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RESEARCH ARTICLE

AMENABILITY OF TRANSFRONTAL APPROACH FOR ALL MIDLINE AND BRAINSTEM STEREOTACTIC SURGERY

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ABSTRACT

Background: An ipsilateral transfrontal entry point provides access to the mesencephalon and midline regions of the pons. A contralateral transfrontal entry point has also been described that allows access to more laterally placed pontine lesions without having to traverse the ventricular system. Both ipsilateral and contralateral approaches allow the patient to remain supine during surgery, in a similar position to that in which images are traditionally acquired thus preventing error due to positional brain shift. In this region, a burrhole can be placed without painful muscle dissection and twist drill holes can be planned to avoid sulci. **Objective:** The purpose of this study was to study the Amenability of transfrontal trajectory for all midline and brainstem stereotactic surgery. **Methods:** The study evaluated 60 patients submitted to stereotactic surgery. The most common site of midline lesions was brainstem, in 24 cases (40%) then thalamus in 21 cases (35%) and 10 (16.66%) patients presented by ganglionic lesions (including pallidotomy surgery) and 5 (8.33%) patients presented by craniopharyngioma. The transfrontal approach was used for all patients. **Results:** Regarding complications of transfrontal approach of stereotactic surgery for midline lesions, the morbidity rate was 3.33% (2 cases) indicating that transfrontal approach is safe and amenable for stereotactic surgery for midline lesions including brainstem lesions. **Conclusion:** In this study, we provide evidence that the transfrontal approach is a reliable and safe approach to midline lesions of the brain with a high diagnostic success rate and no permanent surgery-related morbidity. Considering some technical issues the approach is simple to perform in a routine procedure without any technical modification.

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INTRODUCTION

The diagnosis and management of midline lesions of the thalamus, basal ganglia, corpus callosum, third ventricle and brainstem have presented a difficult challenge for neurosurgeons. Open nonstereotactic craniotomies for biopsies of deep-seated midline brain lesions are known to carry some risks to the patients. Image-guided stereotactic biopsies have been shown to be accurate in establishing specific tissue diagnosis with a low incidence of morbidity (Zamorano *et al.,* 1992). An ideal stereotactic trajectory will pass the short distance, avoid critical neural or vascular structures and require a single initial entrance from the arachnoid space into the brain parenchyma (Zrinzo, 2012). For stereotactic approaches to the brain stem, an ipsilateral or contralateral transfrontal entry point is considered to avoid pial, ependymal or tentorial surfaces.The contralateral transfrontal entry point allows access to more laterally situated pontine lesions. Both entry points permit supine position during surgery, in a similar position to that in which images are acquired, thus minimizing positional brain shift and preventing errors (Manoj *et al.,* 2014).

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In this study we aim to present our experience with the transfrontal approach to midline lesions of the brain to be safe regarding diagnostic success rate and surgery-related morbidity.

MATERIAL AND METHODS

This study included 60 patients diagnosed and managed in Alazhar university hospitals. Those 60 patients were studied over 4 years, with morphological stereotactic surgeries performed as main management modality of their treatment. This study presents our experience with computed tomography (CT)-guided stereotactic procedure of midline lesions of the brain including lesions of the thalamus, basal ganglia, corpus callosum, third ventricle and brainstem by transfrontal approach.

RESULTS

In our study, the number of male patients was 39 cases (65%), and the number of female patients was 21 cases (35%). the peak incidence of our patients were in the 4th and 5th decade of life (25%) each, and (50%) of our patients were younger

Figure 1. a case of brainstem lesion, was diagnosed as cystic astrocytoma (grade II) by stereotactic biobsy. 1. MRI T1 WI brain without contrast showing brainstem cyst. 2. Stereogram of the lesion. 3. Site of skin incision intraoperative with LEKSELL system in place. 4. The aspirated fluid. 5. follow up CT brain showing air at site of cyst meaning accurate localization.

