Stereotactically-Guided Craniotomy for a Cavernous Hemangioma: Technical Note

Stereotaktik Kraniotomi Tekniğinin Bir Kavernöz Hemanjioma Olgusunda Kullanılması: Teknik Not

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Abstract: Stereotaxy-guided surgery offers significant advantages in the treatment of lesions that cannot be localised reliably because of their small size and/or lack of evident landmarks. A stereotactically-guided craniotomy and microsurgical resection technique was described for excision of a cavernous hemangioma. The technique provided advantages in better surgical orientation, precise localization and less invasiveness to the normal brain tissue when compared to the conventional free-hand neurosurgical techniques.

Key Words: Cavernous angioma, minimally invasive, stereotactic craniotomy.

Özet: Stereotaktik tekniklerle desteklenmiş mikroşirürji, küçük çaplı ve bulunmalarında yol gösterici izlerin yetersizliği nedeniyle cerrahi lokalizasyon problemi olan lezyonlarda önemli avantajlar sağlamaktadır. Bu makalede, bir kavernöz hemanjiomalı olguda kullanılan stereotaksi rehberliğinde kraniotomi ve mikroşirürjikal rezeksiyon tekniği tanımlanmaktadır. Bu teknik, stereotaktik yöntemlerin kullanılmadığı konvansiyonel girişimlerle kıyaslandığında, daha iyi cerrahi oryantasyon, kesin lokalizasyon ve normal beyin dokusuna daha az zarar verilmesini sağlamak gibi avantajlar sunmaktadır.

Anahtar Sözcükler: Kavernöz anjioma, minimal invaziv, stereotaktik kraniotomi.

INTRODUCTION

Almost all neurosurgeons realise the accuracy and advantages of stereotaxy for performing biopsies from brain tumors. On the other hand, stereotactical techniques have also been used in assistance in performing craniotomies and microsurgical resection of brain tumors (3, 4, 7). Basically, two kinds of stereotactic systems have been used in order to facilitate microsurgical resection of brain tumors: (1) frameless stereotactic systems; (2) frame based stereotactic systems. Because of its accuracy and easy-to-use frame based stereotactic systems are useful for obtaining accurate approach to most of the lesions in the brain.

A cavernous angioma is one of four the commonly occurring types of cerebral vascular malformations (1, 2, 5). They often occur in cortical and subcortical regions. Frequently, they are located near the Rolandic area, basal ganglia, pons and cerebellar hemispheres. Because they may often be just an incidental finding, surgical excision is not recommended in all patients but especially for patients with medically intractable epilepsy and in those with previous hemorrhage. Magnetic resonance imaging (MRI) technology offers a more reliable diagnosis of this vascular malformation entity, and the incidance of diagnosing of cavernous angiomas has greatly increased since the introduction of MRI. Since these lesions are usually small and may be located in eloquent regions in the brain, essentials of surgery for cavernomas are precision in localisation and minimal operative trauma to the surrounding brain tissue. Conventional surgical techniques may be insufficient for accurate localisation of these lesions, and cavernous malformations may be more safely excised using stereotactic localisation techniques.

We report a patient with cerebral cavernous hemangioma removed by stereotactically-guided craniotomy and microsurgical resection; and the technique is described in detail.

MATERIAL AND METHODS

Patient

A 31-year-old man was presented to our hospital with medically intractable seizures. This patient had an 8-year history of complex partial type epileptic seizures despite a regular daily dose (3X200 mg.) and theraupetic blood level (8.41 μg/ml) of Carbamazepine. Neurological examination revealed no abnormality. MRI showed a right parietal cavernoma (Figure 1). The malformation was spherical, approximatelly 10 millimetres in diameter and located close to the post-central gyrus. Digital subtraction cerebral angiography was normal. Electroencephalography revealed right parietal discharges spreading to the right temporal area, and independent left temporal discharges were also observed.

Stereotactic and Surgical Technique

The stereotactic head frame (Model: Riechert-Mundinger, Leibinger-Fischer GmbH, Freiburg, Germany) was placed to the head under local anesthesia, ensuring that the frame placement would not compromise craniotomy. Contrast-enhanced computerized tompography (CT) scans were obtained under stereotactic conditions. The coordinates of the center of the lesion and the fiducial markers visualised on the CT-scans were computed using software of the stereotactic system (Stereoplan V1.30 SN 1-0187, Leibinger-Fischer GmbH, Freiburg, Germany). A trajectory was calculated from the point of entry to the center of the lesion, using cartesian coordinates x, y, and z. The patient was then carried to the operating room. The target point and the trajectory were checked by means of a target point simulator in the operating room.

