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Occipital Lobe Petalia Measurements on Brain CT Scans

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ABSTRACT

Petalia or occipital bending is an anatomical asymmetry where one occipital lobe protrudes behind the other occipital lobe and makes an impression on the inner table of the skull.

Purpose: The aim of this paper is to measure brain petalias and check the relationship between petalia with age, gender, other measurements in the brain, handedness, location of the petalia, degree of the petalia angle, etc.

Methods: A retrospective study of 33 patients' CT scans were studied and analyzed.

Results: The research shows that there is no relation whatsoever between them. As well, this paper will provide descriptive analyses like; frequency, mean, and standard deviation.

Conclusions: This paper finds new findings about levels of petalia, classification, and handedness/hemisphere dominance association. The results show no relation between age and gender from one side and petalia's dimensions on the other side.

KEY WORDS Petalia; Occipital; Bending; Brain; Computed Tomography.

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Introduction

Petalia is describing the asymmetry of the cerebral hemisphere which is characterized by protruding of one cerebral hemisphere behind the other and it makes an impression on the inner surface of the skull. There are two types of petalia; frontal lobe petalia and occipital lobe petalia which are combined together in some cases. For example, the right cerebral hemisphere is protruding behind the left hemisphere (the right occipital lobe is behind the left occipital lobe), meanwhile, the left frontal lobe is protruding in front of the right frontal lobe. This is not seen in all patients, but in some cases. Similarly, in other situations, one hemisphere is protruding in the front and behind the other hemisphere.

A proposal for a new classification system

Petalia is not described accurately or classified appropriately so far. Petalia can be classified according to the morphology, the bending side, or the level of bending. There are three types seen in petalia cases based on frontal lobe involvement (i.e. the morphology classification);

A- One occipital lobe behind the other occipital lobe and frontal lobes are symmetrical which can be called (partial dominance, no frontal lobe involvement, or classic petalia) see (Fig. 1),

B- One occipital lobe is behind the other occipital lobe (with dominance posteriorly to one side) and the frontal lobe of the other side is in front the frontal lobe of the other side (with dominance frontally on the opposite side) which can be called (a compensatory dominance) which can happen in both sides, not a counterclockwise only and the Yakovlevian torque or cerebral torque can be classified under this category see (Fig. 1), and

C- Dominant occipital lobe behind the other occipital lobe and the frontal lobe of the dominant side is in front of the frontal lobe of the other side which can be called (complete dominance) see (Fig. 1).

It can be classified according to the bending side as in rightward or leftward bending (i.e. the involved side classification). As well, it can be classified according to its level to three levels; infra-tentorial (cerebellar level), tentorial (basal ganglia), and supratentorial (body of the ventricles) (i.e. the level of petalia classification). Petalia is not just a bending in the occipital lobe, but a term describing asymmetry of both brain hemispheres.

Petalia and mental Illnesses

Some studies claim that petalia is more common in right-handed people. There are many studies that associate occipital petalia with schizophrenia, major depressive disorders, and bipolar affective disorder[1, 2, 3, 4]. This petalia or occipital bending is associated with transverse sinus dominance, transverse sinus hypoplasia, and diagnostic difficulties in cases of thrombosis[2], etc. Both petalia and Yakovlevian torque are considered the same, but it will be more appropriate if the Yakovlevian torque is considered as a subtype of petalia. Yakovlevian counterclockwise torque is describing the frontal lobe to be more the center of the asymmetry where logic dictates from an anatomical point of view that the dural venous sinuses are involved in forming petalia and recent studies show it is a way of showing the dominance of the transverse sinus on one side by forming petalia[2]. Yakovlevian torque is described as a geometric torsion of the cerebral hemispheres where the enlarged right frontal lobe is displacing the compressed opposite hemisphere to make it bend behind the left occipital hemisphere which forms a counterclockwise torsion.

