Successful repair of delayed esophageal perforation with sternocleidomastoid muscle flap after anterior cervical spinal surgery

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Abstract: No consensus has been available to optimize the treatment of delayed esophageal perforation. The present study was to investigate the surgical treatment for delayed esophageal perforation with sternocleidomastoid muscle (SCM) flap after anterior cervical spine surgeries. The diagnosis and treatment of 5 esophageal perforations (May 2004 to January 2013) that occurred in a delayed fashion were retrospectively reviewed. The five patients received uniform repair surgery strategy. Cervical spine was accessed through the fistula tract. The esophageal lesion was recognized by the preoperatively swallowed methylene blue. A nasogastric tube was positioned through the rupture to help locate and assess the size and shape of the lesion. The esophageal lesion was primarily closed with interrupted sutures. The ipsilateral SCM was exposed, dissected at the distal end, elevated, medially rotated, and then interposed between the cervical vertebrae and the esophagus. The caudal free end of SCM flap was sutured to contralateral longuscolli muscle. Post-operatively, supportive treatments including adequate drainage, appropriate antibiotics and cessation swallowing were provided for at least 2 weeks to facilitate healing of esophageal perforation. All esophageal perforation healed without further complications. In conclusion, surgical repair strategy including esophageal suture and a local SCM flap is capable of achieving satisfactory clinical outcome, especially in those with a large or chronic perforation.

Keywords: Esophageal perforation, anterior cervical surgery, revision spine surgery, sternocleidomastoid muscle flap, complications

Introduction

Anterior cervical spine surgery is one of the most commonly performed techniques for degenerative disc disease or trauma around the world. However, esophageal perforation is a rare yet challenging complication associated with anterior cervical spine surgery [1]. It has been reported that the incidence of esophageal perforation is around 0.02-1.14%, and its mortality was in 6~34% of cases and varies according to the patient’s general status, perforating site, underlying comorbidities and the time duration from perforation to proper management.

Esophageal perforation can be result of spine trauma or, in iatrogenic cases, induced by retractor, operations or by foreign bodies including surgical implants and bone graft [2-4]. Patients may present with only subtle physical findings and nonspecific complaints in the early stage, and diagnosis of esophagus perforation is therefore difficult to establish and lead to, as exemplified by many cases, delayed treatment. This could result in cervical abscess, mediastinitis, or life-threatening events like septic shock and death [5-8]. It has been reported that the mortality rate is around 50% in delayed esophageal perforation (after 24 h) in contrast to 20% in early diagnosed and treated cases (within 24 h) [9-11].

Early diagnosis and treatment has been the common belief to ensure good outcome for esophageal perforation [12]. However, due to
Table 1. General information of patients

<table>
<thead>
<tr>
<th>No</th>
<th>Gender</th>
<th>Age (year)</th>
<th>Primary pathology</th>
<th>Primary surgery</th>
<th>Fixation failure</th>
<th>Clinical presentation</th>
<th>Time to 1st repair surgery</th>
<th>Strategy for esophageal repair</th>
<th>Repair surgery times</th>
<th>Time to recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female</td>
<td>20</td>
<td>Trauma</td>
<td>C5 corpectomy C4-C6 ACDF</td>
<td>No</td>
<td>neck swelling with palpable mass, difficult breathing, wound dehiscence and alimentary fluid leakage</td>
<td>14 months</td>
<td>Removal of implant; esophageal repair; SCM flap</td>
<td>1</td>
<td>3 weeks</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>28</td>
<td>Trauma</td>
<td>C5/C6 ACDF</td>
<td>No</td>
<td>fever, neck pain, local abscess, wound dehiscence with mucopurulent discharge and alimentary fluid.</td>
<td>3 months</td>
<td>Removal of implant; esophageal repair; SCM flap</td>
<td>2</td>
<td>8 months</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>61</td>
<td>Myelopathy</td>
<td>C5, C6 corpectomy; C4-C7 fixation with titanium mesh</td>
<td>No</td>
<td>fever, wound dehiscence, dysphagia, alimentary fluid leakage, purulent secretion; neck swelling</td>
<td>6 days</td>
<td>Removal of implant; esophageal repair; SCM flap</td>
<td>2</td>
<td>9 months</td>
</tr>
<tr>
<td>4</td>
<td>Female</td>
<td>57</td>
<td>Myelopathy</td>
<td>C5 corpectomy; C4-C6 fixation with titanium mesh</td>
<td>No</td>
<td>fever, neck pain, wound dehiscence, difficulty breathing, mucopurulent discharge</td>
<td>1 month</td>
<td>Removal of implant; esophageal repair; SCM flap</td>
<td>1</td>
<td>2 months</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>41</td>
<td>Trauma</td>
<td>C3/C4 ACDF</td>
<td>No</td>
<td>fever, wound dehiscence, alimentary fluid leakage; dysphagia, neck swelling</td>
<td>3 months</td>
<td>Removal of implant; esophageal repair; SCM flap</td>
<td>1</td>
<td>3 months</td>
</tr>
</tbody>
</table>
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the variable and nonspecific clinical presentations, early identification of esophageal perforation is difficult, which usually lead to delayed diagnosis and treatment. For those with delayed esophageal perforation, no consensus has been available to optimize their treatment. In the present study, we described the diagnosis and management of 5 patients with large chronic esophageal perforation that occurred in a delayed fashion after cervical spine surgery, aiming to provide information for improving clinical outcome of delayed esophageal perforation.

