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Original Article

Tube-reserving rinsing combined with negative pressure drainage in treating esophageal fistula after anterior cervical vertebral surgery

Qiang Deng*, Xuebin Sun*, Weibin Sheng, Maier Dan, Hailong Guo

*Department of Spinal Surgery, The First Affiliated Hospital of Xinjiang Medical University, Urumqi 830054, China. *Equal contributors and co-first authors.*

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Abstract: This study aimed to examine the causes of and prevention measures against esophageal fistula following anterior cervical vertebral surgery (ACVS-EF), as well as to determine the treatment effects of tube-reserving rinsing combined with negative pressure drainage (TRR-NPD). Eighteen patients with ACVS-EF, including 12 men and 6 women were retrospectively analyzed. Of these patients, 1 patient did not exhibit healing of the fistula at 20 weeks after treatment. The other 17 patients were divided into two groups: 4 patients who underwent debridement, fistulous stoma suture, or had partially sutured wounds left open with the open wound packed by nitrofural gauze; and 3 patients who had a drainage tube placed were allocated to the A group. Ten patients who underwent debridement, fistulous stoma suture, and TRR-NPD were allocated to the B group. Both groups were fasted and were not allowed to consume water; a nasogastric tube was placed for feeding. Fluid infusions and anti-infection treatments were administered intravenously. The site of the fistula was then observed. The appearance that the wound had healed without local swelling, leakage, difficulty in swallowing, or fever, and with good general conditions and no leakage of contrast agent visible on barium swallow X-ray imaging, was considered as the complete healing of the esophageal fistula. The 2- to 36-month follow-up period revealed that the 17 cured patients exhibited no recurrence of esophageal fistula, and that their swallowing functions were good. One patient had a fistula that did not heal during the follow-up period. The EF healing time of the rinsing group was significantly shorter than that of the redressing group, and the difference was statistically significant ($P < 0.05$). This shows that TRR-NPD could obtain satisfactory curative effects in treating ACVS-EF.

Keywords: Cervical spine, esophageal fistula, treatment, negative pressure drainage, tube-reserving rinsing

Introduction

Esophageal fistula (EF) [1, 2] is a rare but severe complication of anterior cervical vertebral surgery (ACVS). The main cause of EF is intraoperative iatrogenic injury, although it may also be caused by the implant loosening after surgery and damaging the esophagus. Delayed treatment of EF may lead to other serious complications [3], such as failure of internal fixation, hypoalbuminemia, lung infection, mediastinal infection, long-term non-healing and infection of incisions, bacteremia, cervical osteomyelitis, septic shock, and even death. Existing treatment methods against EF include anti-inflammatories, supportive treatment and wo und re-dressing. Surgical treatments include repairing the EF stoma, muscle flap tamponade, jejunum transplantation, and endoscopic adjuvant therapy, etc. [4-7]. Esophageal repair normally exhibits inefficiency in the treatment of cases with serious postoperative EF infection. Wound infection is one of the main factors affecting wound healing [8-10], and the simple application of antibiotics and normal pressure wound drainage normally exhibits poor infection control effects. Controlling infections and promoting fast EF healing is therefore a difficult problem. There is little evidence on the use of EF wound rinsing and tube-reserving rinsing combined with negative pressure drainage (TRR-NPD) for treating EF. The purpose of this study was to investigate the treatment effects of TRR-NPD in treating ACVS-EF.

From March 2001 to October 2013, a total of 18 EF patients were treated in our hospital. The causes, clinical manifestations, treatment methods, and possible prevention methods were then analyzed and discussed.

Materials and methods

Subjects

Eighteen patients with ACVS-EF, treated between March 2001 and October 2013, were retrospectively analyzed. The cohort included 12 males and 6 females, aged 23 to 59 years old, with an average age of 42.7 years old. EF was detected during the surgery in 1 patient, while in the other 17 patients EF was found after the surgery. Eight EF patients were transferred to our hospital from other hospitals, and 10 patients developed EF in our hospital. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Xinjiang Medical University. Written informed consent was obtained from all participants.

