

INITIAL EXPERIENCE WITH STEREOTACTIC SURGERY IN WEST AFRICA

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Abstract

Background

The first stereotactic surgery program in West Africa was established in Ghana in 1999.

Objective

This study presents a retrospective evaluation of the pattern and outcome of the first seventeen consecutive stereotactic procedures. It also discusses the benefits, challenges and prospects of the program in West Africa.

Methods

17 patients (11F, 6M) with CT disclosure of intracranial mass lesions that could be assessed or managed stereotactically to the patients benefit (9,10). underwent stereotactic procedures during a consecutive 18-month period. Analysis of charts, relevant imaging studies and pathology reports were done.

Result

The average age of the patients was 37 years (range 2-72 years). 71% had a preoperative diagnosis of brain tumor; 83.3% were confirmed. All the procedures were performed in the supratentorial compartment. A biopsy was done in every case. 35% underwent biopsy and aspiration/evacuation. The mean CT scan time was 18 minutes (range 5-48minutes). The mean operating room time was 37 minutes (range 30-43minutes). All the cases were done utilizing local anesthesia and intravenous sedation. The average length of hospital stay was 2.7 days (range 2-7 days). Histopathologic results showed Arachnoid cyst (2), Neoplasms (10), infection (1), Intraaxial hematoma (2), Thrombosis (1), Normal tissue (1). The failed biopsy rate was 6%. The surgical objectives were achieved without complications. No blood transfusions were given or required. Stereotactic procedures cost 50-59% less than conventional surgery.

Conclusion

It is concluded that the initial experience with stereotactic surgery in West Africa consists of utilizing the Leksell Stereotactic System for the safe performance of tumor biopsies and aspirations/evacuations with reduction in health care costs compared to conventional surgery.

Keys words : Neurosurgery, Stereotactic surgery, West Africa.

Résumé

Introduction

Les premières interventions stérotaxiques ont été réalisées en 1999 au GHANA.

Objectif

Notre étude rétrospective évalue les caractères cliniques, paracliniques ainsi que le traitement et l'évolution de 17 patients ayant bénéficié de ce type d'intervention.

Méthodes

L'étude de ces 17 patients opérés sur une période de 18 mois a été faite à partir des dossiers d'hospitalisation. Le cadre de Leksell a été utilisé.

Résultats

La moyenne d'âge est de 37 ans (2-72 ans). La procédure a intéressé uniquement l'étage sus-tentorial et a concerné tous les patients. La durée moyenne du CT-scan a été de 18 mn et celle des interventions 37 mn (30-43mn). La durée moyenne de séjour a été de 2,7 jours (2-7 jours). Les lésions suivantes ont été observées : kystes arachnoïdiens (2), néoplasmes (10), infections (2), hématoïde intra axial (2), thrombose (1), tissu normal (1). Le taux d'échec a été de 6%. Aucune complication n'a été observée. Il n'y a eu aucune transfusion. La technique stérotaxique coûte 50 à 59% moins cher que la chirurgie conventionnelle.

Conclusion

Cette étude préliminaire conduite en Afrique de l'Ouest permet de conclure à l'efficacité de la stérotaxie quant au diagnostic, à la sécurité et aux coûts par rapport à la chirurgie conventionnelle.

Mots clés : Afrique de l'Ouest - Neurochirurgie - Stérotaxie.

Introduction

The introduction of CT scanners into West Africa in the last decade has upgraded the practice of neurosurgery in the sub-region. The CT scanner provides a three dimensional database of the brain. The combination of the CT scanner and stereotaxy optimises the use of the former. Stereotactic instrumentation provides the capability for rapid access with great accuracy to virtually any intracranial point. The rationale for applying stereotactic methodology to neurosurgical procedures is to access targets accurately with a minimum of spatial error (i.e. low bias) and a high degree of reproducibility (i.e. high precision). In the management of intracranial lesions, intracranial access can be achieved and valid answers obtained regarding processes that required craniotomy or high risk cerebral transit. The histological nature of any suspicious intracranial lesion may be determined safely and accurately thereby enabling the compilation of an accurate database for intracranial lesions. It is also possible to evacuate intracranial hematomas; aspirate cysts or abscesses; provide guidance for small lesions; perform functional procedures (eg. for movement disorders, epilepsy) and the implantation of interstitial radioactive sources into intracranial neoplasms.

