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What is This?
Factors Predictive of Voice and Swallowing Outcomes after Anterior Approaches to the Cervical Spine

Saral Mehra, MD, MBA1,2, Thomas E. Heineman2, Frank P. Cammisa Jr, MD3, Federico P. Girardi, MD3, Andrew A. Sama, MD3, and David I. Kutler, MD2

Abstract

Objective. To quantify the incidence of postoperative voice, swallowing, and other problems, including time to resolution following anterior transcervical approaches to the cervical spine, and to assess surgical factors associated with outcomes.

Study Design. Historical cohort study.

Setting. Academic medical center.

Subjects and Methods. One hundred eighty-eight consecutive patients with cervical spine disease who underwent an anterior transcervical approach to the spine by a single head and neck surgeon over a 4-year time period. Rather than primary, single-level approaches, all patients in this study had multilevel, high-cervical (above C4), low-cervical (below C6), and/or revision approaches. Postoperative voice, swallowing, and other complaints were measured as well as time to resolution using Kaplan-Meier method. Surgical factors related to outcomes were analyzed using regression analysis.

Results. Follow-up was available for 129 patients, with average and median time of 35 months. Seventy-seven patients (60%) had a postoperative issue, including 35 patients (27%) with postoperative voice complaint, 62 patients (48%) with postoperative swallowing complaint, and 16 patients (12%) with other problems. Swallowing and voice complaints persisted beyond 1 year in 28% and 9% of patients, respectively. Approaching spinal levels above C4 and exposing more than 3 spinal levels were 2 factors significantly related to voice and swallowing problems.

Conclusion. There is a high incidence of subjective voice and swallowing complaints following transcervical anterior approaches to the spine, and such complaints can persist beyond 1 year in many patients. Exposure of more than 3 spinal levels or above level C4 are 2 factors significantly associated with outcome.

Keywords
dysphagia, dysphonia, complications, anterior approach, outcomes

Introduction

Cervical spine surgery is performed for congenital, degenerative, and traumatic abnormalities in spine motion to restore nerve function or relieve pain, numbness, tingling, and weakness. The anterior transcervical approach, initially described by Cloward in 1958, is a commonly used approach1 that traverses a number of major neurovascular and aerodigestive tract structures. The incidence of voice and swallowing complaints with this approach is primarily published in the spine literature and is inconsistent with rates ranging between 0.4% and 71%.2-8 Also, variables associated with postoperative problems with voice and swallowing have not been clearly elucidated. Finally, there are no guidelines indicating the appropriate role of head and neck surgeons in performing the anterior transcervical approach to the cervical spine and managing subsequent problems.

At our institution, otolaryngologists are consulted for complicated approaches defined as multilevel, revision, high cervical (above C4), or low (below C6) cervical approaches. Otolaryngologists are not routinely consulted for primary, single-level approaches. All patients are evaluated preoperatively with history and physical examination including laryngoscopy to assess preexisting problems and risk factors for postoperative problems. In addition, otolaryngology follow-up is offered to all patients for the evaluation of

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postoperative complaints, including dysphagia, odynophagia, and dysphonia.

The objectives of this study are to review a large consecutive case series of complicated transcervical anterior approaches to the cervical spine in order to quantify the incidence of postoperative voice, swallowing, and other complaints, including time to resolution, and to assess surgical factors associated with these complaints.

**Methods**

After obtaining Weill Cornell Medical College Institutional Review Board Approval, we conducted a chart review and telephone interview on all consecutive patients who underwent an anterior transcervical approach to the spine by a single head and neck surgeon (DIK) and 3 different spine surgeons (FPC, FPG, AAS) at a single academic medical center between January 2007 and February 2011. All patients had multilevel, revision, high-cervical (above C4), and/or low-cervical (below C6) approaches.

There were 188 consecutive patients included in the total cohort, and follow-up data were available for 129 patients. Of the 59 patients for whom no follow-up was available, 30 did not feel comfortable discussing medical issues over the phone and 29 were not reachable by telephone despite multiple attempts at establishing contact. Chart review and a scripted telephone interview were used to identify the variables of interest including postoperative problems related to voice and swallowing. All patient telephone calls took place approximately 1 month after the last surgery included in this analysis. The telephone interview script is shown in Figure 1. Binomial univariate and multivariate logistic regression and Kaplan Meier statistical analysis was performed using SPSS 19 (IBM, Armonk, New York).

