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A New "Ice Globe" Method for Dilating Leaking Cervical Esophageal Strictures

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An esophageal stricture may develop during healing of a large esophageal perforation. When such a stricture occurs, mechanical dilatation is the treatment of choice. As in our case, if a cervical esophageal stricture and leakage are present together, the treatment becomes even more challenging. As a new treatment method, we made spherical ice globes of various sizes using molds created with a 3D printer to treat the esophageal stricture and prevent its progression. This method can be used to safely treat leaking cervical esophageal strictures. A step-by-step of how to do it has been described.

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Anterior cervical spine (ACS) surgery is safe and has a low morbidity rate. Common indications include cervical degenerative disc disease, neoplasms, and trauma. One very rare complication of ACS surgery is esophageal perforation (EP).[1-3] The estimated prevalence of esophageal injuries during ACS surgery is 0% to 1.62%.[4] However, when EP occurs, prompt recognition and management are critical because EP is potentially life threatening. However, consensus on the management of EP is lacking, and delays in initiating treatment raise the mortality rate to 50%.[4,5] There are 2 main causes of EP in ACS surgery. The first is excessive retraction of the esophagus using surgical blades to reach the surgical area, and malpositioning of the blades, which can cause intraoperative cervical esophageal damage. The second is trauma caused by the use of plate and screw fixation during ACS surgery. In cervical trauma patients, the use of plate and screw fixation with or without bone implants promotes early spinal stability and mobilization, improves the bone union rate, and reduces hospital stay duration. This has decreased the need for rigid external immobilization and reduced the indications for posterior procedures.[1,4] Despite the success of this method, EP is one of its important complications. If removal of the cervical plate owing to a lack of cervical stabilization is impossible, the management of EP may be complicated, as in our case.

A new method based on ice spheres created using 3-dimensional (3D)-printed ice molds was applied to treat both leakage and stricture after a complicated cervical EP. During perioperative planning, 3D printing technology is used to produce patient-specific surgical guides, tools, and equipment. We hope to contribute to the healing process by devising practical molds that can produce "ice globes" suitable for cervical EP patients with stricture and leakage.

A 20-year-old man was operated on for a traumatic C5 burst fracture through an anterior cervical approach using C5 corpectomy, cage implantation, and C4 to C6 plate-screw fixation (Artrofiks Medikal, Ankara, Turkey). On postoperative day 18, the patient presented with purulent drainage at the surgical incision and difficulty swallowing. There was a large cervical EP on oral contrast-enhanced cervical and thorax computed tomography (CT) (Figure 1). Endoscopy revealed a large perforation in the posterior wall of the esophagus, and the plate screws fixed to the cervical vertebrae were seen in this EP. The neurosurgery team ruled out removal of the cervical plate because the cervical vertebra had not healed. We performed surgery and detected the 2-cm-long perforation. Although there was a low expectation of recovery in the presence of the plate that caused the perforation, the perforation site was debrided, repaired, and supported using a sternocleidomastoid muscle flap. The patient was fed enterally while the cervical vertebra healed. Follow-up cervical CT and endoscopy showed that the perforation was still present. In a third cervical approach, the cervical plate was removed and the esophagus was

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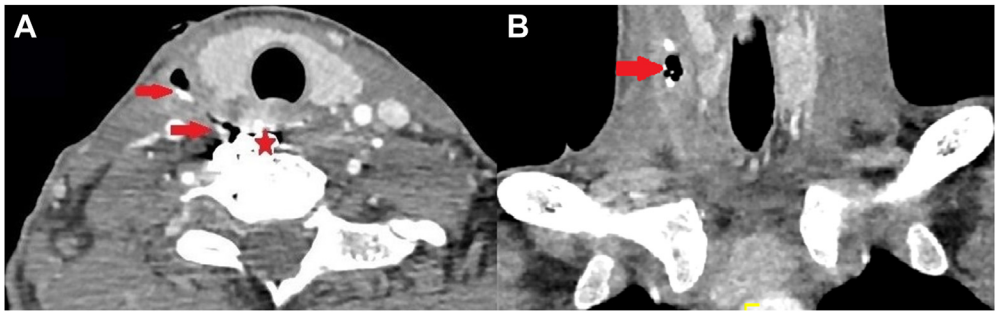


FIGURE 1 (A) Axial and (B) coronal images of cervical computed tomography scan showing extralumination of opaque material (arrows) and screw-plate fixation (star).

repaired for a second time, and supported with an ipsilateral pectoral muscle flap. Minimal leakage from the EP site and esophageal stricture was detected at the 1-month follow-up. Mechanical dilatation was not planned considering the condition of the patient's cervical esophagus.

