Cranial Cavity

REFERENCES:

Moore and Agur, Essential Clinical Anatomy (ECA), 3rd ed., pp. 496-498; 500-507; 512-514
Grant’s Dissector 14th ed., pp. 208-227

OBJECTIVES

After studying the material of this lecture, the student will be able to:

1. Describe the osteological makeup of the three fossae that comprise the cranial cavity.
2. Outline the associated openings of these fossae and describe the cranial nerves and blood vessels which pass through them.
3. Draw and label the major arteries comprising the Circle of Willis at the base of the brain.
4. Outline the projections and reflections of the meningeal dura mater that cover the bones of the cranial fossa.
5. Outline the dural venous sinuses and trace the venous blood flow to the formation of the internal jugular vein.
6. Outline the blood supply and innervation of the cranial cavity dura.

OSTEOLOGY

Several bones make up the cranial cavity. For convenience of discussion, the cranial cavity is divided into three fossae: anterior, middle, and posterior. The fossae will be described in turn; please consult the skull self study package for details not in the syllabus. The student is responsible for knowing all bones, features, and foramina of the cranial fossae. In life, the meningeal dura covers all surfaces of the cranial fossae. (See below).

Anterior cranial fossa:

The anterior cranial fossa is composed of the frontal bone’s orbital plate, the cribiform plate and crista galli of the ethmoid bone, and the jugum and lesser wing of the
sphenoid bone. The orbital plate of the frontal bone is rather thin, and can easily be broken into and removed to gain access to the orbit and its contents. The major openings are the cribriform plate which transmits the olfactory nerve, cranial nerve I, as well as a branch of the anterior ethmoidal artery to the dura, and the meningeal branches of the anterior and posterior ethmoidal nerves, which are branches of the ophthalmic division of cranial nerve V.

Middle Cranial Fossa

This is the most complex of the fossae, and is composed of the greater wing and body of the sphenoid bone, and both squamous and petrous portions of the temporal bone. A ridge on the superior surface of the petrous temporal bone marks the boundary between the middle and posterior cranial fossae. With the exception of the facial hiatus, the major foramina and openings are rather large. The optic canal is through the sphenoid bone and transmits the optic nerve, cranial nerve II, and the ophthalmic artery.

The superior orbital fissure is a large opening between the greater and lesser wings of the sphenoid bone, and is superlative in that it transmits all or part of four cranial nerves. Cranial nerve (C.N.) III (Oculomotor), C.N IV (Trochlear), C.N. VI (Abducens), and V₁ (ophthalmic division of C.N.V), as well as the ophthalmic vein, all go through this opening. The foramen rotundum in the greater wing of the sphenoid transmits V₂ (maxillary division of C.N. V).

The foramen ovale, also in the greater wing of the sphenoid, transmits V₃ (mandibular division of C.N. V), and the accessory meningeal artery, and frequently the lesser petrosal nerve. The latter is from C.N. IX, the glossopharyngeal nerve, and supplies preganglionic parasympathetic fibres to the otic ganglion, eventually effecting secretion of the parotid salivary gland. The foramen spinosum completes the crescent of foramina in the sphenoid’s greater wing, and transmits the middle meningeal artery, the largest of the arteries to supply the cranial dura. The foramen lacerum is the embryological junction of the sphenoid, petrous temporal, and occipital bones. This foramen is covered by cartilage in life, so little passes through it except for an emissary vein or two. It is crossed by the greater petrosal nerve, the latter on its way to the pterygoid canal found on the skull base.

The carotid canal is in the petrous temporal bone, and the internal carotid artery passes through it. This opening also carries the deep petrosal nerve, which is the plexus of postganglionic sympathetic nerve fibres that typically distribute with the internal carotid artery. Lastly, the hiatus of the facial canal on the petrous temporal bone allows
the greater petrosal nerve, a branch of C.N. VII, the facial nerve, which are preganglionic parasympathetic fibres on their way to the lacrimal gland and the mucous glands of the nose and throat.

Posterior Cranial Fossa

The posterior cranial fossa is composed of two bones: the posterior portion of the petrous temporal bone, and the occipital bone. Features of the latter include the cerebellar fossae upon which the cerebellar hemispheres rest, the clivus or basilar occiput, and a prominent groove for the sigmoid sinus. The internal acoustic meatus in the petrous temporal bone transmits two cranial nerves: VII, the facial, and VIII, the vestibulocochlear. The foramen magnum is the largest opening in the cranial cavity, and permits the connection of the fibres between the brainstem and spinal cord. In life the pons of the brainstem rests nicely on the clivus of the occipital bone. The spinal cord begins at the inferior margin of the foramen magnum. The spinal portion of C.N. XI (Spinal Accessory) and vertebral artery also pass through this opening.

The jugular foramen transmits the internal jugular vein, formed when the sigmoid sinus passes through the opening, as well as C.N. IX (Glossopharyngeal), C.N. X (Vagus), and C.N. XI (Accessory). The inferior petrosal sinus drains directly into the internal jugular vein and passes through the jugular foramen to do so. Finally, the hypoglossal foramen (canal) is found superior to the occipital condyles and transmits C.N XII, the hypoglossal nerve.

