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ASSESSMENT OF ANATOMICAL VARIATIONS IN CEREBRALVENOUS SINUSES USING NON CONTRAST MR VENOGRAPHY

Dr. Anushree. C. K[1], Dr. Rakesh Irappa Huddar[2]*, Dr. Karthik N[3], Dr. Kartik Katti[4]

[1]Assistant professor, Dept-Radio- Diagnosis, Dr. B. R Ambekar medical college Bangalore India
Email: dr.anushree09@gmail.com
[2]*Senior Resident, Dept- Radio-Diagnosis, Dr. B. R Ambekar Medical College Bangalore India
Email: rakeshhuddar@gmail.com
[3]Junior Resident, Dept-Radio- Diagnosis, Dr. B. R Ambekar Medical College Bangalore India
Email: karthik.n2401@gmail.com
[4]Junior Resident, Dept-Radio-Diagnosis, Dr. B. R Ambeker Medical College Bangalore India
Email id: kartikkatti5@gmail.com

***Corresponding Author** Dr.Anushree.C.K
* Assistant professor, Dept of Radio-Diagnosis, Dr. B. R Ambekar Medical College Bangalore India
Email: dr.anushree09@gmail.com

Abstract:
Introduction:
Cerebral venous system can be divided into a superficial and a deep system. The superficial system comprises of sagittal sinuses and cortical veins and these drain superficial surfaces of both cerebral hemispheres. The deep system comprises of lateral sinus, straight sinus and sigmoid sinus along with draining deeper cortical veins. Both these systems mostly drain themselves into internal jugular veins. The veins draining the brain do not follow the same course as the arteries that supply it. Generally, venous blood drains to the nearest venous sinus, except in the case of that draining from the deepest structures, which drain to deep veins. These drain, in turn, to the venous sinuses. The superficial cerebral veins can be subdivided into three groups. These are interlinked with anastomotic veins of Trolard and Labbe. However, the superficial cerebral veins are very variable. They drain to the nearest dural sinus. Thus the superolateral surface of the hemisphere drains to the superior sagittal sinus while the postero inferior aspect drains to the transverse sinus. The veins of the posterior fossa are variable in course and angiographic diagnosis of their occlusion is extremely difficult. Blood from the deep white matter of the cerebral hemisphere and from the basal ganglia is drained by internal cerebral and basal veins, which join to form the great vein of Galen that drains into the straight sinus. With the exception of wide variations of basal vein, the deep system is rather constant compared to the superficial venous system.

Material And Methods:
This prospective observational study with 100number Of patients undergoing MRI brain study. Patients were selected as per inclusion and exclusion criteria. Informed consent obtained from the parents/guardian (regarding inclusion in the study)in regional language

Results:
Non contrast MR venography can be used as safe imaging modality for screening of cerebral venous system especially in cases of cerebral venous thrombosis and parasagittal meningioma's. Pitfalls should be kept in mind before giving the diagnosis of cerebral venous thrombosis in early stages without parenchymal findings. In highly suspicious pathological cases, contrast study can be performed for confirming the findings. However, further larger study and standard reference imaging modalities are recommended to validate the data of our study.

Conclusion:
Non contrast MR venography is one of the best and safe imaging modality to study the dural venous sinuses, Vein of Galen, internal cerebral vein, basal vein of Rosenthal and major anastomotic vein. Variations in the calibre of the sinuses and flowgaps were more common in transverse sinuses, which are potential pitfalls for sinus thrombosis. Sigmoid sinus asymmetry with ipsilateral small internal jugular vein excludes thrombosis of sigmoid sinus. In superior sagittal sinus, straight sinus and deep cerebral veins, flowgaps were less common. Hence such findings should raise a suspicion of pathology. Split in the posterior 1/3rd and rostral hypogenesis of superior sagittal sinus are potential pitfalls in the diagnosis of superior sagittal sinus thrombosis.

