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The immediate safety profile after complex anterior cervical reconstruction surgery

Abstract

Study design: Retrospective Study.

Objective: To identify the spectrum of immediate post-operative complications after complex anterior cervical reconstruction surgery, and the risk factors associated with their occurrence.

Summary of background data: Complex anterior cervical reconstruction surgery can be lengthy with more extensive exposure and greater soft tissue disturbance, putting patients at higher risk for immediate complications. Multi-level anterior cervical cases may be associated with a greater number of risks and complications compared to single-level anterior cervical discectomy and fusion (ACDF) cases.

Methods: A retrospective study of 155 patients between 1996 and 2009 who had undergone complex anterior cervical reconstruction surgery at a single institution by one of three fellowship-trained surgeons. Complex anterior cervical reconstruction surgery cases were defined as: ACDF of 3 or more levels (with or without posterior instrumentation). Hospital charts and operative reports were reviewed for procedure-related peri-operative complications.

Results: Reported complications included dysphagia 41/155 (26.4%), dysphonia 15/155 (9.6%), new nerve palsy 1/155 (0.6%), worsening of preoperative radiculopathy 2/155 (1.3%), post-operative hematoma requiring evacuation 2/155 (1.3%), emergent re-intubation 2/155 (1.3%), and dural tear 1/155 (0.6%). Females (aOR: 2.91, 95% CI: 0.81, 10.49) and fusion of the C3-C4 level (aOR: 3.49, 95% CI: 0.89, 13.29) were found to be predictive characteristics for the onset of dysphagia. Anxiety disorder (aOR: 4.94, 95% CI: 1.06, 22.94) was found to have increased risk of post-operative dysphonia. Increasing Nurick grade, however, was found to have a protective effect on the development of dysphagia (aOR: 0.43, 95% CI: 0.23, 0.80) and dysphonia (aOR: 0.47, 95% CI: 0.26, 0.85).

Conclusion: Female gender, fusion of C3-4, and anxiety disorder, were associated with a higher rate of immediate post-operative complications following complex anterior cervical reconstruction surgery. Higher nurick grade was found to have a protective effect on the development of dysphagia and dysphonia.

Keywords: discectomy, dysphagia, ACDF

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Abbreviations: CSM, cervical spondylotic myelopathy; ACDF, anterior cervical discectomy and fusion; RLN, recurrent laryngeal nerve; mJOA, modified japanese orthopedic association scale

Introduction

Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed procedures in spine surgery proven effective in the treatment of various cervical pathologies.[1–4] Single level ACDF is generally a safe procedure with a very good outcome carrying minimal or no complications. However, although rarely encountered, complications can arise but are generally not a source of major morbidity.[4] Reported complications in the literature that are related to ACDF are dysphagia, esophageal perforation, post-operative hematoma, recurrent laryngeal nerve "RLN" injury, Horner's syndrome, vascular injury, thoracic duct injury, respiratory insufficiency, pneumothorax, hemothorax, dural tear with CSF leak, wound infection, epidural abscess, spondylodiscitis, worsening of neurological symptoms, bone graft extrusion, instrumentation failure and some rare complications such as glosso-pharyngeal and facial nerve paresis, hypoglossal nerve injury, injury of the cervical plexus, vertebral artery injury with fistulous connection to the surrounding cervical venous plexus and cerebral infarction.[4–25]

Multi-level ACDF with or without posterior instrumentation is frequently performed for more complex cases; such as in patients with multi-level cervical disease and in cervical Kyphosis requiring complex reconstruction. This complex reconstruction usually requires a more extensive dissection, takes longer, and may impart cervical alignment and mechanical changes that may be associated with a greater number of risks and complications compared to single-level cases.[1-4,7,23]

For the purpose of this study, dysphagia was defined as the inability to advance diet accompanied with a subjective feeling of difficulty of swallowing that required a speech/swallow evaluation. An understanding of the immediate complications in complex anterior cervical surgeries is essential, not only for early detection and management, but also for pre-operative awareness and the development of prevention strategies. The purpose of this study was to identify the type and frequency of the immediate post-operative complications after complex anterior cervical reconstruction, and the risk factors associated with the development of those complications.

