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Original Research Paper

Radiology

NORMAL VARIANT ANATOMY IN MR CEREBRAL VENOGRAPHY - A RETROSPECTIVE STUDY

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ABSTRACT

Purpose: Knowledge of anatomical variations in the cerebral dural venous sinus anatomy seen on magnetic resonance cerebral venography (MRV) on GE 3 Tesla is essential to avoid over-diagnosis of cerebral venous sinus thrombosis (CVST). Limited data is available on gender difference of the cerebral dural venous sinus anatomy variations. **Materials and Methods:** A retrospective study was conducted in D.Y.Patil medical college Kolhapur in the Department of Radiodiagnosis for a duration of 3 years to study the normal anatomy and anatomical of variants the intracranial venous system, as depicted by 3D MR venography, in normal adults and any gender-related differences. **Results:** A total of 150 (70 men, 80 women, age range 16 to 85 years), were included in the study. Most common indication for MR venography was headache (70%). Hypoplastic left transverse sinus was the most common anatomical variation in (30%) patients. Left transverse sinus was hypoplastic in more commonly in male in comparison to females (35 versus 25). Most common variation of superior sagittal sinus (SSS) was hypoplastic anterior one third SSS ,. **Conclusion:** The most common anatomical variation is Hypoplastic left transverse sinus and more common in male compared to female in the present study. The anatomical variants of orther dural venous sinuses are not significantly differ among both genders.

KEYWORDS : SSS- Superior Sagittal Sinus, ISS- Inferior Sagittal Sinus, SS- Stright Sinus, TS- Transverse Sinus, CS- Cavernous Sinus, SPS- Superior Petrosal Sinus, IPS- Inferior Petrosal Sinuses

INTRODUCTION:-

Normal venous anatomy and variants :-

The intracranial venous system has two major components,the dural venous sinuses and the cerebral veins.

Dural venous sinuses

The dural venous sinus subdivided into anteroinferior group and posterosuperior group.

The posterosuperior group is the more prominent and consists of the superior sagittal sinus(SSS),inferior sagittal sinus(ISS),Straight sinus(SS),Sinus confluence (torcular herophili),Transverse sinuses(TSs),Sigmoid sinuses and Jugular bulbs.

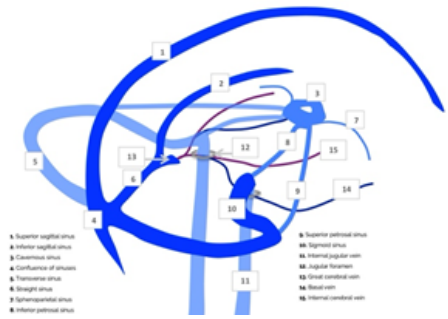
The anteroinferior group consists of the cavernous sinus(CS),Superior and inferior petrosal sinuses (SPSs,IPSs),Clival venous plexus(CVP) and sphenoparietal sinus(SphPS).

Superior sagittal sinus	Cavernous sinus
Inferior sagittal sinus	Superior and inferior petrosal sinuses
Straight sinus	Clival venous plexus
Sinus confluence(torcular herophili)	Sphenoparietal sinus
Transverse sinuses	
Sigmoid sinuses	
Jugular bulbs	

Superior Sagittal SInus(SSS)

The superior sagittal sinus is a large curvilinear sinus that parallels the inner calvarial vault and it originates from ascending frontal veins anteriorly , Runs in the midline at junction of the falx cerebri with the calvaria.

The SSS increases in diameter as it courses posteriorly collecting a number of unnamed small superficial cortical veins and the larger anastomotic vein of Troland.



Variation of SSS are atresia of anterior one third hypoplasia of the middle part of SSS , hypoplasia of anterior one third of SSS, hypoplasia of anterior 2/3rd of SSS and hypoplasia of anterior half of SSS.

Most common variation of SSS are atresia of anterior 1/3rd of SSS.

Inferior sagittal sinus:-

On Comparison with the SSS and ISS ,Inferior sagittal sinus is a much smaller and inconstant curvilinear channel that seen in the bottom of the falx cerebri.

The ISS lies above the Corpus callosum and Cingulate gyrus and it'collecting small tributaries ,curves posteriorly along the inferior free margin of the falx. The ISS terminates at the falcotentorial junction where it join with the great cerebral vein of Galen(VofG) to form the Straight sinus(SS)[1]

Normal variants of Inferior saggital sinus are small or inappropriate and which are inconsistently visualized on imaging studies.