Keywords: Magnetic resonance angiography, Computed Tomographic, Venography, Magnetic Resonance Venography,

INTRODUCTION

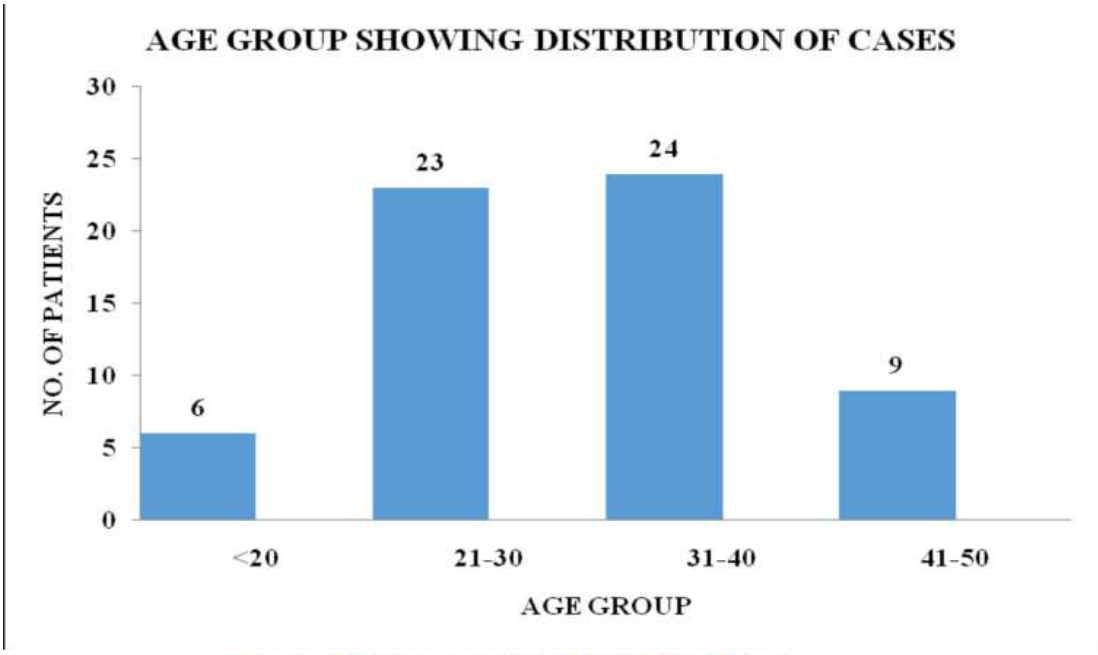
Intra cranial venous system is a complex three-dimensional structure that is often asymmetric and its anatomic variability is often more pronounced than the intraarterial anatomy. Understanding the normal anatomy of the cerebral venous system and its variants is crucial in diagnosis of various venous pathologies in adults and children like cerebral venous thrombosis, cerebral venous malformations, skull fractures which involve dural venous sinuses, idiopathic intracranial hypertension in transverse sinus stenosis, tumoral involvement of cerebral venous system, and also useful for planning of local intrasinus thrombolysis, , pre-operative embolization of extra-axial tumors, especially parasagittal meningioma's and in craniotomies, such as transcallosal approach1. The use of cerebral MR venography is increasing in frequency as a non-invasive means of evaluating the intracranial venous system. This technique is particularly useful in the diagnosis of venous sinus thrombosis, which at times can be difficult5. Knowledge of variations in the cerebral venous anatomy and apparent signal abnormalities seen on Magnetic resonance (MR) angiography are essential to avoid2
Knowing the cerebral venous anatomy is important for planning of intrasinus thrombolysis. Earlier, the standard therapy for cerebral venous thrombosis was anticoagulation with intravenous unfractionated heparin or subcutaneous lowmolecular-
weight heparin. But now the newer advancement is local intra-sinus thrombolysis which dissolves the thrombus by infusion of a thrombolytic drug into the occluded sinus. It is relatively safe and effective in rapid recanalization of thrombosed sinus and reversal of neurologic deficits8. Knowledge of cerebral venous anatomy is also useful in planning of endovascular stenting of Transverse sinus stenosis which has been proposed as a possible treatment for refractory idiopathic intracranial hypertension.
Intracranial sinus and venous anatomy may be visualized by several methods, including conventional digital subtraction venography, Computed Tomographic (CT) Venography, and Magnetic Resonance (MR) Venography. The intracranial venous system has been evaluated traditionally during the venous phase of conventional catheter digital subtraction angiography. The disadvantages of the conventional and CT Venography are the use of ionizing radiation and the invasiveness of the procedure with its inherent complications6.Magnetic resonance (MR) Venography is one of the accepted methods of evaluation of the cerebral venous sinus anatomy as well as pathology. Magnetic resonance (MR) Venography is non-invasive method which does not require exposure to ionizing radiation and can be performed without administration of contrast material.

