

# RELATIONSHIP BETWEEN THE CORONAL SUTURE AND THE CENTRAL LOBE

How important is it and how can we use it in surgical planning?

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**Abstract** – The surgical treatment of the lesions located in the central lobe is a very difficult task for the neurosurgeon. The overall aim of this study is to verify the correlation of the coronal suture and the structures of the central lobe in 32 cadaver hemisphere brains and the importance of this information in surgical planning. The measurement of the nasion to the coronal suture ranged from 11.5 to 13.5 cm. The distance between the coronal suture in the midline to the central, precentral and paracentral sulcus ranged from 5.0 to 6.6, 2.5 to 4.5 and 1.3 to 4.0 cm respectively. Particularly in the normal cortex these measurements can be used to guide the surgical access. However, the identification of the central sulcus is not easy when the anatomical pattern is distorted or displaced by a lesion or edema. In cases such as these the use of other tools becomes crucial for good surgical planning and cortical mapping or awake craniotomy for a safer resection of the lesion as well.

**KEY WORDS:** coronal suture, central lobe, central sulcus, motor cortex, preoperative planning.

## Relação entre a sutura coronária e o lobo central: qual a sua importância e como podemos usá-la no planejamento cirúrgico?

**Resumo** – O tratamento cirúrgico de lesões localizadas no lobo central é difícil para o neurocirurgião. O objetivo deste estudo é verificar a relação da sutura coronária com as estruturas do lobo central utilizando-se de dissecação realizada em 32 hemisférios cerebrais de 16 cadáveres, assim como, a importância desta informação no planejamento cirúrgico. A medida da distância entre o nasion e a sutura coronária variou entre 11,5 e 13,5 cm. A distância da sutura coronária na linha média para os sulcos central, pré-central e paracentral variou de 5,0 a 6,6 cm, 2,5 a 4,5 cm e 1,3 a 4,0 cm respectivamente. O conhecimento destas medidas pode ser usado no planejamento cirúrgico principalmente num córtex normal. Porém, a identificação do sulco central é difícil quando as estruturas anatómicas estão deslocadas pela lesão ou quando há edema. Nestes casos a utilização de outros meios diagnósticos para o planejamento cirúrgico torna-se necessária, como também a estimulação cortical ou a craniotomia com o paciente acordado pode proporcionar uma ressecção mais segura da lesão.

**PALAVRAS-CHAVE:** sutura coronal, lobo central, sulco central, córtex motor, planejamento pré-operatório.

The central lobe is an eloquent area of the central nervous system (CNS), limited anteriorly by the pre-central sulcus and posteriorly by the post-central sulcus. The central sulcus, which separates the pre from the post-central gyri, is one of the most important anatomical landmarks of the cerebral cortex<sup>1-3</sup>.

The central lobe is a site of a wide variety of lesions and sometime surgeons need to approach it directly, for

example in the resection of gliomas. However, manipulation in an eloquent area increases the risk of post-surgical complications and deficits. A knowledge of the morphological relationship of this lobe and its relationship to the craniometric points and sutures facilitates the approach to the lesion preserving neurovascular structures<sup>1-6</sup>. Exact and correct localization of the central sulcus becomes crucial.