Major clinical manifestations

Among the 18 patients, 1 patient was found to have esophageal lesions intraoperatively, and the other 17 patients exhibited symptoms such as swelling, bulging, throat pain, fever, and swallowing difficulty, postoperatively. Two patients exhibited high fever, with body temperatures as high as 39.2°C, and food residues and liquids leaking from the wound after eating. Two patients had barium spill out from the orificium fistulae after the barium swallow esophageal radiography was performed, in 2 patients there was outflow of meilan from the wounds after oral administration, and in the other 12 patients, food residues were observed at the site of the wounds. Five of the 18 patients exhibited loosening and shifting of internal fixation, thus, they were debrided for a second time and internal fixation was re-performed.

Diagnostic criteria

The diagnostic criteria were as follows: (1) esophageal injury found intraoperatively; (2) clinical manifestations such as fever, pain in the neck, difficulty in swallowing, wound dehiscence, and food residue leakage; (3) seeping of meilan from the wound when orally administrated; and (4) esophageal barium swallow X-ray imaging indicating the leakage of barium from the esophagus.

Inclusion criteria

Patients who had undergone ACVS and met the EF diagnostic criteria were included in the study.

Exclusion standard

Exclusion criteria were as follows: (1) non-ACVS patients; (2) the cervical vertebral CT, plain radiographs and MRI showed that the implant had loosened and emerged, without obvious symptoms of EF; (3) with fever, pain in the neck or swallowing difficulty only, without other clinical symptoms or positive radiographic findings; (4) with cervical cancer, malformation, or severe infection; (5) a history of esophageal surgery; and (6) esophageal dysplasia.

Treatment

For the patients with EF secondary to surgical conditions, the repair surgery should be performed as soon as possible. Once EF is diagnosed, the patient should be fasted and water-restricted as soon as possible, administering nasogastric nutrition and anti-infection agents, as well as enteral and parenteral nutrition to create the conditions necessary for EF repair. Among the 18 ACVS-EF patients in this study, 1 patient was found to have EF intraoperatively, and the thoracic surgeons were asked to help to deal with the fistula. EF repairing surgery was performed, using thin sutures to intermittently suture the whole layers of the fistula. After the suture, gelatin sponge and hemostatic gauze were used to separate the EF stoma from the anterior cervical titanium plate; the gastric tube was placed intraoperatively, ensuring smooth penetration of the EF stoma, and an indwelling drainage tube was placed at the wound [7]. Once the patient was found or suspected to have EF postoperatively, fasting and water restriction were carried out immediately, as well as the placing of a gastric tube, nasal feeding, and intravenous fluid infusion and anti-infection agents. Meanwhile, the EF site was examined, and fistula stoma repair or muscle flap tamponade performed accordingly. An indwelling drainage tube was placed postoperatively. The drainage fluid was sent for bacterial culture and drug susceptibility testing at the same time.

Table 1. EF duration of the two groups (n)

	1-2 weeks	3-4 weeks	5-8 weeks	9-20 weeks
A group	1	2	1	3
B group	5	3	1	1

Note: The average EF duration of the A group was 11.2875 weeks, while that of the group B was 4.2 weeks; most EF of the A group stopped at 5 to 20 weeks, while most EF of the B group stopped at 1 to 4 weeks.

Table 2. Comparison of EF off time between the two groups ($\bar{x} \pm s$)

Group	N	EF off time (w)
A	7	11.347 ± 6.878
B	10	4.214 ± 4.934
t	-	2.499
P	-	0.025

Note: The EF off time of the B group was significantly shorter than the A group, and the difference was statistically significant ($P < 0.05$).