Materials and methods

After obtaining Institutional Review Board approval, this retrospective study was performed by reviewing the hospital charts and operative reports for procedure-related peri-operative complications. Our data base search identified 190 patients who had undergone complex anterior cervical surgeries between 1996 and 2009. All patients were treated at a single institution by one of three fellowship-trained spine surgeons. Complex anterior cervical surgeries cases were defined as ACDF of 3 or more levels (with or without posterior instrumentation). One-hundred fifty-five patients had full charts/operative reports available and were included in this study. Patients with missing charts/ reports and those who didn't fulfill our definition were excluded.

The study population carried diverse diagnoses including cervical spondylotic myelopathy "CSM", radiculopathy, and cervical deformity. The indications for surgery were three or more- level cervical spondylosis and/or disc herniation with myelopathy and/or radiculopathy that was unresponsive to conservative treatment. Data was collected retrospectively on patient demographics (gender, age, BMI), preoperative diagnosis and symptoms, comorbidities (smoking status, medications, prior surgery, other diseases), pre-operative patient outcome measures (Nurick grade & modified Japanese Orthopedic Association scale "mJOA") surgical indications, medications, and perioperative details (levels fused, posterior instrumentation, surgery duration, and graft type), length of stay, and reported immediate complications.

Statistical analysis

Overall summary statistics were calculated in terms of means and standard deviations for continuous variables and frequencies and percentages were calculated for discrete variables. For the various outcomes that were analyzed, univariate analyses were performed to compare the differences in patient characteristics. Independent samples t-tests and chi-square tests were performed for normally distributed data, whereas Mann-Whitney U tests were performed for non-parametric continuous variables. Fisher's exact tests were performed for those discrete variables that had 80% of an expected count less than 5.

Following the descriptive analysis, characteristics that were found to be univariately associated with the outcome of interest were included as candidates for inclusion in the multivariate binary logistic model. Using a forward stepwise procedure, characteristics that failed to achieve a p-value of 0.15 or below were removed from the final model. Because of the exploratory nature of the analyses, a p-value of 0.15 was chosen as the critical threshold for retention. Characteristics that achieved a p-value of 0.05 or below were called statistically significant factors. For all regression models, adjusted odds ratios (aOR) and their respective 95% confidence intervals (95% CI) were reported. All analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY).

Results

Patient characteristics

Of the 155 patients, 100 were male (64.5%) and 55 female (35.5%). The mean age at surgery was 60±11 years (range 31-83), with an average BMI of 28.1±5.6 (range 17.2-49.9). The average operative time was 217±80 minutes (range 88-717), and the average number of instrumented levels per patient was 3.1±0.7 (range: 1-7). The average length of stay was 7.4±2.9 days (range 1-32).

Perioperative details

Radiculopathy was present in 137 patients, myelopathy in 101 patients, and both radiculopathy/myelopathy in 92 patients. Posterior instrumentation was performed in 9 patients. The most cranial level fused anteriorly was C3-4 and the most caudal level was C7-T1. The most cranial level fused posteriorly was C1-2 and the most caudal level was T1-T2. Iliac crest bone graft was used in all but 4 patients (allograft). Rh BMP2 was not used in any of the patients.

Patient clinical outcome measures

Preoperative Nurick grade and mJOA were available for 145 patients. The average preoperative nurick grade was 1.53±1.1 and the average mJOA was 14.02±1.79.

Documented complications

Dysphagia 41/155 (26.4%), dysphonia 15/155 (9.6), new nerve palsy 1/155 (0.6%), worsening of preoperative radiculopathy 2/155 (1.3%), post-operative hematoma requiring evacuation 2/155 (1.3%), emergent reintubation 2/155 (1.3%), and dural tear 1/155 (0.6%).

Multivariate analysis

Multivariate regression analysis for the onset of dysphagia following complex anterior cervical reconstruction showed that females (aOR: 2.91, 95% CI: 0.81, 10.49) and fusion of the C3-C4 level (aOR: 3.49, 95% CI: 0.89, 13.29) were predictive characteristics. Increasing Nurick grade, however, was found to have a protective effect on the development of dysphagia after adjusting for all other variables in the model (aOR: 0.43, 95% CI: 0.23, 0.80) (Table 1).

