

Long-term result of vocal cord paralysis after anterior cervical disectomy

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Abstract

Purpose Anterior cervical disectomy and fusion (ACDF) is a highly effective and safe method for spinal cord and cervical root decompression. However, vocal cord paralysis (VCP) remains an important cause of postoperative morbidity. The true incidence and recovery course of postoperative VCP is still uncertain. This study is a report on VCP after ACDF to evaluate the incidence, recovery course, and possible risk factors.

Methods From 2004 to 2008, 1,895 consecutive patients underwent ACDF in our hospital and were followed up for at least 3 years. All surgeons were well trained and used a right-sided exposure. Prolonged VCP, where patients suffered from postoperative VCP lasting more than 3 months, was recorded and analyzed.

Results In this retrospective study, 9 of the 1,895 patients (0.47 %) documented prolonged VCP lasting over 3 months. Six of the nine patients had total recovery within 9 months. Only three patients (0.16 %) still had symptoms even after 3 years postoperatively. All symptoms of VCP, except hoarseness, could be improved. After matching with 36 non-VCP patients, no differences with regard to longer operative or anesthesia time, shorter neck, obesity, and prevertebral edema. All cases of prolonged course of

postoperative VCP occurred in patients who underwent exposure at the C6/7 level.

Conclusion In our study, only 0.47 % documented prolonged postoperative VCP, while most patients recovered within 9 months. However, if symptoms last longer, there could be almost permanent VCP (0.16 %). In our study, choking and dysphagia subsided mostly within 6 months, but hoarseness remained. The exposure of the C6/7 level obviously was a risk factor for postoperative VCP.

Keywords Vocal cord paralysis · Recurrent laryngeal nerve injury · Cervical disectomy

Introduction

Anterior cervical disectomy and fusion (ACDF) is a highly effective and safe method for spinal cord and cervical root decompression. However, vocal cord paralysis (VCP) secondary to recurrent laryngeal nerve (RLN) injury remains an important cause of postoperative morbidity after ACDF [1, 2]. The precise mechanisms are debated and include direct surgical trauma, nerve division, pressure or stretch-induced neuropraxia and ischemia, postoperative edema, pressure on the endotracheal tube, and the side of approach [1, 3–5]. The true incidence of postoperative VCP is still uncertain because of the variable symptoms, including hoarseness, dysphagia, aspiration, cough, and lack of symptoms, and variable diagnostic modalities. The reported incidence of symptomatic VCP or RLN injury after ACDF varies far from 0.07 to 11 % [1, 3–7] and is as high as 24.2 % when routine postoperative examination is checked by laryngoscope [8, 9]. Otherwise, the definition of permanent VCP also varies from 3 months to 1 year, depending on the follow-up period in the published

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literature, although most VCP instances are temporary with symptoms lasting for days to weeks [1, 2, 4, 5, 7–9]. Therefore, we defined VCP as those patients who present with persistent hoarseness, easy choking, dysphagia, and aspiration as confirmed by otolaryngologists while prolonged VCP is defined as VCP lasting more than 3 months. We report on our experience regarding prolonged VCP after ACDF and evaluate the incidence and risk factors.

Materials and methods

This study was a retrospective study including 1,895 consecutive patients who underwent ACDF in Chang Gung Memorial Hospital between January 2004 and December 2008. The study was approved by the Institutional Review Board (IRB: 1014196B). The study was restricted to patients who underwent one to four-level instrumented primary ACDFs and who were followed up for at least 3 years in our hospital. From these charts and the electronic medical records, the following data were collected: surgeon, patient demographics, preoperative diagnosis, pre- and postoperative images, surgical records, number of levels fused, and the lowest level of fusion. All surgeons were well trained and had at least 3 years of experience with surgery of ACDFs in the study. All operators used a right-sided exposure. Because of the temporary post-ACDF symptoms, such as sore throat, hoarseness, cough, dysphagia, and easy choking were very common and almost with self-recovery, patients could be discharged and were followed in the outpatient department. Only if patients had postoperative symptoms lasting over 3 months, they were specially recorded and defined as having a prolonged VCP in the study. Laryngoscopic examination was arranged in all suspected VCP patients. VCP secondary to RLN injury were diagnosed according to the findings of laryngeal videostroboscopy performed by otolaryngologists. VCP was defined as documented postoperative ipsilateral vocal cord paralysis with the vocal cord located in the paramedian position. [5].

