Dysphagia after anterior cervical discectomy and fusion: a prospective study comparing two anterior surgical approaches

Yu Fengbin · Wang Xinwei · Yang Haisong ·
Chen Yu · Liu Xiaowei · Chen Deyu

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Abstract

Background The Smith-Robinson approach is commonly used to expose the vertebrae in anterior cervical discectomy and fusion (ACDF). Postoperative dysphagia has been frequently reported following this procedure. In this approach, surgical dissection can be carried out either lateral (LEO) or medial (MEO) to the omohyoid muscle. The purpose of this study was to compare the degree of dysphagia between the LEO and MEO groups.

Methods In this randomized, prospective study, 80 patients were enrolled and evenly divided into the MEO and LEO groups. Patients underwent two-level ACDF using a right-sided Smith-Robinson approach. Follow-up was obtained 1, 3, 6, 12 week and 6 months after surgery. The degree of dysphagia was assessed using a 14-item questionnaire from the SWAL-QOL survey.

Results There were no differences between the MEO and LEO groups with respect to age, gender, body mass index, or length of surgery. Overall, the SWAL-QOL scores were not different between the two groups at any of the follow-up time points. However, when the level of surgery was taken into consideration, the early postoperative SWAL-QOL scores were significantly lower in the C3–C4 subgroup when the MEO approach was used. Conversely, the SWAL-QOL scores were significantly lower in the C6–C7 subgroup when the LEO approach was used. Two patients

with C6–C7 surgery in the MEO group also developed dysphonia that resolved spontaneously within 3 months.

Conclusion The findings from this study suggest that the LEO approach should be selected if the level of surgery involves C3–C4. For C6–C7 surgery, however, a left-sided MEO approach should be used. Depending on surgeon's preference, either approach can be used if both cervical levels are involved.

Keywords Anterior cervical surgery · Complications · Dysphagia · Omohyoid

Introduction

The Smith-Robinson approach is commonly used to access the cervical spine. It allows safe and direct decompression of ventral pathology with a low incidence of serious complications. Postoperative dysphagia after anterior cervical spinal surgery can, however, occur in up to 71 % of patients in the early postoperative period [1–8]. Possible mechanisms of dysphagia include local trauma to the neuronal, muscular, and mucosal tissues in the aerodigestive tract during retraction, dissection, insertion, and inflation of the endotracheal tube, or adhesions around the cervical plates [8–13].

During the Smith-Robinson approach, two different paths are used to reach the anterior vertebra. One is through the medial edge of the omohyoid (MEO), and the other is via the lateral edge of omohyoid (LEO). Both can achieve good surgical exposure. However, whether they have different effects on the occurrence and degree of dysphagia is unknown. Therefore, the purpose of this study was to prospectively compare the degree of dysphagia in patients treated with anterior cervical discectomy and fusion

Y. Fengbin
Department of Orthopaedic Surgery,
No. 98 Hospital of PLA, Huzhou, China

W. Xinwei · Y. Haisong · C. Yu · L. Xiaowei · C. Deyu (✉)
Department of Orthopaedic Surgery, Changzheng Hospital,
No. 415 Feng Yang Road, Shanghai 200003, China
e-mail: chendyspine@sina.com

(ACDF) using the aforementioned two different anterior approaches.

Patients and methods

Study design

This randomized, prospective study was approved by the Institutional Review Board of the second military university.

We prospectively enrolled 80 patients undergoing two-level ACDF (C3–C7). The indications for surgery were two-level cervical spinal cord or nerve root compression from spondylosis or soft disc herniation that was unresponsive to conservative treatment. Patients with a non-degenerative pathology, such as trauma, infection, tumor, and autoimmune disorders, those with a history of preoperative dysphagia, and those with conditions that might cause postoperative neurogenic dysphagia (such as motor neuron disease, cerebrovascular disease, or psychiatric disorders) were excluded from the study. The radiographic changes were confirmed in all patients with magnetic resonance imaging, computerized tomography (CT) (including images reconstructed in the sagittal plane), and conventional cervical spine radiographs. All surgeries were performed by a single surgeon (Chen Deyu) between June 2011 and January 2012.

To make the two groups of patients more comparable, the risk factors for postoperative dysphagia were assessed. A systematic review suggested that multilevel surgery and female gender were the main risk factors for postoperative dysphagia [14]. Therefore, we stratified the assignment by gender and levels of cervical spine involvement. Qualified patients were selected by a one-stage stratified random sampling technique with proportional allocations. Patients were sub-classified by gender and then randomized using an online computer generated sequence (www.graphpad.com/quickcalcs/randomN1.cfm) for MEO or LEO. To assure the allocation concealment, we kept the randomization sequence in consecutively numbered opaque envelopes. Once the patient was anaesthetized, the sealed envelope with the same serial number was opened to reveal which surgical approach to be taken. Patients were further subdivided according to the level of surgery (C3–C4 vs. C6–C7).