Straight sinus:-

The straight sinus is formed by the junction of the ISS and VofG.it runs posteroinferiorly from its origin at the falcotentorial apex.

Straight sinus variants are relatively uncommon,A persistent

falcine sinus is an unusual variant that is identified on 2% of normal.The persistent falcine sinus will connect the ISS or VofG directly with the SSS.Two-thirds of patients with a persistent falcine sinus have absent/rudimentary SS[4].

Sinus Confluence:-
The straight sinus terminates by joining the SSS and TSs to form the venous sinus confluence(torcular herophili).The venous sinus confluence is often asymmetric with septations and intersinus channels connecting the Tss.

Transverse Sinuses:-
The Transverse sinuses also known as lateral sinuses, The transverse sinuses are contained between attachments of the tentorium cerebelli to the inner table of the skull.The TSs curve laterally from the torcular to the posterior border of the petrous temporal bone,where they turn inferiorly and become the sigmoid sinuses.[6]

Anatomic variations in the TSs are almost the rule rather than the exception.The two TSs are frequently asymmetric with the right side typically larger than the left.Hypoplastic or stenotic segments are present in one-third of the general population. Filling defects caused by arachnoid granulations and fibrous septa are also common.

Sigmoid sinuses:-
The sigmoid sinus are basically the inferior continuations of the two TSs.They fellow a gentle S-shaped curve,descending behind the petrous temporal bone to terminate by becoming the internal jugular veins(IJV),side-to-sides asymmetry of the sigmoid sinuses is common and normal.

Normal variants are Right/Left sigmoid sinuses are hypoplastic or aplastic/atrectic,whereas bilateral sigmoid sinus are hypoplastic[5].

Jugular Bulbs:-
The jugular bulbs are focal venous dilatations at the skull base between the sigmoid sinuses and IJVs.The IJVs provide the main venous outflow system of the brain.

There are concomitant variation in size of the jugular bulbs and their osseous foramina .Jugular bulb pseudolesions with flow asymmetry are common and should not be mistaken for real masses(e.g Schwannoma or paraganglioma)[5]

Cavernous Sinus:-
The CSs are irregularly shaped heavily trabeculated /compartmentalized venous sinuses that lie along the sides of the sella turcica extending from superior orbital fissure anteriorly to the clivus and petrous apex posteriorly(9-5).

Formed by a prominent lateral and much thinner—often almost inappropriate— medial dural wall, the CSs contain the two cavernous internal carotid arteries (ICAs) and abducens (CN VI) nerves. CN III, CN IV, CN V_1, and CN V_2 are actually within the lateral dural wall, not inside the CS proper .

The major tributaries draining into the CSs are the superior/inferior ophthalmic veins and the SphPSs. The two CSs communicate extensively with each other via intercavernous venous plexuses[8].

Superior and Inferior Petrosal Sinuses
The SPS courses posterolaterally along the top of the petrous temporal bone, extending from the CS to the sigmoid sinus. The Inferior Petrosal sinuses courses just above the petro occipital fissure from the inferior aspect of the CVP to the jugular bulb.

Clival Venous Plexus
The CVP is a network of interconnected venous channels that extends along the clivus from the dorsum sellae superiorly to the foramen magnum and it connects the CS and petrosal sinuses with each other and with the suboccipital veins around the foramen magnum[4]

Sphenoparietal Sinus(9-5)
The Sphenoparietal sinus courses around the lesser sphenoid wing at the rim of the middle cranial fossa. The SphPS receives superficial veins from the anterior temporal lobe and drains into the Cavernous sinus/ inferior petrosal sinus[5]

MATERIALS AND METHODS:-
Patients who were sent for MRV examination in tertiary care teaching hospitals from march 2022 to march 2024 were enrolled in this study. MRV data of 200 patients during study period was retrospectively reviewed. Patients with more than 12 years of age were included in this study. Patients with any congenital or acquired intracranial abnormality, venous thrombosis or previous surgery were excluded from the study.

A retrospective study was conducted to study the normal anatomy of the intracranial venous system and its normal variation, as depicted by 3D MR venography, in normal adults.MR imaging was performed with 3 MR machine(GE healthcare) with standard head coil.

Three dimensional MR venography was performed in the coronal plane by using the following parameters:TE-50,TR-500,FOV-230-250,slice thickness 1mm,matrix-240x256,flip angle 50.additional rouine T2WI axial and FLAIR axial sequences were also performed.

