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The Changes of Retropharyngeal Space and Retrotracheal Space in Patients Undergoing Anterior Cervical Discectomy and Fusion Surgery: A Retrospective Study

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CT and YT carried out all parts of this study. Authors HI and TE collected the clinical data. Authors MF and TH revised the presentation and the manuscript. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: Upper airway complications after anterior cervical discectomy and fusion (ACDF) surgery are potentially life threatening. The causes of postoperative airway swelling are tissue swelling in the pharynx in most cases and haematoma in some cases. This study was conducted to identify the postoperative time course of the prevertebral soft tissue swelling after ACDF and compare it between multi-level and single-level surgeries.
Study Design: Case series study.
Place and Duration of the Study: Department of Anesthesia, Nagasaki Rosai Hospital, Sasebo, Japan; 17 months.

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Methodology: We examined 28 consecutive patients who underwent multi-level ACDF surgery and 23 consecutive patients who underwent single-level ACD surgery for degenerative disease and traumatic injury, retrospectively from May 2012 to September 2014. The lateral radiograph of the cervical spine was taken preoperatively, immediately after surgery, on the first postoperative day (1POD), and a few days after surgery (2/3POD). The anteroposterior thickness of the prevertebral soft tissue was measured at the third cervical vertebral level (retropharyngeal space) and the sixth cervical vertebral level (retrotracheal space) on the radiograph. We compared the thickness at predetermined time points between the 2 groups.
Results: Both retropharyngeal and retrotracheal spaces increased immediately after the operation compared with the preoperative values in both groups. Moreover, the retropharyngeal space at 1POD significantly increased, compared with the preoperative values and immediately after the operation in both groups. The retrotracheal space at 1POD increased, compared with immediately after the operation in single--level surgeries, but not in multi-level surgeries. There are no significant differences in both spaces between the 2 groups at any time point.
Conclusions: Regardless of the surgical level, attention to upper airway swelling and complications after anterior cervical discectomy and fusion surgery is needed during the postoperative period as well as immediately after the operation.

Keywords: Anterior cervical discectomy and fusion surgery; airway complication; prevertebral soft tissue swelling; retropharyngeal space and retrotracheal space.

ABBREVIATIONS

1POD : One day after surgery
2/3POD : A few days after surgery
IQR : Interquartile range
ACDF : Anterior cervical discectomy and fusion

1. INTRODUCTION

Upper airway obstruction after anterior cervical discectomy and fusion (ACDF) surgery is rare but potentially life-threatening [1]. The causes of postoperative airway swelling are tissue swelling in the pharynx in most cases and haematoma in some cases [2-5]. The incidence of this complication varies from 1.2% to 6.1% due to tissue swelling and 0.2% to 1.9% due to haematoma, as reported in the literature [6,7].

The risk factors of upper airway obstruction after ACDF surgery are prolonged operation time (>5 h), 3-level surgery, and blood loss of more than 300 mL [8]. It is very difficult to perform postoperative emergency endotracheal reintubation due to pharyngeal swelling and postoperative fixed neck [2,9]. Therefore, it is important to understand the postoperative time course of the prevertebral soft tissue swelling as well as the risk factors of airway obstruction after ACDF.

This study was conducted to identify the postoperative time course of the prevertebral soft tissue swelling after ACDF surgery and compare it between multi- and single-level surgeries, and between patients with clinical symptoms and those without them.

2. MATERIALS AND METHODS

2.1 Patients

The Institutional Research Committee approved this retrospective study and waived the requirement of informed consent because the study procedure was a routine examination after anterior cervical spine surgery (approval number 27021). This study was conducted in the intensive care unit (ICU) of Nagasaki Rosai Hospital from May 2012 to September 2014. We included 28 consecutive patients who underwent multi-level anterior cervical spinal fusion surgery and 23 consecutive patients who underwent single-level ACDF surgery for degenerative disease and traumatic injury, retrospectively. Patients were identified by their medical chart review. The following information was obtained from the medical chart of each patient: 1) preoperative characteristics 2) operative approach and procedure, and 3) postoperative airway complication and clinical symptoms including dyspnoea, nasal obstruction, and dysphagia.