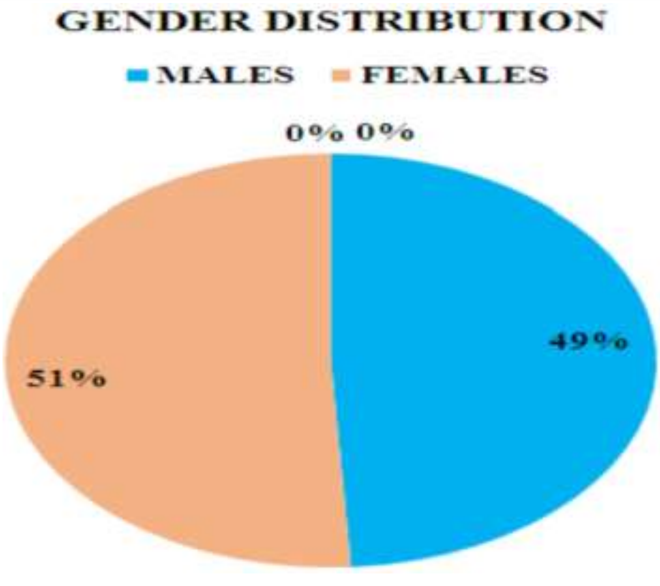
Material and Method

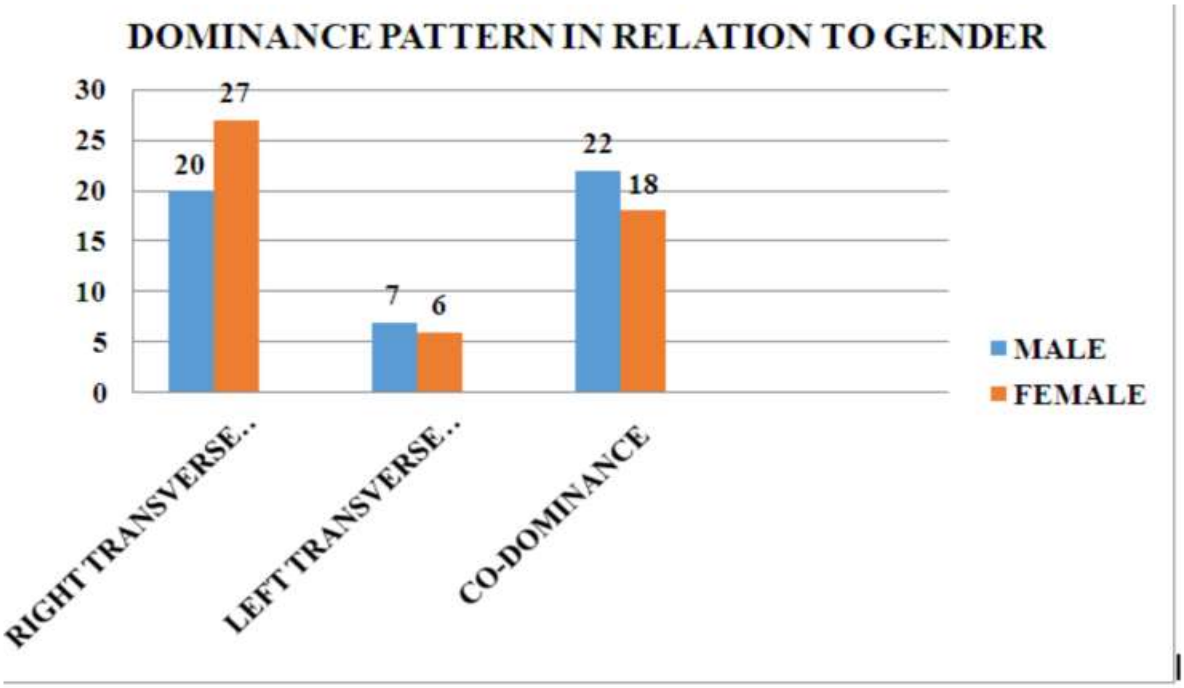
1. The study was limited to the patients presented to **Dr.B R AMBEDKAR** Medical College And Hospital, Bangalore. There fore the results may not be generalized to other radiology centres.
2. The study is limited to non-contrast MR venography protocol as performing the contrast study is not feasible in all patients due to various factors.