Image analysis
Maximum intensity projections (MIPs) were created at the MR operating console for 3D-MR venography data set. The MIP images were viewed in the sagittal, transverse and coronal planes.

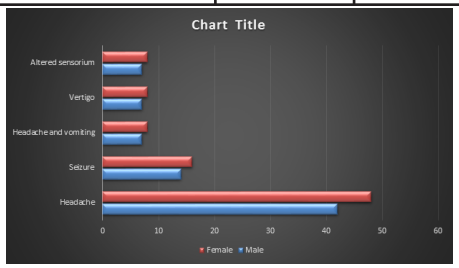
Source images from 3D MRV and MIP images were evaluated for anatomical variations of dural venous sinuses and presence of accessory sinuses. The dural venous sinuses included in this study are superior sagittal sinus, sigmoid sinus, transverse sinus, straight sinus and occipital sinus. The normal variations of transverse and sigmoid sinuses were noted (symmetry, hypoplasia and aplasia or atresia). The transverse sinuses were measured 1 cm from the Torcula heterophili and the sigmoid sinuses were measured 1 cm from the transverse sigmoid junctions. Their liner measurements were compared with the superior sagittal sinus. If the linear measurement was less than half the size of the superior sagittal sinus, it was considered hypoplastic and if not visualised it was considered aplastic or atrectic sinus. The internal jugular veins were not included in the study. The presence of arachnoid granulations were recorded. AGs are defined as well-defined CSF-like signal intensity protuberances extending into the dural sinus commonly associated with adjacent entering cortical veins.

RESULTS
Our study included a total of 150 patients (70 men, 80 women, age range 12 to 81 years, Most common indication for MRV was headache (60%). Other indications were Seizure (20 %), Headache and vomiting (10 %), vertigo (10%), altered sensorium (10%),

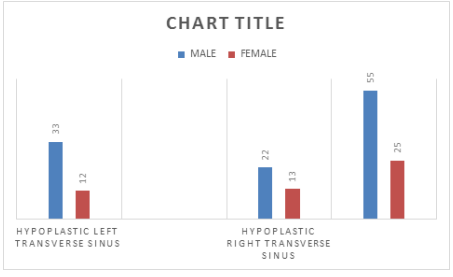
Indications for Magnetic Resonance venography

Indication	Male	Female
Headache	42	48
Seizure	14	16
Headache and vomiting	7	8
Vertigo	7	8

Altered sensorium	7	8



Of the 150 MR venograms obtained, the transverse sinus was found to be symmetrical in 50 patients. Left transverse sinus was hypoplastic in 55 and aplastic/atrectic in 10 cases. Right transverse sinus was hypoplastic in 25 and aplastic/atretic in 5 patients.5 cases had bilateral hypoplastic transverse sinuses.



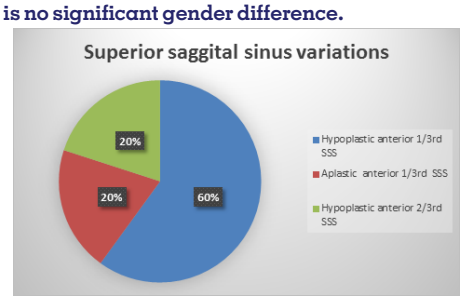
In comparison, female had significantly more symmetrical transverse sinus than male .Left transverse sinus was hypoplastic in more commonly in male in comparison to female (23 versus 22). Right transverse sinus was hypoplastic in more commonly in female in comparison to male (13 versus 12).

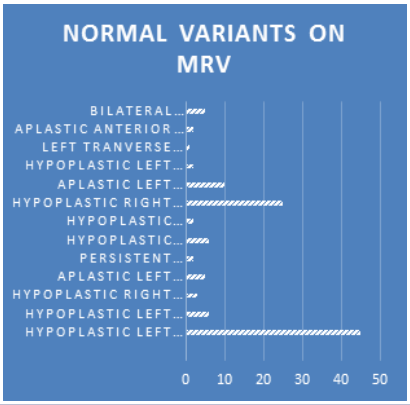
Superior sagittal sinus

Out of 150,140 patients had normal superior sagittal sinus. Most common variation of SSS was hypoplastic anterior one third SSS (3%). Other variations were aplastic of anterior one third of SSS (1%),

Other are hypoplasia of the middle part of SSS,hypoplasia of anterior 2/3rd of SSS and hypoplasia of anterior half of SSS which are not seen in present study.

