Post-Operative Supplementary Motor Area Syndrome

KHALED ANBAR, M.D.

The Department of Neurosurgery, Faculty of Medicine, Cairo University

Abstract

Rationale: Surgical removal of the lesions involving the supplementary motor area, results in immediate motor and speech deficits, which in most cases are reversible.

Aim: Extent of removal of the supplementary motor area influences the post-operative deficits.

Patients and Methods: 12 cases are included in this study, representing lesions involving the supplementary motor area by intra-axial growth, and or extra-axial compression, operated by microneurosurgical excision, after evaluation by magnetic resonance imaging of the brain with contrast, before and after the operation to evaluate the SMA involvement, and its extent of removal.

Results: 12 cases in age range (10-60) years old, presented by, 10 epilepsy, 2 hemiparesis, MRI brain revealed lesions in the SMA, pathology was, 2 oligoastrocytoma, 3 astroctoma grade 2, 2 anaplastic astrocytoma, 2 glioblastoma multiforme, 2 metastases, 1 parasagittal meningioma, 9 cases with complete excision, 3 incomplete excision, SMA removal was complete in 5 cases, incomplete in 7 cases, immediate post-operative hemiplegia with preservation of the muscle tone, complete recovery within the 1st month post-operatively.

Conclusion: Proper diagnostic methods aiming to localizes the sensorimotor area can minimize the risk of deficit in the surgical treatment of SMA lesions. The results suggest a relationship between the incidence of SMA syndrome and the extent of SMA resection.

Key Words: Supplementary motor area – Surgery – Aphasia – Hemiparesis.

Introduction

The anatomical limits of the SMA are the primary motor cortex posteriorly, the cingulate sulcus and genu of corpus callosum inferiorly and the edge of the medial cortex laterally [2,3]. It has been shown to be involved in several aspects of motor control, including movement selection, preparation, initiation, execution, and feedback-monitoring of a motor program as well as in motor learning and in planning of complex sequences of movement [4,5]. Moreover, clinical and electrophysiological studies in patients also support a role of the SMA in speech [6]. Electrical stimulation performed rostral to the supplementary motor representation of the face resulted in vocalization and speech arrest or slowing of speech [6]. Surgical resections of tumors of the medial frontal lobe may result in immediate postoperative motor and speech deficits which in most cases are reversible [7,8]. However postoperative motor deficit is usually unpredictable, while it is more common when the resection limit extends in caudal parts of SMA [9]. Thus, it is of utmost importance for the neurosurgeon to determine the anatomical and functional limits of the surgical resection and the characteristics and the cause of the deficit. This is also important in the preoperative period for informing the patient about the risk of its occurrence and its typical course of recovery. This paper reports a series of 12 patients who experienced various degrees of neurological deficits related to partial or complete SMA syndrome after partial or total resection of SMA had been performed to remove a frontal lesion. It was aimed to analyze the clinical data with respect to diagnosis, surgical technique and prognosis. It was intended to evaluate the correlation between the pattern of immediate postoperative clinical symptoms and the extent of SMA resection.

