Targeting deep intracranial lesions using Craniomapper in a 3D way.

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The Short Title

Using Craniomapper in a 3D way.

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Keywords:

Craniomapper, 3D targeting of deep brain lesions, stereotactic biopsy.

Abstract

Introduction: Accurate localization of intracranial lesions is important to avoid unnecessary brain injury especially in the more challenging deep brain areas. Stereotactic procedures, in addition of being time consuming and complex, are not available in many centers in our locality.

Aim: The aim of this study is to evaluate the accuracy and safety of Craniomapper in targeting sizable deep intracranial lesions**.**

Patients and Methods: Craniomapper is a plastic mesh containing radio opaque wires that are readily identifiable on CT scans. We attached two oblique radio opaque wires to Craniomapper to identify the scan level. It is placed around the patient head during CT scanning. It was used in eighteen patients suffering from different intracranial lesions for aspiration or biopsy. Lesions were at least 4 ml in volume for more safety. Intraoperative clues and postoperative imaging and/or histopathology results were used to judge the procedure accuracy.

Results: Ten patients had cystic intracerebral lesions and eight patients had solid masses. Accurate targeting was achieved in all patients. There was no intaroperative complications related to the method. This new way gave us perfect 3D localization and helped target planning and easy surgery**.**

Conclusion: Craniomapper is a simple, accurate and safe device for 3D targeting of deep brain lesions of 4 ml volume or more.

Keywords: Craniomapper, 3D targeting of deep brain lesions, stereotactic biopsy.

Full Text

Introduction: Various ideas have been utilized to define the correct cranial trajectories and are well known in neurosurgical practice [**1, 2**].

Although frame-based, stereotactic localization is the most accurate method having the lowest rate of postoperative neurological deficits and complications [**3**], it is time consuming, and the stereotactic frame may restrict the operating field [**4**].

Neuronavigation has replaced other methods in many neurosurgical centers, however it is not available in most departments worldwide [**5**].

Craniomapper (from Surgiwear, India) is a plastic mesh containing radio opaque markers and is attached around the patient head at time of CT scanning. It reliably gives a 2D plane definision, but the depth cannot be exactly depicted [**6**].

We established a new idea of measuring the distance and direction of the intracranial lesion from a depicted surface point to convert a 2 D into a 3 D approach to the deeper targets. The aim of this study is to evaluate the accuracy and safety of Craniomapper in approaching deep intracranial lesions in this way.

Patients and methods: We attached two oblique radio opaque wires to Craniomapper to accurately identify the scan level in combination with the craniomapper height letters (Figure 1). During CT scanning, we attach Craniomapper around the patient's scalp (Figure 2). Two suitable points are identified on both sides of the scalp holding a line that passes through the target. The distance from the inner table of the skull (dura matter) to the target center, on this line, is measured (figure 3). After the CT scanning, the two points are marked on the scalp before removal of the craniomapper (figure 4). The epsilateral point is used for burr hole and the contralateral point is used to guide the needle direction during surgery (figure 5).

Figure 1: Two oblique radio opaque wires are attached to Craniomapper to accurately identify the scan level in combination with the craniomapper height letters.

The depth of the target is marked on the biopsy needle. After obtaining the biopsy or aspirate, the wound is closed in the usual way. Histopathology results, cytology or culture sensitivity are analyzed and the data are presented. We included patients with targets deeper than 3 cm from the inner skull table. We excluded patients who had bleeding tendency and those who had targets less than 4 ml in volume for more safety. This method was used in eighteen patients suffering from different intracranial lesions for aspiration or biopsy. Intraoperative aspirates and postoperative imaging and/or histopathology results were used to judge the procedure accuracy.

Figure 2: Craniomapper is placed around the patient's head during CT scanning. Multisclice CT scanner is used in all cases.

Figure 3: Two suitable points are identified on both sides of the scalp holding a line that passes through the target. On this line, the depth from the inner table of the skull (dura matter) to the target center is measured. Reformated images can be used if needed

Figure 4: After the CT scanning, the two points are marked on the scalp before removal of the craniomapper.

Case presentations:

Case 1:

Male patient 40 years old presented with Lt hemiparesis of insidious onset over the past 2 months. The histopathology revealed astrocytoma WHO grade I. Pre and post operative CT images are shown in (figure 6). An air dot appears in the site of the planned target denoting accurate biopsy.