**Results**

One hundred eighty-eight consecutive patients were included in the initial analysis. All patients had benign disease and had plate placement for stabilization of the cervical spine following decompression; a breakdown of the levels approached are presented in Figure 2. The average age of patients was 55.8 years (range, 35-86 years). Forty-five percent of patients were women, and almost all patients were Caucasian. Six patients had undergone prior hemi- or total-thyroidectomy. Twelve approaches (6%) were right sided, 74 (39%) were revision, high-cervical (above C4), and/or low-cervical (below C6) approaches.

There were 188 consecutive patients included in the total cohort, and follow-up data were available for 129 patients. Of the 59 patients for whom no follow-up was available, 30 did not feel comfortable discussing medical issues over the phone and 29 were not reachable by telephone despite multiple attempts at establishing contact. Chart review and a scripted telephone interview were used to identify the variables of interest including postoperative problems related to voice and swallowing. All patient telephone calls took place approximately 1 month after the last surgery included in this analysis. The telephone interview script is shown in Figure 1. Binomial univariate and multivariate logistic regression and Kaplan Meier statistical analysis was performed using SPSS 19 (IBM, Armonk, New York).

Postoperative complaints are presented in Figure 2, with median follow-up of 35 months. Seventy-seven patients (60%) had a postoperative problem or complaint, including 35 patients (27%) with a postoperative voice complaint, 62 patients (48%) with a postoperative swallowing complaint, and 16 patients (12%) with other problems (facial swelling, dysarthria, hematoma, wound infection, pulmonary embolus, and Horner’s syndrome).

Three patients had postoperative vocal cord mobility issues; 1 with paresis that resolved in 3 months, 1 with paralysis with a glottic gap that underwent extensive evaluation and injection medialization but returned to almost normal mobility by 10 months, and 1 who reported “vocal cord paralysis” on telephone survey. None of these 3 cases had notable history or intraoperative characteristics such as prior thyroidectomy.

By telephone, 1 patient described a “droopy eyelid and a dilated pupil” as told to him by neuro-ophtalmology evaluation, but could not say when it started. Though not confirmed, this was classified as Horner’s syndrome in this analysis. This patient had a right-sided revision procedure from levels C3 to C7.

Kaplan-Meier analysis for assessment of the time to resolution of postoperative subjective swallowing and voice complaints is shown in Figure 4. Of the 48% of patients who developed postoperative dysphagia, 16% had resolved by 1 month, 39% by 3 months, 50% by 6 months, and 58% by 1 year. Twenty-eight percent of patients with follow-up data had persistent subjective swallowing complaints beyond 1 year. Of the 27% of patients who developed postoperative voice complaints, 29% had resolved by 1 month, 54% by 3 months, 60% by 6 months, and 66% by 1 year. In total, 9% of patients had persistent subjective voice complaints beyond 1 year.

The final part of the analysis utilized univariate and multivariate logistic regression models to evaluate a number of independent variables, including gender, age, side of approach, number of levels approached, revision approach, C2 and/or C3 approach, and C6 and/or T1 approach to see which were related to postoperative outcomes and problems. Univariate and multivariate $P$ value analyses are shown in Table 2. On univariate logistic regression we found that approaching levels above C4 was significantly associated with postoperative voice problems ($P = .05$). This relationship was strengthened on multivariate logistic regression analysis ($P = .04$) when controlling for a number of factors in a forward entry model including gender, age, plate removal, approach above C4, and approaching more than 3 levels. In addition, procedures involving more than 3 levels were significantly associated with dysphagia on univariate analysis ($P = .04$), and this relationship persisted on multivariate ($P = .04$). Female gender was significantly associated with other postoperative problem on univariate analysis ($P = .04$) but did hold on multivariate analysis. For persistent/unresolved voice and swallowing problems, we added approaching levels below C6 and found that approaching levels above C4 and approaching more than 3 spinal levels were both significantly associated with persistent/unresolved swallowing complaints ($P = .03$ and .02, respectively). No other variables were significantly related.
Phone Interview Follow-up Questions

1. Did you have any voice problems following the surgery?

If yes:
   a. Did you have hoarseness?
   b. Did you have issues with voice pitch (reaching high notes)?
   c. Did you have issues with voice loudness?
   d. Did you have vocal cord paresis or paralysis?

2. Did you have swallowing problems after the surgery?
   If yes:
   a. Did you have difficulty swallowing?
   b. Did you have pain with swallowing?