TECHNIQUE

To treat the esophageal stricture and prevent its progression, spherical ice molds of various sizes were designed to be compatible with the esophageal stricture using 3D parametric modeling software (FreeCAD; https://www.freecadweb.org/) and produced by a 3D printer (Ultimaker 2+; Ultimaker, Utrecht, the Netherlands). Ice globes were prepared using these ice molds filled with isotonic solution (Figure 2). We recommended that the patient swallow 3 ice globes per day, beginning with the smallest and ending with the largest. The success of this procedure was checked by fluoroscopy (Figure 3). Three months after the last operation, the patient had no esophageal leakage and a smaller stricture, and began oral feeding.

COMMENT

EP has high rates of morbidity and mortality. Cervical EPs are less frequent and have better prognoses than those at other esophageal levels.[5,6] However, the etiology and time of diagnosis are the most important factors determining the success of treatment in cervical EP. As in our case, if the cause of the cervical EP cannot be eliminated, the treatment becomes even more challenging.

In our case, EP was diagnosed late. Owing to the incomplete healing of the cervical spine, it was impossible to remove the plate and screw that caused the perforation, and there was a large defect in the posterior wall of the cervical esophagus. This made treatment challenging. Finally, with a third anterior cervical

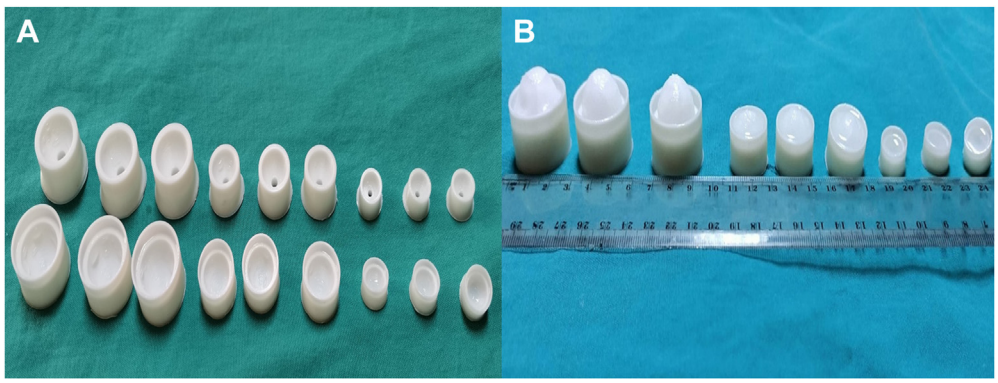


FIGURE 2 (A) Three-dimensional–printed spherical ice molds of various sizes and (B) ice globes with opaque liquid.

approach, the cervical plate was removed, and the EP was repaired again and supported with an ipsilateral pectoral muscle flap. One month after the last surgery, oral contrast-enhanced cervical CT showed minimal esophageal stricture and leakage.

An esophageal stricture may develop during healing of a large EP.[5] When such a stricture occurs, mechanical dilatation is the treatment of choice. However, mechanical dilatation was not planned in our patient because of the condition of his cervical esophagus. As a new treatment method, we made spherical ice globes of various sizes using molds created with a 3D printer, to treat the esophageal stricture and prevent its progression. The goal was to use the ice globes to dilate the stricture and prevent its progression, and lavage the site with isotonic solution. By adding an opaque liquid to the ice, it was possible to see whether the stricture could be passed. It was thought unlikely that ice that could not pass the stricture would cause esophageal obstruction, as it would melt. In addition, this procedure does not require sedation, unlike mechanical esophageal dilatation. Moreover, it does not further damage the EP site and is cost-effective. It can also be used to dilate other cervical esophageal strictures.

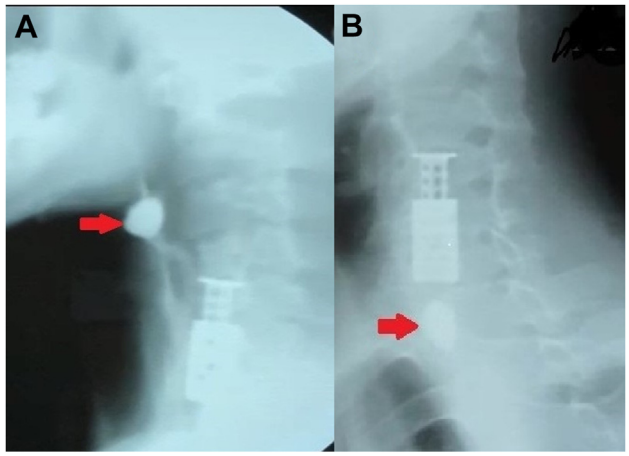


FIGURE 3 Lateral images of video fluoroscopic swallowing study. Ice globes with opaque liquid (arrows) passing from (A) pharynx to (B) cervical esophagus.

In conclusion, ice globes produced from spherical ice molds of various sizes made with a 3D printer can be used to safely treat leaking cervical esophageal strictures.

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