 14.71	0.001
Total length of stay (LOS) (in h)	11.97 ± 10.02	10.80 ± 9.09	0.65
Estimated blood loss (EBL) (in mL)	27.32 ± 9.23	30.68 ± 13.21	0.24
Local application of steroid to the esophagus	17 (41.5%)	12 (52.2%)	0.41
In-hospital complications	3 (7.3%)	1 (4.3%)	0.64
POD 0 average pain score	4.48 ± 1.86	5.18 ± 2.17	0.18

TABLE 3.

Patient Reported Outcomes (PROs)

	Zero-Profile Device	Plate-Graft Construct	*P*-Value
NDI			
Preoperative	45.32 ± 19.85	37.73 ± 14.39	0.081
6-week	33.54 ± 18.86	31.41 ± 20.5	0.69
6-month	25.07 ± 21.13	14.18 ± 15.12	0.071
VAS neck pain I			
Preoperative	6.54 ± 2.24	6.19 ±2.28	0.57
6-week	3.35 ± 2.65	3.98 ± 2.44	0.38
6-month	3.43 ± 3.21	1.05 ± 1.48	0.007
VAS arm pain 1			
Preoperative	5.86 ± 2.61	6.14 ± 2.52	0.68
6-week	2.36 ± 2.33	3.41 ± 2.52	0.12
6-month	2.79 ± 2.97	2.65 ±3.27	0.88
SF-12 PHS 1			
Preoperative	35.65 ± 9.01	33.86 ± 7.17	0.44
6-week	36.82 ± 8.43	35.52 ± 10.16	0.63
6-month	39.52 ± 11.31	39.48 ± 11.12	0.99
SF-12 MHS			
Preoperative	46.54 ± 13.47	48.02 ± 12.59	0.69
6-week	50.99 ± 12.23	49.67 ± 9.69	0.69
6-month	48.01 ± 11.18	50.17 ± 11.53	0.54
Swal-Qol			
Preoperative	92.61 ± 8.46	93.60 ± 12.15	0.70
6-week	89.16 ± 14.05	88.51 ± 15.24	0.86
12-week	88.79 ± 13.28	88.86 ± 16.33	0.99

NDI indicates Neck Disability Index; SF-12 PHS, Short Form-12 Physical Health Score; SF-12 MHS, Short Form-12 Mental Health Score; SWAL-QOL, swallowing quality of life.

TABLE 4.

Linear Regression Analyses Performed for the Impact of Each Predictive Factor on 6-week SWAL-QOL Scores

	B	S.E. Beta	Beta	*t*	*P*	R^2	Adjusted R^2
Age	−0.242	0.194	−0.156	−1.245	0.218	0.024	0.009
Sex (0 = Female, 1 = Male)	−3.822	3.827	− 0.126	−0.999	0.322	0.016	0.000
Body mass index (in kg/m^2)	−0.122	0.361	−0.043	−0.388	0.737	0.002	−0.014
Smoking status	2.120	5.798	0.046	0.366	0.716	0.002	−0.014
ASA Class	−2.798	3.936	−0.105	−0.711	0.481	0.011	−0.011
Type of implant (0 = Zero profile device, 1 = Cage-plate construct)	−0.654	3.774	−0.022	−0.173	0.863	0.000	−0.016
Application of local steroid to the esophagus (0 = No, 1 = Yes)	−2.238	3.111	−0.093	−0.719	0.475	0.009	−0.008
Estimated blood loss (in mL)	−0.335	0.165	−0.252	−2.032	0.047	0.063	0.048
Procedural time (in min)	− 0.355	0.158	− 0.275	− 2.255	0.028	0.076	0.061
Postoperative Day Zero Pain Scores (NRS)	−0.478	0.916	−0.066	−0.522	0.604	0.004	−0.012
Occurrence of in-hospital complications	−4.190	7.464	−0.071	−0.561	0.577	0.005	−0.011
Postsurgical length of stay (in h)	−0.117	0.191	−0.078	−0.611	0.543	0.006	−0.010
Preoperative NDI	−0.143	0.102	−0.181	−1.404	0.166	0.033	0.016
Preoperative VAS arm pain	0.322	0.744	0.057	0.432	0.667	0.003	−0.014
Preoperative VAS neck pain	0.347	0.851	0.053	0.407	0.685	0.003	−0.014
Preoperative SF-12 PHS	0.360	0.196	0.244	1.834	0.072	0.060	0.042
Preoperative SF-12 MHS	−0.013	0.129	−0.014	−0.100	0.921	0.000	−0.019
Preoperative SWAL-QOL	0.836	0.152	0.573	5.507	<0.0001	0.329	0.318

NDI indicates Neck Disability Index; SF-12 PHS, Short Form-12 Physical Health Score; SF-12 MHS, Short Form-12 Mental Health Score; SWAL-QOL, swallowing quality of life.

TABLE 5.

Multiple Linear Regression Model for Predictive Factors of 6-week SWAL-QOL (F[5, 59] = 14.971, P < 0.0001, R^2 = 0.604, adjusted R^2 = 0.564)

	B	**S.E. Beta**	**Beta**	***t***	***P***
Age (in yrs)	0.051	0.116	0.040	0.442	0.660
Sex (0 = Female, 1 = Male)	−1.870	2.348	−0.073	−0.796	0.430
Procedural time (in min)	−0.289	0.095	−0.279	−3.037	0.004
Preoperative SF-12 PHS	0.163	0.135	0.111	1.209	0.232
Preoperative SWAL-QOL	0.788	0.112	0.656	7.061	<0.0001

SF-12 PHS indicates Short Form-12 Physical Health Score; SWAL-QOL, swallowing quality of life.