

# Assessment of Necessity of Neuronavigation in Localization of Clavarial Extra-axial Lesions in the Setting of Limited Resources.

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## Research

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# Abstract

**BACKGROUND:** Neuronavigation is a very beneficial tool in modern neurosurgical

practice. However, the neuronavigation is not available in most of the hospitals in our country raising the question about its importance in localizing the clavarial extra-axial lesions and to what extent it is safe to operate without it.

**METHODS:** We studied twenty patients with claverial extra-axial lesions who underwent surgical interventions. All lesions were preoperatively located with both neuronavigation and the usual linear measurements. Both methods were compared regarding the time consumed to localize the tumor and the accuracy of each method to anticipate the actual center of the tumor.

**RESULTS:** The mean error of distance between the planned center of the tumor and the actual was  $6.50 \pm 1.762$  mm in conventional method, whereas the error was  $3.85 \pm 1.309$  mm in IGS method. Much more time was consumed during the Neuronavigation method including booting,

registration, positioning. A statistically significant difference was found between the mean time passed in the conventional method and IGS method ( $2.05 \pm 0.826$ ,  $24.90 \pm 1.334$ , respectively),  $P$ -value  $< 0.001$ .

**CONCLUSION:** In the setting of limited resources, the linear measurement localization method seems to have an accepted accuracy in localization of clavarial extra-axial lesions and it saves more time than neuronavigation method.

## Background:

Neuronavigation is a very beneficial tool in modern neurosurgical practice. Sometimes it is nearly impossible to start an operation without its availability especially in small and deep lesions such as glioma and brain metastasis[1].

On the other hand, the necessity of neuronavigation usage is questionable especially in the convexity lesions like meningiomas[2]. Given into consideration the price of the machine and the accompanying sophisticated radiological studies, the enthusiasm becomes weaker to have such a technology as a prerequisite to perform a meningioma resection. Unfortunately, the image guided surgery (IGS) is not available in most hospitals in our country raising the question about its importance in localizing the clavarial extra-axial lesions mainly meningiomas and to what extent it is safe to operate without it.

## Methods:

We prospectively studied twenty patients with calvarial convexity meningiomas who would have surgical interventions. The patients were operated upon in the authors' institute in the period between July 2018 to February 2019.

## Data collection:

preoperative evaluation of all patients was done by history taking, neurological and radiological assessment. We excluded the recurrent cases from our study. All the patients had a preoperative CT (Computed Tomography) scan protocol which is compatible with the IGS system. CT scans were performed using a multi-slice CT scanner (Siemens® Somatom Emotion, Erlangen, Germany). MRI (Magnetic Resonance Imaging) study for the brain was done for all the patients before and after administration of IV contrast was done and MRV (Magnetic Resonance Imaging) was done in some cases. MRI was performed using 1.5 Tesla MRI-System (Achieva®, Philips Healthcare, Best, Netherlands). All lesions were preoperatively located with both neuronavigation and linear measurement methods. The intraoperative image guidance was done via (StealthStation® S7® System, Medtronic, Inc, Louisville, CO, USA), whereas the usual linear measurements were based on craniometric points.

## Assessment:

Both methods were compared regarding the time consumed to localize the tumor and the accuracy of each method to anticipate the actual center of the tumor. The calculated time started immediately after the finishing of anesthetic procedures till planning of an appropriate skin flap was finished. Data was analyzed using Paired Sample T-test via the Statistical Package of Social Science (SPSS) advanced statistics version 25 (IBM Inc®, Chicago, IL, US).

## Results:

This study included 20 patients with calvarial extra axial lesions. The mean age at the time of surgery for the studied group was 50.6 years ranging from 20 to 70 years. There was a female predominance. There were 14 females (70%) and 6 males (30%) which provide a female/male ratio of (2.33/1). The lesion was left sided in 11 cases (55%) and right sided in 7 cases (35%) and midline in 2 cases (10%). The duration of the presenting symptoms ranged from 2 week to 3.5 years with a mean of 8 months. Headache was the most common feature occurring in 75%. Seizures were the main complaint in 20% of cases. Weakness and numbness occurred in 10% of cases and two patients (10%) presented with an altered level of consciousness. All the patients had total tumor excision and the pathology was Meningioma in all cases.

A statistically significant difference was found between the mean time passed in the conventional method and IGS method ( $2.05 \pm 0.826$ ,  $24.90 \pm 1.334$ , respectively),  $P$ -value  $< 0.001$ . Also, a statistically significant difference was found between conventional method and brain lab one in the prediction of the center of the tumor. The mean error of distance between the planned center of the tumor and the actual was  $6.50 \pm 1.762$  mm in conventional method, whereas the error was  $3.85 \pm 1.309$  mm in IGS method with  $P$ -value  $< 0.001$  (Table 1,2).

Table 1

Descriptive analysis of the data of the 20 patients regarding accuracy and time consumed in both methods of tumor localization.