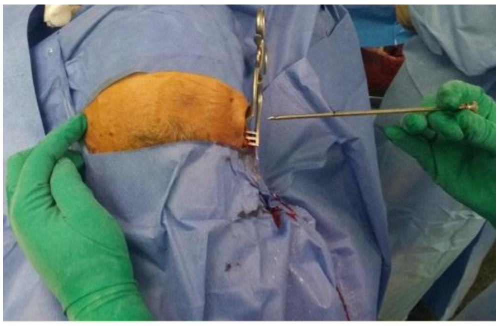
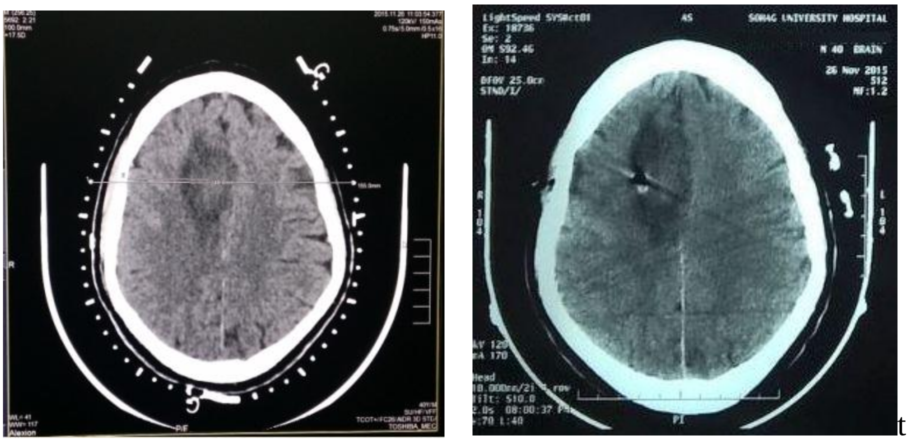


Figure 5: The epsilateral point is used for burr hole and the contralateral point is used to guide the needle direction during surgery.

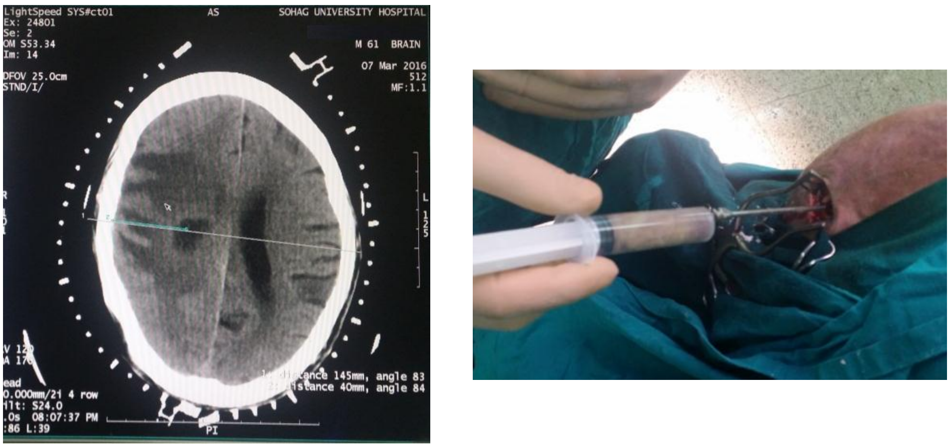


Pre operative　　　　　　　　Pos operative

Figure 6: Pre and post operative CT images of case 1.

Case 2:

Male patient 61 years old presented with Lt hemiparesis of acute onset since the past week. The histopathology revealed brain abscess. Pre operative CT and intra operative images are shown (figure 7) denoting accurate aspiration.



Pre operative　　　　　　　　Intra operative

Figure 7: Pre operative CT and intra operative images of case 2.

Results:

Here we present 18 patients with different intracranial lesions who had been subjected to the procedure for biopsy or aspiration.

Table 1 shows age, sex and presentations of the cases of the study. There was 13 males (72.2%) and 5 females (27.8%). The age of the patients ranged from 10 years to 71 years with a mean of 44.6 years. The most common presentation was contralateral weakness (49.3%) followed by fits (27.8%).