There is no significant gender difference.





DISCUSSION

In our present study Normal study without any variations on MRV is 36(24%),Most common indication to get MRV of the brain was headache in this study. Hypoplastic left transverse sinus was the most common anatomical variation, predominantly in male compared to female. Other anatomical variations of the transverse and sigmoid sinuses did not significantly differ among both genders. Hypoplasia of anterior one third of SSS was the most common variation of SSS, though not different among males and females.

Transverse sinus abnormalities were described by Gourav goyal et al[11]. Of the 1654 MR venograms obtained, the transverse sinus was found to be symmetrical in 1106 (66.9%) patients. Left transverse sinus was hypoplastic in 352 (21.3%) and aplastic/atrectic in 67 (4.1%) cases. Right transverse sinus was hypoplastic in 91 (5.5%) and aplastic/atrectic in 12 (0.7%) patients. 1.6% cases had bilateral hypoplastic transverse sinuses..

Transverse sinus abnormalities were described by Alper et al [12]. Symmetrical transverse sinuses were reported in 31%. Left transverse sinus was hypoplastic in 39% and aplastic in 20% of cases. Right transverse sinus was hypoplastic in 6% and aplastic in 4%. In other study of 100 patients, 10% had symmetrical transverse sinuses, 35% hypoplastic left transverse sinus, 13% hypoplastic right transverse sinus and 1% had aplastic left transverse sinus [13]. In contrast, our study showed symmetrical transverse sinus in 60 %, hypoplastic left transverse sinus in 25% and hypoplastic right transverse sinus in 11 %.

The most frequent SSS variation is the hypoplasia of rostral third of the SSS second only to preferential drainage of SSS to one of the transverse sinus [14,15]. Kaplan and Browder reported hypoplastic rostral SSS in 7 of 382 (1.8%) anatomic specimens in 1 series and in 12 of 201 (6%) specimens in a second anatomic series [14].

Occipital sinuses were reported from 4 to 35.5% of cases in different studies [17,18,19,20]. In a study of 100 children, persistent occipital sinuses were seen in 13% of patients less than 25 months of age but in only 2% of children older than 5 years [21]

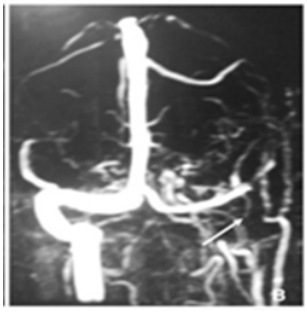
In our study, occipital sinus was identified in 3 % of the patients.

CONCLUSION

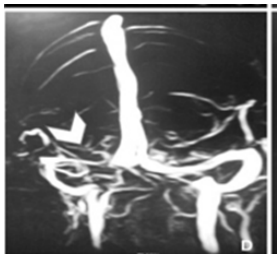
Knowledge of anatomical variations of cerebral dural venous sinuses is important. In the absence of this, flow gap in the venous sinus, hypoplasia and aplasia of the transverse sinus may be mistaken for venous sinus thrombosis. Hypoplastic left transverse sinus is the most common anatomical variation in the present study. Hypoplastic left transverse sinus is more common in male compared to female. Importance of male predominance of hypoplastic transverse sinus is not clear. Other anatomical variations of dural venous sinuses are not significantly differ among both genders.

Representative Cases:

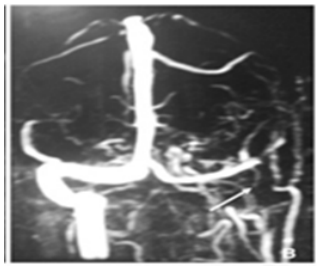
A: Normal MRV including symmetrical transverse sinuses[11].



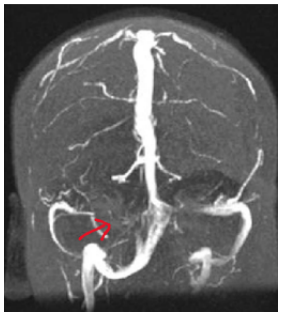
B: Hypoplastic left transverse sinus and aplastic left sigmoid sinus(long thin arrow)[11].



C: Aplastic right transverse and sigmoid sinus (arrowheads) [11].



D:Hypoplastic right transverse sinus(thick arrowhead)[11].



Asymmetric Right transverse sinus hypoplasia.

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