Since stereotactic surgery is a minimally invasive neurosurgical technique that is thought to reduce hospitalization periods, blood transfusion requirements, the need for general anesthesia and consequently health care costs, it was decided to introduce it into Ghana; the neurosurgeon/population ratio in Ghana is 1:9million. This study is a retrospective evaluation of the first seventeen consecutive stereotactic procedures. It also discusses the benefits, challenges and prospects of the program in West Africa.

Materials and methods

17 patients (11F, 6M) with CT disclosure of intracranial mass lesions that could be assessed or managed stereotactically to the patients benefit (3,4) underwent stereotactic procedures during a consecutive 18-month period. Analysis of charts, relevant imaging studies and pathology reports were done.

CT-Guided Stereotactic Procedure.

A Leksell G frame (Elekta AB, Sweden) was placed under local anesthesia and CT imaging performed. Contrast material (60% meglumine iohalamate) was given 10-20 min prior to imaging. Target point selection was based on imaging morphology, location and anticipated risk of causing complications especially hemorrhage or neurologic deficits. The enhancing portion of a suspected tumor was usually targeted; in a nonenhancing mass, the center of the mass was targeted. Stereotactic coordinates were obtained using CT scanner software and verified by a manual method.

Patients were then transported to the OR suite where under sterile conditions and utilizing local anesthesia and IV sedation, intracranial access was obtained via a 2mm or 4mm twist drill calvarial opening. 3-6 biopsy specimens were taken in each case and subjected to histopathologic analysis. The safest and usually shortest transit penetrating one pial surface was utilized while taking into consideration the structures in the transit path to the lesion. Biopsy specimens were obtained with a Blaklund spiral biopsy needle. Facilities for intraoperative frozen section were not available.

No blood transfusions were required. All scalp wounds were closed with the use of only one unit of non-absorbable suture material.

Results

17 consecutive stereotactic procedures were performed. There were 6 males and 11 females; ages ranged from 2 to 72 years with one patient under 10 years. The mean age was 36.7 years (SD, 19.4). 16 cases (94%) achieved a definitive diagnosis, and 1 case was classified as failed biopsy, providing a failed biopsy rate of 6%. The pathological findings of the overall series are presented in table 2.

Imaging Characteristics

All the lesions were in the supratentorial compartment; there were a total of 17 target mass lesions. There were 8 dominant hemispheric and 2 non dominant hemispheric targets. Two targets each were temporal, sellar/parasellar, basal ganglionic and 1 was pineal (Table 1). In all cases, contrast-enhanced CT scans were performed in order to guide target selection. Contrast enhancement was present in 13 of the 17 cases (76%). The mean CT scan time was 18 minutes (R 5-48mins; SD 13).

Pathological Findings, Management

Neoplasm constituted 59% and was the commonest histologic diagnosis 12 cases (71%) had a preoperative diagnosis of brain tumor; 10 cases (83%) were confirmed. 80% of the neoplasms were astrocytomas and formed 47% of the entire series of patients. Two patients had glioblastoma multiforme and 6 had low grade astrocytomas. Two of the low grade astrocytomas had a cystic component which was aspirated. One patient each had a pituitary adenoma and pinealoblastoma. One patient who was thought to have an occipital glioma on biopsy turned out to have an early bacterial abscess and cerebritis, both of which resolved completely after antibiotic therapy.

Two patients had large ganglionic hemorrhages with mass effect and worsening neurologic status. They both underwent stereotactic aspiration/evacuation utilizing the Blacklund device. One died 3 days post operatively following a massive ganglionic rebleed and a new mesencephalic hemorrhage. The other was discharged with GOS 1.

