MICROSURGICAL APPROACH OF ARTERIOVENOUS MALFORMATIONS IN THE CENTRAL LOBULE

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Abstract – Arteriovenous malformations (AVM) are neurovascular disorders that occur mainly in young adults. Their clinical presentation is variable and depends on its location, size and occurrence of bleeding. They can represent incidental findings in neuro radiological exams. The treatment of these lesions when located in eloquent areas, namely around the central sulcus, is controversial, with different therapeutical approaches presented in the literature. We consider that surgical extirpation of many of these lesions is feasible in selected cases, when supported by profound anatomical knowledge and refined microsurgical technique, achieving cure with minimal additional deficit. In the present article, we elaborate a surgical technique for the approach of AVMs located in the central sulcus, specially in finding the topographic lesion location and craniotomy.

KEY WORDS: central sulcus, central lobule, arterio-venous malformation, craniotomy.
procedure, to those patients with progressive neurological
deficit, recurrent bleedings or intracranial hypertension.

Endovascular procedures are an important complement
doing surgery when dealing with AVMs, but the cure
obtained by this modality alone occurs only in a minority of cases. Radiosurgery can be used in small, deep, and
in eloquent areas AVMs, but the approximate two year latency to obtain the lesion obliteration carries the risk of
haemorrhage during this period. The central lobule of the
brain is formed by the precentral and postcentral gyri and
central sulcus. Its anterior limit is the pre-central sulcus
and the postcentral sulcus is the posterior limit. The supe-
rior margin of the brain is the superior limit of the central
lobule, separating it from the paracentral lobule. Inferi-
orly, the sylvian fissure, or lateral sulcus of the brain, limits
the central lobule. Besides the angiogram, the pre-opera-
tive magnetic resonance imaging (MRI) of the brain, es-
pecially the T1W1 sequence, is very useful in refining the
anatomic details of the adjacent brain and sulci, thus,
helping to find the exact location of the AVM (Fig 1).

Considerations can be drawn when AVMs are located
in eloquent cortical areas, especially in the central lobule,
empathized in the present study.

THERAPEUTIC ASPECTS
Concerning non-surgical treatment, several studies like
those by Andrade-Souza et al. and Hadjipanavis et al. eval-
uated the prognosis of patients with AVM located in
primary motor and sensitive areas treated with radiosur-
gery, concluding that this is the treatment of choice for
lesions located in eloquent areas. However, its efficacy is
limited to AVMs with less than 3 centimetres and, during
the time necessary to obliterate these lesions (approxim-
ately 2 years) the patient remains unprotected against
haemorrhagic events. Its long term morbidity is dose-de-
pendent and vascular injury and radionecrosis from the
procedure may result in neurological deficits.

In a different way, some authors reported that neuro-
physiologic intra-operative monitoring makes the sur-
gical procedure in eloquent areas safer. Kombos et al.,
advocated the use of intra-operative monitoring for the
identification of sensitive and motor areas, through soma-
to-sensorial evoked potentials. Ebeling et al., present-
ed low incidence of neurological deficits in 50 patients
with different lesions located in the primary motor and
adjacent areas with the use of cortical stimulation and
evaluation of intra-operative. Firsching et al., also sug-
gested that somato-sensorial evoked potentials utiliza-
tion is useful in identifying post-central gyrus in central
sulcus region areas.

In this way, we verify that there is no consensual con-
duct in AVM treatment, especially those located in elo-
quency areas.

With microsurgical technique development, improve-
ments in neuroradiology, neuroanaesthesia and intra and
postoperative monitoring, the approach of these lesions
is feasible. We believe that many of the lesions located
in the central sulcus region can be safely approached sur-
gically and cured if the removal is based upon anatomic
data and refined microsurgical technique, despite the

In the present study, we elaborate on the surgical tech-
nique for the approach of AVM located in the central sul-
cus, especially in finding the topographic lesion location
and craniotomy.
**CRANIAL ANATOMIC KEY-POINTS**

Cranial topographic knowledge is fundamental to perform an adequate craniotomy. The main points for the approach of lesions in the central sulcus region are identified below.