3. This study was not designed to compare the diagnostic accuracy of non-contrast MR venography in cerebral venous pathologies with other standard imaging modalities such as digital subtraction venography / CT venography / contrast enhanced MR venography.
4. The 3D images of Time-of-flight venography could not provide or substitute additional information to the study in contrary to 3D phase contrast study.
5. Exact cause of flow gaps in the dural sinuses could not be assessed because of the non-contrast study, lack of reference with the other contrast imaging modalities and lack of direct visualisation of the veins.
6. Additional protocols with different sections and angles to avoid flow related artefacts could not be performed due to time related constraints like prolonged imaging periods.
7. Deep cerebral dural sinuses such as cavernous sinus, superior and inferior petrosal sinuses and deeper cerebral veins such as thalamostriate veins, septal veins, anterior caudate nucleus veins could not be assessed due to inadequate visualisation of these sinuses and veins in selected study protocols.

RESULT






DOMINANCE PATTERN IN RELATION TO GENDER
30
25
20
15
10
5
0
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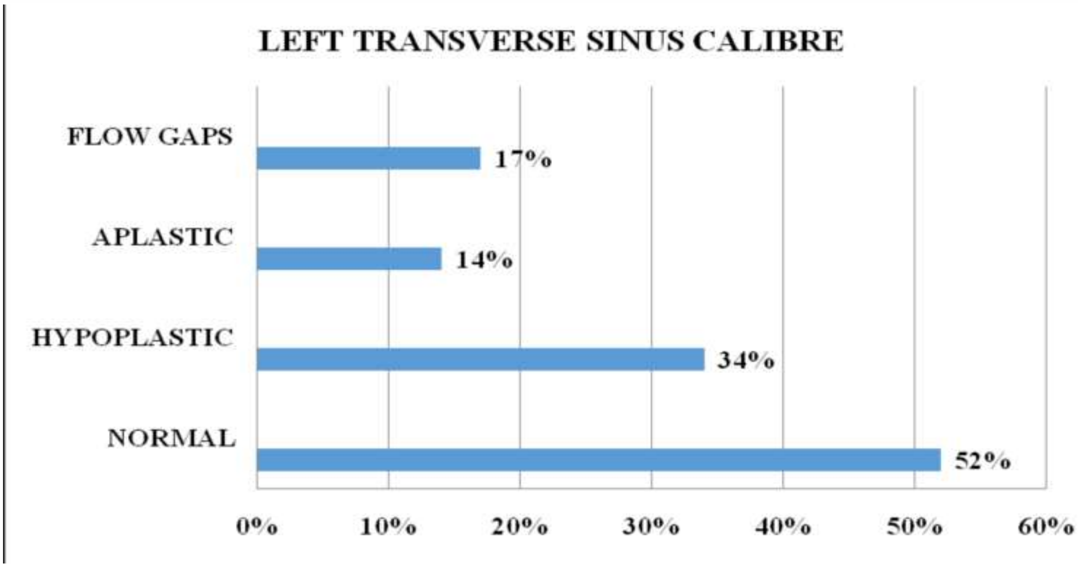
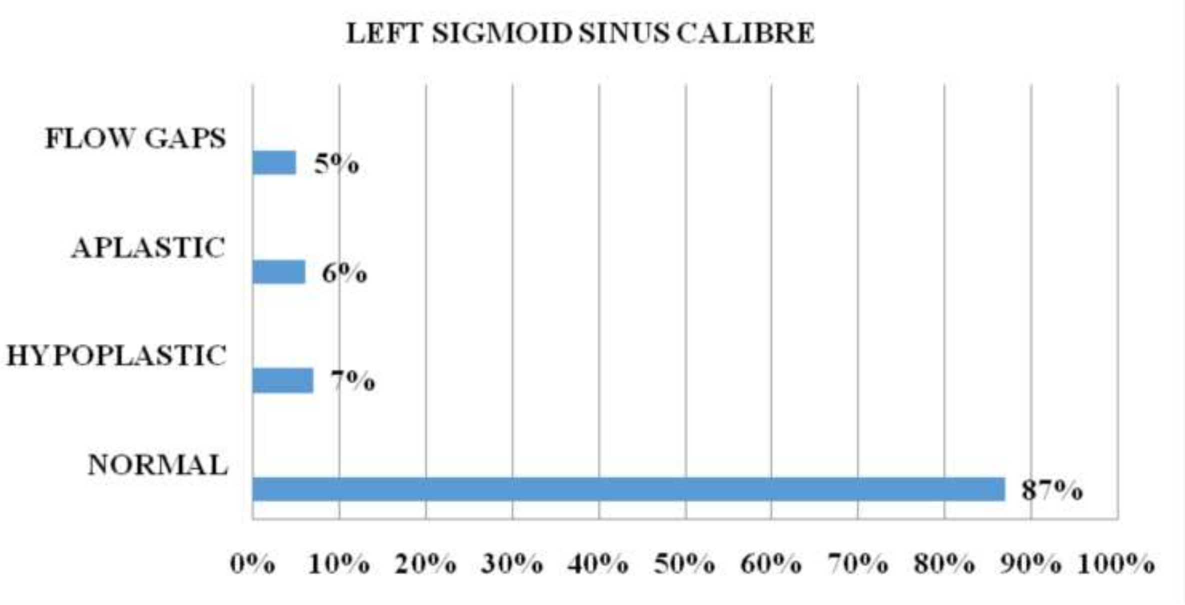
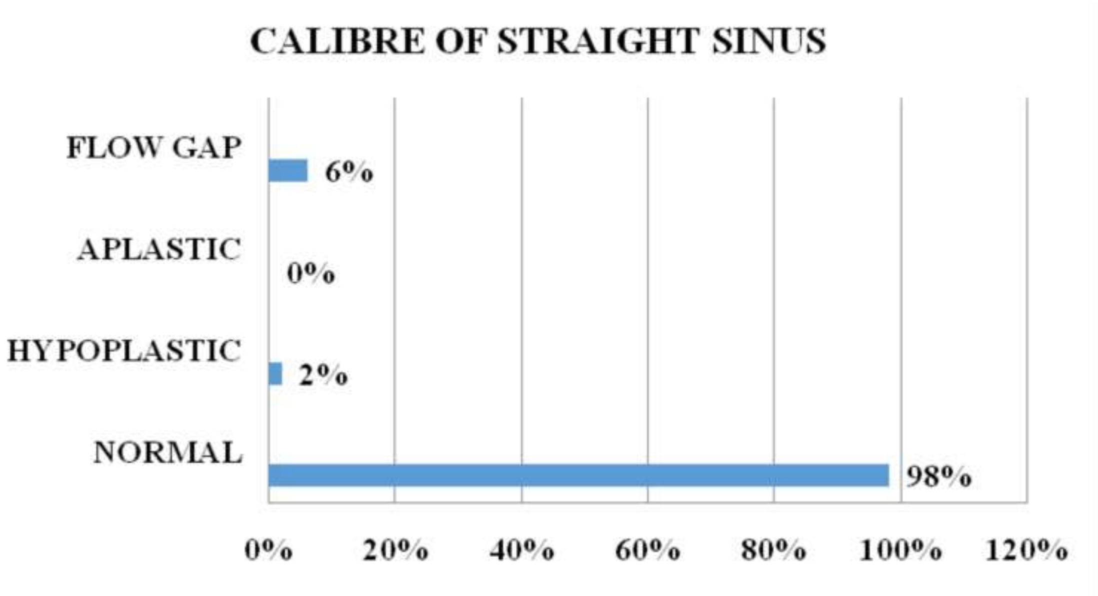
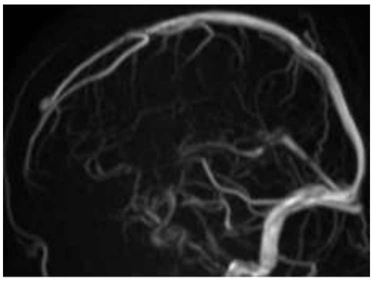
27
7
6
22
18
RIGHT TRANSVERSE..
LEFT TRANSVERSE..
CO-DOMINANCE
MALE
FEMALE