The procedure was carried out under general anesthesia with endotracheal intubation afterwards. The base ring was attached to the operating table firmly, and the head of the table was raised to provide the least depended position for craniotomy.

After draping the patient and placement of the stereotactic aiming bow, the stereotactic probe was used to plan a small craniotomy. The scalp was opened with slightly curved incision. The defined trajectory of the probe was directed through the centre of the planned craniotomy, and a 3-centimeter trephine craniotomy was performed using a craniotome (Midas Rex, Texas, USA).

A sliding stylet was introduced after X-shaped dural opening in order to insert a ventricular catheter (PS Medical Co., California, USA) into the lesion stereotactically, and the stylet was removed. No sign of cavernoma on the cortex was seen as a surgical landmark. The catheter was cut off flush with the cerebral cortex, and a silver clip was applied to the catheter at this point.

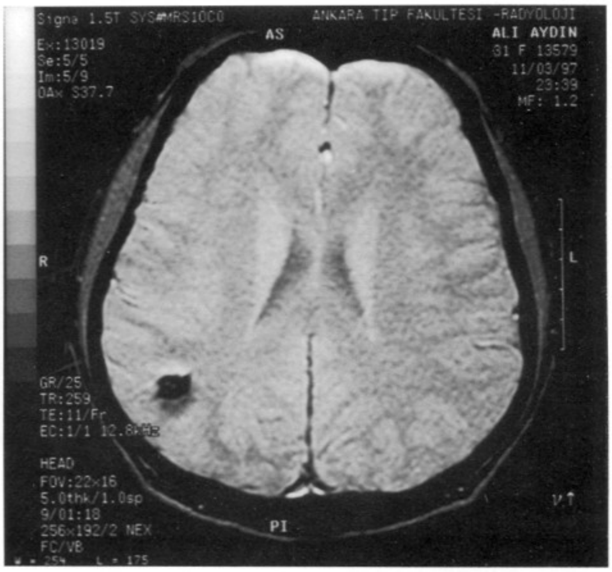

Figure 1. Axial MRI showing sub-cortically placed right parietal lesion.

A convenient sulcus was split microsurgically, and the direction of the subcortical incision was made following the trajectory of the catheter. The gliotic surrounding tissue stained by hemosiderin and the hemangioma came into view, and the malformation was removed using standard microsurgical technique and instrumentation, including Leyla retractors (Aesculap, Tuttlingen, Germany) mounted on the operating table. The operation was concluded in the standart fashion, the dura was closed in waterthight fashion, no epidural drain was placed. and the stereotactic apparatus was removed.

Post-Operative Course

The postoperative course of the patient was uneventful. He was discharged from the hospital without any abnormal neurological findings 3 days after the surgery. Pathological examination confirmed the diagnosis of cavernous hemangioma. Post-operative MRI showed total removal of the malformation with minimal operative changes in the surrounding tissues (Figure 2). Post-operative electroencephalographies revealed well-localised right temporal sharp waves, and a remarkable reduction in frequency of epileptic seizures was observed in 5 months' follow-up.

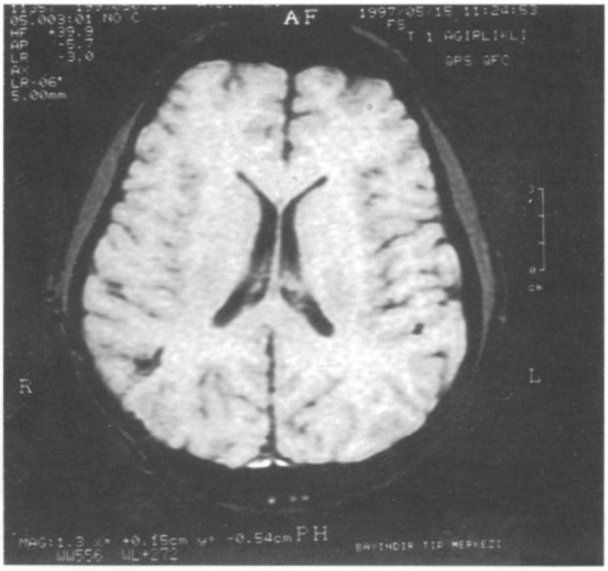

Figure 2. Post-operative MRI demonstrating the total removal of the hemangioma and minimal post-operative changes in the surrounding brain tissue.