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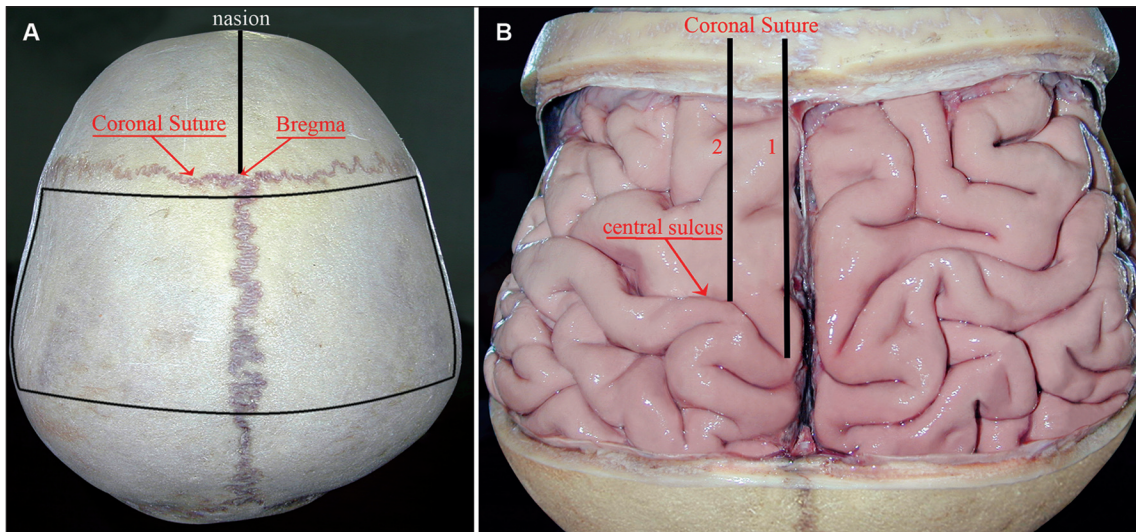


Fig 1. (A) A superior view of the cranium after scalp removal; continuous line – measurement of the distance between the nasion and the coronal suture in the midline and the mark of the bilateral craniotomy to expose the central lobe. (B) After bilateral removal of the piamater and vessels for a better visualization of the sulcus the measurement procedures were undertaken. The line 1 corresponds to the distance between the coronal suture to the beginning of the central sulcus on the midline (6.0 cm in this case) and the line 2 corresponds to the same distance, but just paramedian on the high convexity (5.2 cm in this case).

Table 1. Coronal suture and sulcal points related measurements.

	Average			Standard deviation			Right × left (p value)
	R	L	Total	R	L	Total	
CoSut – CS distance	5.85	5.97	5.91	0.51	0.31	0.37	1.11
CoSut – preCS distance	3.67	3.66	3.67	0.47	0.53	0.41	0.09
CoSut – posCS distance	2.60	2.91	2.76	0.68	0.71	0.62	1.90
CoSut – CS inf ext distance	2.90	3.04	2.97	0.70	0.68	0.62	0.91
ParacLob length	3.76	3.77	3.76	0.44	0.42	0.36	0.05

R, right; L, left; CoSut, coronal suture; CS, central sulcus; preCS, precentral sulcus; posCS, poscentral sulcus; CS inf ext, central sulcus inferior extremity; ParacLob, paracentral lobe. Measurements are in centimeters.

Table 2. Frequencies of coronal suture - nasion distance related measurements.

Distance	Frequencies	Percentage (%)
11.5	1	15
12	13	75
12.5	1	5
13.5	1	5
Total	16	100

Average=12.02; standard deviation=0.41; measurements are in centimeters.

The objective of this anatomical study is to verify the correlation between the coronal suture and the structures of the central lobe and discuss how to use this information to plan the craniotomy and surgical access preserving the structures as well. The pattern of the course of the sulcus and veins were not an aim of this study because these structures have been well studied in the literature.

**METHOD**

A total of 16 adult cadaver brains were studied by a craniotomy, totaling 32 hemispheres. The study was performed in the anatomy laboratory of the Faculdade de Medicina Nova Esperança (FAMENE).

The scalp was removed by a bauricular incision to expose the external cranial surface. Both coronal sutures were identified (Fig 1A). A bilateral craniotomy was performed to expose the entire central lobe leaving the coronal suture as a landmark. The posterior extension of the craniotomy was about 10 cm behind the coronal suture. The opening of the dura was performed including part of the superior sagittal sinus, followed by removal of the piamater and veins (Fig 1B). In addition to measurement between the nasion to the coronal suture, the following measurements were taken in all of the hemispheres: the distance between the coronal suture and the central sulcus in the midline; the distance between the coronal suture and pre-central sulcus in the midline; the distance between the coronal suture and paracen-