One patient with a fistula still present after 20 weeks underwent redressing, NPD rinsing, and anti-infection and nutrition support treatment. The remaining 17 patients were divided into 2 groups: 3 cases who underwent intraoperative debridement, fistula suture and drainage tube placing, plus 4 cases who underwent debridement with partial fistula suture and wounds left open for nitrofural gauze tamponade (the redressing group, or A group); and the remaining 10 cases who underwent single-stage debridement, fistula stoma suture, rinsing tube and NPD placement (the rinsing group, or B group). The drained liquids of all 17 patients were sent for bacterial culture every 2 days. If patients with only drainage tube placement (group A) exhibited a drained liquid amount of less than 10 ml/day, and no bacterial growth for 3 consecutive drainage fluid samples, the drainage tube was withdrawn. For the rinsed and drained patients (group B), if no bacterial growth was found for 3 consecutive drainage fluid samples, the rinsing tube was withdrawn first, and the drainage tube was withdrawn 2 to 3 days later. As the patients with open wounds exhibited bigger fistula stomas, the filling gauze was gradually withdrawn, together with redressing, and the wound inside was flushed once a day with physiological saline and 0.1% mucosal iodine, which was gradually reduced to three times a week, until the wound healed. The wound sites were closely observed. If necessary, esophageal barium swallow X-ray imaging examination was performed, and the EF duration recorded.

Efficacy evaluation

The appearance that the wound had healed, without local swelling, leakage, difficulty in swallowing or fever, with good general conditions, and no leakage of contrast agent in the barium swallow X-ray imaging, was considered as indicating the complete healing of the esophageal fistula.

Statistical methods

The patient numbers of the two groups were 7 and 10 in the A and B group, respectively. The EF durations of the two groups were comparatively analyzed, and the data were expressed as mean ± standard deviation ($\bar{x} \pm s$). The small sample independent sample t-test was performed, and *P* value < 0.05 was considered statistically significant. The SPSS 10.0 statistical package was used for the analysis.

Results

Efficacy situations

The wounds of the A group all healed, and the tubes were all pulled out with water and diet feeding recommencing without difficulty in swallowing. Among the 10 cases in the B group, 1 patient exhibited re-infection and dehiscence after the wound healed. The nasal feeding tube was pulled out, then the internal fixation device was taken out and switched to neck support, the flushing drainage tube was pulled out, and gauze was used to tamponade the wound. With redressing of the wound, the wound healed 18 weeks later. The tube was then pulled out, and normal diet and water intake recommenced. Among the 17 cases, the EF healing time of the B group was significantly shorter than that of the A group (**Table 1**), and the difference was statistically significant ($P < 0.05$) (**Table 2**). The 18 cases were all followed up, with a follow-up time of 2-36 months. A fistula was still present in 1 patient 20 weeks later because the fistula stoma did not heal, with repeated infections developing; this was treated with long-term redressing. This patient was followed up for 36 months, at which time the fistula was not fully healed. Of the 17 patients who did not show the recurrence of EF, 1 case had mild dysphagia, while the rest of the patients had good swallowing function.

