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Analysis of the Anatomical Variations in Sylvian Fissure Using MRI

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Abstract

Background The most common surgical approach in neurosurgery to diagnose and treat tumors and aneurysms is the transylvian-pterional approach. The classification of Sylvian fissure (SF) was proposed based on pure anatomical observations by Yasargil. The SF is the most identifiable feature of the superolateral brain surface, which divides the parietal and frontal lobes from the temporal lobe which lies below.

Aim The aim was to identify the anatomical variations in SF (bilaterally) in the normal population and to identify its morphological asymmetry.

Setting and Design This was a retrospective, observational descriptive record-based study which was done to identify the anatomical variations and morphological asymmetry in SF (bilaterally) in the normal healthy population using a 1.5-T magnetic resonance imaging (MRI) system.

Materials and Methods The SF was classified into five types. The categorization of the SF was done by MRI, either using T1-weighted images in three planes.

Statistical Analysis Percentage and frequency using SPSS 23.0.

Results In this study, we found that type 4 was most common in the general population of 100 patients. We found type 1 was most common in age groups above 50 up to 60 years of age. Types 2 and 4 SF were found in all age groups. Bilateral presentation of the SF can be considered as symmetric in 85% of the general population and asymmetric in 15% of the population considered in this study.

Conclusion Classification of the SF types on MRI was shown to be reliable and practicable. Sound knowledge of SF anatomy before neurosurgery can help reduce procedure-related morbidity, ischemic lesions, or edema.

Keywords
- anatomy
- Sylvian fissure
- surgical landmark
- MRI

Introduction

The most common surgical approach in vascular neurosurgery to the aneurysms of the circle of Willis is the pterional approach. Pterional-transylvian approach is also useful in diagnosing and safely resecting tumors in the insula and temporal horn without damaging the optic radiation and uncinate fasciculus which can avoid postoperative optic visual field deficits and aphasia.[1] The Sylvian fissure (SF) is the most commonly used anatomical pathway/corridor used in pterional approach.[2,3] Sound knowledge of SF anatomy before neurosurgery can help reduce procedure-related morbidity. The classification of SF was proposed based on pure anatomical observations by Yasargil.[2] The SF is the most identifiable feature of the superolateral brain surface, which divides the parietal and frontal lobes from the temporal lobe which lies below. The SF is longer on the left than on the right hemisphere, and it terminates higher in the right

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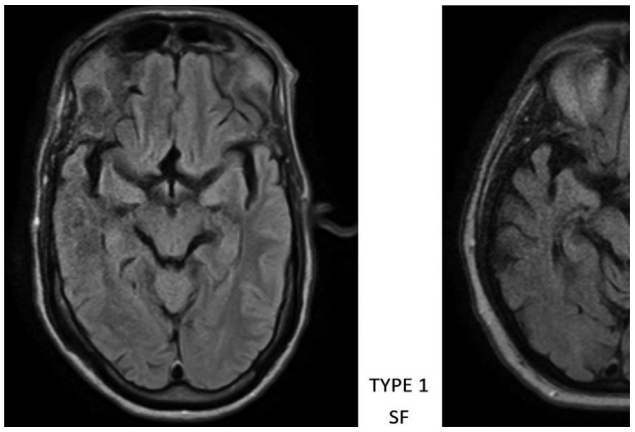

Fig. 1 Type 1 Sylvian fissure.

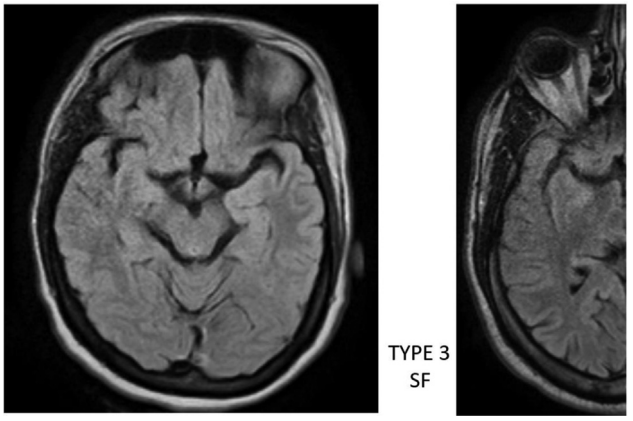

Fig. 3 Type 3 Sylvian fissure.

hemisphere.[4] Any abnormal morphological features of the SF can be frequently associated with neuronal migration disorders.[5]

Materials and Methods

Ethical approval was taken from Scientific Committee of Father Muller Medical College and Father Muller Institutional Ethics Committee (FMIEC).