Material and Methods

This is a cross-sectional study conducted after obtaining the necessary ethical approval from the Institutional Review Board (IRB) where the study was conducted. Consent forms were given to all patients who participated in this study. The study is retrospective and it was done using the Picture Archiving and Communication system (PACs) database for collecting the sample for this paper. The available sample size is 33 patients who were selected randomly and were collected from January 2022 to September 2022 see (diagram 1). The inclusion criteria are any patient, any age, any gender, any race, and any nationality. The exclusion criteria are no space-occupying lesion, bleeding, or pathology in the brain which might cause mass effect see (diagram 1). As well, patients who are not well centralized or tilted to one side see (diagram 1). In addition, hydrocephalus, or any patient with an intracranial medical device. The age and gender are collected and only on the left side petalia patients were asked whether they are right-handed or left-handed.

The CT scan is a 16-slice Siemens Somatom Sensation, and the used protocol is routine brain CT with the fol-

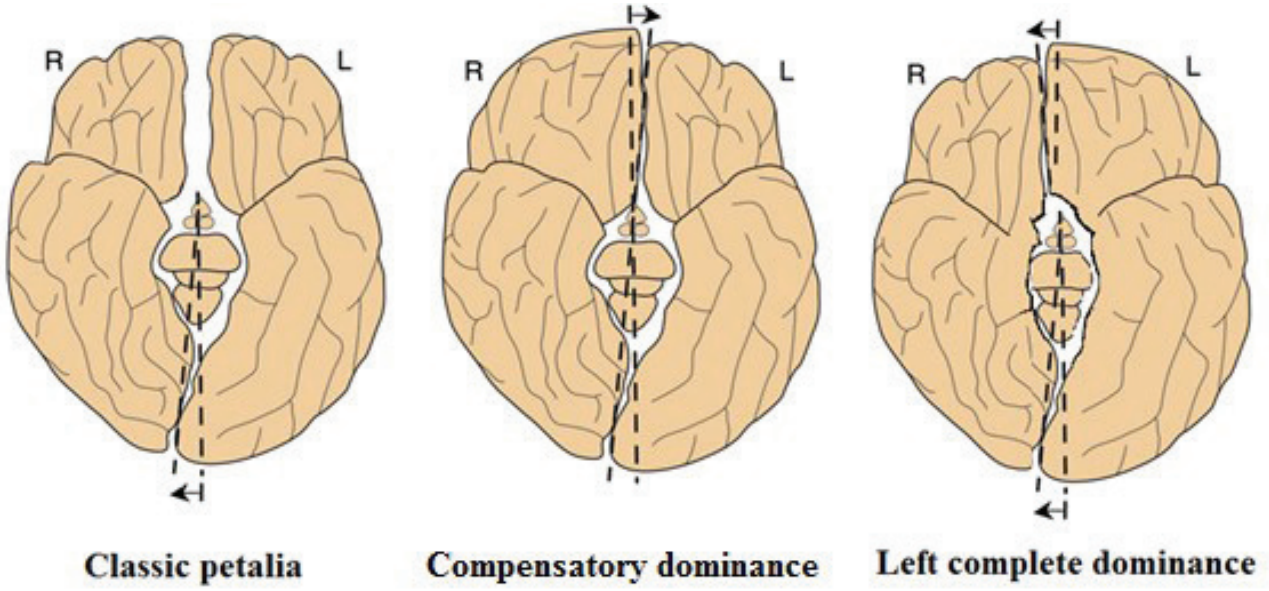

Figure 1. *An illustration of the difference between classic petalia,Yakovlevian torque, and complete dominance.*

lowing factors; 120 kV, 400 effective mAs, 1.0 rotation time, 0.75 mm detector collimation, 4.5 mm slice thickness, 9.0 mm feed/scan, H31ms Kernal, and ca/cr image order.

The measurements were taken on a plain brain CT scan of axial sections and the brain window was used. The measurements include; the length of petalia, the width of petalia, the angle of petalia, the thickness of the skull on the protruding side, the thickness of the skull on the opposite side, area measurements in mm^2, and the distance of the protrusion from the midline see (Fig. 2). The level of petalia were recorded as well. The data is analyzed using (V/22) SPSS and the result will be discussed. The hypothesis of this paper is that sex and age of the patient are related to the measurements of the petalia/occipital bending. The null hypothesis is the petalia/occipital bending is not associated with age or sex. The alternative hypothesis is petalia/occipital bending's variables have a relation among each other with no relation with age or sex.

