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Original Article

Intraparenchymal brain lesion biopsy guided by a rigid endoscope and navigation system

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Abstract

Background: The authors report a continuous case series of navigation-guided rigid endoscopic biopsy via the transcortical route for intraparenchymal brain lesions to assess the feasibility and efficacy of the method.

Methods: Thirty-four patients with intraparenchymal brain lesions found on neurovisualization underwent navigation-guided rigid endoscopic biopsy. Most of the preoperative diagnoses were glioma WHO Grade II–IV (16 cases) or malignant lymphoma (15 cases). Intraoperative photodynamic diagnosis and intraoperative pathological diagnosis were used in 28 and 29 cases, respectively. In 2 cases with small and deep lesions, intraoperative magnetic resonance imaging was used for confirming the accuracy of the biopsy point.

Results: The sampling accuracy determined by postoperative imaging and the definitive diagnosis ratio were 94% (32 out of 34 cases) and 97% (33 out of 34 cases), respectively. There was no postoperative mortality. In 2 patients, mild postoperative permanent morbidity (5.9%), presumably related to this technique, was observed in the early cases in the current group (34 case series).

Conclusion: The method was estimated as safe and feasible for diagnostic tissue sampling of intraparenchymal brain lesions.

Key Words: Endoscopic biopsy, high-grade glioma, malignant lymphoma, needle biopsy

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INTRODUCTION

Various methods of intraparenchymal tumor biopsy in the central nervous system have been proposed to date, and can be roughly divided into the following three categories: Needle biopsy, defined as the use of a biopsy needle; endoscopic biopsy, defined as the use of neuroendoscopy; and open biopsy, defined as the use of microscopy through a small craniotomy. These methods differ in details across institutions, including the use of a stereotactic frame, magnetic resonance imaging (MRI)-based navigation system, and rigid fixation. These techniques have advantages and disadvantages related to sampling accuracy, definitive diagnosis ratio, sample volume, and

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risk of complications.[2-4,6-14,16-20] Our previous study of neuronavigation-guided rigid endoscopic biopsy via the transcortical route showed that the sampling accuracy and the definitive diagnosis ratio were 89% and 100%, respectively, being comparable to those of stereotactic needle biopsy (75% and 87%) or open biopsy (88% and 94%).[18]

Here, we report a continuous case series of navigation-guided rigid endoscopic biopsy via the transcortical route for intraparenchymal brain lesions. The purpose of this retrospective study is to assess the feasibility and efficacy of the rigid endoscopic biopsy.

PATIENTS AND METHODS

In this retrospective study, 34 continuous cases of patients with intraparenchymal brain lesions discovered on MRI who underwent navigation-guided rigid endoscopic biopsy between January 2009 and July 2014 at our hospital were enrolled. The rigid endoscopic biopsy was selected for deep lesions (>3 cm from the brain surface) that were typically noneloquent areas of the brain such as deep frontal tumors. Other biopsy techniques were selected for surface lesions and/or lesions near the major vessels (open biopsy), intra- or para-ventricular lesions (ventriculoscopy or open biopsy), and deep lesions that were located near the eloquent areas (needle biopsy or open biopsy).

The method of navigation-guided rigid endoscopic biopsy was described in previous reports.[8,13,18] In short, the patient's head was fixed with a Mayfield frame under general anesthesia. As shown in Figure 1, a single or dual transparent sheath was inserted into the front of the target lesion via the burr hole under control of the navigation system (StealthStation®; Medtronic, Inc., Minneapolis, MN, USA). Single port technique was typically selected for a deep lesion approximately 3–5 cm from the brain surface, and dual port technique was typically selected for a deeper (approximately 5–6 cm from the brain surface) and/or vascular rich deep lesion (approximately 4–6 cm from the brain surface) in the white matter. Preoperative MRI data were used to plan the entry point, target sites, and trajectories of the navigation system to avoid the eloquent or vascular structures. When the start of the lesion was visible through the rigid endoscope (EndoArm®; Olympus Corp., Tokyo, Japan), three or more sample sets of the suspected pathological tissue were obtained from the target sites of the lesion under control of the navigation system. In most cases, the intraoperative photodynamic diagnosis (PDD) using 5-aminolevulinic acid was performed, and the PDD positive tissue samples were submitted for frozen section intraoperative pathological diagnosis. The biopsy was repeated until the samples were confirmed to contain the pathological tissue.