3. Did you have to return to the operating for any problems related to the surgery?

4. Are there any other problems that you had related to your voice or swallowing that you want to discuss.

**If yes to any question:**
1. When did you notice the problem?
2. Approximately how long did it last until it was resolved?

**If missing information from the chart review, we will also ask:**
1. What was your smoking history at the time of surgery: Never, Active, or Quit?
2. Had you undergone any prior neck surgery? Please describe.
3. After the surgery,
   a. Did you have difficulty breathing and require a breathing tube to be placed?
   b. Did you have swelling, fluid, or air in the neck? Please describe.
   (If required, will need to describe seroma, hematoma, chyle leak, pharyngoesophageal leak).
   c. Issues with moving your tongue?
   d. Eyelid problems?
   e. Facial sweating problems?

Figure 1. Telephone interview script used for supplemental historical data. Of a total of 188 patients, follow-up data were available for 129 patients.

Figure 2. Spinal levels approached in 188 consecutive patients undergoing an anterior approach to the cervical spine. Shaded boxes with numbers represent number of cases for each range of spinal levels accessed between C2 to T1.

to any of the outcomes measured, including spine surgeon performing the procedure.

Discussion

The high incidence of voice and swallowing problems following anterior approach to the spine shown in this study is in accord with a large survey study conducted by Winslow et al\(^4\) that found rates of postoperative dysphagia and dysphonia of 60% and 51%, respectively; however, that study included approaches performed by spine surgeons, and it included primary procedures (155 of 176 patients). In this study, all patients had either multilevel approaches, revision procedures, and/or high or low cervical approaches since head and neck surgeons are not routinely consulted to assist with primary single-level approaches at our institution. Therefore, the 60% prevalence of voice, swallowing, and other complaints seen in this study are likely to be higher than prevalence rates in simple, primary, single-level approaches. Furthermore, though the Winslow study was a survey study, most reports on this topic are retrospective chart reviews and report only short-term, postoperative complication rates. This is important because retrospective chart reviews have been shown to seriously underreport the prevalence of adverse outcomes after cervical spine surgery, with 1 study finding underreporting rates of 80% for dysphagia and 84% for dysphonia when comparing chart reviews to patient surveys at various time points postoperatively.\(^9\) That study found dysphagia and dysphonia rates of 57% and 30% based on chart review and survey data (vs only 5% and 11% based on chart review alone); however,
approaches were performed by spine surgeons and 43 of 166 patients had anterior and posterior fusion. These issues with nature of data collection and differences in surgical characteristics highlight the difficulty in comparing incidence rates between studies.

According to much of the spine literature, except for the rare cases of RLN palsies, dysphagia and dysphonia symptoms are of little significance to patients and resolve within 2 to 3 months of surgery and rarely persist longer than 1 year. Possibly because of this general consensus, most studies limit follow-up to the immediate postoperative period. The few studies specifically looking for persistence of symptoms are in agreement with our findings that symptoms of dysphagia and dysphonia can persist for more than 1 year in 28% and 9% of patients; however, no other study uses the Kaplan-Meier method to evaluate patients at risk accounting for differences in follow-up time. While typically used in survival analysis for cancer outcomes research (as well as for economic and operational outcomes research), Kaplan-Meier is used here because it accounts for patients who are studied for different amount of time and/or lost to follow-up before the final outcome (resolution of symptoms) is observed. Therefore, it gives a better representation of the fraction of patients with persistent symptoms at various postoperative time periods. The main disadvantage of KM analysis in this case is that it assumes resolution of symptoms occurred at the time of follow-up; that is, either the day of the visit with the otolaryngologist or the day of the follow-up telephone call unless a specific date was reported by the patient.

While this series of 129 patients identifies a variety of postoperative issues, a number of previously published complications were fortunately not seen in this cohort including pharyngoesophageal perforation, plate extrusion, chyle leak, and major vessel injury. A number of studies have shown an

Table 1. Surgical characteristics of patients who underwent anterior transcervical approach to the spine.a

<table>
<thead>
<tr>
<th></th>
<th>All Patients (n = 188)</th>
<th>Patients with Follow-up (n = 129)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Right-sided approach</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Revision</td>
<td>74</td>
<td>39</td>
</tr>
<tr>
<td>Multilevel</td>
<td>188</td>
<td>100</td>
</tr>
<tr>
<td>&gt; 3 levels</td>
<td>83</td>
<td>78</td>
</tr>
<tr>
<td>Above C4</td>
<td>73</td>
<td>39</td>
</tr>
<tr>
<td>Below C6</td>
<td>137</td>
<td>73</td>
</tr>
</tbody>
</table>

*aIn comparing all patients, with those patients for whom follow-up was available, the follow-up cohort is shown to be almost identical to the entire cohort of patients.