Arachnoid cysts were biopsied and aspirated in 2 patients. One of the patients who was 2 years at the time of the procedure, had complete resolution of the cyst confirmed by CT imaging performed 11 months after the stereotactic procedure. She has however developed non-communicating hydrocephalus for which endoscopic third ventriculostomy and or aqueductoplasty is planned. In total, 6 of the cases (35%) underwent both biopsy and aspiration/evacuation.

Normal brain was retrieved in one patient. No targeting error was confirmed by postoperative imaging. The mean duration of follow up was 9 months (R 3days-18months; SD 6months).

Cost

The cost of stereotactic procedures was compared to the cost of conventional craniotomy. The following parameters were used to calculate the costs of the two kinds of procedures; 1) cost of stereotactic CT scan 2) cost of OR consumables, viz. Anesthesia, sponges/swabs, patties, 3) laboratory tests. 4) drugs 5) cost of 2 days stay in Intensive/Critical care unit 6) Cost of 7-10 days in hospital.

The following assumptions were made a) no stereotactic scan is required for conventional craniotomy b) for stereotactic procedures, no days were spent in the Intensive/Critical care unit c) 2-3 days of hospital stay is required for stereotactic procedures as compared to 7-10 days for conventional craniotomy. It was found using the above parameters and assumptions that stereotactic procedures cost 50-59% less than conventional craniotomy. In the series, the average OR time was 37 minutes (R 30-43; SD 4). The mean duration of hospital stay was 2.7 days (R 2-7days; SD 1.4).

Discussion

Two old and simple concepts, a three-dimensional positioning stage and a coordinate system were combined in 1906 to create a new one; the stereotactic method (7). The advent of computer-based medical imaging applied to the stereotactic method encouraged the adaptation of the later to the management of intracranial tumors (13). The incorporation of CT scanning into stereotactic technique in the early 1980's was an obvious step for two reasons. First, CT provided a precise 3-D database that can be readily translated into the 3-D coordinate system of a stereotactic frame. Second with CT scanning, tumors could be seen directly instead of having their positions inferred from shifts of components of the ventricular system or from shifts of vessels on cerebral angiography.

Evaluation of the enhanced anatomic detail provided by the CT scanner could therefore be used for surgical planning. The availability of stereotactic surgical equipment and technique therefore optimises the use of the CT scanner. Optimal use of a CT scanner is crucial since the acquisition and maintenance of a CT scanner involves a large capital investment. Our study reveals that the mean CT scan time of 18 minutes required for stereotactic data acquisition can readily be fitted into the schedule of a Radiology Department in the region without significant disruption. Appuzo et al reported that a scan utilization time of less than 15 minutes renders the issue of scanner access in a busy neurosurgical service inconsequential (1). Furthermore, the acquisition of MRI equipment by an institution in West Africa will be superfluous unless that institution has the capability to perform stereotactic surgery.

Hitherto, localization methods for intracranial procedures in West Africa have been qualitative and imprecise. Large skin and bone flaps have been utilized in order to ensure that the relevant lesion lay within the limits of the craniotomy. Consequently, general anesthesia, blood transfusions and several days of critical post-operative care have been required. The lack of relative availability of these resources within the sub-region has made the practice of neurosurgery difficult and problematic. The purpose of incorporating stereotactic methodology into neurosurgical practice is to provide an improvement in localization over that which is available. The proper clinical use of stereotactic methodology, requires a mature technological understanding of the available instruments and a clear understanding of their benefits and limitations. Clinically, the determinants of application accuracy should be considered before every use of stereotactic methodology for any therapeutic intervention (11,18). As shown from this study, stereotactic procedures can be accomplished without the need for general anesthesia, blood transfusions and critical post-operative care. An added advantage is the ability to surgically treat neurologic patients with mild or severe systemic disease that is incapacitating or life-threatening (ASA II-IV) with much less added risk. The average OR time of 37 minutes is much less than that required for a conventional craniotomy.

