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Incidence of Miss Targeting in Frame-based Stereotactic Brain Surgery

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ABSTRACT

Background: accurate localization of a lesion is the ultimate goal of stereotactic surgery. Frame-based systems have the advantage of proven clinical utility and instrument carriage with a high degree of mechanical stability and accuracy. **Aim of the work:** this study aimed to investigate the incidence of miss targeting in frame based stereotactic brain surgery. **Patient and methods:** this was a retrospective study and included non-comparative, consecutive case series of 200 cases of different intracranial lesions, using CT imaged Leksell G stereotactic brain surgery, for diagnostic 180 cases or therapeutic 20 cases purposes and they performed at Sayed Galal University Hospital and other neurosurgical centers at Egypt between Jan 2015 and Jan 2018.
Results: there were 120 males and 80 females. The procedures were performed under local anesthesia. Diagnostic purposes were the most encountered procedures for 180 cases, while therapeutic were 20 cases. The incidence of miss targeting was 2% of the studied group, which was noticed among the diagnostic group (2/180 = 0.011%) more than the therapeutic group (2/20=10%). **Conclusion:** the incidence of miss targeting in frame based stereotactic brain surgery is a concern and must be suspected.
Recommendations: stereotactic surgical team must evaluate every surgery steps very carefully.
Key words: stereotactic surgery, frame based surgery, miss targeting, sliding phenomena.

INTRODUCTION

In clinical practice, brain imaging can now be divided in two parts: the diagnostic neuroradiology and the preoperative stereotactic localization procedure. The latter is a part of the therapeutic procedure. It is the surgeon's responsibility and should be closely integrated with the operation [(1)]. The purpose of incorporating stereotactic methodology into neurosurgical operations is to achieve a consistently high degree of accuracy in localizing intracranial targets [(2)]. Stereotactic surgery is currently undergoing great changes with a large number of frameless methodologies being developed alongside traditional frame-based systems [(3)]. Frame-based systems have the advantage of proven clinical utility and instrument carriage with a high degree of mechanical stability and accuracy [(3)]. It is concluded that conventional frame-based stereotaxic has higher accuracy/precision for hitting a small brain target than the frameless technique. However, the difference is relatively small [(4)]. In this study: I am recording major miss targeting not just small errors of inaccuracy(some due to human factors and others are due to tissue factors or instrument factor).

The aim of the study: the purpose of this study was to investigate the incidence of Miss targeting in frame based stereotactic brain surgery.

Methods and patients : this was a retrospective study and included a retrospective, non-comparative, consecutive case series of 200 cases of different intracranial lesions , using CT imaged Leksell G stereotactic brain surgery , for diagnostic 180 cases or therapeutic 20 cases purposes performed at Sayed Galal University Hospital and other neurosurgeical centers at Egypt between Jan 2015 and Jan 2018.

Results: A total of 200 patients who underwent a frame-based stereotactic surgery using the Leksell G frame system were operated. The mean ± standard deviation of age at time of the procedure was 39.4 years ± 20.3 years and range from 12-72 years. There were 120 males and 80 females. The procedures were performed under local anesthesia to avoid complications of general anesthesia; diagnostic purposes were the most encountered procedures for 180cases, while therapeutic were 20 cases.

Aim of the procedure	Miss targeting
Diagnostic - 180 cases	2 (one is surgeon's miscalculation and the other is lesion displacement) = 2/180 = 0.011% of diagnostic group…..one due to human factor and the other due to pathology instrument relationship.so that the true miss targeting is one.
Therapeutic- 20 cases	2(one surgeon overpassing and the other pathology instrument relationship flexible= stylet displacement by the thick capsule of the lesion) = 2/20 =10% of therapeutic group. So that the true miss targeting is one.
Total number of cases were 200	4/200= 2% of the total number of cases
	2/200= 1% of the total after exclusion cases of malpractice.