All patients consented to participate in the study. None of the patients had dysphagia preoperatively based on the evaluation using the Swallowing-Quality of Life (SWAL-QOL) questionnaire. The dysphagia survey was conducted by the junior author (L.X.W) who was not directly involved in the care of the study patients. The survey was repeated at 1, 3, 6, 12 week, and 6 months after surgery. The 1 and 3 week surveys were performed using a

telephone interview, while the 6-, 12-week and 6-month surveys were performed during regularly scheduled follow-up visits.

Surgical technique

All patients underwent ACDF under general endotracheal anesthesia. The patients were placed in a supine position with a shoulder roll to provide cervical extension. A right-sided Smith-Robinson approach was performed through a 3–4 cm transverse incision. The skin and platysma were incised horizontally, followed by a full longitudinal release of the inferior fascia. For the MEO group, the anterior vertebrae were exposed in the plane between the tracheoesophageal sheath and the omohyoid muscle. For the LEO group, the dissection was carried out in the plane between the sternocleidomastoid and omohyoid muscles. The prevertebral fascia was then carefully incised while undermining the longus colli muscle. Surgical exposure was facilitated by placing two retractors beneath the longus colli muscles on both the sides. Cervical discectomy was then performed at the two required levels. Autogenous bone grafts obtained from the removed osteophytes were placed in the disc space. Anterior cervical plates with locking screws were used in all patients. Plate fixation was confirmed with intraoperative fluoroscopy.

Drains were removed on postoperative day 1 or when the drain output was less than 30 ml per 8-hour shift. Postoperative immobilization with a hard cervical collar was maintained for 2 weeks in all patients.

SWAL-QOL questionnaire

The SWAL-QOL questionnaire is a validated patient-based measure of dysphagia and is commonly used in otolaryngology [15–17]. It requires the patient to answer 60+ questions at each postoperative visit. Many of the questions are, however, less applicable in spinal surgical study [8]. Therefore, we adopted the modification by Peter et al. [17] which used a 14-item questionnaire to assess symptoms frequently associated with dysphagia. The items in this portion of the SWAL-QOL were scored 1–5, corresponding to symptoms occurring almost always, often, sometimes, hardly ever, or never. The scores of the 14 items were summed and transformed into a scale that ranged from 0 to 100, with lower scores indicating more frequent symptoms of dysphagia [18].

Statistical analysis

Descriptive analyses were performed using measures of central tendency (means, medians), dispersion (standard deviation, range), and percentages for categorical variables.

The Student's *t* test was used to determine differences in the degree of postoperative dysphagia between the MEO and LEO groups. Chi square tests were used for categorical variables. $P < 0.05$ was considered statistically significant. Data analysis was performed using SPSS/Mac Version 17.0 (SPSS Inc., Chicago, IL, USA).

Results

Eighty patients who had undergone ACDF were enrolled in the study with 40 patients in each of the MEO and LEO groups. Patients' age, body mass index (BMI), location of surgery, length of surgery, and gender distribution were similar between the two groups (Table 1). All patients tolerated surgery well with no major postoperative complications, such as hematoma, infection, or tracheal-esophageal fistula. Two patients with C6–C7 surgery in the MEO group developed a temporary dysphonia that resolved spontaneously within 3 months.

There were no significant differences in SWAL-QOL scores at any of the follow-up time points between the MEO and LEO groups as a whole. (Fig. 1). However, in the C3–C4 subgroup, the SWAL-QOL scores in the MEO group were significantly lower than that in the LEO group at 1 and 3 weeks follow-up (53 vs. 69, $P < 0.01$; 69 vs. 82, $P = 0.03$; respectively). The scores at 6, 12 week and 6 months follow-up were not significantly different (Fig. 2). In the C6–C7 subgroup, the scores were significantly higher in the MEO than in the LEO group at 1 and 3 weeks follow-up (72 vs. 58, $P = 0.03$; 78 vs. 69, $P = 0.02$; respectively) but were not different at 6, 12 weeks, and 6 months follow-up (Fig. 3). None of the patients required daily nutritional support via a feeding tube or any surgical interventions due to difficulties in swallowing.