This was a retrospective, observational descriptive record-based study which was done to identify the variations in radiological anatomy and morphological asymmetry in SF in the normal healthy population using a 1.5-T magnetic resonance imaging (MRI) system.

The data were collected from the studies done using Phillips Achieva MRI 1.5 T stored in picture archiving and communication system in the Department of Radiodiagnosis and Imaging, Father Muller Medical College and Hospital, Kankanady, Mangaluru for a period of 1 year from the FMIEC approval on November 26, 2020. The patients selected for the study were of an age group of 18 to 60 years. The patients with massive stroke, congenital anomalies/neurological disorders of the brain, postoperative cases, and intracranial mass lesions were excluded from this study.

SF was classified into five subtypes by Yasargil. Type 1 was defined as wide and straight SF (►**Fig. 1**), type 2 as narrow and straight SF (►**Fig. 2**), type 3 as a wide SF with herniation of the frontal or temporal lobe (►**Fig. 3**), type 4 as a narrow SF with herniation of the frontal or temporal (►**Fig. 4**), and type 5 as SF with herniated temporal and frontal lobes (►**Fig. 5**).[2]

The SF subtypes were classified by one independent radiologist. The categorization of the SF was done, using axial, coronal, and sagittal T1-weigthed MR images to evaluate the comparability of the categorization of the SF types with MRI.[6] T1-weighted images were used since it gives good signal to noise ratio and is ideal to visualize anatomical detail in MRI.

Statistical Analysis

SPSS 23.0 (Statistical Package of the Social Sciences, IBM, Armonk, New York, United States) for Windows was used for

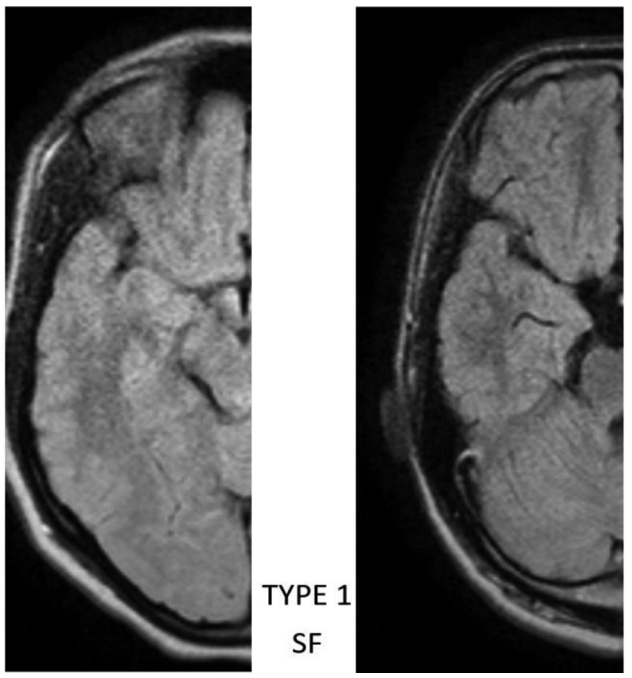

Fig. 2 Type 2 Sylvian fissure.

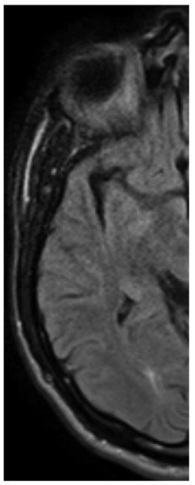

Fig. 4 Type 4 Sylvian fissure.