Results

The number of males in the study is 18 patients and the number of females in the study is 15 patients with the total number of sample size for this study is 33 patients. The average age for men is 48,39 years, the average age for women is 47.73 years, and the average age for both is 48.09 years see (Table 1).

The average size of petalia is 296.27 mm^2, the average distance from the midline is 15.39 mm, and the average angle is 148.13 degrees see (Table 2). The youngest patient's age in the study is a 6-year-old and the oldest patient in the study is 107-year-old see (Table 2).

All tests were done to find any correlation or association between age and gender on one side and petalia's length, width, angle, level, distance from midline, and thicknesses of the skull on the other side. The results were negative for Pearson correlation, Chai square, Anova test, p-value, and t-test. All came without any statistical significance! However, the Pearson correlation test showed a significant relationship between the length of petalia, the width of petalia, and distance from the midline all on one hand and the affected side on the other hand by 0.005, 0.006, and 0.006 respectively which indicate that petalia will be affected (increased or decreased) in dimensions based on the side which the petalia will be on (rightward or leftward). Some data shows that the level in most patients is the basal ganglia (18 patients), secondly, is the body of the ventricles (11 patients), and finally, the cerebellar level is (6 patients) only see (Table 3).

The "leftward" and "rightward" or in simple terms right to left and left to right bendings showed that most of the patients have left to right bending in 29 patients, while only 4 patients have right to left bending. Furthermore, 3 out of the 4 patients are right-handed of