2.2 Operative and Anaesthetic Procedure

In patients with gross instability or in whom hyperextension was contraindicated, fibre-optic awake intubation was performed prior to inducing anaesthesia. Otherwise, standard endotracheal

intubation was performed after the induction of anaesthesia. Anaesthesia was induced with thiamylal or propofol and maintained with sevoflurane or total intravenous anaesthesia with propofol. Fentanyl and remifentanil were used as analgesic agents, and controlled ventilation was maintained with intravenous rocuronium during the operation. The standard anterior procedures were performed by 3 regular orthopedists. The standard anterior procedure included single- or multi-level cervical anterior discectomy and bone graft fusion. Plate and screw fixation was also performed in all patients. The wound was closed in a standard manner using closed suction. Following surgery, all patients were extubated in the operating room prior to being transported to the ICU. If required, postoperative emergency endotracheal reintubation was performed by anaesthesiologists.

2.3 Study Procedure

The characteristics of the patients, duration of the operation, and operative blood loss were reviewed to compare the degree of operative invasion between single- and multi-level surgeries. The lateral views of radiograph of the cervical spine were taken preoperatively, immediately after surgery, on the first postoperative day (1POD), and a few days after surgery (2/3POD). The anteroposterior thickness of the prevertebral soft tissue was measured at the third cervical vertebral level (retropharyngeal space) and the sixth cervical vertebral level (retrotracheal space) on the lateral view of radiographs of the cervical spine using digital measuring instrument. The prevertebral soft tissue was measured as the distance between the anterior surface of each vertebral body and the air shadow of the airway (Fig. 1).

We compared the distances at each time point between single- and multi-level surgeries, and between patients with clinical symptoms of postoperative airway complication and those without them.

2.4 Statistical Analysis

The results were expressed as median (IQR [interquartile range]). A 2-factorial analysis of variance with repeated measures was performed to analyse the interaction among time and the 2 groups. A post hoc comparison between the groups at each time point and among the repeated measures in each group was performed by Bonferroni/Dunn procedure, if appropriate. Continuous data for the patient characteristics were analysed using the Mann-Whitney *U* test. Dichotomous variables were analysed with either the Fisher's exact probability or Chi-square test. A P value < 0.05 was considered statistically significant.

Fig. 1. The anteroposterior thickness of the prevertebral soft tissue were measured as the distances between the anterior surface at the third cervical vertebral level (retropharyngeal space) or the sixth cervical vertebral level (retrotracheal space), and the air shadow of the airway

3. RESULTS

The aetiologies and surgical procedures are outlined in Table 1. There were no significant differences between single- and multi-level surgeries in terms of the patients' characteristics and volume of blood loss during surgery (Table 1). The operative duration of multi-level surgery was significantly longer than that single-level surgery.

Fig. 2 shows the time course of the thickness of the retropharyngeal space in single- and multi-level surgeries. Fig. 3 shows the time course of the thickness of retrotracheal space in single- and multi-level surgeries. The retropharyngeal and retrotracheal spaces increased immediately after the operation, compared with preoperative values in single- and multi-level surgeries. Moreover, the retropharyngeal space at 1POD significantly increased, compared with the pre-operation and immediately after operation in single- and multi-level surgeries. The retrotracheal space at 1POD increased, compared with immediately after the operation in single--level surgeries, but not in multi-level

surgeries. There were no significant changes between 1POD and 2/3POD in both retropharyngeal and retrotracheal spaces in single- and multi-level surgeries. There are no significant differences in both spaces between single- and multi-level surgeries at any time point.

Two patients required emergency endotracheal reintubation during ICU stay. Twenty-one patients (9 patients after multi-level surgery and 12 patients after single-level surgery) had clinical symptoms including dyspnoea, nasal obstruction, and dysphagia. There were significant differences in both retropharyngeal space (Fig. 4) and retrotracheal space (Fig. 5) at 1POD and 2/3POD between patients with clinical symptoms of postoperative airway complication and those without them.