Material and Methods

This clinical study includes 12 patients harboring lesions involving SMA who were operated in
Kasr El-Aini Hospitals from 2007-2010. There were 5 males and 7 females patients with ages ranging from 10 to 60 years (mean age 35 years). All of the patients were right handed. The primary presenting symptoms were seizure in 10 patients and hemiparesis in 2 patients. Of the 10 patients presenting with seizures, 4 had medically intractable epilepsy. All patients underwent preoperative cranial MR imaging with and without gadolinium. The determination of the central and precentral gyrus on MRI was accomplished by examining the typical anatomical landmarks as described before [2]. Lesion resection was performed along the visible lesion borders with careful dissection under the microscope to avoid injuring eloquent cortical areas. The neurological status of each patient was assessed preoperatively as well as postoperatively at 1-day intervals until the patient was discharged. The postoperative motor and language deficits were reviewed and analysed from the patient records. Motor deficits were rated using a standard grading scale: 5/5, normal power; 4/5, active movement against gravity and resistance; 3/5, active movement against gravity; 2/5, active movement only with gravity eliminated; 1/5, trace contraction; or 0/5, no contraction. Hemiplegia or impaired movement contralateral to the side of lesion which improved rapidly was classified as an SMA injury. Immediate speech deficits, including mutism, reduced spontaneous speech, and anomia, that recovered during the postoperative early follow-up period were also considered to be due to SMA injury. In all patients, cranial MRI with and without gadolinium was performed in the postoperative period. In all patients postoperative MRI’s were acquired within 48 hours. The extent of the resection of the lesion and the SMA was evaluated on postoperative MR images and classified as total or subtotal and complete or incomplete, respectively.

Results

The histopathological evaluation of the specimens disclosed tumoral lesions in 12 patients. The distribution of the tumoral lesions were, oligoastrocytoma in 2 patient (WHO grade II), astrocytoma (WHO grade III) in 3 patient, anaplastic astrocytoma in 2 patient, glioblastoma multiforme in 2 patient, parasagittal meningioma in 1 patient, and 2 patients with metastases. The evaluation of the postoperative MRI’s revealed total resection of the lesion in 9 patients (75%) and subtotal resection in 3 patients (25%). The extent of SMA resection was complete in 5 patients (41.6%) and incomplete in 7 patients (58.3%). Immediately postoperatively, 5 patients with a dominant left SMA, displayed severe hemiparesis, neglect of the contralateral extremities, and mutism. Mutism without hemiparesia was observed in a patient with a dominant right SMA. In the series presented, a typical SMA syndrome was encountered in 5 patients. In all these cases, various degrees of hemiparesia were observed in the early postoperative period immediately after surgery. Whenever motor deficits were present, the upper and lower extremities were similarly affected and motor function was later regained in both extremities simultaneously.
Fig. (3): (A) Preoperative axial T-2 weighted cranial MRI section shows a lesion located in the left superior frontal gyrus. (B) Part of the lesion (L) was located in the boundaries of the SMA (black lines) in front of the primary motor cortex (PMC) as shown in the diagram. (C) The postoperative axial T2-weighted cranial MRI section shows total removal of the lesion.

Fig. (4): Axial T2 with contrast, pre-operatively and post-operatively, revealed complete removal of the lesion and incomplete removal of supplementary motor area.

Moreover, the muscle tones were typically preserved in the affected extremities of SMAS cases. In 3 patients the motor deficit were hemiplegia, while in the remaining two the motor deficit grade were 2/5 and 3/5 respectively, the hemiplegia rapidly recovered to 4/5 motor power in 3 days on both right upper and lower extremities. They were back to full recovery at postoperative 1 month follow-up. In one patient, the motor power of the right lower extremity recovered to 4/5 in the postoperative 3rd week, while the right upper extremity was 3/5. At her last follow-up at postoperative 1 year, she had recovered completely except for a mild deficit in the right hand grasping function one case also had a fast recovery period from hemiplegia to 4/5 motor power in both upper and lower extremities in postoperative 10th day. However the tumor recurred and he presented with hemiplegia 4 months after the first operation. He was lost 1 month later. In another two cases, the hemiparesia recovered in 1 month while there were mild deficits in the finger movements in both patients at their 1 year control. When the extent of the resection of the SMA was evaluated, the degree of postoperative motor deficit was in concordant with the resection of SMA. In cases where the SMA syndrome was observed the SMA was totally removed either because the lesion was purely localised to that area or the lesion was extending towards it. In contrast, motor deficits were not present at all in cases which the SMA had been incompletely removed. As for the 7 patients where the SMA resection was incomplete, only one patient experienced postoperative neurological deficit as mutism without hemiparesia.