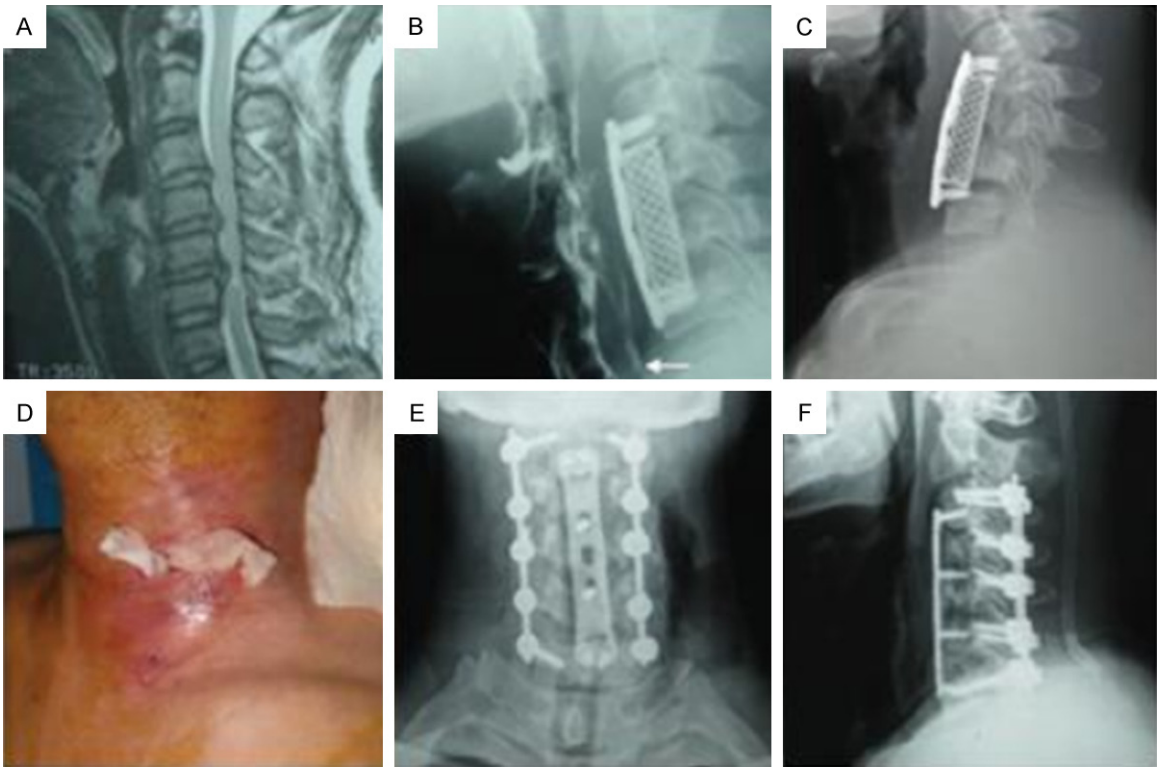

Figure 1. EF-infection-resulted cervical internal fixation loosening, which thus led to the cervical kyphosis, combined anteroposterior cervical orthopedic surgery. A. Cervical MRI: cervical 3/4, 4/5 and 5/6 disc herniation; B. Lateral cervical X-ray image: the barium meal leaked from EF wound; C. The EF would was infected, thus the internal fixation was loosened, and the cervical kyphosis was induced; D. Situations of wound infection; E and F. The patient was firstly performed anterior cervical fixation to remove and debride the infected parts, as well as posterior cervical kyphosis and anterior cervical autoallergic iliac bone graft plus Titanium plate internal fixation. The wound was then placed washing tube and suction drainage tube. The patient was then placed the nasogastric tube for the nasogastric feeding.

Discussion

EF healing time

The average duration of EF in the A group was 11.3 weeks, while that in the B group was 4.2 weeks; the EF healing time of most patients of the A group was 5 to 20 weeks, and that of the B group was 1 to 4 weeks. The EF healing time of the B group was obviously shortened compared to that of the A group, and the difference was statistically significant ($P < 0.05$).

The EF healing time was related to multiple factors [9], including the size of the EF stoma, patients' original nutritional status, patients' immune status, local infection, blood sugar control, and other complications, as well as the treatment situations, etc.; as the stoma sizes varied, and could not be standardized, the wound healing would be affected differently in each patient. Therefore, this comparative analysis indicates only that TRR-NPD of the wound is one of the feasible and effective methods for treating EF.

Case 1

A male patient, 38 years old, visited the hospital with a complaint of neck pain accompanied by right upper limb pain and weakness for 15 days duration. He was diagnosed with cervical 3/4, 4/5, and 5/6 intervertebral disc herniation, and underwent subtotal excision of anterior cervical vertebrae 4 and 5, plus titanium cage autologous bone graft fusion and internal fixation. Four days later, the patient developed neck pain and high fever, and was transferred to our hospital. The esophageal barium swallow X-ray imaging showed the contrast agent leaked out, so the patient underwent debridement, re-operation of the anterior cervical titanium cage bone graft fusion with internal fixation and esophageal suture, followed by debridement, partial suture, nitrofural gauze packing and nasal feeding. Four weeks after development of