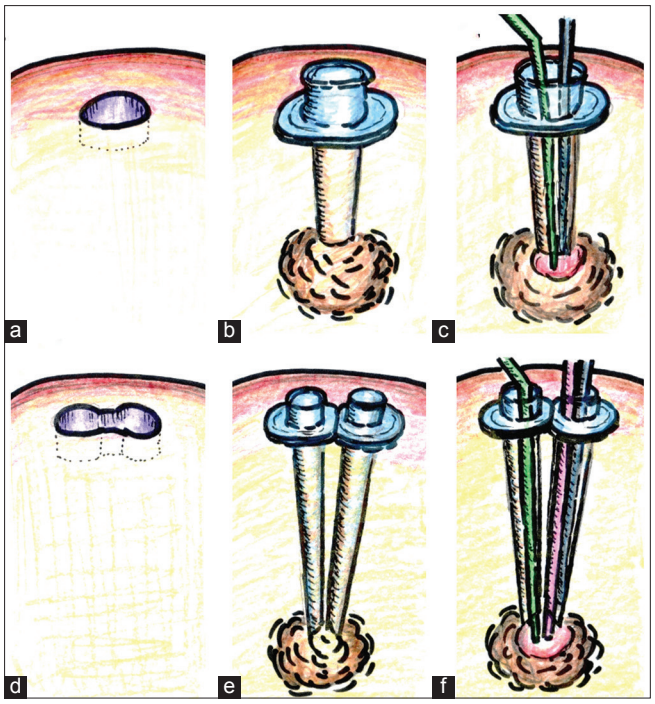

Figure 1: Procedures for rigid endoscopic biopsy using the single port technique (a-c). (a) A round-shaped burr-hole is made. (b) A transparent sheath with diameters of 6.8 mm (or 10.0 mm) is inserted into the front of the target lesion under the control of the navigation system. (c) Observed with a rigid endoscope (a blue column), the lesion is biopsied using a single instrument, such as a biopsy forceps (a green column). Each instrument excepting the rigid endoscope is usually inserted alternately. Procedures for rigid endoscopic biopsy using the dual port technique (d-f). (d) An infinity-shaped burr hole is made. (e) Two transparent sheaths with diameters of 6.8 mm with Nelaton catheters (Fr 18) as alternative inner tubes are inserted into the front of the target lesion under the control of the navigation system. (f) Observed with a rigid endoscope (a blue column), the lesion is biopsied or removed partially using a biopsy forceps (a green column) along with other instrument such as a suction tube (a red column)

RESULTS

The clinical characteristics of the 34 patients with intraparenchymal brain lesions who underwent rigid endoscopic biopsy via the transcortical route are shown in Table 1. A representative case of navigation-guided rigid endoscopic biopsy for malignant lymphoma in the deep white matter of the left parietal region is shown in Figure 2. The mean age of these patients was 61.6 years. Most of the preoperative diagnoses were glioma WHO Grade II–IV (16 cases) or malignant lymphoma (15 cases). MRI-based navigation system and rigid endoscopy were used in all cases. Single neuro-port was used in 28 cases, and the dual ports were used in 6 cases. PDD and intraoperative pathological diagnosis were performed in 28 and 29 cases, respectively, and the endoscopic biopsy without any intraoperative diagnosis was performed only in 1 early case. In 2 cases with small and deep lesions, the intraoperative MRI was used for confirming the accuracy of the biopsy point. In other

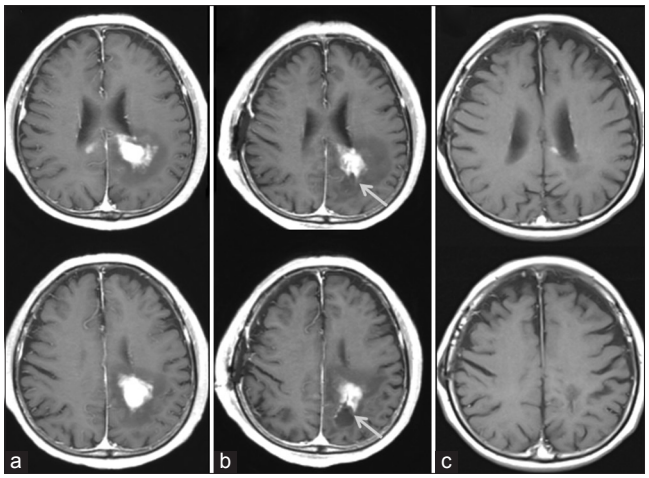

Figure 2: A representative malignant lymphoma case (patient 29) of navigation-guided rigid endoscopic biopsy using the single port technique for the deep white matter lesion of the left parietal lobe. ((a) axial view of T1-weighted images (WI) after gadolinium administration before the biopsy; (b) T1-weighted images-gadolinium 1-day after the biopsy; (c) T1-weighted images-gadolinium after chemotherapy)

cases, biopsy point was confirmed by MRI, or computed tomography scan within 3 days after the surgery.

The results of the endoscopic biopsy are shown in Table 2. Median operation time was 148 min, including waiting interval for the intraoperative pathological diagnosis performed 1–3 times. The sampling accuracy confirmed by postoperative imaging and the definitive diagnosis ratio were 94% (32 out of 34 cases) and 97% (33 out of 34 cases), respectively. Uncertain pathologic tissue in the intraoperative frozen section from a patient with border sampling point resulted in the final pathological diagnosis of large B cell lymphoma. Only in one lymphoma case initial endoscopic biopsy resulted in a failed sampling point and repeated biopsy via small craniotomy (open biopsy) was performed. In that case, the use of corticosteroids before surgery, registration error in the MRI-based navigation, and pseudo positive PDD were the causes of the failure. Navigation-guided endoscopic biopsy using dual port, the technique of which was described in a previous paper,[8] was performed in 6 cases with the deeper-seated and/or vascular rich tumor lesions and the final pathological diagnosis was made for all cases.