Table 1: *Age, sex and presentations of the 18 cases of the study.*

Case No	Age in Years	Sex	Presentation
1	61	Male	Rt HPR *
2	59	Male	Fits
3	55	Female	Behavoral
4	40	Male	Lt HPR
5	56	Male	Lt HPR
6	11	Female	HCP
7	41	Male	Lt HPR
8	65	Male	Fits
9	61	Male	Lt HPR
10	10	Male	HCP **
11	48	Male	Fits
12	40	Female	Rt HPR
13	71	Male	Behavoral
14	35	Male	Fits
15	45	Female	Rt HPR
16	52	Male	Fits
17	40	Male	Visual
18	13	Female	Lt HPR
Mean	**44.6 Years**	**M13/ F5**	

**HPR: Hemiparesis. **HCP: Hydrochephalus*

Table 2 describes the lesions. The site of lesions was in descending order in the frontal lobe (5 cases), the parietal lobe (4 cases), the thalamus (4 cases), the occipital lobe (3 cases), the temporal lobe (1 case) and the corpus callosum (1 case). Ten patients had cystic intracerebral lesions (55.6%) and eight patients had solid masses (44.4%). The lesion volumes ranged from 4 ml to 40 ml with a mean of 12.75 ml. The depth of the target center from the inner table of the skull at the burr hole site ranged from 3 Cm to 6 Cm with a mean of 4 Cm. Accurate targeting was achieved with positive histopathology yield in all patients. In case No 2, there was postoperative hemorrhage inside the mass lesion without any clinical consequences and was no other complications related to the method.

Table 2: Lesion Characteristics in all patients.

Case No	Side	Site	Consist	Volume	Depth	Pathology
1	Lt	Parietal	Solid	4 ml	3 Cm	AST II *
2	Midline	Corp Cal	Solid	40 ml	4 Cm	GBM **
3	Rt	Frontal	Cystic	4 ml	4.5 Cm	AST III
4	Rt	Frontal	Solid	9 ml	4.8 Cm	AST I
5	Rt	Thalamic	Cystic	4 ml	5.1 Cm	AST II
6	Lt	Thalamic	Cystic	8 ml	5 Cm	AST II
7	Rt	Parietal	Solid	13 ml	3 Cm	GBM
8	Rt	Parietal	Solid	5 ml	3.2 Cm	AST II
9	Rt	Occiptal	Cystic	4 ml	4 Cm	Abscess
10	Lt	Temporal	Cystic	38 ml	3.7 Cm	CPG
11	Rt	Frontal	Cystic	25 ml	3.2 Cm	AST II
12	Lt	Thalamic	Solid	7.5 ml	5 Cm	GBM
13	Lt	Occiptal	Solid	20 ml	6 Cm	GBM
14	Lt	Frontal	Cystic	12 ml	3.6 Cm	Abscess
15	Lt	Frontal	Solid	10 ml	3.5 Cm	GBM
16	Rt	Parietal	Cystic	5 ml	3 Cm	AST II
17	Lt	Occiptal	Cystic	15 ml	3.2 Cm	AST II
18	Rt	Thalamic	Cystic	6 ml	4.2 Cm	AST II
Mean	**Rt 9/M 1/Lt 8**		**C 10/S 8**	**12.75 ml**	**4 Cm**	

**AST II: Astrocytoma WHO grade II. **GBM : Glioblastoma Multiform.*

Discussion:

Although great advances in the field of neurosurgery were facilitated by the development of image-guided surgical techniques over the past two decades, neurosurgeons still recognize the difficulty of localization of the small intracranial lesion on CT scans [**6**].

Frame-based techniques have been considered the gold standard for approaching intracranial lesions, with the fixed frame providing excellent target localization [**7, 8, 9, 10, 11**]. However, its use is hampered by the frame's size, patient's discomfort, calculations involved, prolonged surgical time as well as risk of postoperative infection at the frame's fixation points [**12**].

In 1998, Nakajima and colleagues reported a protocol for scalp marking for craniotomy using a set of CT/MRI data. They recommended installing their program in conventional CT/MR scanners [**13**].

