Original Article

ACCURACY AND SAFETY OF CT-GUIDED STEREOTACTIC SURGERY IN THE DIAGNOSIS OF DEEP SEATED, SMALL AND ELOQUENT AREA BRAIN LESIONS

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ABSTRACT

Objective:

To assess the accuracy of the target trajectories and complications risk rate of computed tomography (CT) guided stereotactic surgery in the diagnosis of deep seated, small and eloquent area brain lesion.

Methods:

This three years study from March 2006 to April 2009 was conducted at Department of Neurosurgery, Jinnah Postgraduate Medical Centre Karachi. The study includes 44 patients with clinical and radiologicaly diagnosed brain space occupied lesion (SOL). Relevant history was obtained and clinical and neurological examination was done. CT scan brain and magnetic resonance imaging (MRI) brain with contrast performed. The Cosman Roberts Well (CRW) arc based frame used for all procedures.

Results:

Procedure was carried on 44 patients, 15 females and 29 males with female to male ratio of 1:1.93. Biopsy was performed for deep seated lesions n=23, midline and corpus callosum tumors n=11, lobar lesion n=9 and in 1 patient biopsy taken for suprasellar cystic SOL, with reservoir placement. Astrocytic neoplasm was the commonest which include n=26 (59.09%) cases. Forty two biopsies were positive and clinically and radiologicaly correlated. Two biopsies results were not confirmed. The mortality were n=2 (4.45%).

Conclusion:

Stereotactic procedure is easy to perform, accurate in targeting the lesion, and spare patients from undergoing major surgical procedures. The specimen taken for biopsy is adequate for diagnosis. Target localization is more than 95% if meticulous methodology is applied. Overall, complications arising from stereotactic brain biopsy are infrequent but can be disastrous.

Keywords: Space occupied lesion, stereotactic procedure, eloquent area, CRW

INTRODUCTION

Stereotactic biopsy is commonly used and achieves a better adaptation of the therapeutical strategy according to the lesions site and histological diagnosis.[1] Advances in neuro-imaging techniques and improvements in stereotactic instrumentation have led to the increasing use of stereotactic surgery in the neurosurgical field.[2] The advances in radiological imaging techniques provide early detection of neurological diseases. However, none of these techniques is able to provide an adequate and reliable diagnosis to constitute a definitive treatment modality.[3] The pathologic interpretation is limited by the small size of specimen, however. The accuracy of histologic

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diagnosis in experienced hands is about 90% overall.[4] This study analyzed the results of brain biopsies to investigate the characteristics and accuracy of CT guided stereotactic procedure and to share the experience of Stereotaxy for diagnostic and therapeutic interventions. We described the surgical method used in our centre, the variety of the diseases for which stereotactic surgery was applied and evaluated our results with the help of current literature.

MATERIALS AND METHODS

This three years study from March 2006 to April 2009 was conducted at Department of Neurosurgery, Jinnah Postgraduate Medical Centre Karachi. The guiding instruments used in this series were Head Ring, Brown Roberts Well (BRW) head localizer and the CRW stereotactic arc based frame (Radionics, Burlington, MA, USA). The study includes 44 stereotactic procedures in 44 patients with clinically and radiological diagnosed brain SOL. The gender distribution was 34.09% (n=15) female and 65.90% (n=29) male. The age range was 15 to 62 years.

Stereotactic biopsy procedure

The whole stereotactic procedure completed in multiple stages. After cleansing of the patients head with Iodine solution and then spirit, the stereotactic head ring with BRW head localizer was applied with local anesthesia. The patient was then taken to the CT room and thin slices of (3-mm.) axial CT images were obtained, if necessary intravenous contrast injection applied for clear target. Then the patient was taken to the operating room for surgery. During this period the best axial CT images were taken showing the target lesion, calculated by the computerized Radionics software for CRW arc based system. Only a small area of the scalp was shaved and cleaned with antiseptics, the CRW arc frame was attached to the head ring and a burr hole 1 cm in diameter was performed for the entry point, with special attention to avoid eloquent or vascular areas. Nashold biopsy needle was used for biopsy or aspiration for SOL. In solid tumors we took a small specimen about the size of the kernel of rice while in cystic lesions or abscesses we tried maximum aspiration. The tumor tissue was sent to the laboratory in 10% formalin, while Pus from abscesses for culture and sensitivity and cystic fluid for cytology.