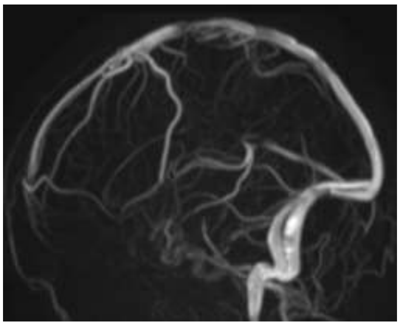

LEFT TRANSVERSE SINUS CALIBRE
FLOW GAPS
APLASTIC
HYPOPLASTIC
NORMAL
17%
14%
34%
52%
0%
10%
20%
30%
40%
50%
60%


LEFT SIGMOID SINUS CALIBRE
FLOW GAPS
APLASTIC
HYPOPLASTIC
NORMAL
5%
6%
7%
87%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

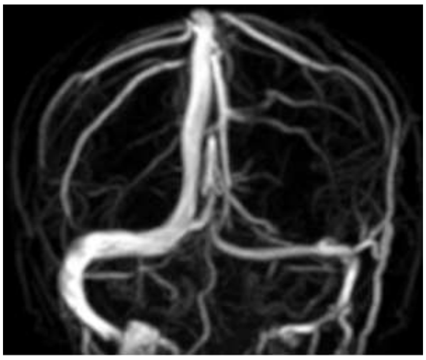




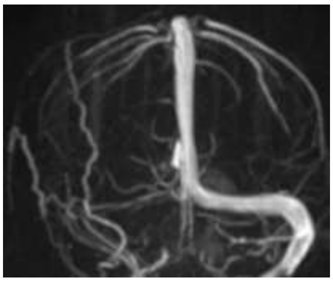
CASE 96: 3D Phase Contrast Sagittal image demonstrating flow gap in Straight Sinus. Also note Rostral hypogenesis of Superior Sagittal Sinus.



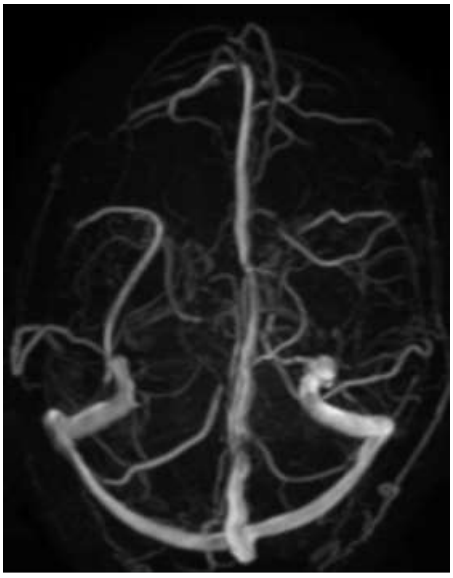
CASE 7: Sagittal 3D Phase Contrast image demonstrating flow gaps in middle 1/3rd Superior Sagittal Sinus.



CASE 12: Coronal 3D Phase Contrast image demonstrating bifurcation of Superior Sagittal Sinus. Hypoplastic Left Transverse and Sigmoid Sinus also noted.



CASE 61: 3D Phase Contrast image demonstrating Aplastic Right Transverse and Aplastic Right Sigmoid Sinus.



CASE 3: 3D Axial Phase Contrast image demonstrating Co-Dominant Transverse Sinuses.

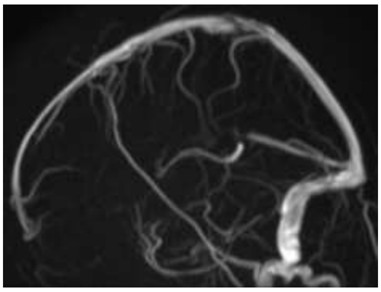


Figure.74 CASE 30: 3D Sagittal Phase Contrast image demonstrating flow related artefact at the junction of Vein of Galen and Straight Sinus. Also note flow gap in posterior 1/3rd of Superior Sagittal Sinus.