In 2003, Fernandes and colleges developed two methods to be used together or separate to define convexity lesions. At the end of their study, they stated that, there technique is not recommended to approach deep-seated lesions and care is neede with very small ones, because some little difference can occur anyway [**14**].

In 2013, H Elnoamany and A Zytoon recommended Craniomapper for marking the scalp in patients with high cerebral convexity lesions. However they didn't address its use in deep lesions [**5**].

In 2015, Yi Lu and colleagues studied the results of intraoperative MRI (ioMRI) guided, frame-based and frameless brain biopsy techniques and found that in their study, the overall diagnostic yield was 87.8% (In the ioMRI group (82.1%), in the frame-based group (95.2%) and in the frameless group (89.4%)) [**15**].

In this study, we present how we could approach deeper intracranial lesions with craniomapper. Our idea is to guide the biopsy needle direction and depth with the aid of scalp marks determined with craniomapper.

The results show the accuracy of the method but we should mention that it is not as accurate as stereotaxy and we didn't recommend its use in very small lesions with a volume less than 4 ml. We can use a simple guiding arc to direct the biopsy needle towards the contralateral point more efficiently for targeting smaller lesions.

The high diagnostic yield reported in this study (100%) expresses the procedure accuracy but is also explained by the patient selection and we can't assume that this method is superior to that of other colleagues. In very small lesions, we still recommend frame-based or frameless stereotaxy.

Although this new way gave us perfect 3D localization and helped target planning and easy surgery, we don't consider it as accurate as stereotaxy and we don't recommend its use in very small lesions with a volume less than 4 ml where we still recommend frame-based or frameless stereotaxy.

Conclusion:

Craniomapper is a simple, accurate and safe device for 3D targeting of deep brain lesions of 4 ml or larger volumes. It doesn't need special training and doesn't take much time or money. It can't replace stereotaxy specially in very small deep lesions.

References

1. Enchev, Y.P.; Popov, R.V.; Romansky, K.V.; Marinov, M.B. and Bussarsky, V.A.: Cranial neuronavigation-a step forward or a step aside in modern neurosurgery. *Folia Med.* **2008**, *50*, 5–10.
2. Woerdeman, P.A.; Willems, P.W.; Noordmans, H.J.; Tulleken, C.A. and van der Sprenkel, J.W: Application accuracy in frameless image-guided neurosurgery: A

comparison study of three patient-to-image registration methods. *J. Neurosurg.* **2007**, *106*, 1012–1016.
3. Spivak, C.J. and Pirouzmand, F: Comparison of the reliability of brain lesion localization when using traditional and stereotactic image-guided techniques: A prospective study. *J. Neurosurg.* **2005**, *103*, 424–427.
4. Mauricio Mandel, Robson Amorim, Wellingson Paiva, Marcelo Prudente, Manoel Jacobsen Teixeira and Almir Ferreira de Andrade: 3D Preoperative Planning in the ER with OsiriX®: When There is No Time for Neuronavigation. *Sensors* **2013**, *13*, 6477-6491; doi:10.3390/s130506477.
5. Hossam Elnoamany and Ashraf Zytoon; Craniomapper: An Accurate 2D Plane in Localizing Lesion during Craniotomy. Egyptian Journal of Neurosurgery Volume 31 / No. 1 / January – March **2016**, 57-60.
6. Pralaya Kishore Nayak and Jawhar Dutta; Craniomapper for accurate localization of lesion during craniotomy: How much benefit does it have over anatomical marking? Report of two cases J Neurosci Rural Pract. **2014** Apr-Jun; 5(2): 202–203.
7. Apuzzo ML, Chandrasoma PT, Cohen D, Zee CS, and Zelman V.: Computed imaging stereotaxy: experience and perspective related to 500 procedures applied to brain masses. Neurosurgery. **1987**; 20:930–937. [PubMed: 3302751]
8. Apuzzo ML, Chandrasoma PT, Zelman V, Giannotta SL and Weiss MH.: Computed tomographic guidance stereotaxis in the management of lesions of the third ventricular region. Neurosurgery. **1984**; 15:502–508. [PubMed: 6387527]
9. Dammers R, Haitsma IK, Schouten JW, Kros JM, Avezaat CJ and Vincent AJ.: Safety and efficacy of frameless and frame-based intracranial biopsy techniques. Acta neurochirurgica. **2008**; 150:23–29. [PubMed: 18172567]
10. Sawin PD, Hitchon PW, Follett KA and Torner JC.: Computed imaging-assisted stereotactic brain biopsy: a risk analysis of 225 consecutive cases. Surgical neurology. **1998**; 49:640–649. [PubMed: 9637625]
11. Sumanaweera TS, Adler JR Jr. Napel S and Glover GH.: Characterization of spatial distortion in magnetic resonance imaging and its implications for stereotactic surgery. Neurosurgery. **1994**; 35:696–703. discussion 703-694. [PubMed: 7808613]
12. Owen CM and Linskey ME.: Frame-based stereotaxy in a frameless era: current capabilities, relative role, and the positive- and negative predictive values of blood through the needle. Journal of neuro-oncology. **2009**; 93:139–149. [PubMed: 19430891]
13. Nakajima S1, Yoshimine T, Wakita S, Sato Y, Hata N, Yamada M, Fujiwara M, Tamura S, Kato A and Hayakawa T.: Scalp localization using a simple algorithm. Neurol Res. **1998** Dec;20(8):751-3.
14. Fernandes YB, Borges G, Ramina R and Carelli EF: Double-checked preoperative localization of brain lesions. Arq Neuropsiquiatr **2003,** 61:552-554,
15. Yi Lu, MD PhD, Cecil Yeung, Alireza Radmanesh, MD, Robert Wiemann, Peter M. Black, MD PhD, and Alexandra J. Golby, MD: Comparative Effectiveness of Frame-based, Frameless and Intraoperative MRI Guided Brain Biopsy Techniques. World Neurosurg. **2015** March ; 83(3): 261–268. doi:10.1016/j.wneu.2014.07.043.

