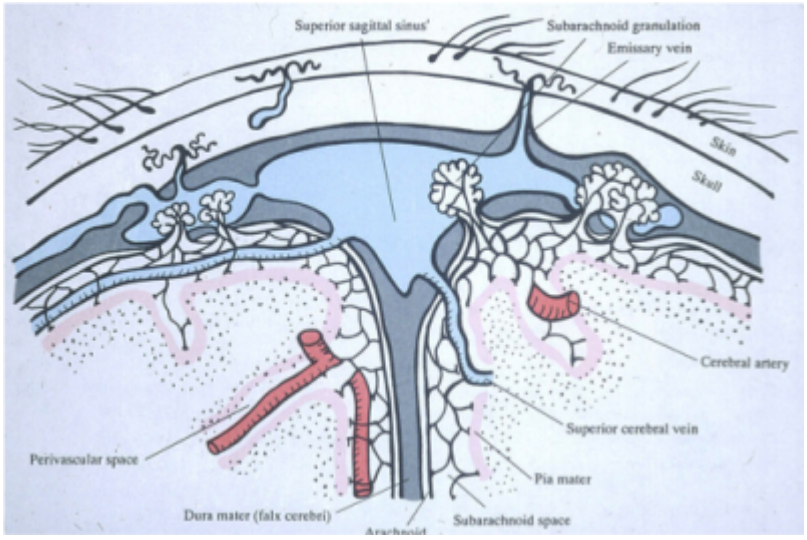
Arachnoid granulation



Arachnoid granulations (or arachnoid villi) are small protrusions of the arachnoid through the dura mater.

These are outpouchings of the arachnoid mater into the venous sinuses around the brain, with valves to ensure one-way drainage.

Largest granulations lie along the superior sagittal sinus.

They are, however, present along other dural sinuses as well. Smaller granulations are called villi, large calcified ones are referred to as pacchionian body.

Function

They allow cerebrospinal fluid (CSF) to exit the subarachnoid space and enter the blood stream.

The diffusion across the arachnoid granulations into the superior sagittal sinus returns CSF to the venous circulation.

They act as one-way valves. Normally the pressure of the CSF is higher than that of the venous system, so CSF flows through the villi and granulations into the blood. If the pressure is reversed for some reason, fluid will not pass back into the subarachnoid space. The reason for this is not known. It has been suggested that the endothelial cells of the venous sinus create vacuoles of CSF, which move through the cell and out into the blood.

The importance of arachnoid granulations for the drainage of CSF is controversial. By some accounts, a large portion (perhaps the majority) of CSF is drained through lymphatics associated with extracranial segments of the cranial nerves. A large proportion of CSF is believed to leave the cranial vault through the axons of CN I (olfactory nerve) through their extension through the cribriform plate.

On the inner surface of cranial bones, small pits called granular fovea are produced by arachnoid granulations.

History and etymology

Arachnoid granulations (older terms: Pacchioni's granulation (after Italian anatomist Antonio Pacchioni) or pacchionian body) resorb CSF into vascular system and occasionally cause a bony radiolucency, usually near the superior sagittal sinus.

Epidemiology

They increase in size and number with age and are seen in approximately two-thirds of patients. They are most commonly seen at the junction between the middle and lateral thirds of the transverse sinuses near the entry sites of the superficial veins.

Pathology

Arachnoid granulations (AG) are composed of dense, collagenous connective tissue that includes clusters of arachnoid cells.

Location

They most frequently occur in a parasagittal location with the transverse and superior sagittal sinuses being the most common locations. The granulations typically occur next to the entrance of a superficial draining cortical vein into a sinus (similiar to colonic diverticuli occuring next to penetrating vessels).

Clinical features

Although usually incidental, giant arachnoid granulations that are of sufficient size to fill the lumen of a dural sinus and cause local dilation or filling defects can rarely cause symptoms due to sinus obstruction leading to venous hypertension.

Spontaneous posterior fossa cerebrospinal fluid fistula, may be due to arachnoid granulations eroding into air sinus compartment.

Entrapped fourth ventricle

Some feel that shunt independence occurs more commonly when the hydrocephalus is due to a block at the level of the arachnoid granulations (communicating hydrocephalus), [1] but others have shown that it can occur regardless of the etiology.

Rodrigues and Santos reported a rare case of a brain herniation into a giant arachnoid granulation in an asymptomatic elderly male patient, which was discovered incidentally [2].