Controlling for all other factors in the model, anxiety disorder (aOR: 4.94, 95% CI: 1.06, 22.94) was found to have increased risk of post-operative dysphonia, while increasing Nurick grade (aOR: 0.47, 0.26, 0.85) was found to have a protective effect against it. Although not retained in the model, increasing age (p=0.160) and history of myelomalacia (p=0.174) trended towards association with dysphonia onset following surgery (Table 2). No variables were identified as potential risk factors for dural tears, nerve palsy, or post-operative hematoma requiring evacuation.

Table 1 Multivariate analysis for dysphagia

Variable	P-value	Adjusted odds ratio	95% confidence interval lower	95% confidence interval upper
Female sex	0.103	2.909	0.807	10.486
Nurick pre	0.007	0.429	0.232	0.795
C3/4 level	0.072	3.448	0.894	13.294

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Table 2 Multivariate analysis for dysphonia

Variable	P-value	Adjusted odds ratio	95% confidence interval lower	95% confidence interval upper
Age	0.160	1.045	0.983	1.111
Myelomalacia	0.174	0.307	0.056	1.683
Anxiety	0.041	4.940	1.064	22.937
Nurick pre	0.013	0.467	0.256	0.853

Discussion

Complex anterior cervical reconstruction is often a lengthy procedure and involves more hardware and greater soft tissue structure disturbance than a single- level ACDF.

Dysphagia

As a result, dysphagia was the most common immediate complication in our series, occurring in 41 patients (16 females, 25 males) out of 155, with an incidence of 26.4%. Dysphagia was defined as the inability to advance diet accompanied with a subjective feeling of difficulty of swallowing that required a speech/swallow evaluation. Identified patients subsequently received nutrition assessment by our nutrition department. Nutrition department followed those patients daily and updated their recommendations according to their swallowing progress. Although the aetiology remains unclear and is probably multifactorial, proposed causes include oesophageal retraction, edema of the pharynx or esophagus after intubation, post-operative soft tissue edema or hematoma, prominence of the cervical plate and finally due to the scarring around the implant especially in patients with delayed dysphagia.[7,22,26–29]

As noted earlier, we found that females (aOR: 2.91, 95% CI: 0.81, 10.49) and fusion of the C3-C4 level (aOR: 3.49, 95% CI: 0.89, 13.29) were predictive characteristics for the onset of dysphagia. This is most likely due to an increased soft tissue dissection and more retraction of the esophagus to get to the C3-4 disc space. Further, the location of greatest retraction is located next to the mechanically important area of the pharynx. Interestingly, increasing Nurick grade was found to have a protective effect on the development of dysphagia (aOR: 0.43, 95% CI: 0.23, 0.80) which warrants additional investigations.

In a prospective study of 38 patients undergoing one- or two-level anterior cervical decompression (i.e., either two-level discectomy or one-level corpectomy) and fusion; Rihn et al.[30] identified an incidence of dysphagia of 71% two weeks post-operatively according to the Bazaz dysphagia scoring system. This decreased to 8% at the 12-week follow-up period. Their indications for cervical surgery were one- or two level cervical spondylosis and/or disc herniation with radiculopathy that was unresponsive to conservative treatment. Bazaz et al.[28] found in their prospective study of 249 patients that the incidence of dysphagia was 50.2% at one month post-operatively, and decreased to 32.2%, 17.8% and 12.5% by two, six and 12 months post-operatively, respectively. A prospective study by Lee et al.[31] found a similar decreasing incidence of 54.2%, 33.6%, 18.6%, 15.2% and 13.6% at one, two, six and 12 months post-operatively, respectively. These studies suggest a high incidence of dysphagia in the first few weeks following surgery that decreases, reaching a plateau of between 12% and 14% one year post-operatively.[28,30,31] Lied et al.[22] reported this complication as 0.9%, in their series of 390 patients. Fountas et al.[7] in their series of 1015 patients reported the incidence of isolated dysphagia as 9.5% whereas Robinson et al.[12] reported this complication in 3.6% of their patients. According to Bertalanffy et al.[9] dysphagia is an inevitable outcome of the procedure and should not be considered as a complication.