		Time of conventional (min)	Time of brain lab (min)	Error in conventional (mm)	Error in brain lab (mm)
Mean		2.05	24.90	6.50	3.85
Median		2.00	25.00	6.50	4.00
Std. Deviation		.826	1.334	1.762	1.309
Minimum		1	23	4	2
Maximum		3	27	9	6
Percentiles	25	1.00	24.00	5.00	3.00
	75	3.00	26.00	8.00	5.00

Table 2

Illustration of statistical significance between conventional and IGS methods regarding accuracy and time consumed in each method.

	Mean	Std. Deviation	P value
Time of conventional (min)	2.05	.826	<0.001
Time of brain lab (min)	24.90	1.334	
Error in conventional (mm)	6.50	1.762	<0.001
Error in brain lab (mm)	3.85	1.309	

## Discussion:

No one can deny the importance of neuronavigation facilities which became a cornerstone in most of the neurosurgical theaters worldwide. In the late eighties of the last century, there was a revolutionary appearance of spatial neuroimaging together with pointing instruments that provided three dimensional data, which in turn led to the development of "frameless stereotaxy" concept which consequently yielded the expression of "Navigation systems" after improvement of guidance and orientation abilities [3]. Multiple modalities of navigation systems then appeared with increasing efficiency to the extent that they helped the neurosurgeons to plan different procedures interactively, making the approaches less invasive and more accurate especially for subcortical lesions[4–6]. but on the other hand those facilities failed to achieve so much popularity among the society of neurosurgery regarding routine craniotomies.[1]

In most cases of claverial meningiomas and other extra-axial lesions, the neurosurgeon may not be compelled to use neuronavigation since most of the lesions are easily accessible immediately after craniotomy [2]. The only concern that might be worrying in those cases is the size of craniotomy. A

suitable size in many opinions is to be slightly larger than the tumor size, giving the surgeons the space needed for dissection of the tumor away from neurovascular structures, on the other hand a small flab makes the surgery more difficult and more risky, also an extremely larger flab carries the risk of more blood loss and unnecessary exposure of normal neural structures [7].

Despite the expenses of installment of intra-operative navigation system, Paleologos et al found that cumulative cost for the overall hospital stay is cheaper when the clavial meningiomas were operated with IGS. They took in consideration a lot of factors including the extra radiological work up that is needed for the navigation guidance and still it was cheaper, they attributed the decreased cost to less ICU (Intensive Care Unit) stay and less postoperative complications in the meningioma patients operated by navigation[2]. But even with this assumption, many tertiary care hospitals in our country lack navigation devices in their operation rooms (OR) due to budgetary difficulties that render purchasing of both hardware and software of the navigation systems primarily, which in turn reduce the dependence on these technologies among the neurosurgeons. Consequently, the neurosurgeons throughout our country, reserve the navigation assistance to operate upon deep and small lesions in more equipped yet few centers. So, we conducted this study to check if it is safe to operate upon clavial meningiomas without navigation. Although we found a statistical significance between the conventional and IGS methods in anticipating the tumor center, yet we believe that the conventional method is of accepted accuracy and the error difference for each case is trivial as long as the conventional method was carried out by a senior and well trained neurosurgeon. Sun et al also concluded that surgical planning for parasagittal meningiomas removal can be conducted safely using the craniometric points[8].

Of course the presence of navigation within OR settings is reassuring to the neurosurgeon, one can feel more confident while operating, knowing that there is an available tool that can help in accurate planning of the surgery with good anticipation for any nearby vascular structures[9][10], yet the neurosurgeons in the developing countries can bear with more worrying feelings for the sake of curing patients from this benign tumors in the limited resources setting whenever it is safe to operate.

On the contrary, the linear method has a relative advantage over IGS in reducing the overall anesthesia time. We found a statistically significant difference in planning time between both methods, the IGS requires several steps to be functioning probably, whereas the linear method requires much simpler steps in localization with accepted accuracy counting on the experience of the surgical team to translate the radiological studies and to match the tumor location to the patients' cranium based on the anatomical landmarks. This reduction in anesthesia time could help in decreasing the rate of extracranial complications such as venous thromboembolic episodes [11,12], postoperative pneumonia[13] and Urinary tract infections[14].

## **Conclusion:**

In the setting of limited resources, the intra-operative linear measurement localization of convexity meningiomas and other extra axial lesions seems to be safe and have an accepted accuracy especially

when conveyed by an experienced neurosurgeon. Moreover, it saves more time than the neuronavigation method decreasing the incidence of extracranial complications of prolonged anesthesia.

## **Abbreviations:**

**CT:** Computed Tomography; **ICU:** Intensive Care Unit; **IGS:** Image Guided Surgery; **MRI:** Magnetic Resonance Imaging; **MRV:** Magnetic Resonance Imaging; **OR:** Operation Rooms; **SPSS:** Statistical Package of Social Science.

## **Declarations:**

## **Ethics approval and consent to participate**

This study was approved by the ethics committee of the Department of Neurosurgery, Kasr Alainy Faculty of Medicine, Cairo University on the 9th of June 2018. All participants provided informed written consent to participate in the study.

## **Consent for publication**

Not applicable.

## **Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## **Competing interests**

The authors declare that they have no competing interests.

## **Funding**

Not applicable.

## **Author's contributions**

H.S. collected, analyzed and interpreted the patient's data, M.A plotted the study design and drafted the manuscript. All authors read and approved the final manuscript

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