**Anterior sylvian point** – Located in the inferior part of the pars triangularis and in the antero-inferior region of the pars opercularis of the inferior frontal gyrus, causing a focal enlargement of the sylvian fissure, with cisternal characteristics. Its relation with the external cranial surface is in the most anterior region of the squamous suture (superiorly to the sphenosquamous suture and immediately posterior to the sphenoparietal suture).

**Central sulcus** – Generally a continuous sulcus without connection with any other anteriorly or posteriorly. Its superior extremity is located in the interhemispheric fissure. The intersection of the central sulcus with the interhemispheric fissure is called superior rolandic point. The region of its projection in the cranium is approximately 5 cm behind the bregma, which is located 12 cm behind the nasion.

The inferior rolandic point corresponds to the intersection of the central sulcus with the sylvian fissure, real or projected. Its correspondence in the cranium is in the region of intersection of the squamous suture with a vertical line projected from the pre-auricular depression.

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The region of the encounter between the superior frontal sulcus and the precentral sulcus is also important in the surgical planning. It is located about 1–2 cm posterior the coronal suture and 2–3 cm lateral to the sagittal suture (Superior Coronal Point).

The region of the encounter between the inferior frontal sulcus and the precentral sulcus, is located where the superior temporal line joins the coronal suture, in a craniometric point called Stephanion.

The Euryon is a craniometric point centred in the parietal tuberosity. It corresponds internally to the supramarginal gyrus region, posterior to the central sulcus and superior to the posterior sylvian point.

The intraparietal point is located 5 cm anterior and 4 cm lateral to the lambda as pointed by Gusmão et al.

**SURGICAL PROCEDURE**

Patients must be supine, with the head in neutral position above the level of the heart to improve venous drainage. The pin of the head holder on the side of the lesion is positioned in the mastoid and the contralateral pins in the superior temporal line, avoiding the temporal muscle.

The hair is shaved as represented in Figure 3, crossing the midline, with better cosmetic effect and without compromising the closure of the skin.

When marking the incision, one must define the regions of the pre-central sulcus and the superior rolandic, inferior rolandic, superior coronal and intraparietal points. The use of skin retractors helps in the exposure and haemostasis.

The craniotomy must be wide, after exposure of the coronal and sagittal sutures for orientation of the regions described above (Fig 3).

The dural opening is made under microscopic visualization, U shaped, with its base in the superior sagittal sinus, being folded over it, carefully not to damage cortical or AVM venous drainage structures. This must expose not only the AVM but also the surrounding normal brain tissue, allowing the correct identification of the vessels, sulci, gyri and central lobule (Fig 3).

Brain retraction is kept to the minimum necessary and the arachnoid plane is respected to avoid damaging the normal cerebral tissue and penetration into the AVM nidus. As in all microsurgical procedures, the operating field must be kept free from haemorrhages that infiltrate the arachnoid and pial plane masking the anatomical references. Then, properly arachnoid dissection is performed, identifying the drainage vein, which comes from the AVM nidus. Careful bipolar coagulation of feeding vessels must be performed as close as possible to the lesion, after as-
suring that they are not just passing through de AVM to supply adjacent and eloquent brain tissue, the “en passage” vessels, always reminding that the feeding arteries of the AVM have fragile walls and are of difficult obliteration. The feeding vessels of central sulcus AVM usually come from the middle cerebral artery (M4 segment). As we know, the same dissection plane must be kept during the whole procedure to ensure the surgeon not to injury the brain tissue and neither enters the AVM nidus. When the AVM shrinks due to obliteration of its feeders, it is resected after coagulating its venous drainage, which can be more than one and usually drains to superior sagittal sinus and/or superficial sylvian vein.

In conclusion, cranial topography should be used for locating the central sulcus region, complementing neurophysiologic studies. Profound anatomic knowledge and refined microsurgical technique are the bases for the surgical treatment of lesions in this region. Neurosurgical procedure performed in reference centres by trained professionals, supported by a multidisciplinary team can be considered as the first line treatment for many AVMs located in eloquent areas.

REFERENCES