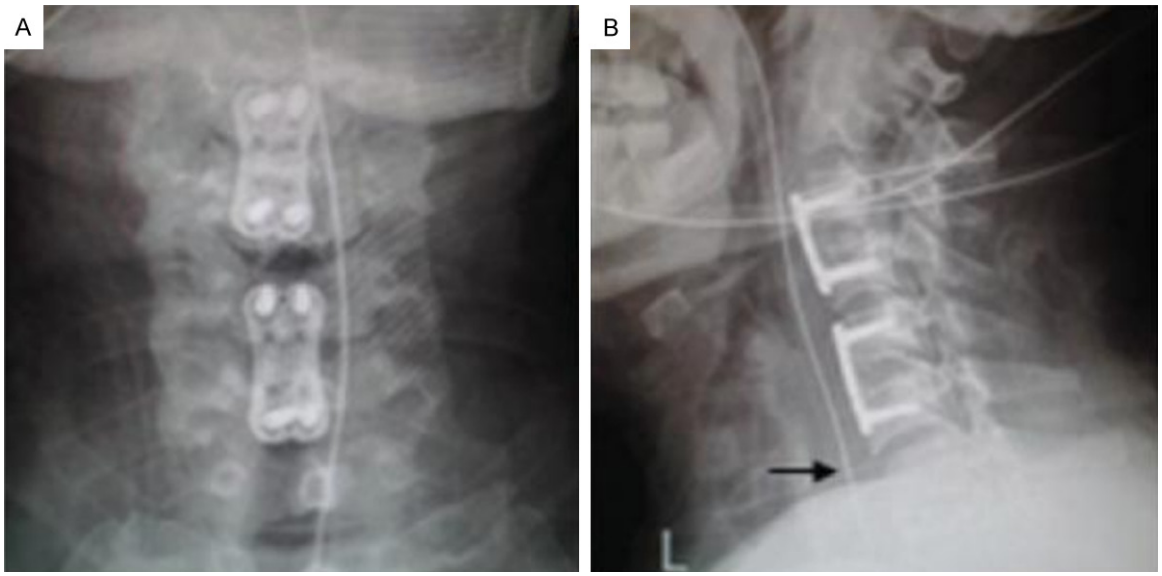

Figure 2. Intraoperative esophageal injury was found, thus the esophageal repairing was performed and placed the nasogastric tube. A and B. After anterior cervical L 3/4 and 5/6 intervertebral decompression plus bone graft fusion and internal fixation, the arrow pointed at the nasogastric tube.

EF, the wound was uncontrollably infected, which resulted in the loosening of the cervical internal fixation, and cervical kyphosis. The patient then simultaneously underwent cervical surgery to remove the anterior cervical internal fixation and remove the infected lesions, as well as cervical kyphosis correction and anterior cervical autologous iliac bone graft titanium plate internal fixation. The indwelling flushing tube and NPD tube were then sited in the wound, combined with supportive treatment involving nasal feeding, nutritional support, and rehydration, etc. Bacterial culture and drug-sensitivity tests were performed on the wound secretions, so that effective antibiotics could be selected. The patient still had a fistula 20 weeks later, at which time he was discharged from the hospital (**Figure 1**).

One of the common causes that led to EF in this case was the loosening and emergence of internal fixation. Long-term oppression caused by this would lead to ischemic necrosis of the esophageal wall, or directly mechanically damage the esophagus, thus forming EF. This case exhibited EF 4 days after surgery, and underwent suture repair of EF. The esophageal edema was severe, and the intraoperative suture was difficult. Therefore, after anterior cervical surgery, it should be routinely checked whether any esophageal injury exists, as the intraoperative finding of EF and its immediate repair are critical for a good outcome.

Case 2

A male patient, 39 years old, visited the hospital with traumatic neck pain for 4 days, accompanied with right upper limb pain and weakness. He was diagnosed with cervical 3/4 vertebral fracture, and cervical 4/5 intervertebral disc herniation, for which he underwent anterior cervical 3/4 and 4/5 vertebral decompression plus bone graft fusion and internal fixation. The intraoperative examination revealed minor esophageal injuries; thus, he immediately underwent repair. A gelatin sponge was packed between the esophagus and internal fixer, the nasal feeding tube was prepared intraoperatively, the NPD tube was sited within the surgical region, and the patient's incision was closely observed. During the rehabilitation, an oral diet was prohibited, with the patient receiving nasal feeding and antibiotics. The incision was redressed frequently with pressure dressings. Four days later, a minimal amount was drained; therefore the draining tube was removed while the redressing continued. The incision healed well 7 days after surgery, the patient's swallowing function was good, and the EF was considered cured. Compared to the first case, the discovery and treatment of EF were earlier, and the effects were relatively better. At the same time, it could be seen that for the prevention and treatment of EF, apart from careful operations, the most important thing was the early detection and timely treatment. Therefore,