Figure 3. Postoperative problems and complaints in 129 patients after anterior transcervical approach to the spine performed by a single head and neck surgeon at a tertiary care specialty hospital based on chart review and telephone survey.
increased risk to the recurrent laryngeal nerve on right-sided approaches.\textsuperscript{16-18} In this study, although only 5\% of follow-up cases were right-sided approaches, we did not find a significant relationship between right-sided approaches and any of the measured voice or swallowing outcomes. All 3 vocal cord mobility issues were on left-sided approaches.

The 2 most important independent variables predictive of postoperative voice and swallowing complaints were approaching above level C4 and approaching more than 3 levels. Specifically, approaching levels above C4 was significantly related to postoperative voice complaints, and this relationship held true on multivariate analysis when controlling for a number of factors. Also, approaching more than 3 levels was significantly associated with postoperative dysphagia. Furthermore, approaches above C4 and approaches for more than 3 spinal levels were both significantly associated with persistent (unresolved) swallowing complaints on multivariate analysis.

Unfortunately, the primary reasons for symptoms of dysphagia and dysphonia following this procedure are still speculative despite extensive literature in the orthopedic, neurosurgical, and otolaryngologic literature. Proposed mechanisms include stretch injury to the RLN or SLN,\textsuperscript{19} denervation of the pharyngeal muscle, and compression of the RLN by adjacent structures.

### Table 2. Univariate and multivariate models used for regression analysis, and associated \(P\) values (\(n = 129\)).\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Variables</th>
<th>Any Problem</th>
<th>Voice Problem</th>
<th>Swallowing Problem</th>
<th>Other Problem</th>
<th>Hoarseness</th>
<th>Dysphagia</th>
<th>Unresolved Voice Problem</th>
<th>Unresolved Swallowing Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.48</td>
<td>.31</td>
<td>.34</td>
<td>.04</td>
<td>.33</td>
<td>.99</td>
<td>.31</td>
<td>.64</td>
</tr>
<tr>
<td>Age</td>
<td>.54</td>
<td>.54</td>
<td>.21</td>
<td>.17</td>
<td>.29</td>
<td>.18</td>
<td>.93</td>
<td>.36</td>
</tr>
<tr>
<td>Laterality</td>
<td>.48</td>
<td>.31</td>
<td>.34</td>
<td>.04</td>
<td>.33</td>
<td>.36</td>
<td>.31</td>
<td>.64</td>
</tr>
<tr>
<td>n of levels</td>
<td>.26</td>
<td>.37</td>
<td>.17</td>
<td>.54</td>
<td>.51</td>
<td>.17</td>
<td>.94</td>
<td>.17</td>
</tr>
<tr>
<td>Plate removal</td>
<td>.62</td>
<td>.23</td>
<td>.67</td>
<td>.10</td>
<td>.26</td>
<td>.98</td>
<td>.34</td>
<td>.08</td>
</tr>
<tr>
<td>Revision</td>
<td>.35</td>
<td>.25</td>
<td>.57</td>
<td>.06</td>
<td>.13</td>
<td>.88</td>
<td>.48</td>
<td>.17</td>
</tr>
<tr>
<td>Above C4</td>
<td>.10</td>
<td>.05</td>
<td>.35</td>
<td>.81</td>
<td>.13</td>
<td>.22</td>
<td>.92</td>
<td>.41</td>
</tr>
<tr>
<td>Below C6</td>
<td>.56</td>
<td>.73</td>
<td>.87</td>
<td>.08</td>
<td>.89</td>
<td>.71</td>
<td>.43</td>
<td>.52</td>
</tr>
<tr>
<td>Level T1</td>
<td>.78</td>
<td>.99</td>
<td>.34</td>
<td>.55</td>
<td>.89</td>
<td>.29</td>
<td>1.00</td>
<td>.20</td>
</tr>
<tr>
<td>&gt; 3 levels</td>
<td>.12</td>
<td>.14</td>
<td>.06</td>
<td>.37</td>
<td>.22</td>
<td>.04</td>
<td>.35</td>
<td>.13</td>
</tr>
</tbody>
</table>

