Intraoperative Spinal Sonography in the Cervical Anterior Approach

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Abstract

Intraoperative spinal sonography was used during cervical anterior approach procedures for cervical discectomy and osteophytectomy to demonstrate spinal pulsation, the protruded disc or osteophyte, the anterior subarachnoid space, and the spinal cord. Spinal pulsation was recognized in some cases before removal of the disc but the anterior subarachnoid space and spinal cord could not be observed. However, the latter were more clearly observed during removal of the disc and could be seen after total removal of the disc and osteophyte. This method allows confirmation of decompression and pulsation of the spinal cord without cutting and removal of the posterior longitudinal ligament.

Key words: intraoperative spinal sonography, cervical disc disease, cervical spondylosis

Introduction

Recently, noninvasive diagnosis of cervical disc hernia or cervical spondylosis has been possible using magnetic resonance (MR) imaging, and decompression of the spinal cord or root sleeves from the herniated disc or osteophyte can be safely achieved under the operating microscope.

Anterior discectomy or osteophytectomy and fusion procedures do not visualize the spinal cord. Pulsation with a fine nerve hook is usually, but not always, sufficient to confirm decompression. For example, a herniated disc migrating behind the posterior longitudinal ligament (PLL) cannot be seen, and the hypertrophic PLL may compress the spinal cord. Cutting and removal of the PLL would visualize the spinal cord and allow confirmation of spinal cord decompression. The PLL can be cut and removed in an anterior discectomy without bone graft to prevent bending of PLL compressing the spinal cord. However, the PLL supports the spinal column, and is better preserved in cases of fusion with bone graft. Therefore, other methods are needed to confirm decompression.

Intraoperative spinal sonography (IOSS) is a

useful monitoring method for procedures using the posterior spinal approach. IOSS can confirm decompression of the spinal cord and pulsation in the spinal canal stenosis, and demonstrate the precise location and laterality of intradural spinal cord tumors.¹⁻⁵⁾ However, IOSS has been little used in the anterior approach. Yamaoka⁶⁾ reported spinal pulsation by IOSS after corpectomy, but corpectomy is invasive and not suitable for all cervical disc diseases and cervical spondylosis.

Our present study assessed the use of IOSS during cervical anterior approach procedures and to confirm decompression of the spinal cord, using a probe small enough to insert in the operative wound and manipulate over the disc space, allowing scanning of the spinal cord and pulsation without corpectomy.

Patients and Methods

This study included three patients with cervical disc disease and nine patients with cervical spondylosis. IOSS used an Aloka SSD 500 or SSD 620 (Aloka, Tokyo) and a 7.5 MHz convex type probe. This probe is 2.5 cm wide and 1.2 cm thick, and small enough to insert into the operative wound (Fig. 1).

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Fig. 1 Photograph of the 7.5 MHz convex probe with 2.5 cm width and 1.2 cm thickness.

The anterior surface of the cervical vertebral body and disc was exposed. The wound was then filled with physiological saline, the probe located on the disc level, and the spinal cord scanned through the disc. After removal of the disc, the probe was located over the disc space for scanning. IOSS detection of spinal pulsation, recognition of the protruded disc or osteophyte, anterior subarachnoid space, and spinal cord were evaluated. Scanning was done at least three times, before the removal of the disc, after partial removal of the disc, and after removal of the disc and the osteophyte under the operating microscope.

Results

IOSS could demonstrate pulsation of the spinal cord and the anterior subarachnoid space in only one of three patients with cervical disc disease before removal of the disc. The spinal cord was not clearly shown in this patient. Protruded disc was found in only one patient before removal of the disc. During removal of the disc, the images became clearer and after partial removal the protruded disc could be seen. After total removal the spinal cord and anterior subarachnoid space were visualized, and decompression of the spinal cord was confirmed without cutting and removal of the PLL (Table 1).

IOSS showed spinal pulsation in three of nine patients with cervical spondylosis before the removal of the disc but the osteophyte, spinal cord, and anterior subarachnoid space were not visible in any patient. During removal of the disc, the images became clear. After the removal of the disc and osteophyte, the spinal pulsation and anterior subarachnoid space were seen in all patients and the spinal cord in eight patients (Table 2).

Table 1 IOSS demonstration of cervical disc disease

	Spinal pulsation	Anterior subarachnoid space	Protruded disc	Spinal cord
Before removal of the disc	1/3	1/3	1/3	0/3
After partial removal	2/3	2/3	3/3	2/3
After total removal	3/3	3/3	—	3/3

Table 2 IOSS demonstration of cervical spondylosis

	Spinal pulsation	Anterior subarachnoid space	Osteophyte	Spinal cord
Before removal of the disc	3/9	0/9	0/9	0/9
After partial removal	7/9	6/9	7/9	3/9
After total removal	9/9	9/9	—	8/9

Each IOSS scan only took a few minutes, so the usual operating time was extended by only about 10 minutes. There were no complications caused by IOSS.