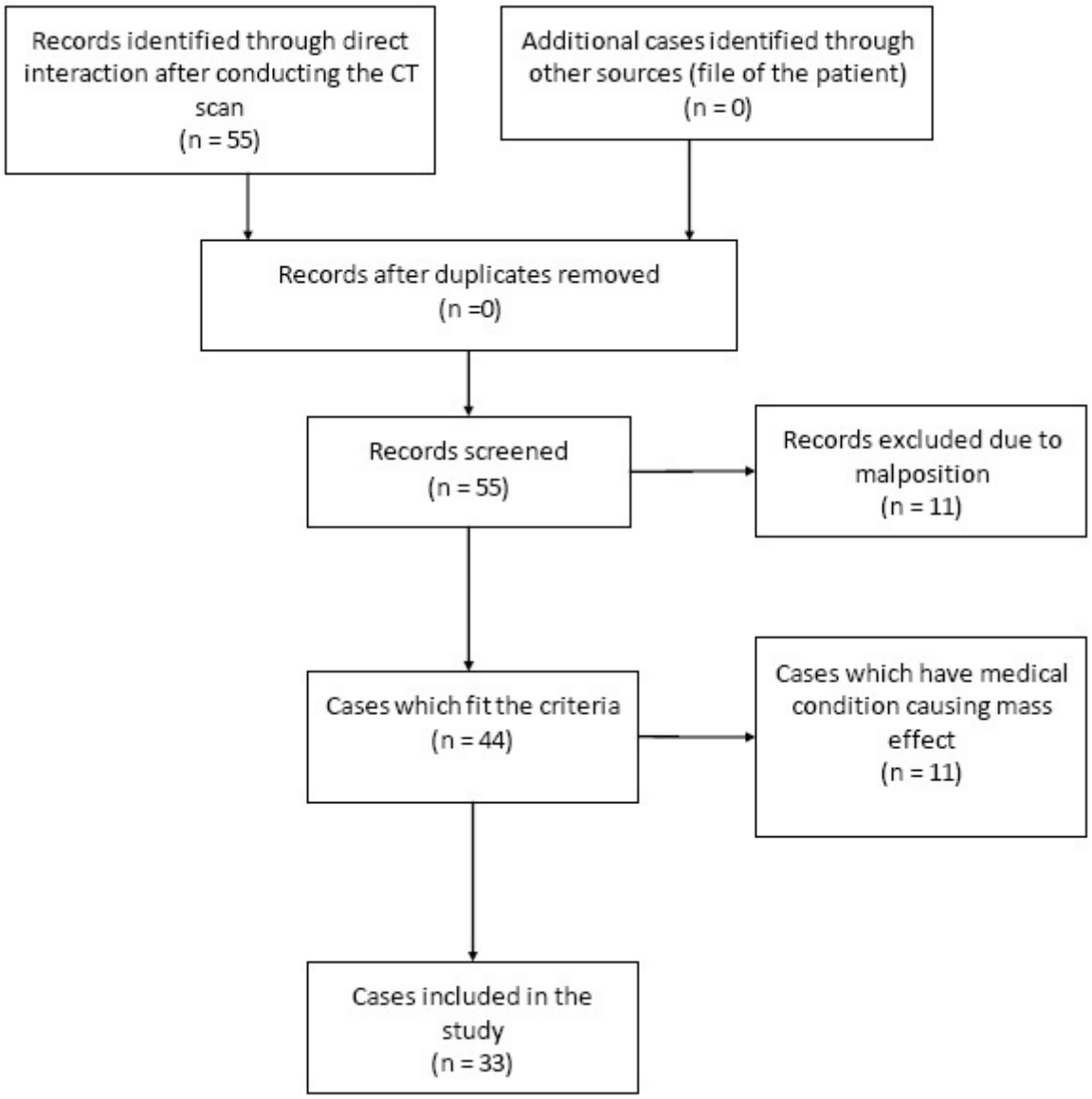

Diagram 1. *A flow diagram (STRAD) which shows the inclusion criteria and explains the sample collection method.*

the patients with the right to left bending which means only one patient is left-handed. In addition, 3 out of the 4 left-handed patients are males and only one is a female see (Table 4).

Discussion

Petalia is not classified and this classification (the morphological classification) proposed in this paper makes a distinction between three different types of petalia. The most common form of occipital bending from the left side to the right side. Some tried to study the relation between ocular dominance with the occipital bending just like handedness and cerebral dominance[5, 6, 7] but they did not find any relation just like recent research which found no relation between ocular dominance, neither handedness nor cerebral dominance with occipital lobe[2]. All these results support the result in this paper. The occipital bending is a sign of transverse sinus dominance and bigger diameter in the majority of patients in a published study[2].

The result of this paper will lead to selecting which hypothesis is more accurate. Males are more than females which might indicate that petalia affects males more, but since the sample is randomly collected as a cross-sectional study with no equal numbers of males and female participants and a normal control group,

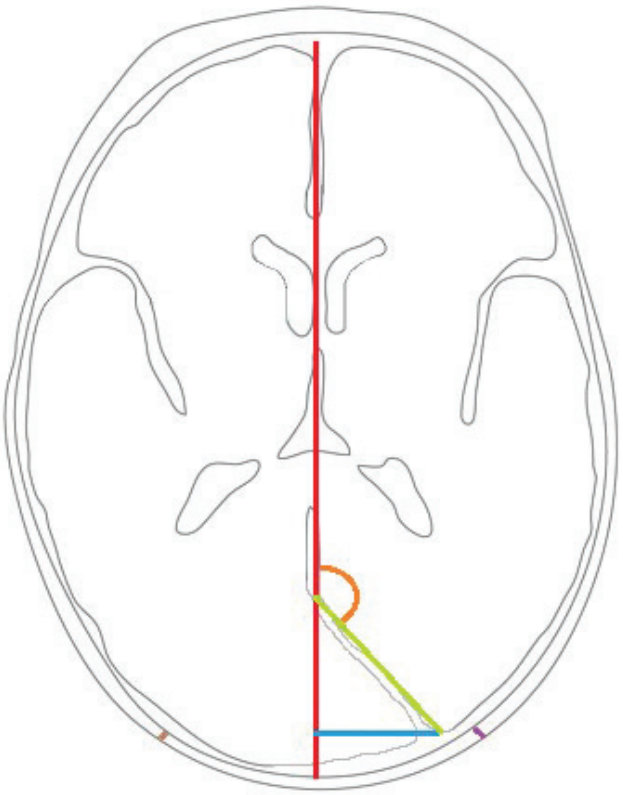

Figure 2. *An illustration of the measurements applied on the brain axial section. The red line is the midline, the green line is the length of the petalia, the blue line is the width of the petalia and the distance from midline, the orange line is the angle of petalia, the purple line is the thickness of skull on both sides.*

it could be a normal numerical difference due to randomness of the sample collection. Furthermore, no statistical relation or association was found between sex and petalia's measurements and data. According to the results, no relation is found between age and sex on one side and petalia's variables. The above stated have led to conclude that hypothesis must be rejected and the null hypothesis is accepted and the alternative hypothesis is partially accepted.