Discussion

The omohyoid is a slender strap muscle located beneath the platysma. It obliquely crosses the inferior neck and is a

Table 1 Patient demographics

	MEO	LEO	<i>P</i> value
Number of patients	40	40	
Age (year)	58.4	60.1	0.53
Gender (percent female)	45	45	1.00
Body mass index	24.8	25.5	0.68
Length of surgery (min)	90	85	0.72
Level of surgery			
C3–C4	12	10	1.00
C6–C7	18	15

Fig. 1 Postoperative SWAL-QOL scores in the MEO and LEO groups. SWAL-QOL Swallowing-Quality of Life

Fig. 2 Postoperative SWAL-QOL scores in patients with C3–C4 surgeries

Fig. 3 Postoperative SWAL-QOL scores in patients with C6–C7 surgeries

landmark during anterior cervical approach for cervical spinal procedures. If the level of surgery is at C3–C4 or C4–C5, surgical access to the vertebrae is usually in a plane along the lateral edge of the omohyoid. If the level of surgery is at C6–C7, the surgical plane is usually along the medial edge of the omohyoid muscle. For levels of C5–C6, either approach can be used. We have found that both approaches can provide good exposure to C3 to C7. However, the present study showed that the swallowing

outcomes differed between the medial and lateral approaches for different levels of cervical spine surgery.

The SWAL-QOL scores within each group improved gradually with time, and reached their preoperative levels at 6 months follow-up. There were no differences in postoperative dysphagia between the MEO and LEO groups, overall. However, in the subgroup of patients who had C3–C4 surgery, the medial approach (MEO group) was associated with a higher degree of dysphagia in the early postoperative period (1 and 3 weeks). Anatomically, the internal branch of superior laryngeal nerve (SLN) courses closely to the superior laryngeal artery at the C3–C4 level and provides innervation to the mucosa of the larynx. It has been shown that injury to the internal branch of the SLN during exposure of C3–C4 may lead to swallowing impairment [19]. Identification of the superior laryngeal artery and SLN during surgery is easier in the plane between the sternocleidomastoid and omohyoid muscles (LEO) than in the space between the tracheoesophageal sheath and omohyoid muscle (MEO). Therefore, there might be a higher incidence of SLN injury during the process of dissection and retraction in the MEO group for C3–C4 surgery, contributing to the higher degree of early postoperative dysphagia. The fact that postoperative dysphagia recovered spontaneously by 6 months suggests that the injury was more likely caused by retraction instead of division of the nerve.

On the other hand, in the subgroup of C6–C7 surgery, the lateral approach (LEO) was associated with a higher degree of dysphagia in the early postoperative period (1 and 3 weeks). At the level of C6–C7, the trachea and esophagus enter the thoracic inlet as these structures angle dorsally, in a deeper plane, thus requiring more retraction for exposure. In addition, the omohyoid muscle has fibrous attachments to the lateral clavicle and obliquely crosses the Smith-Robinson approach as it courses upward and medially. Dissection in a plane lateral to the omohyoid muscle (LEO) also necessitates more forceful medial retraction to obtain the desired exposure. It is therefore conceivable that such retraction forces may have contributed to the higher incidence of early postoperative dysphagia (≤ 3 weeks), although a distinct correlation between intraoperative pharyngeal or esophageal retraction and postoperative swallowing disturbance has not been confirmed. Previous studies suggest that elevated pressure of sufficient duration could damage neural structures, connective tissue, and muscle fibers [20]. Pressure-induced trauma might lead to early postoperative dysphagia [9]. Our study also identified two patients with temporary dysphonia, suggesting a traction injury to the recurrent laryngeal nerve (RLN). Both patients were in the MEO group for C6–C7 surgery. The right RLN may be at a higher risk when the MEO approach is used as the nerve crosses the anterolateral cervical spine

at the C6 level before entering the protection of tracheoesophageal groove. Since the duration of surgery for the MEO and LEO groups was similar (90 and 85 min, respectively), duration of the operation is unlikely the cause of dysphagia, although prolonged traction might cause worse nerve dysfunction.

Limitations of this study include the relatively small sample size of the subgroups, potentially limiting the power of the study. Although this study did not provide an objective evaluation of dysphagia in these patients, the SWAL-QOL survey has been validated as a dysphagia-specific measure to be utilized in research.

In summary, the findings from this study suggest that the LEO approach should be selected if the level of surgery involves C3–C4. On the other hand, the left MEO approach should be used, for C6–C7 surgeries. If surgery involves both the levels, either approach can be used depending on surgeon's preference.

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