Table 3. Specific conditions of patients

Case	Gender	Age	Diagnosis	Implant	Internal fixation	Symptoms	Time from surgery to diagnosis (days)	Time from diagnosis to healing (weeks)	Bacterial culture	Treatment
1	Male	44	Cervical disc herniation	Allograft bone	Failed	Neck pain, swelling, dyspnea	4	3	Staphyloccocus aureus	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
2	Male	47	Cervical tuberculosis	Autogenous bone	Succeeded	Fever, dysphagia	5	4	Staphylococcus epidermidis	One-stage debridement, EF suture, with nasal tube
3	Female	45	Cervical disc herniation	Titanium cage	Succeeded	White frothy sputum, neck swelling, dysphagia	3	1	Enterococcus faecalis	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
4	Female	48	Ossification of posterior longitudinal ligment	Allograft bone	Succeeded	Neck swelling dysphagia	4	8	Staphylococcus epidermidis	Partial suture, with open wound packed by nitrofural gauze and nasal tube
5	Male	55	Cervical disc herniation	Allograft bone	Succeeded	Neck swelling, dysphagia, expectoration	6	20	Acinetobacter baumannii	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
6	Male	54	Cervical disc herniation	Allograft bone	Succeeded	Pharyngeal discomfort, neck swelling	7	13	Staphyloccocus aureus	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
7	Female	53	Cervical tuberculosis	Autogenous bone	Succeeded	Fever, dysphagia	4	10	Pseudomonas aeruginosa	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
8	Male	39	Cervical3/4 fracture, cervical4/5 and 5/6 disc herniation	Allograft bone	Succeeded	Neck swelling, dysphagia	Found intraoperatively	7	negative	One-stage debridement, EF suture, with nasal tube
9	Male	27	Cervical fracture	Autogenous bone	Succeeded	Obvious wound pain, dysphagia	4	2	Acinetobacter baumannii	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
10	Female	35	Cervical tuberculosis	Autogenous bone	Succeeded	Fever, dysphagia	5	15	Staphyloccocus aureus	Partial suture, with open wound packed by nitrofural gauze and nasal tube
11 (not included)	Male	38	Cervical3/4, 4/5 and 5/6 disc herniation	Titanium cage	Failed	High fever, dysphagia, cervical swelling	3	4	Enterococcus faecalis	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
12	Female	52	Ossification of posterior longitudinal ligment	Allograft bone	Succeeded	Neck swelling, dysphagia	5	3	Klebsiella pneumoniae	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
13	Male	23	Cervical tuberculosis	Autogenous bone	Succeeded	White frothy sputum, wound pain	4	3	Staphylococcus epidermidis	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
14	Male	25	Cervical tuberculosis	Autogenous bone	Succeeded	Neck pain	6	19	Staphyloccocus aureus	One-stage debridement, EF suture, with nasal tube
15	Male	37	Cervical fracture	Allograft bone	Succeeded	Dysphagia	4	2	Klebsiella pneumoniae	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
16	Female	47	Cervical tuberculosis	Autogenous bone	Succeeded	Neck swelling, dysphagia	5	2	Streptococcus	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
17	Male	59	Ossification of posterior longitudinal ligment	Allograft bone	Succeeded	Fever, dysphagia	5	18	Staphyloccocus aureus	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube
18	Male	40	Cervical tuberculosis	Autogenous bone	Succeeded	Neck swelling, dysphagia	4	5	Acinetobacter baumannii	One-stage debridement, EF suture, with negative pressure drainage tube and nasal tube

after surgery, no matter whether there is a suspected EF, the surgeons should carefully examine whether the esophagus was damaged or not, as well as performing active treatments to avoid repeated postoperative incision infections (**Figure 2**).