Case Reports

Case 1: A 40-year-old female complained of numbness and weakness of the bilateral upper extremities and right lower extremity persisting for 1 year. MR imaging showed a posterolateral disc protrusion on the left and compression of the spinal cord at the C5-6 intervertebral level (Fig. 2). Before removal of the disc, IOSS showed the left lateral disc slightly but not the spinal cord (Fig. 3 *left*). However, after partial removal the posterior disc protrusion and the spinal cord became clearer (Fig. 3 *center*). Although some deformity of the spinal cord remained after removing the disc under the operating microscope the spinal cord and anterior subarachnoid space were observed clearly (Fig. 3 *right*). Decompression of the spinal cord was confirmed and spinal pulsation and lateral decompression observed without requiring cutting and removal of the PLL.

Case 2: A 46-year-old female complained of sensory disturbance of the left upper extremity. Computed tomography (CT) showed a left lateral osteophyte at the C6-7 intervertebral level (Fig. 4 *left*) and MR imaging showed compression of the spinal cord at the same level (Fig. 4 *right*). Before removal of the disc IOSS could not show the osteophyte and spinal

Fig. 2 Case 1. *upper*: Preoperative sagittal MR image showing posterior disc protrusion and compression of the spinal cord at the C5-6 intervertebral level. *lower*: Axial MR image showing posterolateral disc protrusion on the left.

cord, while after partial removal the osteophyte was slightly visible but not the spinal cord (Fig. 5 *left*). After removal of the disc and the osteophyte under the operating microscope, the spinal cord and pulsation were observed (Fig. 5 *right*). Total removal of the disc and osteophyte and decompression were confirmed without cutting and removal of the PLL.

Discussion

IOSS requires a higher frequency but small size probe to provide a clear image and enter the operating field for spinal lesions. Generally, supersonic waves cannot penetrate to deeper lesions using higher frequencies, and images are coarse when using a small probe.⁷⁾ However, the cervical disc and cervical spinal cord are only a few centimeters in depth, so a probe of high frequency such as 7.5 and 10 MHz can be used in the cervical anterior approach. Our probe in this study was very small, but we could obtain clear images.

This study evaluated IOSS visualization of spinal pulsation, recognition of the protruded disc or the osteophyte, the anterior subarachnoid space, and spinal cord. Spinal pulsation was recognized as a motion on the monitor, so could be observed before discectomy in some patients. However, the anterior subarachnoid space and spinal cord could not be observed before removal of the disc. The protruded disc was found in only one patient before removal of the disc. Removal of the disc and opening of the disc space allowed deeper penetration of the supersonic

Fig. 3 Case 1. *left*: IOSS scan before removal of the disc showing the posterior margin of the disc (arrow) but not the spinal cord. *center*: IOSS scan after partial removal of the disc showing the protruded disc more clearly (arrow), the anterior subarachnoid space (arrowhead), and the spinal cord (double arrow). *right*: IOSS scan showing the remaining deformity of the spinal cord (arrow) after removing the disc, and the opened anterior subarachnoid space (arrowhead).

Fig. 4 Case 2. *left*: Preoperative CT scan showing left lateral osteophyte formation at the C6-7 intervertebral level. *right*: Preoperative MR image showing left lateral disc and osteophyte with cord compression.

Fig. 5 Case 2. *left*: IOSS scan after removal of the disc showing the osteophyte (arrow) but not the spinal cord. *right*: IOSS scan after total removal of the disc and the osteophyte showing the spinal cord (arrow).

waves and the image of the spinal cord became clearer. The anterior subarachnoid space became clearer than the spinal cord behind. The osteophyte present in cervical spondylosis made opening the disc space difficult and blocked the supersonic waves, so the image of the spinal cord was less clear than in cervical disc disease. However, after removal of the disc and the osteophyte the spinal cord could be seen

clearly and decompression confirmed.

Vertebral bodies and osteophytes blocked the supersonic waves passing through the disc space, so the probe had to be placed parallel to the disc space. However, the probe was small enough to enter the operating wound without a longer incision.

IOSS is quite useful for confirmation of decompression of the spinal cord from the disc or the osteophyte. Cutting and removal of the PLL are not necessary to confirm decompression except in discectomy without bone graft. The present small series has encouraged us to use IOSS in all cases of cervical anterior approach.

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