Case Report

Marker-CT assisted surgery using household key ring: A simple substitute to frameless stereotaxy for developing countries

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Abstract

Background: Operative localization systems such as stereotactic frames and neuronavigation are prohibitively expensive to be of use in many centers in developing countries. Here, we present a modified version of marker-computed tomography (CT) assisted technique using a household key ring, which can be performed in any operative set-up lacking modern amenities.

Case Description: For a patient who presents with left posterior frontal lesion, the approximate entry point for the shortest and perpendicular trajectory to the lesion is marked on the scalp using a household key ring and fixed in place. Helical CT is obtained and reconstruction performed in two planes perpendicular to the ring and mutually perpendicular to each other. Based on the measurements of the lesion in relation to the radiologic pointers of the ring, and the location of the corrected entry point with respect to the center of the ring, the shortest perpendicular depth of approach is determined. Freehand technique perpendicular to the surface at the predetermined entry point and depth is employed for the surgical approach. The advantages of key ring over other markers are its simplicity, conformity to the shape of the head, and paucity of artifacts in CT.

Conclusion: The relatively effortless estimation and three-dimensional visual impression renders this method easy enough to be employed anywhere for the operative localization of superficial intracranial lesions both for biopsy as well as resection.

Key Words: Marker-CT, neuronavigation, operative localization, stereotaxy

INTRODUCTION

Operative localization is undeniably the elementary component of any neurosurgical procedure, whether it is for large tumors requiring craniotomy or for deep lesions requiring burr-hole biopsy.[1,2] We have come a long way from surface anatomy guided freehand techniques to breakthroughs in neuronavigation.[1] However, these expensive devices are still beyond the reach of many institutions in developing countries. Marker-computed tomography (CT), once prevalent, became outdated, being crude and inconvenient with extensive artifacts. Here, we present a modified version of marker-CT assisted technique using a circular marker such as household key ring, which can be performed in any operative set-up lacking modern amenities. We found this technique to be simple and effective with no artifacts, and especially useful for relatively superficial intracranial lesions.
CASE REPORT/TECHNIQUE ILLUSTRATION

For a patient who presented with left posterior frontal lesion in magnetic resonance imaging (MRI), the identifiable surface landmarks of skull, such as coronal suture and midline, were used to gauge the approximate location of burr hole for the shortest and perpendicular trajectory. It is marked on the scalp using a household key ring and fixed with either an adhesive tape or sutures [Figure 1]. Helical CT is obtained (contrast if necessary), and reconstruction performed in two planes perpendicular to the ring and mutually perpendicular to each other [Figures 2 and 3]. When the ring is placed parallel to the conventional axial cuts, reconstruction is done in coronal and sagittal planes perpendicular to the ring. The relation of the two ends of the ring with the lesion can thus be defined in the two planes, and appropriate adjustments made based on simple linear calculations. If necessary, the ring is repositioned as per the calculations and helical CT repeated as before. The two points of the ring with respect to the lesion in the mutually perpendicular reconstruction planes would provide the best entry point in relation to the center of the ring. The shortest perpendicular distance of the lesion from the ring would suggest the depth of approach needed. Burr hole is made as per the entry point estimation and freehand biopsy is carried out perpendicular to the surface at the predetermined depth [Figure 4]. Ultrasound guidance may be used for real-time visualization. Multiple passes through the lesion are taken to improve the diagnostic yield of the procedure.

The leverage of this technique over surface-localized freehand biopsy is obvious. This technique has been utilized in a total of nine patients (five patients of burr-hole biopsy and four patients of craniotomy for superficial fronto-parietal lesions). We could successfully hit the target in all patients who underwent biopsy using this technique. Craniotomy planning based on this technique resulted in relatively smaller bone flaps exactly over the lesion. The main advantage of using a circular marker is that it provides two fixed radiological pointers in two mutually perpendicular planes, making interpretation simple and quick. Also, it fits and conforms to the shape of the calvarium at any point. The size of the circular marker may be chosen according to the lesion. The paucity of artifacts in CT in comparison to other markers is remarkable.

DISCUSSION

Operative localization of intracranial lesions is essential for neurosurgery. The spectrum of methods employed
ranges from traditional surface localization to stereotaxy and further advances in neuronavigation. Surface localization had been the indispensable anchor for all other techniques. Framed and frameless localization of intracranial lesions are well-established procedure protocols in the field of neurosurgery with very good accuracy. Different types of frames (CRW, Leksell), and sophisticated navigation systems are available across the globe for accurate operative localization. Their safety, accuracy, reliability, ease, and versatility have been established over the years in procedures like biopsy, drainage of abscesses and hemorrhages, and functional neurosurgery. Economic factors have been the most influential in determining neurosurgical practice in most developing countries, making such costly equipments prohibitive, thereby limiting their use to only a few centers.

Marker-CT technique was of much relevance in the past, before the availability of stereotactic and neuronavigation systems. Different kinds of markers and techniques have been described: Single-marker method of Hahn et al., vertically oriented strips of Maroon et al., the grid system of Piskun et al., and two crossed radio-opaque method as described by Goldstein et al. These procedures, though accurate, were cumbersome, inconvenient with varying artifacts, and reported success rates of 78-90%. Moreover, radiology suite–based techniques had added risk of aseptic violations.

The technique described herein is very cost-effective and simple with no complex calculations involved. The conformity of circular marker fitting the spheroidal shape of head and the paucity of artifacts in CT are added advantages. Moreover, simple measurements based on the mutually perpendicular reconstruction planes, perpendicular to the plane of the ring, provide the three-dimensional accuracy and visual impression, making it quite effortless enough to be practiced in any set-up.

This can be utilized for planning surgical approach for both burr-hole–based biopsies and craniotomy-based resections. This is especially helpful in lesions close to vertex due to the imprecise nature of surface localization. This method, though accurate for superficial lesions, may not be good enough for deep-seated lesions, in which we would prefer stereotactic technique.

**CONCLUSION**

Marker-CT assisted surgery using a circular key ring appears to be a simple and effective technique for operative localization of superficial intracranial lesions, especially in institutions lacking modern infrastructure.

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