DISCUSSION

Cerebral venous pathologies can be asymptomatic or symptomatic which can present with a variety of clinical symptoms, ranging from isolated headache to severe coma1. In present study, routine MR brain studies which were done on 100 patients referred to department for giddiness, seizures and other non-specific symptoms were observed after excluding cerebral venous thrombosis and other cerebral venous pathologies. Sub-optimal studies due to motion and other artifacts were also excluded. After obtaining history, written consent for the study and ruling out routine contraindications, routine MR brain sequences with the additional 3D Timeof- Flight venography and 3D Phase contrast venography sequences were performed. Total number of 100 patients were observed for statistical simplification. The structures studied were transverse sinuses, sigmoid sinuses, superior sagittal sinus, straight sinus, occipital sinus, inferior sagittal sinus using the proforma enclosed. In present study, the mean age of the patients was 43.8 years (mean). Majority of the patients in this study were in the age group of 31-40 years. There was no significant relation of variations with age. In all the patients sinuses were studied for dominance pattern, hypoplasia, aplasia and flow gaps. Transverse sinus asymmetry was the commonest variation seen in present study which was consistent with previous studies, Ayanzen et al5 , Surendrababu et al6 and Manara et al30.The calibres of the transverse sinuses (1 cm from the torcular herophili) were compared with the size of the superior sagittal sinus (also measured 1 cm from the torcular herophili). Right transverse sinus was dominant in 47% cases where as in previous studies performed by Ayanzen et al5 , Surendrababu et al6 and Manara et al3 , right transverse sinus was dominant in 59%, 59% and 61% cases respectively . In present study left transverse sinus was dominant in 13% cases, which is consistent with the previous study performed by Manara etal3, in which left transverse sinus was dominant in 17% cases. However, in the previous studies performed by

Ayanzenetal5, Surendrababu et al6, dominance of left transvers sinus was seen in 25% and 30% cases respectively. Codominance pattern in the present study was seen in 40% cases, which is not consistent with the previous studies performed by Ayanzen et al5, Surendrababu etal6 and Manara etal3, which shows codominance pattern in 16%,10% and 22% respectively. The reason for this discrepancy in dominance pattern may be because of different geographical location. Right transverse sinus

dominance is more common in females (52%), than males (40%). In males codominance transverse sinus pattern is more common (45%). In present study, hypoplasia and aplasia were more commonly seen in left transverse sinus, accounting for 34% and 14% respectively, where as 8% and 5% in right transverse sinus. Present study results were consistent with previous study done by Alper F et al31, which shows 6% hypoplastic right transverse sinus, 4% aplastic right transverse sinus, 41% hypoplastic left transverse sinus and 20% aplastic left transverse sinus. Unequal heights, asymmetrical sizes, mild to marked irregularities, or even absence of the medial portion of the transverse sinuses are therefore requently encountered due to developmental factors29. Hence, aplasia or hypoplasia of transverse sinuses are potential pitfalls in the diagnosis of transverse sinus thrombosis. Flow gaps in the transverse sinus can be due to flow related artefacts, developmental factors and arachnoid granulations68 which for potential pitfall for diagnosis of transverse sinus thrombus. Sigmoid sinuses were studied for hypoplasia, aplasia and flow gaps. Sigmoid sinus hypoplasia was noted in 5% cases on right and 7% cases on left side. Sigmoid sinus aplasia was noted in 1% cases on right and 6% cases on left side. In previous study performed by Surendrababu NR et al6 , sigmoid sinus hypoplasia were noted in 6% cases on right side which was consistent with the present study , 19 % cases on left side and 2%cases had aplastic sigmoid sinus on the left side. In present study, 3/4th of hypoplastic sigmoid sinuses were associated with transverse sinus hypoplasia's and 1/3rd of cases were associated with aplastic transverse sinus. 57% of aplastic sigmoid sinus cases were associated with hypoplastic transverse sinus and 43% of cases were associated with aplastic transverse sinus. In present study, majority of hypoplastic and aplastic sigmoid sinuses were assosciated with small calibre of ipsilateral internal jugular vein. Hence, presence of small calibre of internal jugular vein in cases with ipsilateral hypoplasia and aplasia of sigmoid sinus may rule out sigmoid sinus thrombosis. Superior sagittal sinus was consistent structure observed in all patients in present study, which is correlating with previous studies performed by Ayanzen et al5, Surendrababu etal6. It shows limited variations such as high splitting and rostral hypogenesis and it is also studied for flow gaps. In present study, bifurcation of superior sagittal sinus was noted in 18% of cases, however in previous study by Fukusumi A et al34 it was observed as 27%. The partial split sinus especially in the region of the posterior aspect of the superior sagittal sinus is a potential pitfall in the diagnosis of superior sagittal sinus thrombosis6. Rostral hypogenesis of superior sagittal sinus was seen in 10% cases, which is consistent with the previous study by D. San Milla´ n Ruízet al. Flow gaps in superior sagittal sinus were observed in 10% cases, out of which 50% flow gaps were noted in middle 1/3rd, 30% were noted in anterior 1/3rd and 2% in posterior 1/3rd. In previous study by Surendrababu NR et al6 , flow gaps in superior sagittal