RESULTS

Between March 2006 to April 2009, out of 44 patients the 42 had a confirmed histo-pathological diagnosis after the initial biopsy. The localizations of the lesions were 9 (20.45%) lobar (frontal, temporal, parietal, occipital), 23 (52.27%) deep seated (thalamic, basal ganglia, brain stem), 11 (25%) mid line and 1 (2.27%) suprasellar (Table 1). The histo-pathological diagnoses were 26 (59.09%) neuroepithelial tumors, 2 (4.45%) metastases, 3 (6.81%) primary lymphomas, 6 (13.63%) tuberculomas, 4 (9.09%) pyogenic abscesses, and 1 (2.27%) were craniopharyngioma, (Table 1). The two (4.45%) patients were not having satisfactory biopsy results, one patient reported with suspicion of tuberculoma. Anti tuberculosis treatment started and in follow-up MRI after three months the size of lesion decreased. Second reported with necrotic tissue advised additional operation but patient refused. The correct histological diagnosis was made for 42 of the 44 patients so the diagnostic accuracy in this series was 95.45% (42/44). Astrocytic neoplasm were the commonest which include 16 glioblastoma multifome, 3 grade III astrocytomas, 2 grade II astrocytomas, and 5 diffuse low grade

Table 1. Male to female ratio, anatomical location and histological findings of lesions in patients undergoing stereotactic operation (n=44).

Total patients	44
Male	29 (65.9%)
Female	15 (34.1%)
Age (years)	15-62
Localization	
Deep seated	23 (52.27%)
Midline	11 25.00%)
Lobar	9 (20.45%)
Suprasellar	1 (2.27%)
Histological Findings	
Glioblastoma multiforme	16 (36.36%)
Tuberculomas	6 (13.64%)
Diffuse low grade Astrocytoma	5 (11.36%)
Abscess	4 (9.09%)
Astrocytoma grade III	3 (6.82%)
Lymphoma	3 (6.82%)
Astrocytoma grade II	2 (4.55%)
Metastases	2 (4.55%)
Craniopharyngioma	1 (2.27%)
True diagnosed cases after initial biopsy	42 (95.45%)
Undiagnosed	2 (4.55%)

astrocytomas. Of the 26 astrocytic tumors, 12 were located in thalamus, 8 midline corpus callosum, 2 in the brain stem (Figure 1), 3 in the basal ganglia and 1 hemispheric (eloquent area). All the 3 cases of primary central nervous system lymphomas were located in midline. All 4 small abscesses aspirated from the parietal, frontal and temporal lobes (Figure 2).

Fig. 1. T1 weighted contrast axial MRI of a 20 years female patient, showing a small brainstem lesion. Histopathological report after stereotactic biopsy grade III astrocytoma.

There were two mortality (4.45%) with post-operative complications, one patient with intraventricular hemorrhage and the second with acute subdural hematoma (Figure 3). Both patients died within 12-24 hours of the stereotactic procedure.

DISCUSSION

Computed tomography (CT) and magnetic resonance (MR) imaging provide precise three dimensional information on the location and configuration of intracranial lesions. Even before the advent of CT guidance, stereotactic surgery was used to localize, biopsy, and treat certain deep-seated lesions. Certain modern technological modifications have facilitated this kind of surgery, although stereotactic procedures with the aid of CT have been widely used in brain biopsy.[5]

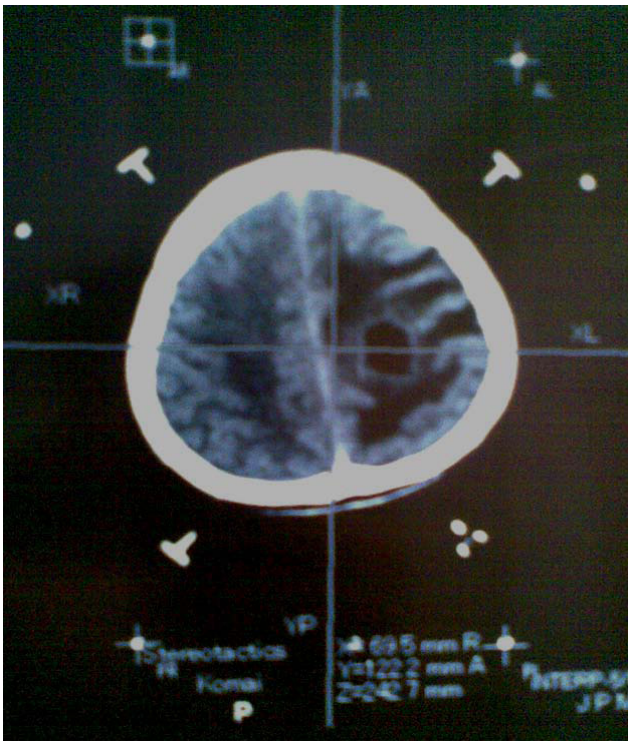

Fig. 2. CT scan brain plain axial image (during procedure) of a 28 years old male patient, stereotactic aspiration performed, diagnosed pyogenic abscess.