A comparative cost analysis revealed a 50-60% reduction in total costs for stereotactic procedures when compared to conventional craniotomy. This analysis took into account the cost of the stereotactic CT scan, operating room costs, pharmaceuticals and length of hospital stay. The mean duration of hospital stay of 2.7 days is considerably lower than for conventional craniotomy. In the sub-region almost all patients who undergo craniotomy have had to remain in hospital for at least 7 days in order to ensure proper wound healing and suture removal before discharge. Stereotactic procedures also reduce the need the OR swabs/sponges, patties, scalp clips, sutures, wound drains, wound dressings and laboratory tests. Further cost reductions are obtained by reducing the need for Intensive/Critical care and the utilization of local anesthesia

complemented by intravenous sedation for procedures. Stereotactic procedures will help to reduce the on health care professionals and resources in the sub-region.

All the target lesions were in the supra-tentorial compartment. However, stereotactic procedures can also be performed for posterior fossa lesions (1,8,12,20). Table 2 gives the histopathologic processes substantiated in the 17 biopsied lesions. The diagnostic biopsy rate has varied between 91 and 100% (2,9). Diagnostic success is predicated on proper case selection, precise point target tissue retrieval and informed pathologist feedback. Proper case selection demands that the decision to employ stereotactic biopsy should be preceded at all times by a thorough neurologic and radiographic assessment of the patient. Lesions such as ischemic infarcts, vascular malformations and multiple sclerosis should not be biopsied. The prevention of targeting error can be technically achieved by careful data entry and the avoidance of angulation of biopsy probes at the calvarial entry point. Real-time intraoperative imaging can in the future provide for monitoring the biopsy needle in relation to the intended target. Finally, the availability of intraoperative frozen section/smears often provides useful information to guide the surgeon and should be used whenever possible (21). We had to depend entirely on review of histologic sections after permanent fixation; facilities for frozen section review are not available.

There is a wide range of failed biopsy rates in the literature, 3-47%. This is as a result of the wide differences in definition of failed biopsy rates (1, 5, 10, 15-17, 19, 22-24). Soo et al have classified failed biopsies as lesional or nonlesional (24). Lesional failed biopsies reflect a nonspecific pathologic change e.g astrogliosis, necrosis or inflammatory change. Lesional failed biopsies can be further divided into representative and nonrepresentative. The representative group have a time window outside which definitive diagnosis cannot be made as the pathologic elements become less distinct e.g radionecrosis, subacute infarction or a demyelinating plaque from multiple sclerosis. In these situations it is sometimes impossible to obtain a definitive diagnosis even after craniotomy and open biopsy. Although these lesions are generally not biopsied, in some instances, neither clinical judgement or current available imaging modalities can differentiate them from neoplastic or infective processes, hence necessitating biopsy. The lesional nonrepresentative failed biopsies are due to biopsying either the reactive edges or the necrotic areas of heterogeneous neoplastic or infectious processes. These may be considered as a relative target selection error or minor targeting error. In spite of the limited diagnostic usefulness of lesional failed biopsy, in certain cases the pattern of the changes suggests a specific diagnosis such as tumor necrosis versus coagulative necrosis of infarction. In nonlesional failed biopsy, the predetermined target on a static CT scan was missed, yielding normal brain. This may occur as a result of the lesion migrating away from an advancing biopsy needle. A slight angular deflection of the semirigid biopsy needle on account of an angled twist drill calvarial entry may lead to the biopsy device missing the lesion tangentially. The failed biopsy rate for the series is 6%. Meta-analysis of 9,467 published cases of stereotactic biopsy from series with over 100 cases yields a failed biopsy rate of 9% (24).

It has been commonplace to blame diagnostic failure on the size of the biopsy specimen, i.e it is too small (14). However a representative specimen is always of sufficient size for a diagnosis to be made and representative tissue is better obtained with stereotactic technique than with open biopsy methods (6). The elucidation of the molecular pathogenesis of CNS tumors will hopefully lead to a molecular classification and enable improved diagnostic yields from small stereotactic biopsy specimens, eg DNA analysis using polymerase chain

reaction requires less than 100ng of DNA to identify infectious agents such as toxoplasma; differentiation of astrogliosis from a low grade glioma using molecular markers such as p53 mutation, loss of genetic information on chromosome 19q or over expression of growth factor receptors implicated in tumorigenesis (24).

