

Morphometric analysis of the Paracentral Lobe

Análises morfométricas do Lóbulo Paracentral

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Abstract

Introduction: There are no studies that evaluate the measurements of the distances between the grooves that demarcate the Paracentral Lobule (PCL) in literature. This study seeks to contribute to the knowledge regarding the anatomy of the PCL, conducting an analysis of morphometric measurements in this region and its correlation with the paracentral sulcus, marginal branch of the cingulate and central sulci. **Methods:** 42 hemispheres were evaluated, 22 from the right and 20 from the left hemisphere. Using a digital caliper rule Western®, model Dc – 6, measurements of the size of Paracentral Lobe in the sagittal axis and coronal axis were made, in addition to measures of the Central Sulcus to the Paracentral Sulcus (motor area) and Central Sulcus to Marginal Branch of the Cingulate Sulcus (somesthetic area), comparing the prevalence of each of these lengths between hemispheres. **Results:** The average length between the Paracentral Sulcus and the Central Sulcus was 24.49 cm (14.2 to 38.6 cm) in the right hemisphere and 25.50 cm (11.7 to 37.0 cm) in the left. As between the Central Sulcus and the Marginal Branch of the Cingulate Sulcus was in average 10.03 cm (2.6 to 22.7 cm) in the right and in the left PCL 9.17cm (2.6 to 22.7 cm). In the right hemisphere, 19 samples (86,4%) presented greater length of the motor area than somesthetic, and, in the left hemisphere, 19 samples (95%) had greater length of the motor area. **Conclusion:** The motor area showed larger size in relation to the sensory area in the analysis of the two hemispheres, while the comparison of other measures between the two hemispheres showed no significance.

Keywords: Central Nervous System. Brain. Cerebral Cortex.

Resumo

Introdução: Não há registro de estudos na Literatura que avaliem as medidas das distâncias entre os sulcos que delimitam o lóbulo paracentral. Este estudo busca contribuir com o conhecimento da anatomia do Lóbulo paracentral, realizando uma análise das medidas morfométricas dessa região e suas correlações com os sulcos paracentral, ramo marginal do sulco do cíngulo e central. **Métodos:** Foram avaliados 42 hemisférios, 22 direitos e 20 esquerdos. Utilizando paquímetro digital Dc-6 Western®, foram aferidas as medidas do tamanho do Lóbulo Paracentral no eixo sagital e no eixo coronal, além das medidas do Sulco Paracentral ao Sulco Central (área motora) e do Sulco Central ao Ramo Marginal do Sulco do Cíngulo ao Sulco Central (área somestésica), comparando a predominância de cada um desses comprimentos entre os hemisférios. **Resultados:** A medida entre o sulco paracentral e o sulco central teve a média de 24,49 cm (14,2 – 38,6 cm) no hemisfério direito e 25,50 cm (11,7 – 37,0 cm). A medida entre o sulco central e o ramo marginal do sulco do cíngulo teve como média 10,03 cm (2,6 – 22,7 cm) no LPC direito e 9,17 cm (2,6 – 22,7 cm). Quanto à predominância da área motora e sensitiva no lóbulo paracentral, no hemisfério direito, 19 amostras (86,4%) apresentavam maior comprimento da área motora que a somestésica e, no hemisfério esquerdo, 19 amostras (95%) apresentavam maior comprimento da área motora. **Conclusão:** A área motora apresentou um predomínio em relação à área sensitiva na análise dos dois hemisférios, enquanto a comparação das outras medidas entre os dois hemisférios não apresentou significância.

Palavras-chave: Sistema Nervoso Central. Cérebro. Córtex Cerebral.

INTRODUCTION

The paracentral lobule (PCL) is a quadrilateral gyrus located on the medial surface of the telencephalon, outlined anteriorly by the paracentral sulcus, inferiorly by the cingulate sulcus and posteriorly by the marginal branch of the cingulate sulcus (Figure 1). The PCL surrounds the indentation of the central sulcus on its upper border, which divides this lobe in the anterior and posterior regions, respectively, which are extensions of the pre-and post-central gyre of the superolateral face of the hemisphere¹.

