

CASE IMAGE

Intraoperative transesophageal three-dimensional ultrasound of the spinal cord

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Key Clinical Message

Three-dimensional transesophageal ultrasound of the spinal cord is a new and promising imaging modality that could easily be used clinically for real-time evaluation of the spinal cord anatomy or for intraoperative guidance.

KEYWORDS

intraoperative, spinal cord, three-dimensional, transesophageal

1 | INTRODUCTION

Transesophageal ultrasonography (TEUS) was first used in 1974,¹ and it has since then become a widely utilized method of cardiac imaging in a wide variety of clinical scenarios. However, non-cardiac applications of TEUS have been described including assessment of vascular structures and the spinal cord.² These noncardiac applications have been limited by image quality, but as three-dimensional ultrasound imaging improves in quality and availability, other roles for TEUS may arise.

2 | CASE PRESENTATION

A 48-year-old man with a history of bicuspid aortic valve, ascending aortic aneurysm, and coronary artery disease previously treated with simultaneous mechanical aortic valve replacement, ascending aorta replacement, and a coronary bypass grafting. Postoperative echocardiography demonstrated perivalvular leak and a left-to-right shunt from the left ventricular outflow tract to the basal right ventricle. The perivalvular leak was closed with percutaneous placement of an Amplatzer Duct Occluder and an Amplatzer Vascular Plug. TEUS was used to guide placement of the percutaneous devices and to assess for residual shunting after

implantation. During this procedure, the ultrasound probe is retracted to the level of the upper thoracic spine for unobstructed fluoroscopic imaging. While in this position, we perform an anatomic survey of the structures surrounding the esophagus. Based on prior reports of two-dimensional TEUS assessment of the spinal cord,^{3,4} we surmised that it would be possible to obtain a three-dimensional TEUS image of the spinal cord. We obtained an acoustic window through a high thoracic intervertebral disk and were able to visualize the spinal cord and its pulsatile motion with each cardiac cycle (Figure 1). This was seen in the three-dimensional video recording by correlating the movement of the cord to the cardiac rhythm strip. The epidural space, dorsal nerve roots, and ventral nerve roots could each be separately distinguished. We were also able to visualize other surrounding structures such as the anulus fibrosus and nucleus pulposus components of the intervertebral disk and components of the vertebrae including the spinous process, lamina, and costovertebral facet (Figure 1).

3 | DISCUSSION

Though limited two-dimensional TEUS of the spinal cord has been described,²⁻⁴ this is the first reported case of three-dimensional TEUS of the spinal cord in an adult.

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FIGURE 1 Three-dimensional transesophageal ultrasound of the spinal cord. The intervertebral disk is seen in the upper half of the image and the spinal cord is seen surrounded by the vertebrae in the lower half. The epidural space, dorsal nerve roots, ventral nerve roots, anulus fibrosus, nucleus pulposus, spinous process, lamina, and costovertebral facet can each be clearly seen.

TEUS of the spine may be employed clinically for real-time evaluation of the spinal cord for hematomas, other masses, or ischemia, which could be particularly relevant for traumatic patients with transportation contraindications and for intraoperative guidance during neurosurgical procedures. The technique of this evaluation is simple to replicate in the prone or supine position. A weakness of TEUS is that it requires sedation, but this weakness is obviated when TEUS is utilized intraoperatively when sedation is required regardless. Additionally, it relies on narrow acoustic windows which could be compromised by degenerative disk disease or implanted spinal column hardware.

The spinal cord can also be assessed with other modalities including MRI and CT. Both are appropriate in the correct clinical context as they offer higher image resolution and are non-invasive. However, neither of these modalities can be employed intraoperatively for monitoring and guidance, and both require the patient to be stable for transport to a scanner.

Our ability to image spinal anatomy during this cardiac procedure serves as a reminder to all providers who use TEUS of the potential non-cardiac value of this imaging modality.

AUTHOR CONTRIBUTIONS

Adam Kisling: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; visualization; writing – original draft; writing – review and editing. **Cristah Prost:** Writing – review

and editing. **Lisa Conte:** Writing – review and editing. **Edward Hulten:** Supervision.

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CONFLICT OF INTEREST STATEMENT

Nothing to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author Adam Kisling upon reasonable request.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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REFERENCES

1. Frazin L, Talano JV, Stephanides L, Loeb HS, Kopel L, Gunnar RM. Esophageal echocardiography. *Circulation*. 1976;54(1):102-108.
2. Godet G, Couture P, Ionanidis G, Gosgnach M, Kieffer E, Viars P. Another application of two-dimensional transesophageal echocardiography: spinal cord imaging. A preliminary report. *J Cardiothorac Vasc Anesth*. 1994;8(1):14-18.
3. Lohser J. Spinal cord imaging by transesophageal echocardiography. *J Cardiothorac Vasc Anesth*. 2009;23(3):442-443.
4. Nath MP, Gupta S, Kiran U, Chauhan S, Dhawan N. Spinal cord imaging by transesophageal echocardiography: a new modality of monitoring. *Acta Anaesthesiol Taiwan*. 2011;49(3):114-115.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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