MENINGES

Dura Mater

The dura mater is the outermost and toughest covering of the meninges, its Latin name meaning “tough mother”. It is composed of two layers; the outermost is continuous with the periosteum of the inner aspect of the calvaria of the skull, and the inner layer continuous with the coverings of the spinal cord and cranial nerves. The dura has projections or reflections which invaginate into the skull cavity or cover the cranial fossae.
The falx cerebri is a large sickle shaped projection of the dura between the cerebral hemispheres found within the intrahemispheric sulcus. It has a free inferior border. The falx cerebelli is a similar but much attenuated invagination of the dura between the cerebellar hemispheres. The tentorium cerebelli, covering the cerebellum from above, is a dural reflection attached to the superior margin of the petrous temporal bone, and has free medial borders which permit the passage of the brain stem. Lastly, the diaphragma sellae covers the sella turcica of the sphenoid bone, and has a midline opening which allows the stalk of the pituitary gland to suspend the gland into its resting position on the hypophyseal fossa.

Dural Sinuses

The dural sinuses are dural spaces filled with venous blood, which drain the brain to form the internal jugular vein. The superior sagittal sinus runs just above the intrahemispheric sulcus in the midline. It begins in the foramen cecum, a small opening just anterior to the crista galli in the anterior cranial fossa. The inferior sagittal sinus runs in the free inferior border of the falx cerebri, and joins the great vein of Galen to form the rectus (straight) sinus, which runs in the junction of the falx cerebri with the tentorium cerebelli. The rectus sinus joins the superior sagittal sinus at the confluens of sinuses, then forming two transverse sinuses which run in the margin of attachment of the tentorium cerebelli to the occipital bone. The two transverse sinuses each form a sigmoid sinus, which effects a prominent groove in the occipital bone on either side. The sigmoid sinuses form the internal jugular veins which pass through the opening of the same name.

The cavernous sinus, paired, lies within the carotid groove and drains veins that lie anteriorly in the orbit, face, and pterygoid area. A superior petrosal sinus runs on the superior margin of the petrous temporal bone, where the tentorium cerebelli attaches, and joins the junction of the transverse and sigmoid sinuses on either side. The inferior petrosal sinus runs in the junction of the occipital bone and petrous temporal bone in the posterior cranial fossa, and drains directly into the internal jugular vein as described previously.

Blood and Nerve Supply

In the anterior cranial fossa, the blood supply is mainly from the anterior meningeal artery, which is a branch of the anterior ethmoidal artery from the ophthalmic. The middle cranial fossa is supplied via the middle and accessory meningeal arteries, which are branches of the maxillary artery. The middle meningeal artery is large enough to pass through its own foramina, the foramen spinosum, so named because it is adjacent to the spine of the sphenoid on the base of the skull. The posterior meningeal arteries to the posterior cranial fossa are various branches of the ascending pharyngeal artery and the occipital artery, both branches of the external carotid, and the vertebral artery.

The sensory innervation of the dura in the cranial cavities is derived from all three divisions of the trigeminal nerve. The anterior fossa is supplied by the meningeal branches of the anterior and posterior ethmoidal nerves from the nasociliary nerve of V1. Meningeal branches of V2 and V3, the latter accompanying the course of the middle meningeal artery, supply the middle fossa. Branches from C1 and C2 that enter the foramen magnum supply the posterior fossa.
ARACHOID AND PIA MATER

The arachnoid is a thin filamentous layer containing a fluid filled space beneath it, the subarachnoid space. This is filled with the cerebrospinal fluid (CSF), produced by the choroid plexus found within the ventricles of the brain. It is reabsorbed into the venous blood through cauliflower like projections of arachnoid called arachnoid granulations (villi). These granulations are found mainly in widening of the dural sinuses, especially adjacent to the superior sagittal sinus, called lacunae. These villi can press against the inside of the skull vault effecting pits in the bone called fovea granulares.

The pia mater is the thin, delicate most intimate covering of the brain, and tightly adheres to the brain surface, following the sulci and gyri of the hemispheres. In ordinary dissection, the pia is difficult to separate from the brain itself. The arachnoid and pia mater are collectively called the leptomeninges.

CEREBRAL CIRCLE OF WILLIS

Although we will be de-emphasizing the gross structure of the cerebral hemispheres and cerebellum at this time, attention should be paid to the circulation at the base of the brain and the contributions of the vertebral artery and internal carotid artery to form a remarkable anastomoses of blood vessels to assure adequate cerebral blood flow should a blockage or hemorrhage occur.

Before the two vertebral arteries unite at the lower end of the pons, they each give off the posterior inferior cerebellar artery (PICA) to the cerebellum. The two vertebral arteries unite to form the unpaired basilar artery, which lies in the ventral sulcus of the pons. The basilar artery immediately gives off a paired anterior inferior cerebellar artery (AICA), again to the cerebellum. There are various branches of the basilar artery to the pons and adjacent structures that will be studied in neuroanatomy. The two superior cerebellar arteries are the last branches of the basilar artery before it divides into its terminal branches- the posterior cerebral arteries. Cranial nerve III, the oculomotor, invariably exits the brain stem between the superior cerebellar artery and the posterior cerebral artery.

On each side, the internal carotid artery divides into a large middle cerebral artery and a smaller anterior cerebral artery, the latter traveling near the midline in the interhemispheric sulcus that separates the two cerebral hemispheres. An unpaired anterior communicating artery joins the two anterior cerebral arteries. A posterior communicating artery branch from each posterior cerebral artery is joined to the internal carotid on each side. Thus a cerebral arterial circle is formed called the cerebral arteriosus of Willis, from the physician first describing its anatomy and significance.