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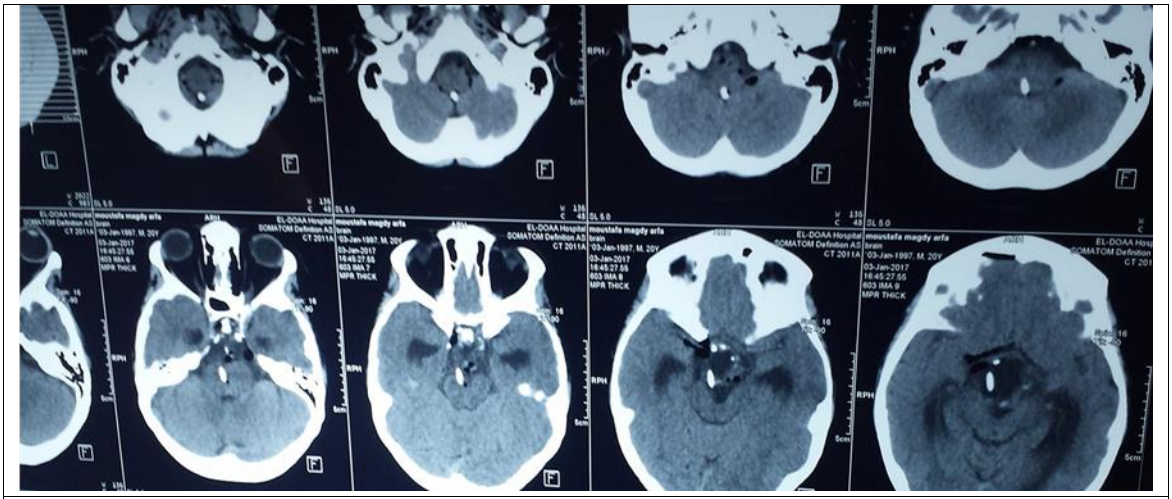
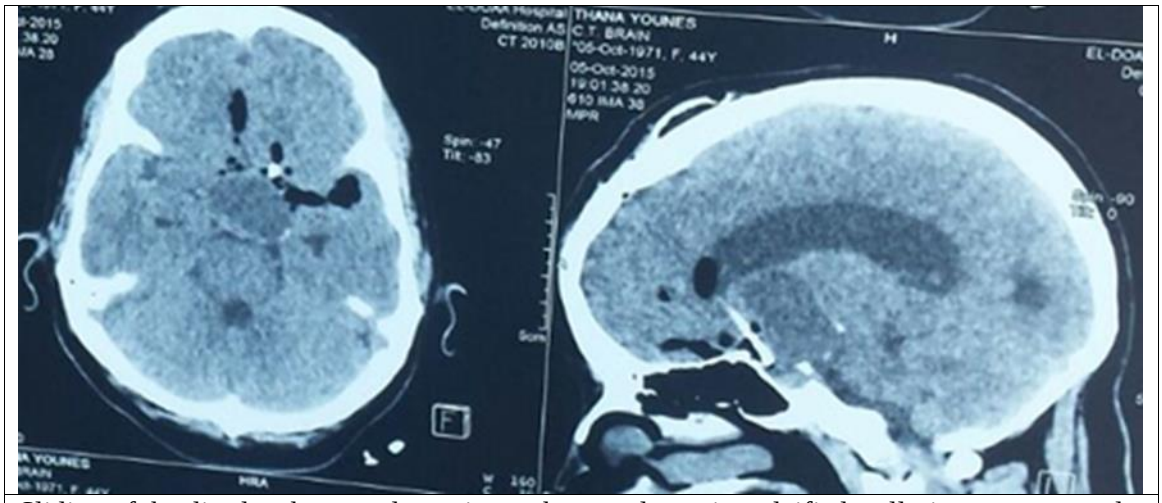
CASE NO 1



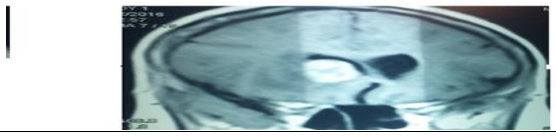
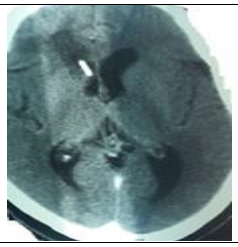
Displacement of the distal catheter end passing through the pons then 4th ventricle till below the foramen magnum which was corrected safely without any disaster. This case is attributed to miscalculation of the desired distance. Actually it is related to human factor (malpractice).

CASE NO 2



Sliding of the distal catheter end anterior to the cyst due to its calcified wall , it was corrected by introducing the needle first to open the calcified wall then the stylet..

CASE NO 3

		
Axial CT brain (stereogram) showing right frontal periventricular hyperdense lesion ….with stereotactic biopsy from the calculated target …histopathology astrocytoma grade 2 but the lesion of the same size without intralesional hyper or hypodense sign.	Coronal MRI brain of the same patient showing the hyperintense peri or intraventricular lesion….the lesion is solid wihout surrounding supporting tough tissue. So it is liable to be pushed rather than to be punctured .so the histopathology is not satsisfactory for the surgeon. So the patient was prepared for open surgery and complete excision.	Complete excision of the lesion with shunt insertion ….histopathology showing cavernoma

CASE NO 4

60 years old male patient with deeply seated thalamic lesion, prepared for stereotactic biopsy with manual calculation, but during insertion of the needle for biopsy miscalculation of the X, Y, and Z points was discovered, so recalculation was done with proper needle insertion.

Deep thalamic lesions were the most frequently encountered location of lesions biopsied in our study (49 = 24.5%) followed by deep frontal (29 = 14.5%) and parietal (23 = 11.5%) locations. Other locations included supraseller (9), occipital (4), pineal (4) and brainstem (2) lesions. All cases were carried out using CT images. The CT based stereotactic surgery was preferred by the surgical team because of rapid, safe, and accurate stereotactic measures.

The original size of the lesions ranged from 1-8 cm in maximum diameter, with a mean of 3.63 ± 1.8 cm. Targeting accuracy was calculated as the percentage of cases when 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.The signs confirming accurate lesion targeting may be one or more of the following: hyperdense sign denoting blood inside the lesion caused by the needle, hypodense sign denoting air dots inside the lesion or aspiration of abnormal cystic content.

