Endoscopic biopsy of brain tumors: Does the technique matter?

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Received: 03 July 14  Accepted: 20 September 14  Published: 12 November 14

Abstract

Background: Endoscopic biopsy of brain tumors is an important part of the armamentarium of management of intra- and periventricular tumors that is generally considered an acceptable and, in some situations, a preferred method for tissue sampling. The diagnostic yield of the procedure has been variably reported. Technical aspects of the procedure should undoubtedly reflect on its success rate and accuracy. Such impact on diagnostic yield of endoscopic brain biopsy is infrequently discussed in the literature.

Methods: A search of the medical literature was conducted for publications on endoscopic brain biopsy. These reports were analyzed regarding the various technical aspects.

Results: In the 43 publications analyzed, lenscopes were exclusively used in 22 reports and a tissue diagnosis was possible in 362 out of 387 endoscopic biopsies with a diagnostic yield of 93.54%. Only fiberscopes were used in 8 reports and a tissue diagnosis was possible in 100 out of 132 endoscopic biopsies with a diagnostic yield of 75.76%. The diagnostic yield in the mixed and unspecified groups was 88.95 and 88.04%, respectively. Very few details on the histopathological methods and tumor molecular genetics could be found.

Conclusion: Endoscopic biopsy of brain tumors has a higher diagnostic yield when lenscopes are used. Neuronavigation seems to add to the diagnostic accuracy of the procedure. Studies detailing molecular genetic features of biopsied tumors are necessary in the future.

Key Words: Biopsy, brain, endoscopic, fiberscope, flexible, intraventricular, lenscopes, periventricular, rigid, tumor

INTRODUCTION

Fukushima was the first to introduce endoscopic brain biopsy in 1973 using a flexible fiberoptic ventriculofiberscope. Five years later, he reported a series of 21 endoscopic biopsies for intraventricular tumors, of which a correct histopathological diagnosis was achieved in 11 patients. Currently, the procedure is an important part of the armamentarium of management of intra- and periventricular tumors that is generally considered an acceptable and, in some situations, a preferred method for tissue sampling. Notwithstanding this, the diagnostic yield of endoscopic brain tumor biopsy has been variably reported.
technical aspects of the procedure undoubtedly reflect on its success rate and accuracy, a review of the literature was conducted in order to shed light on the technical aspects of endoscopic biopsy of brain tumors as they pertain to the diagnostic yield of the procedure.

MATERIALS AND METHODS

A search of the English literature was conducted and 43 reports were retrieved from 1990 to July 2013 [Table 1]. The following technical aspects were evaluated in each study: Type of endoscopes used, use of stereotactic guidance, and histopathological methods utilized for diagnosis.

Regarding the type of endoscopes used, the published studies were subdivided into four groups according to the use of lenscopes versus fiberscopes [Tables 1 and 2]. These four groups included: (1) Lenscopes only, (2) fiberscopes only, (3) mixed group, where both types were used without specification of the diagnostic yield for either type, and (4) unspecified group, where the type of endoscope was not reported by the authors. The diagnostic yield in each group was then calculated as the percentage of biopsies leading to a histological diagnosis to the total number of biopsies performed. When both types of endoscopes were used in one report, results were considered to belong to either the lenscopes or the fiberscope group only if the authors specified the diagnostic yield according to the type of the endoscope used. Unfortunately, a specific diagnostic yield based on the type of endoscopic device was rarely reported in these mixed studies.[15,17,29,34,36]

RESULTS

The results of the study are presented in Tables 1-3 and Figure 1.

In the 43 reports analyzed, lenscopes were exclusively used in 22 reports and a tissue diagnosis was possible in 362 out of 387 endoscopic biopsies with a diagnostic yield of 93.54%. Only fiberscopes were used in 8 reports and a tissue diagnosis was possible in 100 out of 132 endoscopic biopsies with a diagnostic yield of 75.76%. The diagnostic yield in the mixed and unspecified groups was 88.95 and 88.04%, respectively [Table 2 and Figure 1].

DISCUSSION

Endoscopic biopsy of brain tumors is currently regarded an effective tool that is sometimes indispensable in establishing tissue diagnosis and tailoring further treatment [Figures 2-4]. Using the procedure for lesions within the ventricular system or in its vicinity offers direct visualization of the intraventricular anatomy and enables precise sampling of areas of the lesion that are highly likely to be pathologically representative, a feature that has been found to improve diagnostic accuracy. Additionally, biopsies from areas with an overlying blood vessel can be avoided, and areas with high vascularity can be coagulated to reduce bleeding during the procedure.[25]

The literature is currently replete with reports of endoscopic brain biopsies in which success rates range from as low as 61% up to 100%.[2-4,7,9,18,19,20,23,26,33,41,43,48,50] Analysis of the published reports retrieved a total of 1927 endoscopic brain biopsies in which the procedure led to a diagnostic information in 1735 cases, a collective diagnostic yield of 90.04% [Table 2]. In 2008, Fiorindi and Longatti calculated a collective success rate of 88% in 206 endoscopic brain biopsies compiled from eight published series.[11] In the largest two series published so far, Constantini et al.[3] reported diagnostic yield of 90.4% in 691 biopsies and Hayashi et al.[15] reported a diagnostic yield of 89.7% in 293 procedures.