ملخص البحث

عنوان البحث:

استهداف الآفات الدماغية العميقة باستخدام الكرانيومابر بطريقة ثلاثية الأبعاد.

الباحث:

دكتور / عابدين خيرالله قاسم – مدرس جراحة المخ والأعصاب بكلية الطب – جامعة سوهاج

مقدمة:

التحديد الدقيق للآفات داخل الجمجمة مهم لتجنب إصابات دماغية لا لزوم لها وخاصة في مناطق الدماغ العميقة الأكثر تحديا. والجراحة المجسمة، بالإضافة إلى كونها تستغرق وقتا طويلا ومعقدة، غير متوفرة في العديد من المراكز في منطقتنا.

الهدف:

الهدف من هذه الدراسة هو تقييم دقة وسلامة شبكة كرانيومابر في استهداف الآفات العميقة داخل الجمجمة.

المرضى والطرق:

كرانيومابر هو عبارة عن شبكة بلاستيكية تحتوي على أسلاك معدنية يمكن التعرف عليها بسهولة على الأشعة المقطعية. نحن نعلق اثنين من الأسلاك المائلة إلى كرانيومابر لتحديد مستوى المسح المقطعي. يتم وضعها حول رأس المريض أثناء المسح المقطعي. تم استخدامه في ثمانية عشر مريضا يعانون من آفات مختلفة داخل الجمجمة لأخذ عينة منها أو لتفريغها. وكانت الآفات لا تقل عن ٤ مل في الحجم لمزيد من السلامة. واستخدمت أدلة أثناء العملية والأشعة بعد العملية الجراحية و نتائج فحص الأنسجة للحكم على دقة العمليات.

النتائج:

كان لدى عشرة مرضى آفات سائلة داخل المخ وثمانية مرضى لديهم آفات صلبة. كان الاستهداف دقيق في جميع المرضى. لم يكن هناك مضاعفات أثناء العمليات. أعطت هذه الطريقة الجديدة لنا تحدبد دقيق ثلاثي الأبعاد وساعدت على التخطيط الامن وسهولة الجراحة.

الاستنتاج:

كرانيومابر هو جهاز بسيط ودقيق وآمن لاستهداف ثلاثي الأبعاد للآفات الدماغية العميقة بحجم ٤ مل أو أكثر.

الكلمات الإفتتاحية:

كرانيومابر، استهداف ثلاثي الأبعاد ،آفات الدماغ العميقة، الجراحة المجسمة.