We assigned serial numbers to the remaining 792, 926 and 166 patients and sampled them at regular intervals (every 39, 77, and 41 patients with a starting point of 1) according to the ratio of patients with a given level fusion to total patients without postoperative VCP. Using systematic sampling, we selected 36 patients (20 in one, 12 in two, and four in three-level fusion patients) from the non-VCP Group. We proposed that the more difficult approach and long-term stretching resulted in prolonged VCP. Higher body mass index [$BMI = \text{body weight (kg)}/\text{height}^2 \text{ (m)}$], shorter neck, and prevertebral edema may render the surgical approach difficult and result in higher risk of damage to the recurrent laryngeal nerve. Prolonged

surgical and anesthesia time led to long-term stretching of RLN. Severe postoperative soft tissue edema maybe resulted from more intra-operative damage. Data concerning patient age, gender, and the patients' characteristics with the preoperative BMI, neck length (distance between chin and shoulder in cervical lateral view), pre- and postoperative prevertebral soft tissue thickness (distance between vertebral body and trachea at middle surgical segment), operative duration, and anesthesia duration were recorded. The differences between the two matched groups were tested for significance using the Student *t* test and Wilcoxon ranked sum test for categorical variables. Statistical analyses were performed using SPSS software (standard version 16.00; SPSS, Inc.) Values are reported as mean \pm standard deviation while statistical significance was set at $p < 0.05$.

Results

Only 9 of the 1,895 patients (0.47 %) documented prolonged postoperative VCP lasting over 3 months within at least 3 years of the follow-up period. The diagnoses of VCP in the nine cases were all confirmed by laryngoscope performed by the otolaryngologists. Demographic data of the patients who had persistent VCP are presented in Table 1. There were five men and four women. The average age was 56.11 years, ranging from 45 to 68. All of the nine patients with prolonged VCP presented with hoarseness. Four patients suffered from more severe symptoms such as dysphagia, easy choking, or aspiration. No patient required intubation or tracheotomy resulting from bilateral VCPs or aspiration pneumonia. All patients were initially treated conservatively with short-term steroid medication, and speech and swallowing rehabilitation training. Reflux precautions and H₂ blockers or proton pump inhibitors were given when indicated. During the follow-up period, three of the nine patients had total recovery after 4 months, one after 5 months, one after 6 months, and one after 9 months. However, the remaining three of the nine patients who had prolonged VCP for more than 9 months suffered from constant symptoms even after 3 years of postoperative period. Otherwise, regarding symptoms, more severe symptoms such as choking and dysphagia in three of the four patients showed obvious improvement and subsided after 6 months postoperatively. Only one patient required laryngoplasty for persistent dysphagia. After surgery, his dysphagia almost recovered but hoarseness remained. Hoarseness remained in the three patients who had persistent symptoms over 3 years. Patients who suffered prolonged VCP had 1–3 fusion levels. Noticeably, all of the nine patients had exposure on the C6/7 level.

Table 1 Patient information for the post-ACD vocal cord palsy group

Patient no.	Age	Sex	Hoarseness	Dysphagia/choking/aspiration	Surgical procedure	Recovery period (months)	Surgical level
1.	64	F	+		ACD	6	C5/6/7
2.	45	F	+	+	ACD	No	C6/7
3.	62	M	+	+	ACD	No ^a	C6/7
4.	52	M	+		ACD + plate	4	C6/7
5.	46	F	+	+	Corpectomy + bone graft + plate	No	C5/6/7
6.	68	M	+		ACD	9	C4/5/6/7
7.	49	M	+	+	ACD + plate	5	C6/7
8.	58	M	+		ACD + plate	4	C6/7
9.	61	F	+		ACD + plate	4	C5/6/7

ACD anterior cervical disectomy

^a Underwent laryngoplasty 6 months later

Table 2 Lowest exposure level of anterior disectomy and number of VCP

Last level of ACD	C23	C34	C45	C56	C67	C7–T1
Total cases	4	163	397	934	381	16
VCP cases	0	0	0	0	9 (2.36 %)	0
Total ACD level	One level	Two levels	Three levels	Four levels		
Total cases	797	929	167	2		
VCP cases	5 (0.63 %)	3 (0.32 %)	1 (0.60 %)	0		