Methods and results

From May 5th 2004 to January 16th 2013, five patients (2 male and 3 females) who had received anterior cervical spine surgery by our team (2 of 5 cases) or other centers (3 of 5 cases) were treated in our department for delayed esophagus perforations. We retrospectively reviewed the medical records and imaging of the 5 patients. Clinical characteristics and conditions of all 5 patients were assessed and summarized in Table 1.

The surgical revision focused mainly on esophagus repair techniques, which was illustrated in

Figure 1. In brief, the procedure of repair begins with an incision along the anterior border of the SCM muscle on the side of the lesion. The supraomohyoid muscle and the middle thyroid vein were dissected. Thyroid gland and the carotid sheath were retracted to both sides for better exposure of the perforation lesion. Methylene blue was injected via nasogastric tube to identify the location and morphology of the perforation (Figure 1A). Plate, mesh, cage, screws or any implants could be removed depending on the specific case. After debridement of granulation tissue and repeated rinsing with metronidazole solution, the perforation was sutured with absorbable interrupted stitches (Figure 1B). Since complete closure of the perforation might be compromised in delayed cases where edema or chronic inflammation was present on the esophagus wall, a SCM flap was used to promote the healing of esophageal lesion.

The entire lateral and medial surface of the SCM muscle was exposed. The SCM muscle was incised at the distal sternal end while preserving the accessory nerve, forming a free end to the caudal direction and a pedicle to the cephalic direction. The SCM muscle flap was...

Figure 1. Repair procedures for esophageal perforation. A. Cervical spine was accessed through the fistula tract. The esophageal lesion was recognized by the preoperatively swallowed Methylene blue and then further explored. A nasogastric tube could be positioned through the rupture to help locating and assessing the size and shape of the lesion. B. After debridement of granulation tissue and repeated rinsing of the wound, the esophageal lesion was primarily closed with interrupted sutures. C. The ipsilateral sternocleidomastoid muscle was exposed, dissected and incised according to the location and size of the lesion. The pedicled SCM flap was then elevated and tract toward the esophageal defect. D. The elevated SCM flap was interposed between the cervical vertebrae and the esophagus, and then sutured with contralateral longuscolli muscle. Suture of the esophageal wall was therefore reinforced.
Figure 2. Surgical repair of a female patient with delayed esophageal perforation. The anteroposterior (A, B) and lateral (C, D) views of the cervical spine before (A, C) and after repair surgery (B, D) were shown. The patients showed a complete paraplegia at C5 and wound dehiscence with viscous secretion on admission (E) and the wound healed at the latest follow-up (F). The cervical spine was approached through the original incision and the implants were removed (G). A nasogastric tube was positioned through the perforation site to locate and assess the size and shape of the lesion (H). The esophageal perforation was then sutured (I) and a SCM flap was sutured with contralateral longuscolli muscle to protect the esophageal from the vertebrae (J).
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Figure 3. The anteroposterior (A, B) and lateral (C, D) views of the cervical spine before (A, C) and after repair surgery (B, D) were shown. The patients showed a wound dehiscence on admission (E) and the wound healed at the latest follow-up (F).

Figure 4. The anteroposterior (A) and lateral (B) views of the cervical spine before the repair surgery were shown. No wound dehiscence was observed for this patient (C). This patient received a series of surgical procedures including removal of implants (D, E), suture of perforation site and a local SCM flap transfer. The wound healed at 9 months after repair (F).

Elevated until a sufficient length of SCM flap (8 cm to 10 cm) was available. The SCM flap was then medially rotated, crossed over the vertebrae, interposed between vertebrae and the posterior wall of esophagus, and then sutured to contralateral longuscolli muscle (Figure 1D). The SCM flap forms a soft tissue barrier between the esophageal lesion and cervical vertebrae as to reinforce the primary repair, protect the esophageal wall and provide with abundant blood supply for the healing of perforation.