Pyramidal cells of the anterior portion of the PCL, which are located in the primary motor cortex (Brodmann area 4), send fibers to the skeletal muscles of the lower limbs and muscles of the perineum, making this an important area in the control of bladder and anal sphincters, thus being called area of the cortical center of defecation/urination^{1, 2}. While the posterior portion of the PCL, located in the primary somesthetic area (Brodmann Area 1), is related to the sensitivities of the lower limbs and perineum^{3, 4, 8}.

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Several anatomical variations have been observed in PCL. The paracentral sulcus may appear in four morphological patterns: it can present itself as a branch of the cingulate sulcus, a groove as the superior-lateral surface, as both being a branch of the cingulate sulcus and a branch of the upper- surface lateral, or as an extension of the posterior segment of the cingulate groove.

In high-definition MRI studies, cingulate groove presents continuous over 80% of the studied hemispheres⁶. However, studies with brain hemispheres conserved in formol show that this sulcus appears continuous in about 51% of cases^{1,6}. The marginal branch of the cingulate sulcus presents no interruption in the way to the superior-lateral margin of the cerebral hemisphere in 80% of cases¹⁰.

The PCL is often affected by anterior cerebral artery infarcts, causing sensory and motor deficits. Moreover, this area may be a primary site for tumors and focal seizures, making its surgical access of great importance for neurosurgery^{9,11,12}.

Due to advances in the endoscopic neurosurgery, which decreased the incidence of morbidity in conventional surgery, it has become extremely necessary to better understand the detailing of the PCL's anatomy and its anatomical variations.

This study seeks to contribute to the knowledge regarding the anatomy of the PCL, conducting an analysis of morphometric measurements in this region and its correlation with the paracentral sulcus, marginal branch of the cingulate and central sulcus.

MATERIAL AND METHODS

Telencephalic hemispheres conserved in a solution of 50% alcohol and 50% glycerin, archived at the Vicente Paulo Jorge Lemos's Anatomy Laboratory from The University Centre Unichristus

(Fortaleza –Northeastern Brazil) were analyzed. Information as to age and sex was not available. It was not possible to determine how many hemispheres belonged to the same individual. Using a digital caliper rule, Western[®], model Dc–6, which has a precision of 0.1 mm, measurements of the size of Paracentral Lobe in the sagittal axis and coronal axis were made, in addition to measures from the Central Sulcus to the Paracentral Sulcus (motor area) and Central Sulcus to Marginal Branch of the Cingulate Sulcus (somesthetic area), comparing the lengths between the hemispheres. The statistical test ANOVA was used to compare the means. The present study followed the existing legislation in Brazil which authorizes the use of unclaimed corpses for research and education (Law 8501 of 30/11/1992) and is in accordance with Resolution 196/96 of the National Health Council.

RESULTS

Forty-two hemispheres were enrolled in the study, including 22 from the right and 20 from the left (Table 1). The mean length of the paracentral lobe of the right and left hemispheres in the sagittal axis was 34.53 cm (22.9 to 47.2 cm) and 34.65 cm (28.4 to 47.9 cm), respectively, ($p = 0,408$). The average length of the coronal axis of the PCL was 21.97 cm (17.6 to 27.0 cm) in the right and 21.67cm (16.3 to 26.8 cm) in the left ($p = 0,334$). Comparing the distance between the paracentral sulcus and the central sulcus, the right hemisphere had an average length of 24.49 cm (14.2 to 38.6 cm) and the left of 25.50 cm (11.7 to 37.0 cm) ($p = 0,454$). Between the central sulcus and the marginal branch of the cingulate sulcus the right had average of 10.03 cm (2.6 to 22.7 cm) and the left PCL 9.17cm (2.6 to 22.7 cm) ($p = 0,660$). Comparing the motor and sensory areas in the paracentral lobule, in the right hemisphere 19 samples presented greater length of the motor area, and in the left hemisphere 19 samples presented greater length of the motor area.