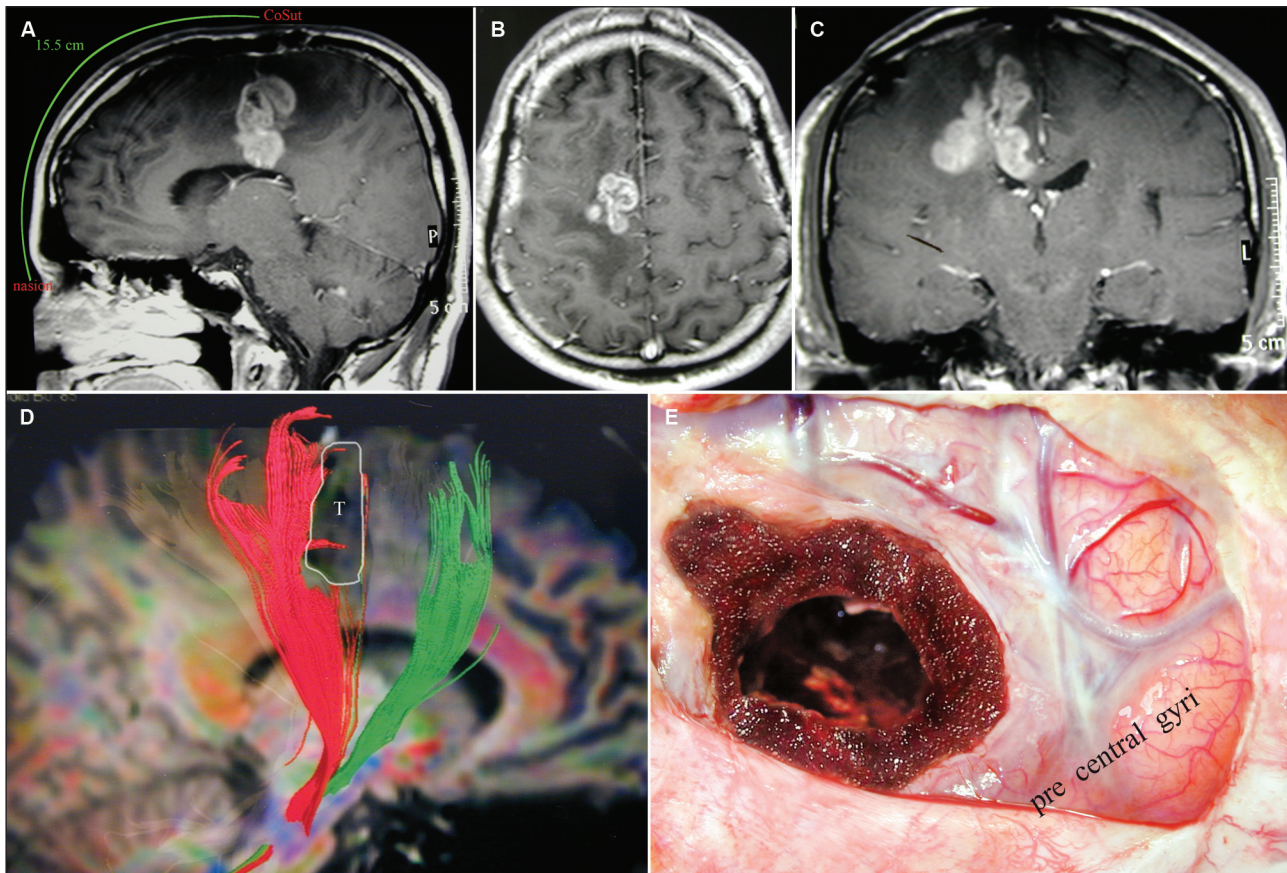


Fig 2. An illustrative case: 42 year old, male, presented a motor deficit on the left side (grade 4 on the upper and lower limbs). (A) Pre-operative sagittal MRI, (B) axial and (C) coronal showing a subcortical anaplastic astrocytoma in the right motor area with perilesional edema causing a distortion of the sulcus. (D) Tractography shows a close relationship between the tumor (T) and the pyramidal tract (some fibers were interrupted by the tumor). In cases such this, the risk of damage in the motor cortex or descendent tract is high. The knowledge of the relationship between the coronal suture and structures of the central lobe helps the neurosurgeon to estimate the site of the incision and craniotomy based on the MRI data. But, for a safer resection of the tumor preserving the normal structures we decided to operate on the patient by an awake craniotomy. (E) Surgical cavity post resection.

tral sulcus; the length of the paracentral gyrus and the distance between the coronal suture in the pterion to the central sulcus.