\textsuperscript{a}For unresolved voice and swallowing problems, low cervical spine approaches were added into the regression model.  
\textsuperscript{b}Bold values are \(p\) values that are less than or equal to 0.05, and therefore were determined to be statistically significant.
plexus followed by disorganized reinnervation, prolonged endo-
laryngeal pressure on the terminal branches of RLN from the
ETT cuff,\textsuperscript{20} infection, hematoma, edema, fibrosis, bone graft
dislodgement, adhesions between the cervical esophagus and the
plate,\textsuperscript{21} as well as a few case reports of unique causes such as
delayed osteophyte formation,\textsuperscript{22} retropharyngeal cerebrospinal
fluid collection,\textsuperscript{23} and pharyngoesophageal diverticulum.\textsuperscript{24}

It was beyond the scope of this study to look at prevention
and treatment of these apparently common postoperative
problems. Some effective preventive measures such as preo-
perative tracheal traction exercises and endotracheal tube cuff
deflation following surgical positioning have been

described.\textsuperscript{20,25,26} In terms of treatment, the optimal interven-
tion depends on the specific problem, the severity of that
problem, and the length of time the problem persists. The lit-

terature describes plate and adhesion removal, cricopharyngeal
myotomy, and pharyngeal dilation as among possible treat-
ment modalities for severe dysphagia.\textsuperscript{2,21} Unfortunately, in
this study, only 29 patients returned for otolaryngologic
follow-up with the surgeon performing the approach, and
therefore treatment was not systematically assessed. Twenty-
six patients (90\%) had dysphagia, 12 patients (41\%) had dys-
phonia, and 15 patients (52\%) had odynophagia. While this
low rate of otolaryngologic follow-up may be due to the
national catchment of patients coming to this tertiary care
specialty orthopedic hospital, it may also be because of great
improvement in neurologic symptoms for which the surgery
was performed with limited impact on quality of life related
to mild dysphagia or dysphonia. Patients with these problems
can be worked up further with laryngoscopy, esophagoscopy,
esophagogram, modified barium swallow studies, functional
endoscopic evaluation of swallowing with sensory testing
(FEESST), and treated with medications, voice and swallow
therapy with a trained therapist, or vocal cord medialization
as indicated. While this study does not compare otolaryngol-
ogy versus spine surgeon outcomes, the high incidence of
postoperative symptoms related to voice and swallowing
alone supports otolaryngology involvement in the care of
these patients. By being involved in pre-, intra-, and post-
operative settings, the otolaryngologist will be in a better
position to manage patient expectations and provide counsel-
ing to this large cohort of patients. Further studies with vali-
dated questionnaires to assess the impact on quality of life
and objective postoperative findings with better otolaryngolo-
logic follow-up will provide even more support to otolaryngol-
ogy involvement and hopefully lead to better prevention and
treatment strategies that were beyond the scope of this study.

The limitations of this study are the retrospective and pri-

carily subjective nature of the data, as well as the recall and
selection bias inherent to survey studies. This bias can be
compounded because participants were contacted by tele-
phone from 1 month to over 3 years after their procedure.
Furthermore, the \(P\) values reported herein are marginally sta-
tistically significant; however, they do hold up on multivari-
atе analysis.

In conclusion, the incidence of subjective voice and swal-
lowing complaints following transcervical anterior approaches
to the cervical spine are higher than often published based on
retrospective chart reviews and can persist beyond 1 year in
many patients; this should be discussed with patients preopera-
tively to manage expectations. Approaching spinal levels
above C4 and exposing more than 3 spinal levels are signifi-
cantly related to voice and swallowing problems. Head and
neck surgeons may play an important role in quickly and
safely performing the anterior transcervical approach for spine
surgeons in multilevel, high or low level, and revision cervical
spinal procedures and assisting with diagnosis and manage-
ment of postoperative complaints.

Author Contributions

Saral Mehra, conception and design, acquisition of data and data
analysis, interpretation of data; drafting article and review; final
approval; Thomas E. Heineman, design of study, acquisition of data
and data analysis, interpretation of data; critical review and revision
for intellectual content; final approval; Frank P. Cammisa Jr, conception,
an acquisition of data; critical review and revision for intellectual content;
final approval; Federico P. G hrardi, conception, acquisition of data;
critical review and revision for intellectual content; final approval;
Andrew A. Sama, conception, acquisition of data; critical review
and revision for intellectual content; final approval; David L. Butler,
conception and design, acquisition of data, interpretation of data;
critical review and revision for intellectual content; final approval.

Disclosures

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