Lee et al.[31] found that the prevalence of dysphagia was significantly higher in women (18.3%) than men (9.9%) 2 years after the surgery, and they concluded that gender was a risk factors for long-term dysphagia after anterior cervical spine surgery. Rihn et al.[30] & Riley et al.[32] failed to show that gender was a significant risk factor. Whereas Lee et al.[31] and Bazaz et al.[28] found no correlation between age and the incidence of post-operative dysphagia. Smith-Hammond et al.[33] found older age to be a significant risk factor. Riley et al.[32] also found severe neck pain to be a significant risk factor. Edwards et al.[34] assessed the accuracy of identification of dysphagia after anterior cervical surgery and found a poor correlation between patient surveys and the medical records, suggesting that the rate of post-operative dysphagia was significantly under-reported.

Andrew et al.[35] found that the greatest level of swelling or change in the pre vertebral soft tissues occurred at the mid-body of C4 {upper cervical spinal levels (C2-C4)} rather than the lower cervical spine (C5-C7), and this has an increased risk for complications in the postoperative ACDF patient including, and not limited to dysphagia and airway compromise. Lee et al.[31] found that fusion of higher levels did not significantly increase the prevalence of dysphagia in their series.

Whereas three studies found multilevel procedures to be a significant risk factor.[28,31,32] Rihn et al.[30] did not find a significant correlation between the number of levels involved in the surgery and the incidence of dysphagia. Furthermore, other studies failed to show that duration of surgery is a significant risk factor.[28,31,36] The average operative time for our patients was 217 minutes, although not statistically significantly linked to any of the immediate complications, might be partially responsible to their occurrence.

One major limitation of all studies examining dysphagia in the setting of anterior cervical surgery is the lack of an agreed upon definition of dysphagia. Further, there are no patient derived validated outcomes instruments for dysphagia or dysphonia for this very specific patient population.

Postoperative hematoma

In our case series, the incidence of post-operative hematoma requiring evacuation was 1.3% (2/155 patients). Those 2 patients needed emergent reintubation, and subsequently stayed in the

Intensive Care Unit "ICU" for 2 days. Both of them had a Jackson-Pratt drain. Bertalanffy & Eggert[9] reported that only 1.3% of their patients developed postoperative hematoma, however, they didn't specify what percentage of them required evacuation. Fountas et al.[7] reported that postoperative hematoma occurred in 5.6% (n=57) of their patients, 31/57 patients developed hematoma despite using Jackson-Pratt drain after the surgery. However, surgical intervention was required in only 2.4% of the cases. Nanda et al.[4] reported this complication in only two (0.1%) patients in their series.

Dysphonia and RLN injury

We reported dysphonia in our series in 15/155 (9.6%). However, none of them had a vocal cord paralysis. As mentioned earlier, anxiety disorder (aOR: 4.94, 95% CI: 1.06, 22.94) was found to have increased risk of post-operative dysphonia, while increasing Nurick grade (aOR: 0.47, 0.26, 0.85) was found to have a protective effect against it, which again warrants additional investigations. Nanda et al.[4] showed that 1.2% (19 out of 1576) of the patients in their series had post-operative hoarseness, however only two of these patients (0.1%) had vocal cord palsy. Fountas et al.[7] found in their study that Symptomatic recurrent laryngeal nerve palsy in 3.1% of the cases. Morepeth et al.[8] reported an incidence of 5% for vocal fold paralysis resulting in dysphonia in their study. Lied et al.[22] and Robinson et al.[12] reported this complication in 0.2%, and 7.1% of their patients respectively. Again, as in the case of dysphagia, one of the major limitations in studying dysphonia is the lack of an agreed upon definition and valid outcomes instrument.