than 30 years, ages ranging between 3 and 50 years, with a mean age of 25.45 years. In our study, the most common clinical presentation was hemiparesis, in 39 cases (65%) followed by ataxia in 18 cases (30%) and cranial nerves affection and Headache in 15 cases each (25%). In our study, the most common site of midline lesions was brainstem, in 24 cases (40%) then thalamus in 21 cases (35%) and 10 (16.66%) patients presented by ganglionic lesions (including pallidotomy surgery) and 5 (8.33%) patients presented by cranio pharyngioma. All patients underwent thin slice preoperative MRI with contrast and in all patients CT, with the stereotactic frame attached was performed on the day of the surgery. Lesions was Hyperintense at T2 WI and flair MRI in 51 cases (85%). Lesions was divided according to contrast into four divisions: 1. Non contrasted in 15 cases (25%) 2. Homogenous enhancement in 9 cases (15%) 3. Ring enhancement in 12 cases (20%) 4. Heterogeneous enhancement which include a. nodular enhancement in 9 cases (15%) b. Heterogeneous in 15 cases (25%). Trajectory chosen for the stereotactic procedures were done through transfrontal approach. In our study, Local anesthesia was used in 45 cases (75%), general anesthesia was used in 15 cases (25%) and in these 15 patients application of the base ring and data acquisition were performed under local anesthesia while the actual biopsy procedure was performed under general anesthesia. The main indications for general anesthesia were young age, uncooperative patients. The commonest stereotactic procedure became biopsy in 14 cases (70%), then aspiration alone in 9 cases (15%), both aspiration and biopsy in 9 cases (15%). the most common lesion was glioblastoma multiform (grade IV), then pilocytic astrocytoma in 9 cases (15%). In our study, only two cases showed complication as minimal subarachnoid hemorrhage which was managed conservatively (3.33%).

Case presentation: 31 years old male patient presented by right sided weakness G4/5 (weakness at the knee and elbow) and partial foot drop on the right side and numbness on the entire right side. Histopathologically: cystic astrocytoma (Grade II).

DISCUSSION

The ipsilateral transfrontal approach is effective for biopsy of the midbrain, upper pons, and medulla. For midline lesions, an anterior coronal entry point is chosen in such a way that the trajectory enters through the midpoint of a gyrus approximately 15 to 25 mm from the midline. For lower pons or medulla biopsies, an ipsilateral transfrontal approach necessitates a trajectory traversing the lateral ventricle before entering the anterior thalamus, cerebral peduncle, and then the brainstem (Olivi *et al.,* 2017). The contralateral, extraventricular, transfrontal approach is a good option during biopsy of the lateral pons and medial middle cerebellar peduncle. With an entry point approximately 4 cm off midline in the coronal plane, the needle's trajectory remains completely intraparenchymal, avoiding the ventricle and limiting the number of crossed pial surfaces to one. This trajectory limits the potential for intraventricular hemorrhage, shift associated with cerebrospinal fluid loss, and subdural hematomas (Amundson *et al.,* 2005).

Patient demographics: Stereotactic biopsy of brain lesions of unknown entity is a standard procedure in numerous neurosurgical departments nowadays. Also eloquent areas such as the brainstem have been accessed since the 1980s (Kelly *et al.,* 2003), but decision-making whether to biopsy a lesion in this eloquent area is not easy. Today most cases are discussed in an interdisciplinary tumor board, evaluating the indication and consequence of stereotactic biopsy (Quick-Weller *et al.,* 2016). This study represents data from 60 patients underwent to 60 stereotactic procedures (biopsies and/or aspiration) were collected and analyzed. In our study, the number of male patients was 39 cases (65%), and the number of female patients was 21 cases (35%). In *Manoj et al.* (2014). Eighty-two patients underwent stereotactic biopsy for a brainstem lesion during the study period. There were 41 children (≤18 years) and 41 adults (>18 years). The age of the patients ranged from 3 to 60 years (mean 22.11 years, median 18.5 years). When grouped separately, median age of the children was 9 years and that for adults was 34 years. There was a male preponderance in both groups with 26 males (63.4%) among the children and 29 males (70.7%) among the adults (Manoj *et al.,* 2014). In our study, the peak incidence of our patients were in the 4th and 5th decade of life (25%) each, and (50%) of our patients were younger than 30 years, ages ranging between 3 and 50 years, with a mean age of 25.45 years. In Quick-Weller *et al.,* (2016), Eighteen patients were male and 8 were female, median age of all patients was 33 years.