ACD anterior cervical disectomy, VCP vocal cord palsy

Table 3 Univariate analysis (VCP cases versus matching case–controls, $n = 45$)

Characteristics, mean (SD)	Cases ($n = 9$)	Controls ($n = 36$)	Student <i>t</i> test, <i>p</i> value	Wilcoxon ranked sum test, <i>p</i> value
Age (year)	55.2 (8.1)	55.4 (7.6)	–	–
Gender, <i>n</i> (%)				
Females	5 (55.6)	20 (55.6)	–	–
Males	4 (44.4)	16 (44.4)		
BMI (Kg/m ²)	25.7 (3.8)	25.4 (4.2)*	0.8739	0.6395
Prevertebral pre-op (mm)	14.3 (4.0)	13.4 (2.7)	0.5101	0.6497
Prevertebral post-op	20.2 (3.4)	18.6 (3.0)	0.2515	0.3243
Neck-shoulder (mm)	71.6 (16.7)	81.8 (16.8)	0.1101	0.0810
Anesthesia time	25 (10.5)	19.8 (11.6)*	0.1342	0.0734
OP time	211.7 (58.4)	179.6 (63.0)	0.1742	0.0941

* Rejected the normal distribution assumption; in the parametric test, \log_2 (value) was used

Table 2 shows the incidence of prolonged VCP, the total levels of fusion, and the lowest exposure level of the ACDs. Five of the nine patients (0.63 %) with one-level fusion suffered from prolonged symptoms while three (0.32 %) with two-level, one (0.60 %) with three-level fusion had prolonged symptoms. Longer fusion procedures seem to carry no higher risk for prolonged VCP. As many as 2.36 % patients (9/381) suffered from prolonged postoperative VCP when the surgical level involved C67. The exposure of the C67 level was obviously a risk factor for postoperative VCP. After matching with 36 non-VCP patients, no differences

with regard to demographic and clinical characteristics were observed when comparing the two groups (Table 3). Longer operative time, longer anesthesia time, shorter neck, greater obesity, pre- and post-operative prevertebral edema showed no increased risk of prolonged VCP.

Discussion

VCP secondary to RLN palsy is rare but considered the most common neurologic complication after ACDF. The

reported incidence of symptomatic VCP varies from 0.07 to 11 % [1, 3–7]. The actual incidence of VCP after ACDF may in fact be underestimated if postoperative laryngoscopy were not conducted routinely [8, 9]. That is because most patients will experience symptoms of a minor nature and of short duration. Most investigators used clinical criteria (hoarseness and dysphagia) to identify patients with possible laryngeal dysfunction. In our study, the incidence of prolonged VCP >3 months was only 0.47 % and that of permanent symptoms lasting more than 3 years was only 0.16 %. Two large series based exclusively on survey information estimated the permanent paralysis rate to be between 0.15 and 0.20 %, whereas temporary paralysis rates were not noted [2, 10]. In another prospective study, Jung et al. [9] performed routine laryngoscopy on 120 patients a few days after ACDFs and reported that the incidence of VCP was 24 %. Generally and in our study, visual laryngoscopy was only performed in symptomatic patients and routine use was unnecessary since most postoperative symptoms were self-limited [9, 11]. Otherwise, the definition of permanent VCP varies between 3 months and 1 year, depending on the follow-up period of the published literature [7, 11–13]. VCP after ACDF is usually temporary and resolution may occur within days and weeks [7, 13]. In Heeneman's study [12], 66 % of patients regained function within 3 months. Netterville et al. [11] reported 25 % with partial or complete return within 10 months. 83.3 % in Morpeth's study [7] was resolved within 12 months. In our study, only 0.47 % had symptoms lasting more than 3 months but 66.6 % (6/9) of patients still had a chance to recover within 9 months. The remaining patients (0.16 %) suffered from constant symptoms of hoarseness even after 3 years.

