

# Diagnostic yield of stereotactic brain biopsy

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## ABSTRACT

**الهدف:** لتقييم دقة وسلامة التشخيص في أخذ عينة من الدماغ عن طريق الجراحة الفراغية.

**الطريقة:** أجريت هذه الدراسة في مستشفى الملك فيصل التخصصي ومركز الأبحاث في الرياض في الفترة ما بين 1993م-2005م. لكل عمليات أخذ خزعة من آفات المخ عن طريق الجراحة الفراغية بواسطة القرص.

**النتائج:** أجريت هذه العملية على 120 مريض (67 ذكرا و53 امرأة) لأخذ العينة لغرض التشخيص بواسطة الجراحة الفراغية بواسطة القرص. أعمار المرضى تراوحت بين 3-72 سنة (متوسط العمر 20.3 ± 39.4 سنة). كانت مواقع الآفات: 49 المهاد، 29 الفص الأمامي، 23 الفص الجداري، 9 الفص الصدغي و10 حالات في أماكن أخرى متفرقة. دقة التصويب كانت 99.2%. التخدير الكامل استخدم في 103 حالات (85.8%) وبالباقي استخدم التخدير الموضعي. النتيجة التشخيصية الإيجابية قدرت ب96%. أكثر النتائج شيوعا كانت الأورام الدبقية ثم الأحماس البكتيرية و سرطان الخلايا اللمفية (63%، 16%، 7%). حدثت حالة وفاة واحدة (0.8%) وخمس حالات مرضية (4%).

**خاتمة:** إن عملية أخذ العينة عن طريق الجراحة الفراغية بواسطة القرص هي عملية آمنة نسبيا للحصول على تشخيص مرضي يعبر عن الآفة. إن التطورات الحديثة ساهمت في تحسين النتيجة التشخيصية لهذه العمليات وجعلها أكثر سلامة.

**Objective:** To evaluate the diagnostic yield, accuracy, and safety of frame-based stereotactic brain biopsy procedures.

**Methods:** A retrospective study of all pathologically diagnosed intracranial lesions, using frame-based stereotactic guided brain biopsy procedures performed at King Faisal Specialist Hospital and Research Centre (KFSH&RC), Riyadh, Kingdom of Saudi Arabia between 1993 and 2005 was conducted. Medical charts, radiological studies, and pathological slides were reviewed.

**Results:** A total of 120 consecutive patients who had frame-based stereotactic diagnostic biopsy procedures were identified. Data regarding procedural techniques, lesion locations, pathological diagnosis,

and postoperative complications were collected. Patients' ages ranged from 3-72 years (mean ± standard deviation: 39.4 ± 20.3), 67 males and 53 females. Sites of biopsied lesions included: 49 thalamic, 29 deep frontal, 23 parietal, 9 temporal, and 10 others. Targeting accuracy was 99.2%. General anesthesia was used in 103 patients (85.8%). The rest was carried out under local anesthesia. Diagnostic yield was estimated at 96%. Most frequently encountered pathological diagnosis includes gliomas (63%), infections (16%), and lymphomas (7%). One mortality (0.8%), and 5 (4%) morbidities were encountered.

**Conclusions:** Stereotactic brain biopsy is a relatively safe technique to obtain a tissue biopsy that represents the pathology of the lesion. Recent advances in stereotactic neurosurgical techniques have helped to improve the safety and diagnostic yield of such procedures.

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The word "stereotactic" comes from the Greek word "stereos," which means 3 dimensional and "tactus" the Latin word meaning to touch.<sup>1</sup> Therefore, stereotactic is a 3 dimensional system used to reach deep objects in the brain, and provides a high level of accuracy and safety.<sup>2</sup> In neurosurgery, such a system has many advantages since the trajectory to deep targets through brain tissues may be hazardous and can be associated with significant complications.<sup>3</sup> This developing technology is utilized in variable procedures practiced in modern neurosurgery.<sup>4</sup> Surgery for movement disorders,<sup>5-7</sup> image guided tumor resection procedures,<sup>8</sup> insertion of drains,<sup>9,10</sup> and obtaining pathological tissues sample for diagnostic purposes,<sup>11</sup> are all examples of this technology. The

latter indication became very important recently. Some brain tumors are radiosensitive, like germinomas,<sup>12,13</sup> or chemosensitive, like primary CNS lymphomas.<sup>14,15</sup> A simple and safe stereotactic biopsy procedure followed by an appropriate adjuvant therapy may avoid major neurosurgical procedures with all its consequences. In addition, CNS infections, which are not uncommon in this part of the world, would be an ideal case for a stereotactic brain biopsy procedure.<sup>16,17</sup> This would confirm the infectious etiology and provide guidance for the appropriate antimicrobial therapy based on in vitro cultures and sensitivities. It was felt important to review the outcome of a series of patients who underwent this procedure in our neurosurgical practice. In this study, we are presenting a series of consecutive patients operated for stereotactic brain biopsy at King Faisal Specialist Hospital and Research Centre (KFSH & RC) in Riyadh, the major neurosurgical referral centre in Saudi Arabia. Accuracy of this procedure, diagnostic yield, encountered diagnosis, and observed complications are reported.