Clinical presentation: In our study, the most common clinical presentation was hemiparesis, in 39 cases (65%) followed by ataxia in 18 cases (30%) and cranial nerves affection and Headache in 15 cases each (25%). In ***Manoj et al., (2014)***, Nine out of 41 children (22%) and 20 out of 41 adults (48.8%) had symptoms of cranial nerve dysfunction as the first feature. Headache was noted in 35.4% patients, while limb weakness and ataxia were noted in 42.7% and 47.6%, respectively. Seizure was documented in one patient (1.2%). In ***Cage et al., (2013)***, The most common presenting symptoms were cranial neuropathies experienced by seven out of nine patients, followed by ataxia or falls (five patients), and headache in three patients.

The lesions sites: In our study, the most common site of midline lesions was brainstem, in 24 cases (40%) then thalamus in 21 cases (35%) and 10 (16.66%) patients presented by ganglionic lesions (including pallidotomy surgery) and 5 (8.33%) patients presented by craniopharyngioma.

Radiological diagnosis: All patients underwent thin slice preoperative MRI with contrast and in all patients CT, with the stereotactic frame attached was performed on the day of the surgery. Lesions were Hyperintense at T2 WI and flair MRI in 51 cases (85%). Lesions was divided according to contrast into four divisions: 1. Non contrasted in 15 cases (25%) 2. Homogenous enhancement in 9 cases (15%) 3. Ring enhancement in 12 cases (20%) 4. Heterogeneous enhancement which include a. nodular enhancement in 9 cases (15%) b. Heterogeneous in 15 cases (25%).

Surgical position and Trajectory: In our study, Trajectory chosen for the stereotactic procedures were done through transfrontal approach. In Quick-Weller *et al.,* (2016) (73 %) a frontal approach was used and in (27%) the approach was trans-cerebellar. The transfrontal route, although longer, allows sampling of a mass located in any of the 3 segments of the brain stem (Rajshekhar and Moorthy, 2010). In Steck and Friedman, (1995), Twenty-two of the biopsies were approached transfrontally and two were approached via the suboccipital transcerebellar route. In Amundson *et al.* (2005), several approaches are available for use during stereotactic biopsy of the infratentorial brainstem, including the ipsilateral transfrontal, the transtentorial, and the suboccipital trans cerebellar routes. Although these techniques have proven effective, they assert that the contralateral, transfrontal, extra ventricular trajectory is a safe, straight forward, and, in some cases, preferable alternative to these approaches. In Chen *et al.,* (2011), a number of approaches are available for brainstem stereotactic biopsy, including the ipsilateral or contralateral transfrontal, and suboccipital transcerebellar routes. Surgical approach should be tailored to each case, with consideration of safety, accuracy, and efficacy, according to the location, neurological function, and patient tolerance. In our study, Local anesthesia was used in 45 cases (75%), general anesthesia was used in 15 cases (25%) and in these 15 patients application of the base ring and data acquisition were performed under local anesthesia while the actual biopsy procedure was performed under general anesthesia. The main indications for general anesthesia were young age, uncooperative patients. In Quick-Weller *et al.* (2016), (19%) underwent the procedure under local anesthesia, (81%) under general anesthesia. In children stereotactic biopsies are usually performed under general anesthesia (Quick-Weller *et al.,* 2016). In Steck and Friedman, (1995), all the adult patients except one have undergone biopsy under local anesthesia and mild sedation. One adult patient underwent biopsy under general anesthesia because of declining mental status. General anesthesia was used for the patients under age 16.