Table 1. Patients characteristics

	Multi-level surgery	Single-level surgery	p
Number	28	23	
Age (year)	58 (16, 78)	60 (45,80)	0.37
Male/Female	23/5	16/7	0.30
Weight (kg)	61 (55, 68)	61 (52, 69)	0.75
Height (cm)	166 (154, 171)	165 (158, 170)	0.92
Operative duration (min)	158 (129, 175)	121 (104, 138)	0.04
Blood loss (mL)	35 (20, 70)	20 (10, 37)	0.72
Aetiology			
Disc herniation	8	5	
Myelopathy	10	11	
Bone fracture	3	6	
Cervical dislocation	1	0	
Tumor	1	0	
OPLL	3	0	
Monomelic amyotrophy	2	0	
Vertebral osteomyelitis	0	1	

Values are number, madian (interquartile range)
Blood loss, blood loss during surgery; OPLL, Ossifications of posterior longitudinal ligaments

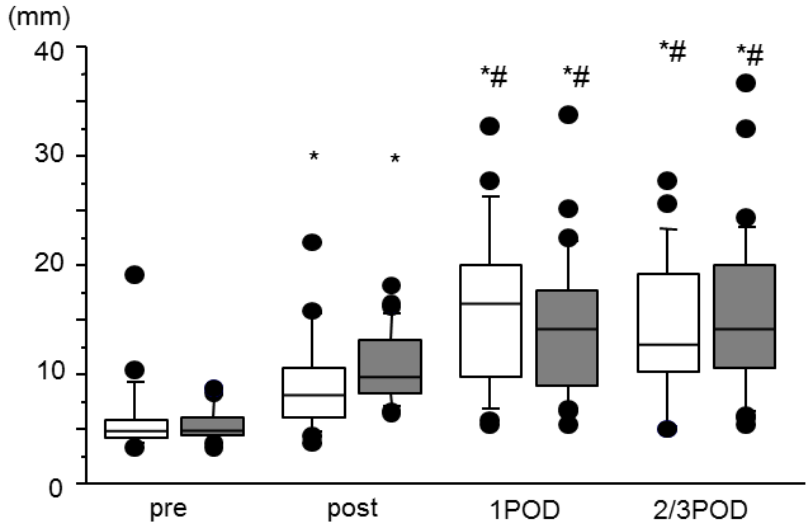

Fig. 2. Time course of the thickness of retropharyngeal space in one level (white) and multi-level (grey) surgery

*Values are expressed as median (line inside the boxes), IQR (boxes), and 10-90 percentiles (whiskers). pre, preoperation; post, postoperation, 1POD, a day after surgery; 2/3POD, a few day after surgery, * P<0.05 vs. pre. # P<0.05 vs. post*

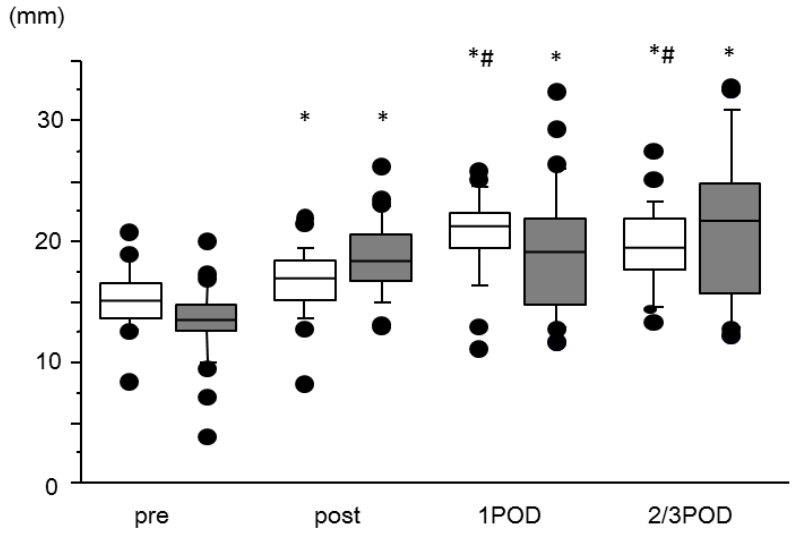

Fig. 3. Time course of the thickness of retrotracheal space in single-level (white) and multi-level (grey) surgery

