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"Picture-in-picture" endoscopic images in the microscope

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The authors describe a new piece of equipment that enables simultaneous monitoring of the endoscopic image and unilateral microscopic image; that is, "picture-in-picture" images for endoscope-assisted microsurgery. The system is simple and purely optical, consisting of light-weight semi-rigid fibers and a special adapter incorporated in the microscope. Throughout the initial neurosurgical procedures in which it was tested, the system proved particularly useful for inspecting the facial nerve behind the acoustic neurinoma and for observing the contact between arteries and the facial nerve during decompressive procedures for hemifacial spasm.

Key Words * endoscope-assisted microneurosurgery * semi-rigid endoscope * "picture-in-picture" endoscopic image

The efficacy of endoscopy as an adjunct to microneurosurgery has already been established.[2] For instance, by using the endoscope it is possible to view perforating vessels located outside of the direct line of vision obtained using the microscope during clip placement in aneurysm surgery, and to observe the contact between arteries and the facial nerve before a critical cerebellar retraction when performing Jannetta's microvascular decompressive surgery for hemifacial spasm.

Although the safe and optimum placement of the endoscope into the narrow operative space requires direct visual guidance under the microscope, until now we could not obtain images from the endoscope and from the microscope simultaneously. To solve this problem, we developed a new system that enables us to place a "picture-in-picture" endoscopic image in the microscope.

DESCRIPTION AND USE OF THE SYSTEM

The endoscopic display, which is transmitted via the image fibers, reflects on the mirror within the adapter and is projected as a part of a unilateral microscopic image. The size of the mirror is related to that of the path of the microscopic image. To balance the luminous intensity of each side of the binocular microscope, the adapter incorporated in the microscope is equipped with an identical mirror on the opposite side as well. Optical fibers are of a flexible type; 15,000 pixels transmit the endoscopic image,

and the surrounding fibers convey light of sufficient intensity from the 175-watt Xe light source (Figs. 1 and 2).

Fig. 1. Schematic drawing depicting the "picture-in-picture" endoscopic system. The endoscopic image reflects on the mirror in the adaptor and is projected as a part of the unilateral microscopic image, thus allowing the surgeon to perform endoscope-assisted microsurgery without moving his eyes away from the operative field.

Fig. 2. Photograph showing the setup of the system. The A and L indicate the adapter incorporated in the microscope (OPMI-CS; Carl Zeiss, Oberkochen, Germany) and a toolbox-sized light source, respectively.

The 2.5-mm tip of the endoscope, which is enveloped in a rigid stainless pipe of 2.11 mm in outer diameter, is bent 70° to obtain an angle of vision for practical use (Fig. 3). The focus is adjusted at 3 mm, with the width of the vision being 80° .

Fig. 3. Photograph displaying the tip of the endoscope. The 2.5-mm tip is bent 70° without enlarging the outer diameter more than 2.11 mm. The unit of measure indicates 1 mm.

After the endoscope is optimally placed, controlling the brightness of each light source provides a clear endoscopic image within that provided by the microscope (Fig. 4).

Fig. 4. Intraoperative photograph, revealing a left medium-sized acoustic neurinoma (lateral position), is made from a video printer. The endoscope was applied after debulking an adequate amount of the tumor. Upper Round Portion: "Picture-in-picture" endoscopic image demonstrates the trigeminal nerve (V) rostrally and the facial nerve (arrowheads) running between the brainstem (B) and the tumor (T). Lower Portion: Direct microscopic visualization enables the surgeon to ensure the optimum and safe placement of the tip of the endoscope in the narrow space made between lower cranial nerves that enter the jugular foramen and the caudal pole of the tumor, even when the light of the microscope has been turned off.

From April 1997 through October 1997, we used this system in 17 operations. Of these cases, there were seven patients with brain tumors, eight who underwent Jannetta's microvascular decompressive procedures, and two patients with aneurysms. Of the seven brain tumors, five were acoustic neurinomas, all of which were removed totally via suboccipital-transmeatal approach. In cases of medium-sized and large tumors, after some gutting the endoscope proved particularly useful in inspecting the course of the facial nerve behind the tumor, which is otherwise invisible from the surgeon's side (Fig. 4). In performing Jannetta's microvascular decompressive procedure, especially in that for hemifacial spasm, the system was also useful in observing the contact between arteries and the facial nerve prior to a critical retraction of the cerebellum. In aneurysm surgery, the endoscope was effective in viewing the perforating arteries located behind the sac in one case of unruptured aneurysm but not so in another because a thick subarachnoid clot prevented visualization.

DISCUSSION

At present, there are two uses for neuroendoscopy: endoscopic neurosurgery and endoscope-assisted microneurosurgery.[1] The former has been developed mainly to treat disease related to ventricles such as hydrocephalus, in which the surgeon performs the operation while manipulating special instruments through the working channel of the endoscopic lens under TV monitoring. In contrast, the latter supports conventional microsurgery because the endoscope reveals the blind portion during surgery. Compared

with a conventional or lighted micromirror,[3] endoscopy can expose much deeper and more concealed aspects. However, because safe and optimum placement of the endoscope requires direct visual guidance under the microscope, the surgeon has had either to ask an assistant to report on the endoscopic image displayed on the TV monitor or to replay the video up to that point after withdrawing the endoscope. To solve such an inconvenience, we devised a new system that enables us to place a "picture-in-picture" endoscopic image in the microscope.

To obtain an adequate angle of vision for practical purposes, we also succeeded in bending the 2.5-mm tip of the semi-rigid endoscope 70°, without enlarging the outer diameter more than 2.11 mm. Although the image quality of the semi-rigid fiberscope is inferior to that of a lens endoscope, the former is the light-weight "pen-style" system designed to be held in one hand and, thus, is very practical for performing endoscope-assisted microneurosurgical procedures.[1]

Unlike overlaying endoscopic and microscopic images on a TV monitor, by using the system presented here the surgeon's vision is never diverted from the operative field while performing endoscope-assisted microsurgery.

One of the disadvantages of the system is that some of the microscope's light intensity is reduced by the insertion of the mirror into the path of the microscopic image. However, based on our experience, using the maximum light intensity of the microscope (Superlux 300, Carl Zeiss, Oberkochen, Germany), the image was bright enough to perform surgical procedures. Another disadvantage may concern the bulk of the adapter. Neurosurgeons are generally not comfortable with long microscopes when performing microsurgery. One of the extension rings for the Zeiss microscope, as thick as 3.7 cm, is used directly in making the adapter of this system. Although the adapter can theoretically be shortened to the size of the mirror (2 cm), we did not believe that its length was inconvenient because endoscopes are always handled in a deep operative field.

There are a number of future potential uses for the system. 1) The opposite side of the mirror in the adapter, which is placed to balance the luminous intensity of the biocular microscope, may allow us to remake the system easily for stereoscopic endoscopy if the endoscope can be manufactured without a remarkable increase in the outer diameter from the practical standpoint. 2) The adapter could be applied to any type of microscope by adjusting its diameter. 3) If the light source of a microscope with sufficient luminous intensity could be temporarily switched into that for the endoscope, appreciable cost reduction might be realized.

Disclosure

The system represented here was custom manufactured by Fujikura, Ltd., Chiba, Japan. The company is in the process of applying for a patent from the government of Japan for sale and distribution of the equipment.

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