DISCUSSION

The use of stereotactic methods to localise a visible region of cerebral morphology for surgical purposes is called "morphologic stereotaxy". In this surgical discipline, pathologic structures are readily visualised with appropriate imaging and their x, y, z (Cartesian) coordinates are usually calculated according to a stereotactic head frame using the computer technology. Surgery is planned, and then performed according to these calculations. The recently developed methods for localising any point on the digital imaging modalities, such as computed tomography (CT), magnetic resonance imaging (MRI) and digital angiography (DSA), with respect to the stereotactic head frame have provided that any intracranial point could be accessed surgically with great accuracy.

The stereotactic systems may be used not only for stereotactic biopsies or similar procedures made through a burr-hole but also for microsurgical resection of the cerebral lesions via small craniotomies (6). Such assistance is beneficial, particularly for subcortically or deeply located lesions or those near eloquent or functionally important nervous structures. Stereotactic systems used for excision of the cerebral lesions may basically be divided into two: (1) Frameless systems, and (2) Frame based systems.

The frameless stereotactic systems have been obviating the need for conventional head frames but they are still evolving. In frameless stereotactic systems, the digital imaging modalities, such as CT, MRI, and DSA, and positron emmision tomography (PET) scans are obtained as three dimensional volumetric data bases. Usually, fiducial markers are attached to the patient's skin, and each digital image points are registered according to the markers. This registration can employ information about the spatial localisation of any target or selected volume, which is obtained preoperatively, or postoperatively. Preoperative planning the frameless systems takes place in the operating theatre in interactive fashion within the intended operating field; they may be used to mark the normal anatomical structures providing the surgeon with a much more realistic setting to understand the surgical anatomy; and their range of usage will be more unlimited since they don't cause any mechanical restriction when compared to frame based systems. There is no doubt that these systems will emerge as extremely useful in their own right and serve a bridge into the next era of surgical technology (3). The most important disadvantages of these systems may be summarised as following: They are very expensive and not available in most of neurosurgical clinics; their usage limited only in neuronavigation during microsurgical resections.

Frame based systems have still remained the gold standard in terms of precision and accuracy of localisation. Stereotactic frames are available in most of the reference neurosurgical clinics and used in various purposes. Additionally, they are cheaper in comparison to the frameless systems. The described technique can be performed with almost all kinds of commercial stereotactic frame systems, and the procedure requires no specially designed equipment. With this technique, standard neurosurgical retractors (such as Leyla retractors, etc.), in any size according to the neurosurgeon's preference and the size and localisation of the lesion, can be used following the stereotactically placed teflon catheter as a guide. The arc-mounted stereotactic cylindrical retractors and dilators, which were described and frequently used by Kelly, may be much more traumatic to the brain tissue when compared to the technique described above.

On the other hand, the greatest limitation of the frame based stereotactic methods in craniotomy and resection of brain lesions is that the frame attached to the patient's skull is restrictive and bulky providing only a restricted and temporary reference. Since mostly the frames are usually placed more or less in parallel to the orbitomeatal plane and close to skull base, usage of the technique may be more difficult in lesions with temporal lobe, posterior fossa, occipitopolar or frontopolar localisation. However, no difficulty may be expected in lesions located in parietal lobe, frontoparietal and parietooccipital regions, and in lesions with deep brain localisation. As additional disadvantages, the aiming arc is usually cumbersome in front of the neurosurgeon's view and only one target point and trajectory are selected at a time.

Cavernous hemangioma (cavernoma) is one of the four major clinicopathological categories of vascular malformations of the nervous system. Since most of the cavernomas may remain clinically silent, surgical removal of these malformations is controversial in some cases. On the other hand, these tumors may be small sized, located subcortically or in eloquent areas, and there may be no evident landmarks on the brain surface to aid surgical orientation. Precise localisation and minimal surgical trauma to the surrounding neural tissue, which may be provided with the help of stereotactical guidance optimally, are essentials of microsurgical resection of cavernomas (1, 2, 5). We think that with modern neurosurgical techniques, including stereotactic localisation, there will be fewer difficulties in surgical removal of these lesions, and thus postoperative results will become much more satisfactory.

The described technique provides precise localisation during surgery, smaller and more accurate craniotomies and scalp incisions, and shorter hospital stays. Stereotaxy-guided microsurgery with frame based systems allows easy and safe resection of small, subcortically placed cerebral lesions, e.g. cavernous hemangiomas.

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