This paper proposed a new classification for petalia/occipital bending according to different factors. In addition, this paper showed the prevalence of petalia according to the subtypes of petalia according to the proposed classifications in the introduction of this paper.

The term "occipital bending" indicates a specific lobe (occipital lobe) or the occipital fossa. At the same time, the center of the petalia (center of the bending) is seen in the cerebellum (inferior) and in the parietal lobe (superior). Meanwhile, the occipital lobe is free of any bending or has a small bending! This makes it clear that the term "occipital bending" is wrong and the term petalia is more general and it is more inclusive for those different types.

According to the level of petalia, the infratentorial and the body of ventricle levels, both together were found in 15 patients which means 45.54% of all patients. Meanwhile, the basal ganglia level was seen in 18 patients which means 54.55% of all patients. This shows that 45.54% of all petalia cases are infratentorial and at the level of the body of the ventricles which is a big percentage and should not be dismissed. The infra-tentorial level petalia alone is found in 12.12% of all patients, the body of ventricles level petalia alone is found in 33.33% of all patients, and the highest one is the basal ganglia level petalia alone is seen in 54.54% of all patients.

The percent of the left to right bending is 87.88% of all cases and the percent of the right to left bending is 12.12% of all cases. Males were higher in the right to left bending and the left to right bending more than females in both categories. Since the bending makes an impression on the skull, the skull thickness average was higher on the left occipital bone compared to the right occipital lobe. The average measurement of the left occipital bone is 8.52 mm and the average measurement of the right occipital lobe is 8.36 mm.

Conclusions

Sex and age are not affecting the process of forming petalia in any shape or form. Different classifications of petalia according to previously mentioned factors is a key point for differentiating which type can cause pathological or mental implications. The left-to-right petalia is the most common form of bending. No indication of cerebral dominance was found in the right-to-left bending. A classification was proposed in this paper for different types of petalia and some of these types were studied, while the morphological classification was not studied in this paper since this paper was more focused on the occipital fossa or the posterior cranial fossa mainly. As well, the term occipital bending should be replaced with petalia. Future studies must focus on

Table 1. The mean for both genders.

Age			
Sex	**Mean**	**N**	**Std. Deviation**
Male	48.39	18	25.629
Female	47.73	15	26.391
Total	48.09	33	25.569

Table 2. The mean for all categories.

	Minimum	Maximum	Mean	Std. Deviation
Age (year)	**6**	**107**	**48.09**	**25.569**
Area (mm2)	73.50	581.60	296.2758	129.48987
Distance (mm)	7	27	15.39	4.723
Length (mm)	15	58	32.24	10.461
Width (mm)	7	27	15.39	4.723
Thickness_ Lt_Skull (mm)	6	12	8.52	1.564
Thickness_ Rt_Skull (mm)	6	12	8.36	1.655
Petalia_ Angle (degree)	42.27	167.68	148.1497	20.87013

Table 3. Distribution of petalia based on the level in the brain between males and females patients.

		Petalia_Level			Total
		Infra-tentorial	Basal ganglia	Body of the ventricles	
Sex	Male	2	11	5	18
	Female	2	7	6	15
Total		4	18	11	33

Table 4. Distribution of petalia based on the side in the brain between males and females patients.

Count		Affected_Side		Total
		Left to right	Right to left	
Sex	Male	15	3	18
	Female	14	1	15
Total		29	4	33

the prevalence of petalia according to the morphological classification (proposed in this paper) and focus on the relationship between mental illnesses in patients with each type of petalia (according to the classification proposed in this paper). R

Declaration

The author declares no conflict of interest.

Acknowledgment

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Ethical Approval

This research was approved by the ethical committee of King Khalid University to be adhering to the accordance of the Helsinki Declaration principles.

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