Fig. 3. The axial plan CT scan of a 40 years old male patient, just after 1 hour of stereotactic biopsy procedure. A complication of Rt sided acute sub dural hematoma.

The stereotactic brain biopsy (SBB) is indicated for the histopathological diagnosis of a deep seated lesion or a lesion in the eloquent areas of the brain that could be approached by craniotomy with high risk to the patient, for a diagnosis of diffuse infiltrative brain lesions, multiple lesions, cystic lesions and for the patients with poor medical conditions for a craniotomy. In these patients, stereotactic biopsy provides a small sample of a tissue from a target point predetermined by radiological methods with low morbidity and mortality rates.[6]

In a review of large stereotactic brain biopsy series G.R. Sharma *et al.*[2] has shown 100% accuracy of target localization and the non-diagnostic biopsy rate was 3.1% and this occurred predominantly in non-neoplastic lesions. Calişaneller T *et al.*[3] described that the accuracy rate of histopathological diagnosis reached in the first CT-SBB session in 81 out of 94 (86.16%), Jain D *et al.*[7] presented (84.21%) 80 in out 95. Ferreira MP *et al.*[8] mentioned that stereotactic CT-guided biopsies allowed diagnosis in 157 cases out off 170 (92%). Yu X *et al.*[9] diagnosed pathologically 266 cases out of 310 patients of brain tumors (85.8%), supporting author's observation i.e. 42 out of 44 patients (95.45%). It suggests that if meticulous methodology is applied then this procedure carries high accuracy ratio and gives an excellent diagnostic yield. The over all diagnostic accuracy varies from 80 to 99%.[7,10]

A number of methods have been offered to increase the accuracy of the CT guided stereotactic brain biopsy, such as targeting multiple regions of the lesion, delaying the localization scan after the administration of contrast medium to improve resolution and target selection, using intraoperative frozen section or cytological examinations, utilizing modern histopathological techniques.[3,6,9,10] Because of the small sample size of specimens, communication with the neurosurgeons as well as correlation with clinical and radiographic information is necessary to increase the diagnostic yield.[7]

The most common cause of the stereotactic procedure related morbidity and mortality is hemorrhage.[3,6,10] Takahashi H *et al.*[11] from 1991 to 1995, performed CT-guided stereotactic biopsy in 310 patients with intracerebral lesions. Intracranial hematomas after biopsy were found in 5 patients (1.6%). There were no deaths induced by the biopsy or other serious complications. In the studies of Kongkham PN *et al.*[12] morbidity and mortality rates were 6.9% (43/622) and 1.3% (8/622), respectively. The risk of symptomatic hemorrhage (intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH) was 4.8%. In the series of G.R. Sharma *et al.*[2] n=2 cases (1.7%) were complicated with intracerebral hematomas and both died within 48 hours of the stereotactic procedure. Mildly raised pattern of mortality with complications were noted in author's series. There were two mortalities (4.45%) with postoperative complications, one patient with intraventricular hemorrhage and the second with acute subdural hematoma. Acute subdural hematoma was a new experience of stereotactic procedure's complications. There was no morbidity found in remaining 42 patients.

Avoidance of procedural complications like intra cerebral hemorrhage is largely dependent upon case selection, pre operative evaluation of patients and surgical expertise.[13] Detailed preoperative surgical planning, using small biopsy forceps, limiting the number of specimens and performing intraoperative histopathological examination, avoiding pial/ependimal surfaces in trajectory select a convenient and safe probe trajectory, and the type of biopsy forceps we used provided adequate tissue sampling for a variety of lesion types and texture. Although this type of probe can cause complications due to traction of the neighboring vessels, this can be avoided by careful selection of the biopsy probe trajectory or using another type of biopsy probe as needed.[2,6,14]

Stereotactic brain biopsy associated with a low likelihood of post biopsy hemorrhage, despite unremarkable findings on an immediate post biopsy head CT scan, but this risk justifies an overnight hospital observation stay for all patients after having undergone stereotactic brain biopsy.[15]

CONCLUSION

This study provided evidence that stereotactic procedure is easy to perform, accurate in targeting the lesion, and spare patients from undergoing major surgical procedures. The specimen taken for biopsy was adequate for diagnosis. Target localization is more than

95% if meticulous methodology is applied. Overall, complications arising from stereotactic brain biopsy are infrequent but can be disastrous.

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