Our data were submitted to statistical analysis using t Student test; p-values <0.05 were considered statistically significant.

The study protocol was submitted to and approved by the local ethical committee.

## RESULTS

The results are summarized in the Table 1 and 2. The distance from the nasion to the coronal suture ranged from 11.5 to 13.5 cm (average 12.02 cm). The distance between the coronal suture and the central sulcus in the midline ranged from 5.0 to 6.6 cm (average 5.91). Between the coronal suture and the precentral sulcus the measurement ranged 2.5 to 4.5 cm (average 3.67 cm). The measurement between the coronal suture and the paracentral sulcus ranged from 1.3 to 4.0 cm (average 2.76 cm). The distance from the coronal suture on the pterion region to the central sulcus ranged from 1.5 to 4.0 cm (average 2.97).

There was not a significative difference between the right and the left hemispheres.

## DISCUSSION

There are many situations in which the neurosurgeon needs to work in the central lobe to make a direct approach to cortical or subcortical lesions at the convexity or at the midline hemisphere. Although technology already offers modern intraoperative localization tools such as magnetic resonance image (MRI) and neuronavigation<sup>7-9</sup>, anatomical knowledge remains as an important way of the surgical planning. Also, those tools are not always available in the operative room.

The first step in the surgical planning is to know the localization of the coronal suture. According to our study the distance between the nasion and the coronal suture ranged from 11.5 to 13.5 cm (average 12.02 cm). Although these measurements are in accordance to literature<sup>1-3,6</sup> it is common to find patients in which these distances can

be very different, as we can see in the illustrative case (Fig 2A). So, an interesting and easy way to plan the craniotomy, based on the distance of the nasion and coronal suture is to take this measurement by using the radiological image and then transfer it to the cranium.

The second step is the identification of the central sulcus. There are many ways to identify this important landmark<sup>1,5,7-9</sup>. The use of the coronal suture as a point of reference, and especially, its relationship to the sulcus of the lateral surface of the frontal lobe, allows to estimate the assessment of the projection on the cranium of the superficial cerebral lesions, with the purpose of delimiting the surgical access and to guide the approach to the cerebral convexity. According to our study the distance between the coronal suture and the central sulcus ranged from 5.0 to 6.6 cm (average 5.9 cm). Gusmão et al.<sup>1,2</sup> studied these measures and observed that this distance was 4.5 cm. Ribas et al.<sup>6</sup> found it to be 5 cm. We think that this measurement was a little different from our study probably because we considered the distance of the coronal suture to the exact point where the central sulcus begins. So, in surgery around the paracentral lobe we must consider the measurement represented by the line 1 in Fig 1B and in surgery of the high convexity we must consider the measurement represented by the line 2 in the same figure. This anatomical information is useful to localize the central sulcus. However, as we can see again in the illustrative case (Fig 2A-D) this measurement is not easy when there is edema or dislocation of the structures of the central lobe. So, although these measurements give the neurosurgeon an idea about the localization of the central sulcus, the use of other tools becomes necessary in the surgical planning. For such cases the use of functional magnetic resonance (fMRI) and/or electrophysiological studies<sup>10-14</sup> or awake craniotomy are recommended<sup>15</sup>. It is very important to remember that the central lobe must be manipulated carefully, avoiding excessive and unnecessary traction of the structures according to the principles of Yasargil<sup>16</sup>.

In conclusion, the relationship between the lesion and the structures of the central lobe can be inferred from anatomical landmarks mainly the central sulcus and the

coronal suture. However, this method may be unreliable in some cases. When the sulcus or gyrus are displaced by pathological conditions or edema making the anatomical identification difficult, the neurosurgeon should use other tools such as fMRI, cortical stimulation or awake craniotomy for good surgical planning and safer resection of the lesion, particularly in the gliomas.

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