Various mechanisms of trauma are assumed to cause nerve palsy. Because direct surgical trauma to RLN is so rare, the most likely mechanisms of injury seem to be indirect stretch or focal pressure on the nerve. Netterville [11] and Tew [14] hypothesized that overstretching of the RLN was less likely to occur on the left, because it has a longer loop and lies better protected within the trachea–esophageal groove, although not all authors have confirmed this hypothesis. Because the anterior approach is more commonly performed from the right, based mostly on surgeon handedness, such possibilities have significant implications. The endotracheal tube (ET) alone can be a cause for RLN palsy and is reported to account for 7.5–11.2 % of all vocal cord paralyses [9, 15, 16]. Other authors have demonstrated the possible influence of endotracheal tube cuff pressure on RLN injury [2, 9, 17, 18]. Consequently, it is more susceptible to retractor-mediated stretch injury [1–5, 7–9, 11]. Overstretching seems to be the major cause of VCP after ACDF. So we have proposed that difficulty in the surgical approach, long-

term, and overstretching resulted in prolonged VCP. Higher BMI (obesity), shorter neck, and preoperative prevertebral edema may cause difficulty in the surgical approach. Prolonged surgical and anesthesia time mean long-term stretching of RLN. Postoperative soft tissue edema may imply the intra-operative damage and overstretching of the nerve. However, in our study, we could not prove that the longer operative and anesthesia time, shorter neck, obesity, prevertebral, and postoperative edema carry increased risk of prolonged VCP. We also could not prove the association between VCP and the number of fusion levels involved in the surgery. Experienced surgeons and anesthesiologists may overcome the obstacles of difficult airway and long-segmental approaches. At the same time, they also shorten the surgical and anesthesia time, which means less stretching against the RLN.

Surgical field involving C6/7 was the only risk factor for prolonged VCP after ACDF in our study. Prolonged course of postoperative VCP occurred in 2.36 % of all C6/7 surgeries. Anatomic studies have shown that the right RLN is shorter and travels up the neck in a more oblique angle than its left counterpart [7]. The oblique course of the right RLN places it at greater risk for stretch injury when the retractor is placed and the larynx is displaced horizontally. Furthermore, right RLN has less redundancy and lies outside the trachea–esophageal groove near the C6/7 level. Significant tension is increased on the RLN during lateralization of the larynx and is more vulnerable during lower cervical procedures [7, 11, 19]. In Razfar's [20] series, significant correlation between the voice change and included level C6/7 surgery was noticeable. A notable trend was also observed for higher rates of temporary paralysis in procedures performed at lower cervical levels in Apfelbaum's series, but had no statistical significance [1]. In a cadaveric model [19], it supported stretch neuropraxia based on evidence that operating on lower levels of the cervical spine increased the risk of nerve stretch. Although it has not been substantiated, there is potentially greater ET deflection and RLN compression involved in surgery at lower cervical levels.

Patients with immediate postsurgical VCP do not need an extensive workup since it is often transient with spontaneous recovery within days and weeks. Laryngeal electromyography may provide further diagnostic and prognostic information, but is not routinely performed at our institution. Assessment by a speech pathologist is useful in patients with VCP to initiate compensatory mechanisms and voice therapy [1, 2, 11, 15]. Laryngoplasty or thyroplasty is well known to increase better swallowing function and helps patients experience immediate rehabilitation during recovery. In our study, laryngoplasty was arranged in only one patient whose dysphagia and easy choking persisted longer than 6 months, but with good functional recovery.

Several technical considerations may help prevent vocal cord paralysis [1, 2, 7–9, 11, 14, 15]. Careful dissection and surgical technique, along with proper retractor placement beneath the bodies of the longus colli muscles away from the tracheoesophageal groove, are critical in preventing direct surgical trauma, as are intermittent release of retraction during prolonged operations and deflation of the ET cuff after retractor placement. According to our result, we strongly suggest that these procedures be kept in mind, especially when approaching at C67 level.

Conclusion

ACDF is a highly effective and safe method for spinal cord and cervical root decompression. Most VCP are transient, with spontaneous recovery within 3 months. In our study, only 9 of the 1,895 patients (0.47 %) documented prolonged VCP lasting over 3 months, while 66.6 % (6/9) of patients had total recovery within 9 months. However, if symptoms lasted more than 9 months (0.16 %), they were almost permanent. Most severe symptoms, such as choking and dysphagia, subsided within 6 months. If not, laryngoplasty provided good of recovery facility. Only hoarseness remained in the patient with permanent VCP. Since all prolonged VCP occurred on the C67 level, special attention must be given when approaching the C67 level and patients must be informed of the possible risk before surgery when necessary.

Conflict of interest None.

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