*Values are expressed as median (line inside the boxes), IQR (boxes), and 10-90 percentiles (whiskers). pre, preoperation; post, postoperation, 1POD, a day after surgery; 2/3POD, a few day after surgery, * P<0.05 vs. pre. # P<0.05 vs. post*

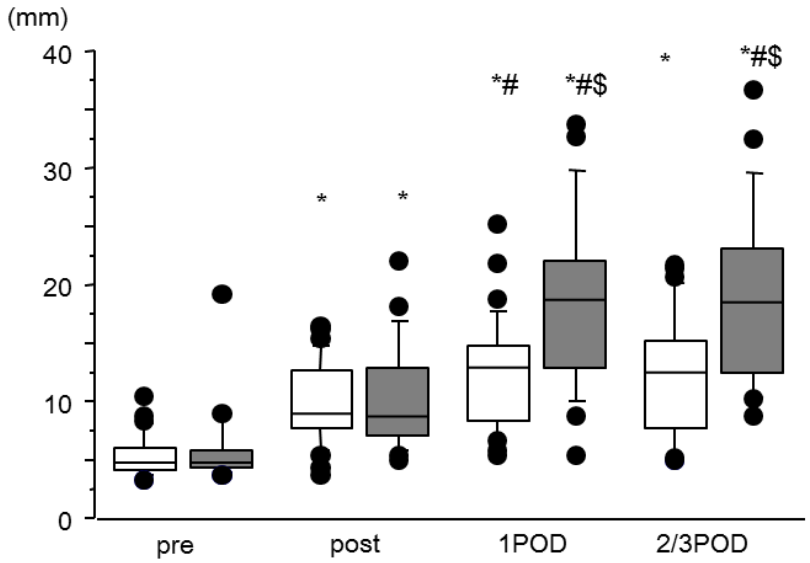

Fig. 4. Time course of the thickness of retropharyngeal space in the patients (grey) with clinical symptoms of postoperative airway complication and the patients (white) without them

*Values are expressed as median (line inside the boxes), IQR (boxes), and 10-90 percentiles (whiskers). pre, preoperation; post, postoperation, 1POD, a day after surgery; 2/3POD, a few day after surgery, * P<0.05 vs. pre. # P<0.05 vs. post. $ P<0.05 vs. no clinical symptom*

4. DISCUSSION

Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed spine surgeries. ACDF is considered the gold standard for many degenerative cervical diseases due to simplicity, minimal risk, and reliability [8]. Although ACDF has many advantages, the airway obstruction due to the prevertebral soft tissue swelling after ACDF is rare but potentially life-threatening [10,11]. A few previous studies [12,13,14] suggested the methods to avoid and

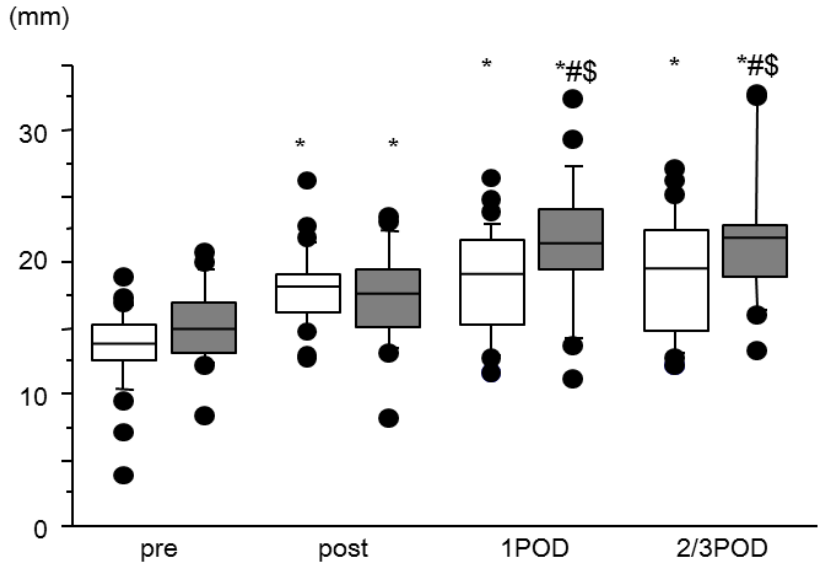

Fig. 5. Time course of the thickness of retrotracheal space in the patients (grey) with clinical symptoms of postoperative airway complication and the patients (white) without them