Neurologic deficit

The incidence of a new nerve palsy (radiculopathy that did not exist pre-operatively) in our case series was 0.6% (1/155), and worsening of preoperative radiculopathy was 1.3% (2/155). Fountas et al.[7] reported that worsening of preexisting myelopathy/radiculopathy secondary to a spinal cord contusion/nerve palsy occurred in only 0.2% of their patients. Flynn reported in an older questionnaire-based study that transient or permanent postoperative myelopathy/radiculopathy occurred in 0.4% of the reported cases.[25] Bertalanffy & Eggert[9] reported that 5.4% of their patients had a new myelopathy or radiculopathy after surgery. However, worsening of preexisting myelopathy was reported in only 3.3% of the patients. Of note, their cases in that study were only discectomies without fusion. Nanda et al.[4] encountered this complication in 0.88% of their patients. Both Nanda & Fountas et al.[4,7] reported Horner's syndrome in 0.1% of their patients.

Acute airway obstruction and re-intubation

As mentioned earlier, only 2 patients (1.3%) in our series required emergent reintubation as a result of acute airway obstruction caused by post-operative hematoma. In a prospective study by Suk et al.[37] on 87 patients who underwent 1 or 2 levels ACDF, only one patient required re-intubation (1.1%) due to acute airway obstruction caused by prevertebral soft tissue swelling. Emery et al.[38] reported upper airway obstruction after multilevel cervical corpectomy in seven patients. Their reported risk factors were smoking and asthma. Fujiwara et al.[39] reported in their study that four of 171 patients who had undergone anterior cervical spine surgery required re-intubation (2%). Those four patients were fused to C3. They concluded that upper airway obstruction due to the intense swelling of the soft tissue at C3 may have been the reason for postoperative reintubation. Epstein et al.[40] used direct fiberoptic visualization of reactive tracheal swelling before extubation to decrease the emergency reintubation rate after multilevel cervical corpectomy and fusion. Their reported risk factors were prolonged operative time, obesity, transfusion, reoperations, surgery at C2, four-level corpectomy and fusion, and asthma. In a retrospective study by Sagi et al.[41] 311 patients who had undergone anterior cervical spine surgery were studied. Their incidence of airway obstruction was 6.1% and reintubation rate was 1.9%. Their reported risk factors were prolonged operation time, three level surgery, and blood loss of more than 300ml.[41]

Dural penetration

Durotomies during ACDF have been reported and described.[9–13,42,43] In our series, only one patient had a dural tear (0.6%). Fountas et al.[7] reported that the incidence of accidental dural tears in their series was 0.3% (4 of 1140 patients). Bertalanffy & Eggert[9] reported that the incidence of accidental dural tear in their series was 1.8%.

Vascular injury

Vascular injuries including vertebral artery (VA) injuries have been reported to be as high as 0.3%.[44] Many other studies described vascular injuries during ACDF.[5,6,45] We did not t have any VA or any other vascular injuries in our series.

Esophageal & pharyngeal perforation

Esophageal and pharyngeal perforation during ACDF has been also previously reported.[7,10,11,44,46] Fountas et al.[47] documented esophageal perforation in 0.3%. Nanda et al.[4] encountered this complication in one of their patients (0.1%). Again, we did not have any of those complications in our series. The importance of early detection and immediate management of this complication cannot be overemphasized.

Other complications

Mortality was reported in the literature as one of the peri-operative complications related to ACDF. Fountas et al.[7] reported one mortality in their series (0.1%) which was secondary to esophageal perforation and infection. Nanda et al.[4] reported one mortality as well (0.1%), which was not related to the surgical procedure. We didn't report any mortality in our series. Finally, the limitations of our study include all the limitations and weaknesses described in the literature for retrospective studies. Furthermore, we only studied the immediate postoperative complications, and thus our study lacks all the possible complications mentioned in literature on follow up visits.

Conclusion

Female gender, fusion of C3-4, and anxiety disorder, were associated with a higher rate of immediate post-operative complications following complex anterior cervical surgeries. Higher nurick grade was found to have a protective effect on the development of dysphagia and dysphonia. Although the reported complications were not unanticipated, their prevalence requires pre-operative awareness, proper patient education, and post operative vigilanceness.

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Institutional review board

This study was approved by our Institutional Review Board.

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Conflicts of interest

The authors declare there is no conflict of interest.

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