sinus were seen in 24% cases, partial split was seen in 12% cases and rostral hypogenesis in 10% cases. Results of the present study were consistent with this study.
Drainage patterns of superior sagittal sinus and straight sinus was highly variable. Fukusumi A et al34in his study described drainage of superior sagittal sinus into transverses sinus in various patterns : the superior sagittal sinus draining into confluence of sinuses, the superior sagittal sinus draining exclusively into the right transverse sinus and the superior sagittal sinus draining exclusively into the left transverse sinus. In previous study done by Fukusumi A et al34the superior sagittal sinus drained into confluence of sinuses in 46%, the superior sagittal sinus drained exclusively into the right transverse sinus (44.2%); the superior sagittal sinus drained exclusively into the left transverse sinus (9.2%). In present study, drainage of superior sagittal sinus was seen into torcular herophili in 43% cases, right transverse sinus in 40% cases and left transverse sinus in 17% cases. These observations were consistent with the study performed by Fukusumi A et al34. Drainage of straight sinus was seen into torcula herophili in 50% cases, right transverse sinus in 36% cases and 14% in left transverse sinus in present study. The occipital sinus is the smallest of all the dural sinuses and is not seen commonly. Dora and Zilelietal67 observed that the size of the transverse sinus to be more closely related to the presence of occipital sinus than the sigmoid sinus. Occipital sinus was seen in 10% of cases in present study which is consistent with previous studies, where the presence of occipital sinus was reported as 10% cases by Ayanzen RH et al5, 17% in Surendrababu NR et al6 and 18% in Widjaja E et al32. 7 out of 10 cases with occipital sinus, demonstrate transverse sinus variations, such as hypoplasia (50%) and aplasia (20%). Inferior sagittal sinus is another sinus which is not constantly seen. In present study it was seen in 32 % of cases. In previous studies by Ayanzen RH et al5, inferior sagittal sinus was observed in 52% of cases and 23% of cases in Widjaja Eet al32. Discrepancy is noted in the observation of inferior sagittal sinus among the before mentioned studies, which may be due to different geographical variation and small sample size in the previous study. Non visualisation of occipital and inferior sagittal sinus was observed to be more common and it should not be considered as pathology.

Conclusion

We found, transverse sinus asymmetry is the most common anatomical variation in cerebral venous system. Hypoplasia, aplasia and flow gaps in transverse sinus are potential pitfalls in the diagnosis of transverse sinus thrombosis. Sigmoid sinus calibre is in relation with the calibre of transverse sinus and internal jugular vein on same side. Presence of sigmoid sinus variations with ipsilateral small internal jugular vein excludes sigmoid sinus thrombosis. Though superior sagittal sinus is constant structure, variations such as bifurcation, rostral hypogenesis are observed. Flow gaps are usually caused by flow related artefacts, arachnoid granulations and dural septations which are potential pitfalls for diagnosis of superior sagittal sinus thrombosis. Straight sinus is constant structure and flow related artefact is commonly seen at its junction with vein of Galen. Drainage patterns of superior sagittal sinus and straight sinus were variable. It was observed that the drainage of superior sagittal sinus and straight sinus was more common into the torcular herophili. Next common drainage pattern of both the sinuses was right transverse sinus with superior sagittal sinus being more common. Drainage into left transverse sinus is more common with straight sinus than superior sagittal sinus. Occipital sinus and inferior sagittal sinus are less commonly visualised structures. So, non-visualisation of these sinuses should not be confused for thrombosis. Non contrast MR venography is one of the best and safe imaging modality to study the dural venous sinuses. Variations in the calibre of the sinuses and flow gaps were more common in transverse sinuses, which are potential pitfalls for sinus thrombosis. Sigmoid sinus asymmetry with ipsilateral small internal jugular vein excludes thrombosis of sigmoid sinus. In superior sagittal sinus, straight sinus and deep cerebral veins, flow gaps were less common. Hence such findings should raise a suspicion of pathology. Split in the posterior 1/3rd and rostral hypogenesis of superior sagittal sinus are potential pitfalls in the diagnosis of superior sagittal sinus thrombosis.

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