There was no postoperative mortality. Only in 2 early cases of this 34-case series, minor postoperative permanent morbidity (5.9%), presumably related to this technique, was observed. One patient with moderate hemiparesis before surgery had worsened hemiparesis probably due to edema and ischemia of the pyramidal tract. Another patient had quadrantanopia due to the injury of the optic tract. Only 2 patients had transient neurological deterioration after the surgery, including 1 patient with transient symptomatic increased bleeding in the residual tumor lesion with mild preoperative intratumoral bleeding, and 1 patient with worsened aphasia due to the enlargement of the biopsy cavity. One patient had complete atrioventricular block after surgery, which was thought to be incidental cardiac trouble independent of the neurosurgical technique. Three cases had asymptomatic minor bleedings in the postresection cavity or in the residual tumor lesion.

Table 1: Case series of navigation-guided endoscopic biopsy

Number (cases)	34
Sex (Men/Women)	21:13
Mean age	61.6
Most suspected diagnosis on preoperative imaging (cases)	
Glioma (GII-IV)	16
Lymphoma	15
Others	3
Used techniques (cases)	
MRI-based navigation system	34
Rigid endoscopy	34
Port (transparent sheath)	34
Single port	28
Dual ports	6
Intraoperative photodynamic diagnosis	28
Intraoperative pathological diagnosis	29
Intraoperative MRI	2

MRI: Magnetic resonance imaging

Table 2: Results of navigation-guided endoscopic biopsy

Number (cases)	34
Operation time (median)	148 min (78-255)
Intraoperative photodynamic diagnosis (cases)	28
Positive diagnosis	26
Negative diagnosis	2
Intraoperative pathological diagnosis (cases)	29
Positive (including pathologic tissue)	28
Negative (no pathologic tissue)	1
Accuracy of biopsy point on postoperative imaging (cases)	34
Accurate point	32
Border point	1
Failed point	1
Final pathological diagnosis (cases)	34
Glioma (GII-IV)	18
Lymphoma	13
Others	2
No pathologic tissue	1

DISCUSSION

In the present study, the largest case series among other reports using navigation-guided rigid endoscopic biopsy has been analyzed; with the definitive diagnosis ratio of 97% in 34 continuous cases of patients. In 6 cases,

the dual port technique was used to access deeper lesions, resulting in 100% of the definitive diagnosis ratio. Such results were similar to those in smaller case series (100% in 6 cases and 100% in 21 cases) of navigation-guided rigid endoscopic biopsy performed in other institutions.[10,17] The analysis of medical reports showed that the tissue diagnosis was feasible in 362 out of 387 rigid endoscopic biopsies for intraparenchymal brain lesions (38 cases) as well as in other lesions including those in periventricular and intraventricular location (349 cases), with a diagnostic yield of 93.54%. From this, we can conclude that rigid endoscopic biopsy of brain tumors has a high diagnostic yield.[1] The results are comparable to those of the previous reports describing other surgical techniques.[2-4,6,7,9,12,14,16,20]

We believe that the key characteristics of the ideal biopsy procedure include (1) accurate sampling using a variety of techniques including neuronavigation, intraoperative PDD, and intraoperative pathological diagnosis, (2) sampling a large volume, and (3) visualization of the intraparenchymal structures during surgery. Although open biopsy might be superior to needle biopsy with regards to these key points, both approaches are not always optional for all biopsy cases, including lesions in some deep areas of the white matter, the brain stem and the basal ganglia. We believe that the navigation-guided rigid endoscopic biopsy is a good alternative to other biopsy methods, except for superficial brain lesions, and brain stem lesions.

PDD might be helpful to immediately evaluate whether an accurate sample is obtained from the intraparenchymal brain lesion, including high-grade glioma and malignant lymphoma diagnosis.[5,15,19] However, there were some negative-fluorescence cases including 2 patients in our series. In addition, positive fluorescence is not always sufficient for detecting an accurate sample because the surrounding area containing normal tissue can be fluorescently positive. Therefore, a combination of multi-modal techniques including intraoperative pathological diagnosis and PDD might be necessary to ensure accurate sampling from a small target. It should also be taken into consideration that the navigation-guided endoscopic biopsy might prolong the operation time when compared with the stereotactic needle biopsy. However, the needle biopsy has the disadvantage of non visualization of the intraparenchymal structures. Also in our previous study, stereotactic needle biopsy had the highest complication rate (13%) among the three approaches,[18] although there was no statistical difference.

CONCLUSION

We have reported 34 cases of the navigation-guided endoscopic biopsy for intraparenchymal brain lesions. This method was concluded to be safe and feasible for diagnostic tissue sampling.

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Conflicts of interest

There are no conflicts of interest.

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