*Values are expressed as median (line inside the boxes), IQR (boxes), and 10-90 percentiles (whiskers). pre, preoperation; post, postoperation, 1POD, a day after surgery; 2/3POD, a few day after surgery, surgery, * P<0.05 vs. pre. # P<0.05 vs. post. $ P<0.05 vs. no clinical symptom*

limit the complication, such as using a steroid and/or topical gelatin-thrombin matrix sealant and maintaining intubation overnight. The most important postoperative management after ACDF in anterior cervical spine surgery is to find the advancing airway obstruction symptoms before the obstruction is completed, and patients fall into hypoxia. In fact, studies have been performed to detect the risk factors for airway obstruction [1,7].

Suk KS et al. reported a prospective study with 87 consecutive patients after one- or two-level ACDF and measured the thickness of the prevertebral soft tissue on cervical spine lateral radiographs [3]. The method was derived from a study by DeBehnke and Havel, who measured the prevertebral soft tissue to identify cervical spinal fracture [15]. They measured the prevertebral soft tissues serially (preoperatively and postoperatively on the first, second, third, fourth, and fifth days) to identify the time course of the prevertebral soft tissue swelling after ACDF. They concluded that the peak prevertebral soft tissue swelling was observed on the second and third days after the operation [3].

After the previous study [3], we also focused on the change in retropharyngeal and retrotracheal spaces by imaging the lateral views of the cervical spine using a radiograph, preoperatively, immediately after surgery, on the first postoperative day (1POD), and a few days after surgery (2/3POD). We compared the retropharyngeal and retrotracheal spaces between the multi- and single-level surgeries to find the relationships between the changes on the radiograph and clinical symptoms. Our results showed that the retropharyngeal and retrotracheal spaces were significantly different between immediately after the operation and one day after surgery. Apart from this difference, there was no significant change between 1POD and 2/3POD at both multi- and single-level surgeries. This result was different from the previous study [3]. Hence, it is important to determine the sufficient follow-up periods. There were no significant differences between the single-level surgery group and multi-level surgery group. This result was same as the previous study [3].

Two of the patients (3.9%) required postoperative emergency reintubation and 21 patients (41.2%) had clinical symptoms. A large and multicentre study showed that the incidence of postoperative airway management including prolonged intubation and postoperative reintubation is 1.3% [16]. The incidence of postoperative airway management after ACDF in

our hospital was slightly more frequent than that in the previous study [16]. This large, multicentre, and nationwide study in the United States showed that the independent predictors for postoperative airway management included a history of cardiac disease, dialysis along with a low preoperative albumin level, a history of recent weight loss of more than 10%, recent operation within 30 days, low preoperative haematocrit levels, and high serum creatinine levels. It is essential to pay attention to the postoperative airway management after ACDF in patients at high risk.

There are several limitations of the present study. The present study was conducted in a single-centre retrospectively and with relatively small sample size. The present study showed the lack of correlation among the threshold values of clinical symptoms and respiratory difficulty and the prevertebral soft tissue swelling. Endotracheal tube might affect the border of the airway shadow in intubated patents. The different position and the different distance from cassette to the X-ray tube might affect the dimensions of retropharyngeal and retrotracheal spaces in this study.

5. CONCLUSIONS

The retropharyngeal and retrotracheal spaces enlarged postoperatively at 1POD than immediately after the operation, regardless of the surgical level. Moreover, the clinical symptoms are associated with enlarged retropharyngeal and retrotracheal spaces at 1POD. It is difficult to predict the edema level and upper airway difficulties based on only the radiograph, immediately after the operation. It seems necessary to follow up at least one day after surgery because peak retropharyngeal and tracheal space swelling was observed at 1POD. Regardless of the surgical level, attention to upper airway swelling after anterior cervical discectomy and fusion is needed during the postoperative period as well as immediately after the operation, especially in patients at high risk.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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