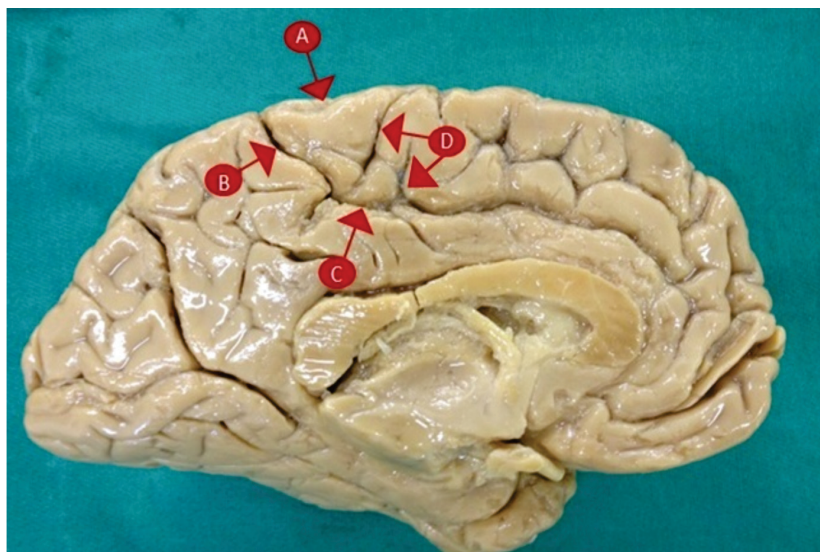


Figure 1 Delimitation of the Paracentral Lobe: a) Central Sulcus; b) Marginal Branch of the Cingulate Sulcus; c) Cingulate Sulcus; d) Paracentral Sulcus (in the figure the Paracentral Sulcus is discontinuous).

Table 1 Average of the lengths analyzed in the study

Length	Right Hemisphere (cm)	Left Hemisphere (cm)	p values
Between the Paracentral Sulcus and the Central Sulcus	24,49 (14,2 - 38,6)	25,50 (11,7 - 37)	0,454
Between the Central Sulcus and the Marginal Branch of the Cingulate Sulcus	10,04 (4,1 - 28,3)	9,17 (2,6 - 22,7)	0,660
Sagittal axis	34,53 (22,9 - 47,2)	34,65 (28,4 - 47,9)	0,408
Coronal axis	21,97 (17,6 - 27,0)	21,67 (16,3 - 26,8)	0,334

DISCUSSION

A comparison between the measurements of two hemispheres did not reveal a significant difference between the lengths of the regions analyzed in the paracentral lobe. Nevertheless, a predominance of the motor area was found when measurements between somesthetic and motor regions were compared.

In a high-definition MRI study by Spasojević *et al.* comparing the right and left areas of the paracentral lobes in 84 hemispheres, the mean extrasulcal surface of the left paracentral lobule was significantly larger, both in males (left 6.79 cm² vs. right 5.76 cm²) and in females (left 6.05 cm² vs. right 5.16 cm²)⁷.

The knowledge about the dimensions of brain structures, such as the PCL, is greatly important for the practice of safe neurosurgery, once minimal errors can lead to substantial functional damage. Therefore, the benefit of knowing the findings of this study is important of reducing the incidence of surgical errors.

The main limitation of the study was the lack of information regarding demographic and clinical data on

the patients whose brains were evaluated. The purpose of obtaining these information data from the corpse would be to correlate these variables with morphometric measures, checking if there is any correlation between the lengths of these regions with pre-mortem data.

To the best of our knowledge, there have been no similar studies on the evaluation of the measurements between the grooves that delimit the paracentral lobule in the literature.

CONCLUSION

In the current study, the length of the motor area was greater than the sensory area in both hemispheres, while the comparison of other measurements between the two hemispheres showed no significance. Significant statistical correlations between these measures could be inferred through studies with a larger sample correlating variables such as age, body weight, height, race and education level to the length of the measures analyzed in this study.

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