Direct suture of the SCM flap to the margins of the perforation as a patch was not used in our cases since the anticipated scar tissue might contract the esophageal wall and contribute to discomfort. Fistula tract and accompanying scar tissue were also resected when exist since their presence could interfere with normal closure and adherence of local tissue. Surgical operations should be performed with caution when the fistula tract was anatomically close to vascular structures. The incision is then closed with a drainage retained for 72 hours.

Postoperative management strategies were planned accordingly to the condition in each case. All patients were asked not to intake food orally unless the esophagographic result at 14 days postoperatively was negative. Follow-up
was carried out to ensure solid food intake (generally 2 to 3 weeks after surgical repair) and spinal stability in all cases.

Case 1

A 20-year-old female with C5 burst fracture underwent C5 corpectomy and C4-C6 anterior fixation at another hospital (Figure 2A-D). Six days after the surgery, the patient presented with neck swelling with a palpable mass, difficult breathing, wound dehiscence and alimentary fluid leakage (Figure 2E). The symptoms were not effectively controlled for over 14 months after the index surgery, and she was then transferred to our hospital with long-term artificial ventilation over tracheostoma. On admission, the patient showed complete paraplegia below C5 and wound dehiscence with viscous secretion. Diagnosis of esophageal perforation was confirmed by dye leakage through the cervical wound after swallowing methylene blue. The revision surgery was then planned on December 2nd, 2008. Repair surgery was performed as described above (Figure 2G-J). The patient resumed eating liquid food 3 weeks after the revision surgery. No sign of recurred perforation was noticed since then and all symptoms were relieved up to the latest follow-up (Figure 2F).

Case 2

A 28-year-old female underwent anterior cervical disectomy and fusion at C5/C6 ACDF in October 2011 (Figure 3A-D). One month later, the patient presented with fever, neck pain and local abscess. A 2cm wound dehiscence with mucopurulent discharge was seen (Figure 3E). Esophagoscopy demonstrated anesophageal perforation at the level of C6, which was confirmed by a barium swallow test. Nasogastric nutrition, local wound irrigation and drainage were then given for 3 months, but salivary liquid and food pieces could still be seen on the wound dressing. On May 28th, 2012, we performed the first repair surgery and found a 1cm longitudinal esophagus rupture with bulging mucosa at the site adjacent to the implanted plate. We then sutured the esophageal rupture and closed the wound with drainage. Daily dressing change, intravenous antibiotics, nasogastric nutrition were maintained. Ten months later, visible dehiscence could still be observed with liquid discharge on the wound dressing. A second repair surgery was performed in April 2013.

After exposure of the cervical esophagus, the esophageal perforation sutured 10 months ago was found unhealed and a 1.8 cm longitudinal esophagus rupture was detected. Infection was found in the tissue around the cage, so the interbody cage was removed since the C5/6 was confirmed to be stable. We firstly repaired the ruptured esophagus with absorbable interrupted stitches. Then the SCM muscle flap was sutured to the contralateral longuscolli muscle to promote healing of esophageal perforation. The patient was encouraged to take liquid food at the 2nd postoperative week and all symptoms were relieved up to the last follow-up (Figure 3F).

Case 3

A 61-year-old male patient had suffered quadriplegia after a motor vehicle accident on May 15th, 2004. X-ray and MRI showed severe spondylotic myelopathy and spinal canal stenosis from C4 to C7, ruptured C4/C5 intervertebral disc and protruded intervertebral disc (C5/6 and C6/7). Anterior corpectomy of C5 and C6, and fixation with an anterior plate from C4 to C7 were performed (Figure 4A, 4B).

The patient complained of neck swelling and short of breath by the second postoperative day, and his condition had worsened by the tenth day with fever (39.0°C), difficult and painful swallowing, alimentary fluid leakage and purulent secretion. No wound dehiscence was observed for this patient (Figure 4C). Suspecting esophageal injury, we exposed the esophagus through the original incision site on June 3rd. Purulent material in the parapharyngeal space was observed and a 8 cm esophageal perforation was seen in the posterolateral wall of esophagus at the level of C3 to C6. The perforation was repaired with simple interrupted sutures. The SCM flap was prepared and sutured to the contralateral longuscolli muscle by crossing underneath the esophagus (Figure 4E). Drainage, intravenous antibiotics, nasogastric nutrition were maintained. Three weeks later, the patient was encouraged to orally take liquid food. However, symptoms including fever, neck swelling, wound dehiscence and mucopurulent discharge recurred up to nine months. We performed another surgery on March 8th, 2005. It was observed that the esophageal perforation had healed, and no significant mucopurulent discharge or inflammation was seen around esophagus. Infection in the bone graft and tita-
nium mesh was found by further exploration. We then removed the bone graft together with the titanium mesh and no further fixation was performed since the segments were confirmed to be stable (Figure 4D). The patient resumed eating liquid food 3 weeks later. Up to latest follow-up, all symptoms were relieved without complications (Figure 4F). The neurological condition continued to improve without any sign of cervical spine instability.