From the technical point of view, one of the drawbacks inherent to neuroendoscopes of today’s technology is...
Table 1: Overview of the literature on the diagnostic yield of endoscopic biopsy detailing types of endoscopic equipment and the histopathological methods reported

| Endoscopic equipment | No. of biopsies* | Tumor location | Diagnostic yield (%) | Histopathological exam used |
|----------------------|-----------------|----------------|---------------------|-----------------------------|
| Tanei et al. (2012)  | Lenscope navigation 6 | Intraparenchymal | 100 | NA |
| Domínguez-Páez et al. (2011) | Lenscope 28 | Intra- and/or periventricular | 89 | NA |
| Tsuda et al. (2011)  | Lenscope Navigation 9 | Intraparenchymal | 100 | NA |
| Morgenstern et al. (2011) | Lenscope 15 | Pineal region | 86.67 | NA |
| Chibbaro et al. (2012) | Lenscope navigation 8 | Pineal region | 100 | NA |
| Song et al. (2010) (Jkns) | Lenscope navigation 5 | Intra- and/or periventricular | 100 | NA |
| Song et al. (2010) (Ch.N.S) | Lenscope 49 | Intra- and/or periventricular | 95.9 | NA |
| Akai et al. (2010)  | Lenscope navigation 3 | Intraparenchymal | 100 | GFAP |
| Al-Tamimi et al. (2008) | Lenscope 8 | Pineal region | 75 | NA |
| Kim et al. (2004)    | Lenscope navigation 5 | Pineal region | 100 | NA |
| Kim et al. (2013)    | Lenscope navigation 23 | Suprasellar (around 3rd ventricle) | 95.7 | NA |
| Wong et al. (2011)   | Lenscope 25 | Pineal region | 84.0 | NA |
| Naftel et al. (2011) | Lenscope navigation 20 | Intraventricular | 90 | NA |
| Tirakotai et al. (2007) | Lenscope Frame-based, frameless stereotaxy 29 | Peri- and intraventricular | 100 | NA |
| Prat and Galeano (2009) | Lenscope navigation 22 | Intraventricular | 100 | NA |
| Yurtseven et al. (2003) | Lenscope 18 | Peri- and intraventricular | 100 | NA |
| Wellons et al. (2004) | Lenscope 7 | Third ventricular | 100 | NA |
| Robinson and Cohen (1997) | Lenscope 3 | Pineal region | 100 | NA |
| Najjar et al. (2010) | Lenscope 8 | Intraventricular | 100 | NA |
| Roopesh Kumar et al. (2007) | Lenscope navigation 24 | Posterior 3rd ventricle | 100 | NA |
| Luther et al. (2006) | Lenscope 6 | Pineal region and suprasellar | 83 | NA |
| Nagahisa et al. (2013) | Lenscope navigation 21 | Intraventricular | 100 | H/E, Olig2, CGH |
| Depreitere et al. (2007)** | Lenscope fiberscope 31 (+1 case not operated, excluded) | Intraventricular | Total 69 Lenscope 19/25 = 76 Flex 3/7 = 43 | NA |
| Ahn and Goumnerova (2010)** | Lenscope fiberscope 33 | Intra- and/or periventricular | Total 23/33 = 70 Rigid 17/21 = 81.0 Flexible 5/11 = 45.5 | NA |
| Fiorindi and Longatti (2008) | Fiberscope 23 | Intra- and/or periventricular | 82.6 | NA |
| Endo et al. (2009)   | Fiberscope 1 | Pineal region | 100 | CD20, CD79α, CD3 |
| Gangemi et al. (2001) | Fiberscope 5 | Pineal region | 100 | NA |
| Shono et al. (2007)  | Fiberscope 12 | Third ventricle | 100 | H/E Immunostaining |
| Oka et al. (1994)    | Fiberscope 12 | Intraventricular | 100 | NA |
| O’Brien et al. (2006) | Fiberscope 33 | Intra- and/or periventricular | 76 | NA |
| Ferrer et al. (1997) | Fiberscope 4 | Pineal region | 75 | H/E |
| Macarthur et al. (2002) | Fiberscope 28 | Intra- and/or periventricular | 61 | NA |
| Mohanty et al. (2010) | Lenscope fiberscope 87 | Intra- and/or periventricular | 83 | NA |
| Oppido et al. (2011) | Lenscope fiberscope 60 | Intra- and/or periventricular | 90 | NA |
| Hayashi et al. (2011) | Lenscope fiberscope 691 | Intra- and/or periventricular | 89.7 | NA |
| Souweidane et al. (2000) | Lenscope fiberscope 12 | Third ventricle | 92 | NA |
| Yamini et al. (2004) | Lenscope fiberscope 6 | Pineal region | 66.67 | NA |
| Pople et al. (2001)  | Lenscope fiberscope 34 | Pineal region | 94 | NA |
Notably, however, no prospective group with endoscopic biopsy alone, 77.42%; and with tumor irrigation fluid along with biopsy, 93.55%