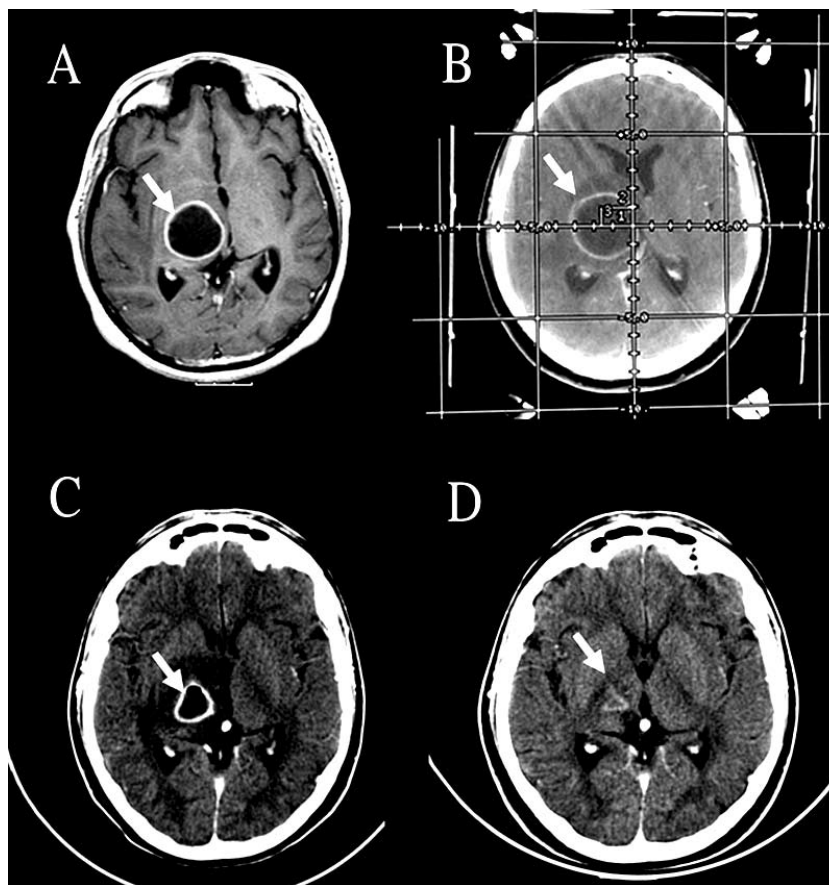
**Methods.** A retrospective study for all cases of frame-based stereotactic brain biopsy procedures carried out at KFSH & RC, Riyadh, Saudi Arabia between 1993 and January 2005 (1993 is the year when a modern Leksell G stereotactic frame was first introduced to the hospital).<sup>18</sup> All procedures performed for tissue biopsy were included. Cases of catheter insertion or aspiration of cystic components for lesions with known histopathological diagnosis were excluded. Medical charts, radiological, and pathological diagnostic studies were reviewed. The study was approved by the Research Advisory Council in the hospital (No. 2021043).

**Results.** A total of 120 patients who underwent a frame-based stereotactic biopsy using the Leksell G frame system were identified. The mean  $\pm$  standard deviation age of the patients at time of the procedure was 39.4 years  $\pm$  20.3 years, and range from 3-72 years. There were 67 males and 53 females. The procedures were performed under general anesthesia (GA) in 103 cases (85.8%). However, in the last 3 years of the study and to avoid complications of GA, local anesthesia became the most commonly used type of anesthesia, unless the patient could not tolerate the procedure under local anesthesia like children or unstable patients. Deep thalamic lesions were the most frequently encountered location of lesions biopsied in our study (49, 40.8%), followed by deep frontal (29, 24.2%), and parietal (23, 19.2%) locations. Other locations included temporal (9), occipital (4), pineal (4), and brainstem (2) lesions. All cases but 2 (118 cases), were carried out using CT images. The CT based biopsy was preferred by the surgical team because of rapid, safe, and accurate stereotactic measures. The MRI was used only when the lesion was not well-

visualized on CT. The original size of the biopsied lesions ranged from 1-8 cm in maximum diameter, with a mean of  $3.63 \pm 1.8$  cm. Targeting accuracy was calculated as the percentage of cases when the biopsied tissues were from the area targeted, confirmed either by a definite histopathological diagnosis or a post-operative CT clearly showing the site of the biopsy within the body of the lesion. In all cases, but one, the lesions were accurately targeted (99.2%). In one case the needle biopsy missed the targeted tissue. This was proven by a post-operative scan and it was related to miscalculation by the operating team. Diagnostic yield was positive in 115 cases (96%). This was calculated as the number of cases with definite histopathological diagnosis divided by the total number of procedures. In 5 cases, the pathology report concluded non-diagnostic materials (including the mis-targeted one). In 4 cases, frank necrosis was seen microscopically. A variety of pathological diagnoses were encountered in our series. As expected, gliomas of different grades (both astrocytomas and oligodendrogliomas) were the most commonly encountered pathology (72 cases, 62.6%). Infections came second (18 cases, 15.7%) followed by lymphoma (8), ganglioma (6), and others (11). **Figure 1** illustrates the natural course of one of the cases.