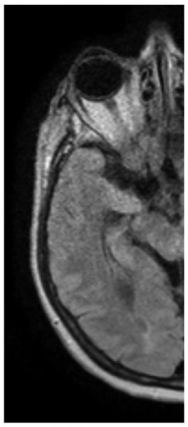

Fig. 5 Type 5 Sylvian fissure.

Table 1 Distribution of population

Sex	Frequency	Percentage
Female	34	34.0
Male	66	66.0
Total	100	100.0

Table 2 Frequency and percentage of age

Age, y	Frequency	Percentage
≤ 20	9	9.0
21–30	16	16.0
31–40	19	19.0
41–50	21	21.0
> 50	35	35.0
Total	100	100.0

statistical analysis. Percentage and frequency were measured for sex, age, and pattern of SF.

Results

In a total of 100 patients involved in this retrospective study, 66 were male (66%) and 34 were female (34%), and the average age was 42.1 years. The average age for men was 43.7 and female was 40.1 which is represented in ►**Table 1**.

Among the total population, 9 patients (9%) were 20 and younger than 20 years, 16 (16%) were in the age range of 21 to 30 years, 19 (19%) of the age range of 31 to 40 years, 21 (21%) of the age range of 41 to 50 years, and 35 (35%) were older than 50 years (►**Table 2**).

Out of the total population, majority had a SF of type 4 (►**Fig. 4**), on the right and left sides of the cerebral hemisphere, that is, 30 and 28, respectively. Type 1 (wide and straight SF) (►**Fig. 1**) was most common on left and right sides in the population over 50 years, 8 and 9; type 2 (narrow and straight SF) (►**Fig. 2**) was most common in age group of 21 to 30 years, 7 and 7; type 3 (wide SF with herniation of the frontal or temporal lobe) (►**Fig. 3**) was most common in ages older than 41 years on the right side and ages older than 50 on the left side, 12 and 13; type 4 (narrow SF with herniation of the frontal or temporal) (►**Fig. 4**) was most common in ages group of 21 to 30 and 31 to 40 years on the right side and 31 to 40 years on the left side of the hemisphere; and type 5 (SF with herniated temporal and frontal lobes) (►**Fig. 5**) was most commonly seen in age group of older than 50 years, 11 and 7, respectively (►**Table 3**).

The most common combination among the types was 4.4 (25 patients) on right and left sides of the cerebral hemisphere.

In Males

Among the 66 males, SF type 3 (39 males) was more common on right and left sides of the cerebral hemisphere, that is, 20 and 19.

In Females

Among the 34 females, SF type 4 was more common on right hemisphere and type 2 on the left side of the cerebral hemisphere, that is, 11 and 11, respectively. Upon further evaluation, it was noted that type 4 was dominant in 21 females.

Types of SF

Among the total population of 100 patients in our study, the frequency of having the same pattern of SF on both right and left sides of the cerebral hemisphere was 85 (85%) and that of having a different pattern was 15 (15%) (►**Table 4**).

In relation to age groups, in patients of ages 20 years and older, 8 had same pattern and 1 had different pattern of SF; in those of age groups 21 to 30 years, 14 had same type of SF and 2 had different type of SF; in age group 31 to 40 years, 16 had same type and 3 had different type of SF; in age group of 41 to 50 years, 18 had same type and 3 had different type of SF; and

Table 3 Distribution of types of Sylvian fissure on right and left sides of the brain

Type	1		2		3		4		5	
	Count	Row *N* %	Count	Row *N* %	Count	Row *N* %	Count	Row *N* %	Count	Row *N* %
Right	11	11.0%	18	18.0%	26	26.0%	30	30.0%	15	15.0%
Left	11	11.0%	21	21.0%	26	26.0%	28	28.0%	14	14.0%

Table 4 Frequency and percentage of types of Sylvian fissure

Types of SF	Frequency	Percentage
Different	15	15.0
Same	85	85.0
Total	100	100.0

in patients of age groups older than 50 years, 29 had same type and 6 had different type of SF.

Among the total population of males (66), 57 had same type and 9 had different types of SF. Among the total females (34), 28 had same type of SF and 6 had different type of SF.