Table 2: Segregation of diagnostic yield of biopsy by the type of endoscopic equipment used in 43 literature reports

| Equipment                          | No. of Biopsies* | Tumor Location          | Diagnostic Yield (%) | Histopathological Exam |
|-----------------------------------|------------------|-------------------------|----------------------|------------------------|
| Kinfe et al. (2010)               | Lenscope fiberscope | 17                      | Periventricular       | 100                    | NA                     |
| Jingui et al. (2013)              | Lenscope fiberscope | 11                      | Pituitary stalk       | 100                    | NA                     |
| Husain et al. (2010)***           | Unspecified      | 178                     | Multiple              | 80.3                   | GFAP, NSE, synaptophysin, EMA, desmin, cytokeratins S-100, LCA, PCR |
| Constantini et al. (2013)         | Unspecified      | 293                     | Intra- and/or periventricular | 90.4                   | NA                     |
| Petroinici et al. (2013)          | Unspecified      | 14                      | Pineal region         | 92.8                   | NA                     |

Table 3: Diagnostic yield of endoscopic biopsy using lenscope endoscope with and without navigation

| No. of reports                  | Total | Lenscope | Fiberscope | Mixed | Unspecified |
|--------------------------------|-------|----------|------------|-------|-------------|
| Number of reports              | 43    | 23       | 9 (8 + 1/2 + 1/2)* | 8     | 3           |
| Performance of biopsies        | 1927  | 387*     | 132        | 923   | 485         |
| Successful biopsies            | 1735  | 362      | 100        | 821   | 427         |
| Diagnostic yield (%)           | 90.04 | 93.54    | 75.76      | 88.95 | 88.04       |

Ahn and Goumnerova (2010) and Depreitere et al. (2007) used fiberscopes and lenscopes and segregated diagnostic yield for each. *Number of biopsies taken from each report.

Table 3: Diagnostic yield of endoscopic biopsy using lenscope endoscope with and without navigation

| With navigation | Without navigation |
|----------------|--------------------|
| Performed biopsies | 151               | 191               |
| Successful biopsies | 148               | 177               |
| Diagnostic yield (%) | 98                | 92.67             |

It is evident from literature analysis that using stereotactic guidance resulted in higher chances of obtaining a pathologically diagnostic material. The success rate for neuronavigation-guided endoscopic biopsy was 98% versus 92.67% when lenscopes were used alone. It is of note that although intraventricular anatomical structures would normally serve as the anatomical landmarks which give the neurosurgeon a spatial orientation, navigated endoscopy would be very important in cases with small or distorted ventricles, posterior third ventricular and periventricular tumors.
Although the objective of this review was not to investigate all variables related to the diagnostic accuracy of endoscopic brain biopsy, it is important to point out that tumor location seems to play a role in the success rate of the biopsy. Ahn and Goumnerova reported success rates of 100%, 87.5%, 57%, and 25% for lateral ventricular, pineal region, thalamic, and tectal plate lesions, respectively. High failure rates for superior vermian biopsies and posterior fossa tumors have also been reported. Such suboptimal success rates can probably be ascribed to difficulty of access to some areas. More importantly, the pathological approach to endoscopic brain tumor biopsy has not previously been detailed. In none of the studies did the authors refer to uncertainties expressed by the pathologist regarding the final diagnosis, which may partly explain the variations in biopsy success rates. Upon reviewing the literature, it was noticed that the histopathological diagnostic methods are seldom discussed and always overlooked, especially with respect to the molecular and immunohistochemical features of brain tumors. Except for one study by Husain et al. published in 2010, only very few studies with scarce information or single case reports are available.

Molecular subtyping of brain tumors is becoming increasingly recognized as a valuable tool with diagnostic, prognostic, and therapeutic significance. For instance, the inactivating abnormalities of hSNF5/INI1/
SMARCB1/BAF47 tumor suppressor gene on chromosome 22q11.2 allowed segregating atypical teratoid rhabdoid tumors (ATRTs) from potential mimickers, and the fusion between KIAA1549 and BRAF oncogene specific to pilocytic astrocytomas is becoming an area for potential novel treatments. 

To date, almost all assessments of successful endoscopic biopsy have been based upon conventional histopathological criteria. To the best of our knowledge, only one report on endoscopic biopsy of brain tumors has documented the immunohistochemical characteristics and in none of the studies have the molecular subtypes of tumors been reported. As some of these advanced pathology assays are dependent to a degree on the volume of tissue and the method of tissue processing, the technique of sampling and the equipment utilized may have an impact on the ability to obtain such increasingly important pathologic information. Prospective studies comparing the different contemporary endoscopic techniques as they relate to the molecular subtyping of brain tumors may help guide the surgeons’ selection of biopsy technique.

CONCLUSION

Endoscopic biopsy of brain tumors has a higher diagnostic yield when lensscopes are used. Neuronavigation seems to add to the diagnostic accuracy of the procedure. Studies detailing molecular genetic features of biopsied tumors are necessary in the future.

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