**Complications.** One unexpected intraoperative mortality was encountered. The patient developed cardiopulmonary arrest most likely secondary to massive pulmonary embolism. This mortality was considered directly related to the procedure itself. Peri-operative morbidities (5 cases, 4.1%) included clinically significant hemorrhages (3 cases), new onset seizure (one case), and one patient developed hemiparesis secondary to tissue swelling due to possible venous engorgement. Morbidities and mortalities related to the natural history of the original brain pathology were not considered here.

**Discussion.** This series of 120 consecutive patients who underwent frame based stereotactic tissue sampling illustrates procedure accuracy, diagnostic yield, and potential complications. The results are contrasted in some aspects, against selected series in the literature (Table 1). Distribution of cases according to the site of targeted lesion is influenced by many factors, including: 1. Superficial easily accessible lesions are usually approached with open procedures and aimed at excisional biopsies when applicable, as with other series, deep seated brain lesions such as thalamic, were the most encountered type. 2. The approach to lesions in specific brain locations may depend on the practice in different neurosurgical centers,<sup>19</sup> for example, pineal-region lesions are principally treated, in some centers, with stereotactic biopsy followed by adjuvant therapy,<sup>20</sup> whereas such tumors in other centers are approached through open surgery and resection.<sup>21-23</sup> Such trends



**Figure 1** - Case illustration: An 18 year-old male, presented with a few weeks history of headache and left sided weakness. a) An axial MRI illustrating an enhancing right sided deep thalamic ring enhancing cystic lesion (arrow). b) Axial CT illustrating the stereotactic target planning to the center of the lesion. c) Post stereotactic biopsy and aspiration of the cyst. The CT illustrates significant decrease in the cyst size (histopathological and microbiological results confirmed the diagnosis of pyogenic abscess (*Staphylococcus Aureus*)). d) Few weeks follow up CT after antibiotic therapy illustrating near total resolution of the lesion.

**Table 1** - A summary of some selected series of stereotactic biopsy published in the literature comparing encountered morbidities and mortalities.

Series, year of publication	No. of cases	Morbidities (%)	Mortalities (%)
Lunsford et al, 1984 <sup>29</sup>	102	5.9	0.0
Kelly et al, 1991 <sup>30</sup>	547	2.9	0.3
Broggi et al, 1987 <sup>31</sup>	227	3.9	2.6
Apuzzo et al, 1987 <sup>11</sup>	500	1.0	0.2
Bernstein et al, 1994 <sup>32</sup>	300	4.7	1.7
Cook et al, 1993 <sup>33</sup>	183	6.5	0.0
Alkhani et al, 2008	120	4.1	0.8

in practice can reflect in the percentage of lesions biopsied in the pineal region. In our center such lesions are approached with the open surgical procedure. This would explain the lower percentage of pineal-region lesions biopsied in this series.

The distribution of histopathological diagnosis is also influenced by similar factors mentioned above. Different histopathological diagnoses are more common in specific biopsy sites such as pineal region pineoblastoma and germ cell tumors.<sup>24,25</sup> A similar practice philosophy can influence the percentage of certain pathological entities such as glioblastoma multiforme (GBM) infiltrating the corpus callosum (butterfly GBM).<sup>26-28</sup> Lesions with classical radiological features of butterfly GBM are treated with conventional radiotherapy and possible chemotherapy without histopathological tissue confirmation in some centers. In our center, and because of the relatively higher incidence of CNS infections that may mimic GBM, like tuberculomas, we are more inclined to advocate a tissue diagnosis.

Interestingly, the percentage of CNS infections in this series is quite impressive. This would support the need for tissue biopsy should there be any doubt of a possible infectious etiology.

The encountered mortality was calculated for the patient who died unexpectedly from the procedure and not from the original pathology per se. An attempt to critically analyze our own series to that regard, may highlight the relative accuracy of technical safety of the procedure. Whereas, on the other hand, by excluding the resultant mortality due to extensive pathology (such as seen in infiltrating high grade glioma being treated conservatively), may undermine the accuracy in measuring outcome mortality. Table 1 compared our results to some of the previously reported series.<sup>29-33</sup>

In conclusion, based on the above one can conclude that the present series of cases illustrates that frame-based stereotactic brain biopsy is a relatively safe procedure with a high rate of accuracy and diagnostic yield. This would meet positively the advances in radiotherapy and chemotherapy as possible alternatives to open neurosurgical procedure and allow inclination towards lowering the threshold to obtain a tissue diagnosis.

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