Case 4

A 57-year-old female underwent C5 corpectomy and C4-C6 fixation with titanium mesh for spondylotic myelopathy. Two weeks postoperatively, she developed fever, neck pain, difficult breathing, wound dehiscence and mucopurulent discharge. Surgical intervention was performed by 1 month after the index surgery since all symptoms were not relieved with treatments including nasogastric feeding, intravenous antibiotic, drainage, local irrigation and dressing change. By a lateral cervical approach, we found a 3 cm esophageal perforation and closed it with interrupted suture. The SCM flap was prepared and sutured to the contralateral longuscolli muscle as described above. Drainage was placed and the incision was closed. All nonsurgical managements were continued. The patient started oral intake of liquid food 2 weeks later, and all symptoms were relieved at 3 months after the revision surgery.

Case 5

A 41-year-old male underwent C3/C4 ACDF on July 18th, 2009. Two weeks after surgery, the patient presented with fever, wound dehiscence, alimentary fluid leakage, dysphagia and neck swelling. He was given nasogastric nutrition, intravenous antibiotics, local wound irrigation and drainage for three months, but salivary liquid and food pieces could still be seen on the wound dressing. On October 28th, 2009, we performed a repair surgery and found a 2 cm longitudinal esophageal perforation at the level of C3/C4. The ruptured esophagus was repaired with absorbable interrupted stitches. The SCM muscle flap was subsequently sutured to the contralateral longuscolli muscle to promote healing of esophageal perforation. After surgery, he was given nasogastric nutrition, intravenous antibiotics, local drainage, and wound dressing change. The patient was encouraged to take liquid food at the 14th postoperative day. The wound healed well and the patient returned to normal diet at 3 months postoperatively with all symptoms relieved.

Discussion

Current management strategy for esophageal perforations remains conventional and nonsurgical, such as nasogastric drainage, antibiotics, intravenous alimentation and other treatments. In cases with large perforation, poor systemic condition or delayed management, the consensus for ideal treatment have not yet been reached [13, 14]. Nevertheless, a multidisciplinary approach that includes surgical intervention and supporting managements is warranted to ensure the successful repair of esophageal perforation [15, 16].

A favorable environment of soft tissue is required for wound healing and tissue regeneration. The musculature of the cervical spine offers the possibility for surgeons to repair the perforated esophagus with a muscle flap, and such reinforcement has therefore been attempted in surgical treatment of esophageal perforation. To our knowledge, the use of a SCM flap for treatment of esophageal perforation following a repairing suture has been described and established, and promising outcomes have been seen in several publications with limited number of cases [17-21]. Therefore, more studies are encouraged to report the results of SCM flap in the repair of esophageal perforation. In the present study, the SCM flap was sutured only on the caudal end to the contralateral longuscolli muscle, but not directly on the esophageal defect margin nor the platysmamuscle. Satisfying results were obtained in all 5 cases, providing more evidence for the reliability of SCM flap repair.

Alternative techniques of soft tissue coverage to close a esophageal perforation include free jejunal graft [22], longuscollimuscle flap [23] and pectoralis major flap [24]. We prefer SCM flap since it is close to the perforation site and does not cost another surgical incision to harvest. Occasionally, owing to either the delayed recognition or severe inflammation, the closure of perforation may fail even with SCM flap repairing. In such a situation, a pectoralis major flap may be more appropriate because of its large size [25]. Meanwhile, adequate drainage, cessation swallowing and antibiotic therapy should also be relied on. Direct repair was indi-
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cated only when patient’s systemic condition was stable.

Conclusions

The management of esophageal perforation following anterior cervical spine fusion has been considered as a significant surgical challenge. Although conservative management remains irreplaceable, we suggest in the present study that surgical repair strategy including removal of implants, esophageal suture, and a local SCM flap is capable of achieving satisfactory clinical outcome, especially in those with a large chronic perforation site.

Disclosure of conflict of interest

None.

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