Discussion

A characteristic syndrome of immediate postoperative contralateral motor and speech deficits emerges following complete or incomplete resection of the SMA [9,10]. One of the main characteristics of this syndrome, namely the SMA syndrome, is a complete or almost complete recovery within several weeks or months [11,12]. The specific evolution of this syndrome has been reported to occur in three stages [13]: a) immediately after surgery there is a global akinesia, which is more prominent contralaterally with an arrest of speech; b) sudden recovery a few days later, with persistent reduction in contralateral motor activity, emotional facial palsy, and reduction in spontaneous speech; and; c) within weeks to months after operation, the only sequel is disturbance of the alternating movements of the hands. Typically, the muscle tone of the paralyzed extremities are preserved. These observations have been confirmed by other series of surgical resection of the SMA [11]. Typical SMA syndrome have been encountered in 5 of the patients in this series with various degrees of hemiparesia occurring in the early postoperative period immediately after surgery. The degree of postoperative motor deficit was concordant with the resection of SMA as SMA syndrome was observed in all cases where the SMA was totally removed and it was not encountered in cases which the SMA had been incompletely removed. Thus, the location and severity of SMAS were proportional to the antero-posterior extent of the resection and thus to the amount of SMA preserved. Following surgery, the motor deficit remains unpredictable, although it is
more frequent when the resection extends in caudal parts of the SMA [8,9]. Postoperative speech disorders as the component of SMAS in this series were observed as a transient aphasia followed by a stage of constant improvement in speech fluency. This finding is similar to the previous reports [14]. It has been suggested that only the SMA in the dominant hemisphere is involved in language function, thus aphasia occurs as a result of the resection of dominant SMA [15]. However, there are reports where the resection of SMA in the nondominant hemisphere resulted in speech dysfunction [16]. In this series, postoperative aphasia was only observed as a component of SMAS except for one patient. Thus there was no postoperative speech disorder in 6 patients. As all SMAS cases in this series had lesions in the dominant hemisphere, one cannot argue that only the resection of the dominant SMA leads to postoperative aphasia. Moreover, it was noted that postoperative mutism was also observed in one case, although the lesion was in the nondominant hemisphere. Thus, it can be agreed with the previous reports which find the role of SMA dominancy in speech production controversial [12]. Identification of eloquent areas of the brain to avoid resection-induced damage is of utmost importance for minimizing the neurological deficit and postoperative quality of life. Thus in patients harboring lesions associated with SMA, the anatomical and functional association must be defined and shown preoperatively. Invasive and non-invasive methods are used for this purpose. Krainik et al., retrospectively evaluated motor deficits in 23 patients who had undergone resection of tumors involving the medial frontal lobe and concluded that the risk of developing postoperative weakness increased when surgical resection included the SMA as demonstrated on preoperative functional magnetic resonance (fMR) image mapping [9]. Similar findings has been reported by Nelson et al., who measured the distance between the edge of the tumor and the center of SMA activation in fMRI of 12 patients preoperatively and correlated these results with the risk of postoperative neurological deficit [16]. It was believed that fMRI should be performed in every patient having suspected lesions involving the eloquent areas. In cases where the preoperative epilepsy surgery work up necessitates invasive monitoring, fMRI can be used as an additional procedure for further estimating the motor strip and eloquent areas. In conclusion, presurgical planning in patients having lesions involving SMA requires the proper identification of eloquent areas that are very important for minimizing the postoperative neurological deficit [17,18]. The occurrence and severity of SMAS is associated with the extent of SMA resection and patients should be informed preoperatively about the risks and natural course of this syndrome [19]. Whenever possible fMRI should be performed preoperatively in every patient, even in cases where invasive monitoring is required, as it can further aid in mapping cortical function [20,21].

References

12. KRAINIK A., LEHÉRICY S., DUFFAU H., CAPELLE L., CHAINAY H., CORNU P., COHEN L., BOCH A.L.,
Khaled Anbar