Stereotactic procedure: The commonest stereotactic procedure became biopsy in 42 cases (70%), then aspiration alone in 9 cases (15%), both aspiration and biopsy in 9 cases (15%). A literature research by Samadani evaluated 469 stereotactic biopsies of brainstem tumors in adults. They analyzed whether a patient should undergo biopsy or empiric therapy by relying on the certainty of the diagnosis reported by the radiologist, neurosurgeon and consulting physician.

Histological diagnosis: In our study, the most common lesion was glioblastoma multiform (grade IV), then pilocytic astrocytoma in 9 cases (15%). In Quick-Weller *et al.* (2016), Astrocytoma WHO II was diagnosed in (34.6%) patients, astrocytoma WHO III in (7.7%) and glioblastoma in (19.2%) patients. Medulloblastoma was diagnosed in (11.5%), diffuse intrinsic brainstem glioma in (7.7%) and lymphoma (11.5%). Primitive neuroectodermal tumor (PNET) and germinoma were diagnosed in each (3.8%). In Steck and Friedman, (1995), Histology of the lesions revealed anaplastic astrocytoma in 11, glioblastoma multiforme in 5, metastasis in 3, lymphoma in 1, germinoma in 1, chordoma in 1, progressive multifocal leukencephalopathy in 1, and nondiagnostic in 1. In Manoj *et al.* (2014), malignant gliomas were the most common histological diagnosis in the whole cohort. Glioblastoma was signifcantly more common in children. It comprised of 29.3% of all pathologies in children, compared to only 4.9% of the pathologies in adult population. *De León et al.* (2003), the results of the pathological analyses showed that the most frequent neoplasias were low-grade gliomas (60%) and anaplastic astrocytomas (26%).

Complications: In our study, only two cases showed complication as minimal subarachnoid hemorrhage which was managed conservatively (3.33%). In Quick-Weller *et al.,* (2016), Surgery related complications occurred in (19.2 %). In Steck and Friedman, (1995), Complications included 1case of increased hemiparesis, 1 case of obstructive hydrocephalus, and 1 death. In Rajshekhar and Chandy, (1995), there was no procedure-related mortality. (5.6%) experienced transient morbidity. Complications were relatively rare in Manoj *et al.,* 2014, study. In Grossman *et al.* (2005), (7%) of patients experienced a hemorrhagic complication associated with the stereotactic biopsy, In recent reports of large series of stereotactic biopsies, complication rates ranged from 1.2% to 7.2%. In series of Coffey and Lunsford (1985), thirteen stereotactic procedures upon twelve patients with no morbidity or mortality reported. study of Dellaretti *et al.* (2011), verified a higher diagnosis rate in patients submitted to the transfrontal approach than in those submitted to the suboccipital transcerebellar approach (95.1 vs. 84.2%); however, the difference was not statistically significant. Regarding complications, the rate was similar in both groups of patients. The overall morbidity rate associated with biopsy in Schumacher *et al.* (2007) study was 3.2%. In general Stereotactic biopsy is a safe procedure with low mortality and morbidity rates, nevertheless some authors reported higher complication rates for lesions in the brainstem. In contrast the reviews of Samadani et al. and Kickingereder et al. stated no higher complication rates for STX of lesions in the brainstem (Kickingereder *et al.,* 2013). In his review from 2013

Kickingereder et al. showed diagnostic success of the procedure between 94.5 and 97.6 %, morbidity was between 5.6 and 10.2%, mortality was 0.5-1.4%. Quick-Weller *et al.* (2016) results meet the results of his work, finding diagnostic success in 100 % of the patients who underwent biopsy. In QuickWeller *et al.* (2016) study morbidity was 19.2% (including hemorrhages without clinical symptoms in 11.5% and neurological deficits in 7.7 %) mortality was 3.9 %. Morbidity and mortality rates of the patients in Quick-Weller *et al.* (2016) study are somewhat higher than presented by Kickingereder *et al.* (2013.)

Conclusions

In this study, we provide evidence that the transfrontal approach is a reliable and safe approach to midline lesions of the brain with a high diagnostic success rate and no permanent surgery-related morbidity. Considering some technical issues the approach is simple to perform in a routine procedure without any technical modification.

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