Kan et al., reported a 31-year-old man presented with a 3-month history of progressive bifrontal headaches and a giant arachnoid granulation at the posterior superior sagittal sinus. Intrasinus

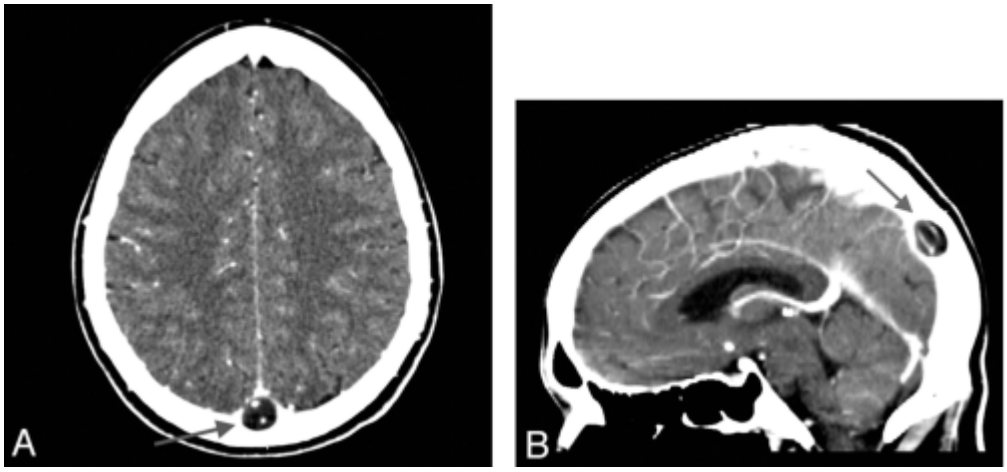
pressure measurements showed no significant pressure difference across the lesion to explain the headaches, which were then treated medically. Dural sinus pressure measurement, in certain cases of giant arachnoid granulations, can be used to exclude the lesion as the cause of the patient's symptoms [3].

Diagnosis

They are often discovered as incidental findings in the transverse and posterior superior sagittal sinus [4] [5] [6].

They appear osteolytic, sharply circumscribed indolent-appearing lucencies on skull CT or x-rays, or a filling defect in dural venous sinuses, which can be mistaken for Dural venous sinus thrombosis.

CT



The granulations are typically of CSF density and protrude into the calvaria or a dural venous sinus causing a filling defect. They may simulate a dural venous sinus thrombosis but are usually easy differentiated given their round well-defined shape and classic location.

MRI

Signal characteristics are generally those of CSF [7]:

T1: low signal intensity

T2: high signal intensity; iso- or even slightly hyperintense to CSF

FLAIR: should attenuate

T1 C+ (Gd): no enhancement

Giant granulations (>10 mm) may show atypical MRI signal characteristics, with higher T1 and T2 signal than CSF and incomplete FLAIR signal suppression [8]. Rarely these may cause sinus obstruction [9].

Differential diagnosis

1.- Extradural mass.

Unicameral bone cysts (UBC), also known as simple bone cysts, are common benign bone lesions filled with fluid, primarily occurring in children and adolescents. Although they can develop in any bone, UBCs usually affect the long bones.

A 53 year old male patient was found incidentally to have a calvarian lesion in the parietal region overlying the superior sagittal sinus (SSS). The differential diagnosis included a large arachnoid granulation, haemangioma of bone, a giant cell tumour or tuberculous infection. The patient was planned for elective surgery to remove the lesion and establish the diagnosis. Surgery was uneventful.

This is the first case of UBC affecting the cranial vault. The patient underwent surgery [10)].

2.- Dural venous sinus thrombosis.

MR imaging combined with MR venography is the most useful diagnostic tool to differentiate [11)].

The differential diagnosis with thrombosis or intrasinusal tumoral lesions can easily made on the basis of three typical radiological features of the granulations: the hyperintensity of the lesions on FLAIR, a blood vessel within the lesion and bone erosion [12)].

Case reports

A 6-year-old girl complained of diplopia and headache over a 2-week period after sustaining a minor head injury. Her neurological examinations were normal, but visual examination identified bilateral papilledema. Magnetic resonance imaging of the brain revealed a protruding nodular lesion causing compression within the anterior superior sagittal sinus in the midline, showing high signal intensity on T2-weighted imaging (T2WI) and low signal intensity on T1WI, similar to that of cerebrospinal fluid. Enhanced T1WI showed irregular narrowing of the anterior superior sagittal sinus adjacent to this lesion. The cortical vein drained to the frontal pole of the arachnoid granulation lesion and into the superior sagittal sinus. No other parenchymal abnormality was noted. A lumbar puncture showed increased opening pressure (30 mmHg), and the laboratory findings were normal. Based on the imaging and clinical findings, benign intracranial venous hypertension with giant arachnoid granulation was diagnosed. The patient's symptoms were reduced satisfactorily following daily treatment with 750 mg acetazolamide [13)].

A 45-year-old male patient which was associated with left temporal thrombosed dural arteriovenous fistula (AVF) whose thrombosed draining veins were seen converging towards the site of giant arachnoid granulation (GAG). The patient presented with three episodes of generalised tonic-clonic seizures and improved with conservative treatment. No reports of such association of GAG with AVF is available in the literature, and Karegowda et al., believe it could have occurred due to venous hypertension induced by GAG [14)].

A child who presented with a mass within the superior sagittal sinus and an anomalous draining vein. Herein, the diagnosis of a giant AG was made. Clinicians who view or interpret imaging of the head should be aware of these anatomical variants and though when very large, apparently, do not necessarily result in pathology. Based on this case report, giant AG might also demonstrate anomalous draining veins [15].

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