



## Review

# Multivariate analysis of airway obstruction and reintubation after anterior cervical surgery: A Retrospective Cohort Study of 774 patients



Haoxi Li, Yufeng Huang, Bin Shen, Zhaoyu Ba, Desheng Wu\*

Dept. of Spine Surgery, Shanghai East Hospital, Tongji University School of Medicine, 150 Jimo Rd, Shanghai, 200120, China

## HIGHLIGHTS

- Airway obstruction after anterior cervical surgery is rare.
- The risk factors for and the pathogenesis of this symptom are still unknown.
- The low incidence leads to little concern from clinicians and a lack of countermeasures.

## ARTICLE INFO

*Article history:*

Received 2 December 2016

Received in revised form

19 February 2017

Accepted 4 March 2017

Available online 16 March 2017

*Keywords:*

Cervical spine

Anterior surgery

Airway obstruction

Risk factors

## ABSTRACT

*Study design:* A retrospective study.

*Purpose:* To explore the risk factors for reintubation after airway obstruction following anterior cervical surgery.

*Study background:* Anterior cervical surgery is an effective surgical therapy for cervical spine disorders. As the anterior approach is adopted more frequently, some rare postoperative complications come under the spotlight, among which, airway obstruction is extremely detrimental. However, the risk factors and the pathogenesis of the airway obstruction still remain unknown. Therefore, finding out the incidence rate and the risk factors of airway obstruction after anterior cervical surgery weighs significantly on preventing airway obstruction.

*Methods:* We retrospectively analyzed the history and follow-up data of 774 patients who underwent anterior cervical surgery during January 2007 and June 2016. The patients were divided into two groups according to the occurrence of airway obstruction complication. Patients' age, sex, smoking history, drinking history, the presence of diabetes, body mass index (BMI), course of disease, surgical method, the location of the surgical segment, operation duration and the number of surgical segments were recorded and analyzed. Univariate analysis was conducted for the foregoing factors which might associate with concurrent airway obstruction, to screen out statistically significant factors, followed by a multivariate logistic regression analysis to analyze the relationship between these factors and the incidence rate of reintubation for airway obstruction after anterior cervical surgery.

*Results:* 14 of 774 patients developed postoperative airway obstruction followed by reintubation, which makes the incidence rate of 1.81% (14/774) for patients having airway obstruction after anterior cervical surgery. Among the 14 patients, 12 (85.7%) developed airway obstruction within 48 h after surgery, and 2 (14.3%) postoperative showed delayed airway obstruction in 9–11d after surgery. All of them had reintubation. The results of univariate analysis showed that there were statistically significant differences in age, smoking history, body mass index (BMI), surgical method, the location of the surgical segment, operation duration and the number of surgical segments between the two groups ( $P < 0.05$ ). Multivariate logistic regression analysis showed that age (OR = 2.038, 95% CI = 1.045–4.012), smoking (OR = 1.502, 95% CI = 1.012–2.375), BMI (OR = 1.807, 95% CI = 1.126–2.842), operation duration (OR = 2.503, 95% CI = 1.580–3.966), surgical method (OR = 3.386, 95% CI = 1.036–3.625), the location of the surgical segment (OR = 2.391, 95% CI = 1.085–5.159) and the number of surgical segments (OR = 2.512, 95% CI = 1.564–3.768) were the risk factors for airway obstruction and reintubation after anterior cervical surgery ( $P < 0.05$ ).

\* Corresponding author.

E-mail address: [eastspine@yahoo.com](mailto:eastspine@yahoo.com) (D. Wu).

**Conclusions:** Age, smoking, obesity, the number of surgical segments, surgical method and surgical segment location are the important factors which may induce airway obstruction after anterior cervical surgery and therefore led to the decision of reintubations.

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## 1. Introduction

Cervical degenerative changes often cause spinal cord dysfunction and spinal vessel compression. Spinal degenerative changes affected 76% of population in North America [1], where 50% of people over 55 years were diagnosed with cervical spine disorders through imaging and 10% with cervical spondylotic myelopathy [2,3]. In the foreseeable future, we may expect a tendency of more incidence of degenerative spine disorder. For the treatment of cervical spondylotic myelopathy (CSM), surgical therapy has been acknowledged as the gold standard, in addition, the anterior cervical surgery has been one of the most frequently performed operative approach regarding to the treatment of CSM [4]. Surgery help patients regain health while it inevitably triggers many complications.