Direct damage by the electrotome was the cause of EF in two cases; in 1 case it was caused by the postoperative loosening of the internal fixation device, which directly damaged the esophagus, and EF developed in 1 case during a repeat operation to fix loosening of the internal fixation. Most patients in this study displayed the 3 main prodromes of EF, namely fever, neck swelling, and swallowing difficulty [11]. A proportion of patients exhibited pharyngeal pain, incision dehiscence, food residue leakage from the incision, or liquid food inside the drainage tube postoperatively. They all underwent esophageal barium swallow or showed methylene blue leaking from the wound after being swallowed, indicating a diagnosis of EF. EF patients are at risk of secondary progressive subcutaneous emphysema, hypoalbuminemia, mediastinal infections, esophageal tracheal fistula, cervical osteomyelitis, pneumonia, pleurisy, and even such complications as sepsis and shock; therefore, EF should be aggressively and effectively treated as early as possible to avoid serious secondary diseases [12-14].

The treatment methods of CVS-EF should be based on the size of the EF and the stage at which it is found (**Table 3**). If the esophageal injury is found intraoperatively, the thoracic surgery doctors should perform the repair immediately; if found postoperatively, the patient should be fasted and water-restricted immediately, and switched to nasal feeding or intravenous nutrition. EF found intraoperatively can be treated with early fasting and water restriction, nasal nutrition, intravenous nutrition, antibiotics, appropriate dressing, etc., [15-17], with which it generally heals without a second repairing surgery. If the EF stoma does not heal for a long period of time, it should be considered whether the wound infection is more serious, accompanied by cervical osteomyelitis and/or loosening and emersion of the cervical internal fixation, thus causing the anterior cervical titanium plate to compress the fistula, stimulating inflammation and impairing healing. In this situation, a second operation is needed to remove the internal fixation and repair the damaged esophagus, dismantle the suture of the incision, expose the wounds, and re-dress the wounds appropriately; as well as intravenous antibiotics to prevent infection, or placement of a flushing tube and NPD tube. Once the internal fixation has been removed, patients may exhibit cervical instability, thus a neck collar may be required for fixation, as well as posterior internal fixation if necessary. Additionally, the adjacent muscle flaps could be filled into the gaps between the internal fixation and the esophageal wall to reduce friction and promote healing [18, 19]. The coverage effects of sternocleidomastoid flap or pectoralis major flap in this case series were satisfactory. According to the results of wound bacterial culture, a sensitive antibiotic treatment should be selected for the infection [20]. After the wound heals, and barium swallow exhibits no leakage, the patient should also be observed for at least 3 to 5 days, until the esophageal wall and the wound are thoroughly healed, at which point the nasal tube can be withdrawn, and oral feeding can be performed.

The rinsing time and speed of the wounds can be decided according to the wound infection situation and secretions. Patients with serious wound infections and copious amounts of secretions required continuous wound rinsing to control the infections, while patients with mildly infected wounds and fewer secretions could be rinsed with smaller amounts of fluids several times a day, gradually reducing to once a day. After the infection was controlled, the rinsing tube could be withdrawn firstly, while the NPD tube could be left in-situ. When using saline to flush the wound, the saline usually infiltrated the patients' esophageal tract and caused discomfort. One slightly thick drainage tube under negative pressure could be used to increase the flow rate. If the drainage fluid gradually turned clearer, and such symptoms as fever were improved, the treatment could be considered effective. Otherwise, the wound needed to be explored to find out the reason for the failure of treatment.

Conclusions

The keys to EF treatment are the intraoperative prevention, early discovery, and timely treatment. Careful intraoperative operations, as well as the detection of esophageal damage after the surgery, were very important factors for a

good outcome. This study comparatively analyzed different treatment methods and found that compared with debridement-suture, redressing or simple indwelling drainage tube placement, the performance of debridement-suture and TRR-NPD could significantly shorten the healing time of EF. The comparison of treatment time between the 2 groups indicated that after EF, TRR-NPD of the wound is one of the feasible and effective methods for treating EF.

Disclosure of conflict of interest

None.

Address correspondence to: Weibin Sheng, Department of Spinal Surgery, The First Affiliated Hospital of Xinjiang Medical University, No. 137 South Liyushan Road, Urumqi 830054, China. Tel: +86 991 4362829; Fax: +86 991 4365444; E-mail: weibinshengcn@126.com

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