Discussion

This study helps us better understand and identify the anatomical/morphological variations in SF with relation to MRI. Better understanding of the SF anatomical variation can be useful before neurosurgery as it can reduce procedure-related morbidity.[2] SF is the most recognizable part of the outer layer of the brain making it one of the main anatomical indices during neurosurgery.[7] The types of SF varied with patients age which might be due to difference in brain volume with respect to age.[6]

According to the study conducted by Maslehaty et al, wide SF types 1 and 3 occur more frequently in patients older than 60 years. Narrow and twisted SF types 2, 4, and 5 occurred in patients of age group younger than 60 years.[6] In our study, we did not consider patients older than 60 years and found that type 4 (narrow SF with herniation into frontal or temporal lobe) was most common in the general population of 100 patients. We found type 1 (wide and straight SF) was most common in age groups above 50 up to 60 years of age. Types 2 and 4 SF was found in all age groups.

When it comes to sex differences, males have been found to have a distribution pattern more like the right hemisphere and females have a distribution pattern like the left hemisphere. The superior branch of SF was found to be larger in males than in females who had curved type of inverted fissure resulting in decreased average length of the superior branch segment.[8] In our study, we found that among the 66 males, SF type 3 (39 males) was more common on right and left sides of the cerebral hemisphere, and among the 34 females, SF type 4 was more common on right hemisphere and type 2 on the left side of the cerebral hemisphere.

Among the total population, the frequency of having the same pattern of SF on both sides of the cerebral hemisphere was 85 (85%) and that of having a different pattern was 15 (15%). Among the total population of males (66), 57 (86.3%) had same pattern and 9 (13.6%) had different patterns of SF. Among the total females (34), 28 (82.3%) had same pattern of SF and 6 (17.6%) had different patterns of SF on both sides of the cerebral hemisphere. This shows that majority of the population had the same pattern of SF of both sides of the cerebral hemisphere.

Since Mashouf et al did not find any significant differences in the measured values of left and right brain hemisphere and concluded that the cerebral surface landmarks are similar on the left and right sides[7]; therefore, we did not measure SF length in our study.

SF is known to be one of the most asymmetric structures in the brain with the left SF being significantly longer than the right according to Idowu et al.[3] Knaus et al reported that left SF had longer horizontal length, while the right SF has a longer vertical length and 75% of the population has this type of configuration.[9]

Tumor arising from the brain parenchyma near the SF (frontal or temporal lobe) can cause effacement of the SF due to adjacent mass effect.[10] Acute bleed within the SF due to rupture of middle cerebral artery aneurysm or posttrauma can cause widening of SF.[11] Postinfarct and bleed the brain parenchyma undergoes atrophy causing widening of the SF.[12] Postsurgery also leads to gliosis resulting in widening of SF.

Ngando et al described the formation of brain edema to be more common in patients having SF categories II and III, and more brain retraction during surgery was required for SF categories III and IV.[2] Preoperative evaluation of the brain should be done based on the anatomical data available on MRI since that can help decide for a transsylvian approach (proximal/distal opening) before a surgery to reduce brain retraction or occlusion of crossing veins to prevent involuntary postoperative complications such as edema and ischemic lesions.[6]

Limitation

- This is a single-center and time bound study.
- No correlation was done with cadavers or intraoperatively post-MRI.

Conclusion

In this T1-weighted MRI-based anatomical study, we could show type 4 (narrow SF with herniation into frontal or temporal lobe) was most common in the general population of 100 patients. We found type 1 (wide and straight SF) was most common in age groups above 50 up to 60 years of age. Types 2 and 4 SF was found in all age groups. Classification of the SF types on MRI was shown to be reliable and practicable. The anatomical variation might in turn influence the neurosurgeon's choice of the approach to the SF. Preoperative evaluation on the basis of the above study may help the neurosurgeon decide for a transsylvian approach or an opening of the SF from its origin. Sound knowledge of SF anatomy before neurosurgery can help reduce procedure-related morbidity, ischemic lesions, or edema. From this study, we were able to evaluate the type of SF present in the healthy population and comment on the symmetry or asymmetry on both the cerebral hemispheres for age groups between 18 and 60 years and in both male and female population.

Conflict of Interest
None declared.

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