From an initial start of biopsies and aspirations/evacuations, a stereotactic surgery program in West Africa can be expanded to include stereotactic endoscopy, stereotactic craniotomy, functional neurosurgical procedures and radiosurgery. The benefits from such a program will include, the acquisition of an accurate histologic database for intracranial lesions, capability for neurophysiologic research, enhanced medical education for medical students and neurosurgical residents, clinical improvements in patient care and reduction of health care costs.

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Table1

Location of target masses (17 procedures)

CEREBRAL (17)	
Dominant hemisphere	8
Non-dominant hemisphere	2
Basal ganglia	2
Sellar/Parasellar	2
Temporal	2
Pineal	1

Table2

Summary of histologic diagnosis in 17 stereotactic biopsies

Diagnosis	Cases	
	N	%
NEOPLASTIC		59
Glioma	8	47
Others	2	
VASCULAR	3	
ARACHNOID CYST	2	
INFECTION	1	
NORMAL	1	

Poems of Black Africa

SOUFFLES

écoute plus souvent
les Choses que les Êtres
la Voix du feu s'entend
Entends la Voix de l'Eau
écoute dans le Vent
le Bourdon en sanglots
C'est le Souffle des ancêtres

Ceux qui sont morts ne sont jamais partis
ils sont dans l'Ombre qui s'éclaire
Et dans l'ombre qui s'épaissit
les Morts ne sont pas sous la Terre
ils sont dans l'Arbre qui tremble
ils sont dans l'Bois qui se meut
ils sont dans l'Eau qui coule
ils sont dans l'air qui souffle
ils sont dans la Case
ils sont dans la Loue
les Morts ne sont pas morts

écoute plus souvent
les Choses que les Êtres
la Voix du feu s'entend
Entends la Voix de l'Eau
écoute dans le Vent
le Bourdon en sanglots
C'est le Souffle des ancêtres morts
qui ne sont pas partis
Qui ne sont pas sous la Terre
Qui ne sont pas morts
Ceux qui sont morts ne sont jamais partis
ils sont dans le Sein de la Femme

ils sont dans l'Enfant qui vaude
Et dans le lion qui s'effarouche
les Morts ne sont pas sous la Terre
ils sont dans l'Arbre qui tremble
ils sont dans l'Bois qui se meut
ils sont dans l'Eau qui coule
ils sont dans l'air qui souffle
ils sont dans la Case
ils sont dans la Loue
les Morts ne sont pas morts

écoute plus souvent
les Choses que les Êtres
la Voix du feu s'entend
Entends la Voix de l'Eau
écoute dans le Vent
le Bourdon en sanglots
C'est le Souffle des Ancêtres

il récite chaque jour le Père
le grand Père qui le
Ouille à la Loue s'entend
Ouille dans les Souffles plus forts
ce sont les mort vivants qui ne sont pas morts
le lion de l'air qui se meut
il récite le grand Père qui le
des Souffles qui se meutent
dans le lion sur les crânes de Fleuve
des Souffles qui se meutent
dans la Kacher qui gémit et dans l'Herbe qui
pleure

des Souffles qui se meutent
dans l'Enfant qui s'éclaire et s'effarouche
dans l'Arbre qui tremble dans le Bois qui
se meut
ce sont les mort vivants qui ne sont pas morts
ce sont les mort vivants qui ne sont pas morts
ce sont les mort vivants qui ne sont pas morts
ce sont les mort vivants qui ne sont pas morts
ce sont les mort vivants qui ne sont pas morts
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écoute plus souvent
les Choses que les Êtres
la Voix du feu s'entend
Entends la Voix de l'Eau
écoute dans le Vent
le Bourdon en sanglots
C'est le Souffle des ancêtres

BURACO DIOP
(Sénégal)
in *Présence Africaine*