Dyspnea caused by postoperative airway obstruction is rarely seen but can be life-threatening if it is improperly treated [5]. The risk factors for and the pathogenesis of this complication are still unknown [5–8]. There are many causes for the complication. The main causes may be laryngeal edema and prevertebral soft tissue edema which are resulted from an airway injury caused by surgery, while other uncommon causes include wound hematoma, abscess, cerebrospinal fluid leak and tissue structure variation [6]. Airway obstruction may be caused by a single factor or multiple factors. Postoperative airway obstruction usually occurs 12–72 h after the surgery. Generally, the obstruction develops gradually from the stage when the patients were asymptomatic to the ultimate stage of complete obstruction. The main early symptom of airway obstruction is normally the disturbance of respiration. Blood gas analysis is the most objective evaluation method. Early detection is the best way to prevent airway obstruction from further exacerbation [5–8].

The incidence of reintubation for such dyspnea was reported to be about 1.1%–1.9% in previous literature [5,9]. The overlook of the physicians concerning such disorders was led by the relatively low incidence rate, which may further result in lack of countermeasures. Therefore, finding out the incidence of and the risk factors for airway obstruction after anterior cervical surgery plays a significant role for preventing of the airway obstruction. We retrospectively analyzed the history data of 774 patients who underwent anterior cervical surgery in our department during January 2007 and June 2016, and discussed the incidence and relevant risk factors mentioned above. The study was reported as follows:

## 2. Materials and methods

### 2.1. General information

We retrospectively analyzed the history data of 865 patients who underwent anterior cervical surgery in our department during January 2007 and June 2016, adopting exclusion criteria as follows: ① cases complicated with cervical tumor or infection; ② cervical soft tissue or bony structure deformity; ③ heart disease; ④ respiratory system disease; ⑤ oral or laryngopharyngeal disease; ⑥ coagulopathy; ⑦ hysteria or mental disease. Based on the foregoing criteria, 91 patients were excluded and 774 were included

into statistical analysis. The patients included were divided into a reintubation group ( $n = 14$ ) and a non-reintubation group ( $n = 760$ ) according to the experience of postoperative airway obstruction and reintubation. All the surgeries were performed by the same team of spinal surgeons. Amid the selected cases, there were 406 males and 368 females with an age ranging from 26 to 85 years (average age,  $53.87 \pm 12.91$  years), among them, 617 underwent anterior cervical discectomy and fusion (ACDF), 157 anterior cervical corpectomy and fusion (ACCF), 329 single-segment surgery, 264 double-segment surgery and 181 multi-segment surgery ( $n = 3$ ). In order to evaluate the correlation between the location of the surgical segment and the incidence of reintubation for airway obstruction after anterior cervical surgery, all the patients included were subdivided into two groups according to the level of surgical segment, namely a group with the surgical segment located higher than the C5 vertebra ( $n = 297$ ) and a group with the surgical segment located lower than the C5 vertebra ( $n = 477$ ).

### 2.2. Surgical method

ACDF or ACCF was performed based on the evaluation of preoperative imaging data. All patients were placed on Wilson frames. After successful anesthesia, they were placed in a supine position, with the neck slightly stretched. The affected segment was localized with a G-arm X-ray machine. A transverse incision was made in the right side of the neck (Smith-Robinson approach). Blunt dissection was performed from the space between cervical vessel sheath and tracheoesophageal sheath to prevertebral fascia. Under the circumstance of no developmental spinal canal stenosis or ossification of the posterior longitudinal ligament, ACDF was performed, where the intervertebral disc at the affected segment was removed and a cage was implanted after proper decompression. If the following situation were perceived, eg. developmental spinal canal stenosis, severe degenerative changes and obvious osteoproliferation at the posterior edge of the vertebra complicated with ossification of the posterior longitudinal ligament, ACCF was performed, where the corpectomy of the corresponding cervical vertebral segment with compressed spinal cord was done for thorough decompression, followed by bone graft with titanium mesh. A proper anterior cervical locking titanium plate was selected after either one of two surgical procedure approach. The screws were fixed and tightened, followed by an X-ray examination with the help of G-arm X-ray machine. If the X-ray shows satisfying result, then the surgical incision was cleaned and was closed with a drainage tube in place after bleeding was well controlled.

### 2.3. Observation indexes

According to clinical observations and previous literature, 11 factors which might affect the incidence of reintubation for airway obstruction were selected as the evaluation indexes and assigned values for quantification, including age (year) ( $<45 = 0$ ,  $45-59 = 1$ ,  $60-69 = 2$ ,  $\geq 70 = 3$ ), sex (female = 0, male = 1), smoking history (No = 0, Yes = 1), drinking history (No = 0, Yes = 1), diabetes (No = 0, Yes = 1), body mass index (BMI) ( $<18.5 = 0$ ,  $18.5-24.9 = 1$ ,  $25-29.9 = 2$ ,  $30-34.9 = 3$ ,  $\geq 35 = 4$ ), course of disease (year)

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