In all cases, but 4, the lesions were accurately targeted. The incidence of miss targeting was (4/200= 2%) of the studied patients, which was noticed among the diagnostic group (2/180 = 0.011%) more than the therapeutic group (2/20=10%). one of the cases was corrected intraoperative by recalculation while the other 3 were corrected at another session. By exclusion the cases of malpractice, the true miss targeting was 2 cases only.

List of abbreviations:

ioMRI	intra-operative MR
SBS	Stereotactic brain surgery
Jan	January

DISCUSSION

Conventional frame-based stereotaxic has higher accuracy/precision for hitting a small brain target than the frameless technique. However, the difference is relatively small and does not influence the clinical result [(4)]. The purpose of incorporating stereotactic methodology into neurosurgical operations was to achieve a consistently high degree of accuracy in localizing intracranial targets [(2)]. But, some fallacies in stereotactic practices may occur which may be related to one of the following: miss targeting, insufficient biopsy or factors related to histopathologists. Frame-based, frameless and ioMRI-guided brain biopsy techniques were approximately equivalent in their ability to reliably obtain a histopathological diagnosis following lesion sampling in the group of patients with no prior radiation or surgical treatments.

Frame-based brain biopsy has better diagnostic yield than ioMRI guided biopsy when all patients are included in the analysis [(6)].The frame-based approach, however, required significantly less anesthesia resources, less operating room time and shorter hospital stays, and thus should still be considered a first-line approach for stereotactic brain biopsy [(7)].**Dammers *et al***. found no difference in frame-based and frameless stereotactic brain biopsy with a combined 89.4% diagnostic yield and no difference in complication rates comparing the two methods [(8)].

Woodworth *et al*. also reported similar findings, showing a 90% combined diagnostic yield with no differences between frame-based or frameless techniques [(9)]. **Dorward *et al***. compared frameless and frame-based biopsy techniques and found superior imaging, target visualization and flexibility of the frameless stereotactic biopsy when compared with the current gold-standard frame-based biopsy [(10)]. Irrespective of the superiority of the used localizing tool (either frame based stereotaxic, frameless stereotaxy or ioMRI) or the bias of histopathological examination of stereotactic biopsy, the goal of this study is to record the miss targeting errors only. Miss targeting is suspected if the surgeon loss one of the confirming signs which are: hyperdense sign denoting blood inside the lesion caused by the needle, hypodense sign denoting air dots inside the lesion or aspiration of abnormal cystic content.The miss targeting in this study was recorded to be 4 cases among 200 cases (2%).

The issue in this study was recording the miss targeting problems, which may be (1) preoperative inaccurate calculation or (2) intraoperative sliding of the lesion or sliding of the used catheter.

Regarding the preoperative miscalculation by the operating team: it is so rare to occur in the presence of software programs for calculation, but may occur if the surgeon depends only on the manual method for calculation .it is recorded in one case of this study like another study which was done by **Alkhani *et al***. [(11)].To overcome this problem, everyone in the surgical team must recheck the calculated figures at every step during presurgical planning and intraoperative.

Also miscalculation may occur during catheter insertion for therapeutic purposes, like case number one in this study. Regarding intraoperative sliding of the lesion for explanation of miss targeting in case number 3: it occurs if the lesion is solid without surrounding supporting tough tissue, so it is

liable to be pushed rather than to be punctured .it is more liable to occur by using the side cut needle biopsy than the oldest spiral needle biopsy.

Sharp tip probe would theoretically result in less brain deformation; however, the blunt tip probe is favored in view of potential penetration, rather than displacement, of intraparenchymal vessels and the resulting hemorrhage.

Twirling movements while advancing the probe will result in a corkscrew action and greater trauma to the brain parenchyma if the probe is not perfectly straight. A smooth, steady advancement will allow displacement rather than rupture of any vessels encountered by the advancing blunt tip [(5)].Sliding phenomena may be target sliding or probe sliding according to the power of penetration and stability of the target. Regarding sliding of the used catheter: this occurs if the capsule of the lesion is hard or calcified, with basal support so no chance for lesion sliding but the semimaleable catheter stylet will slide, it is recorded in one case of craniopharyngioma with calcified tough capsule, this case was corrected at the same day by penetrating the capsule firstly by the side cut stereotactic biopsy needle followed by insertion of the ommaya tube.

Giving attention to the proper targeting preoperatively by the 3 person checkup method and intraopertively by aspiration of the cystic content if the lesion is cystic and postoperatively by one or two of the following CT brain findings: CT brain hyperdense sign denoting hemorrhage inside the lesion confirming good targeting or hypodense sign of the lesion denoting air inside the lesion confirming accurate targeting. So, the hyperdense or hypodense signs both are new concepts in stereotactic surgery.

Point of weakness: limited number of cases and short period of the study.

Point of strength: hyperdense and/or hypodense sign [(12)] for every case of stereotactic surgery.

CONCLUSION

The incidence of miss targeting in frame based SBS stereotactic brain surgery must be a concern.so that the hyper and /or hypodense intralesional sign must be evaluated in every case postoperatively.

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