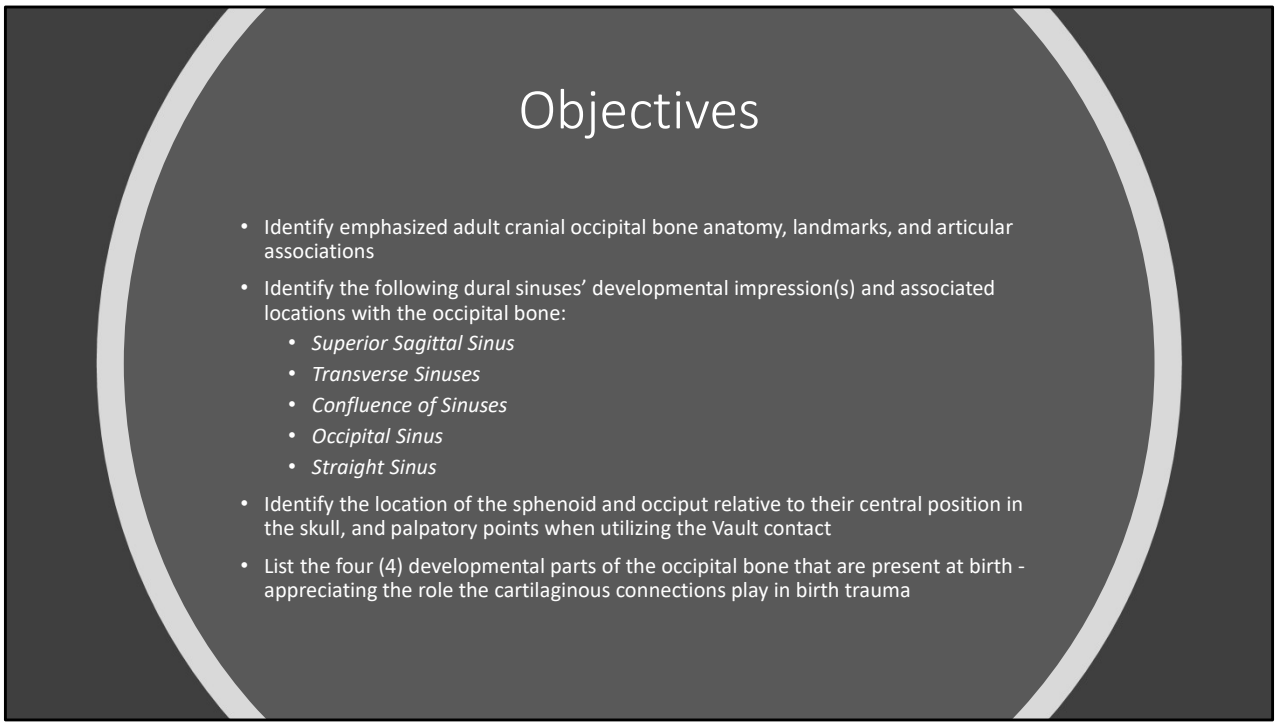
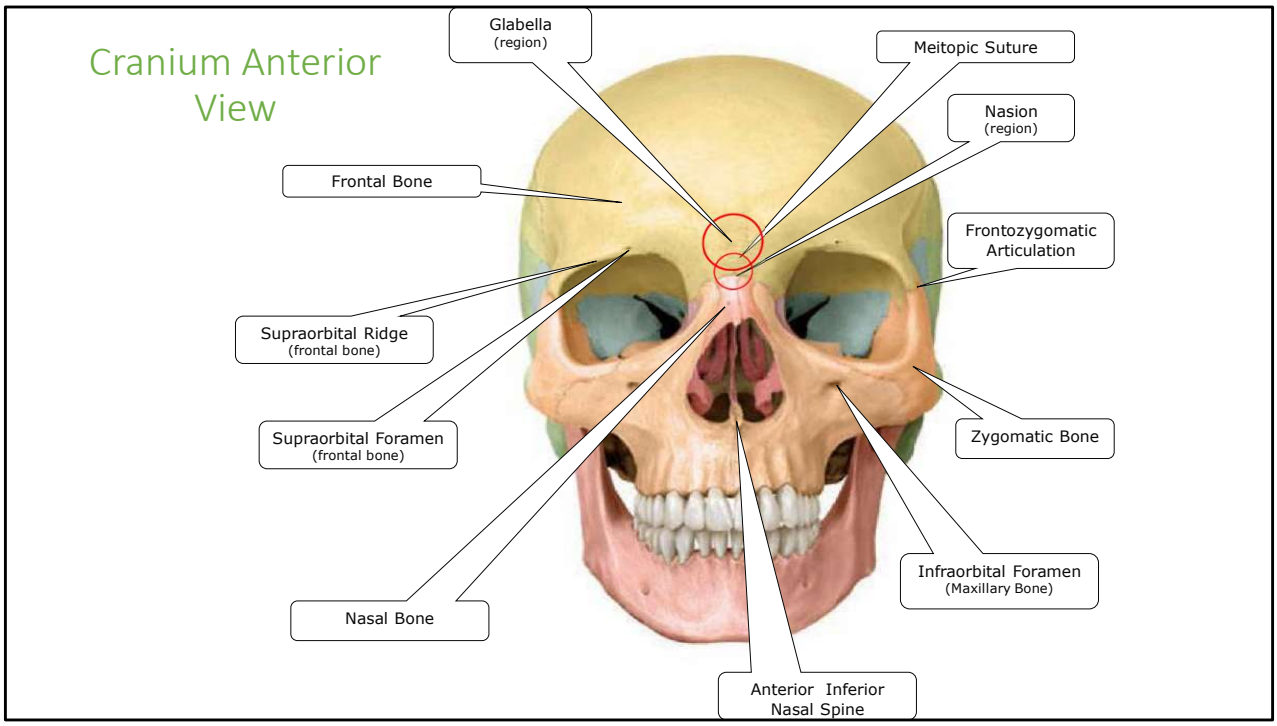
Welcome to your second lecture on osteopathic cranial manipulative medicine. This is, although a longer PowerPoint this is all landmarks for you. So we'll give you some context for what you will be palpating in lab. And some important locations in the skull that have clinical significance as you're palpating them. So this is mostly for you to process on your own and in conjunction with what we will be palpating in lab with you as well.



So our objectives
Identify the emphasized adult occipital bone anatomy, which is very different than the pediatric. And we're going to talk about that landmarks and articular associations. We're going to be looking specifically at the occipital bone because of the dural sinuses, developmental impressions, and associated locations because we will be doing a venous sinus drainage with you shortly in lab. And these include the superior sagittal sinus, the transverse sinus, confluence of sinus days, occipital and straight sinuses.
We will also identify the location of this sphenoid and occiput relative to their central position in the skull and palpatory points when utilizing the vault contact. We already introduced that in your first lecture, but now we'll give you a little bit more context of, again, we're that anatomy is that's under your hands.
And list the four developmental parts of the occipital bone that are present at birth. Appreciating the role that the cartilaginous connections play and birth trauma.



Quick note that anywhere you see a red circle implies a region rather than a point of contact.

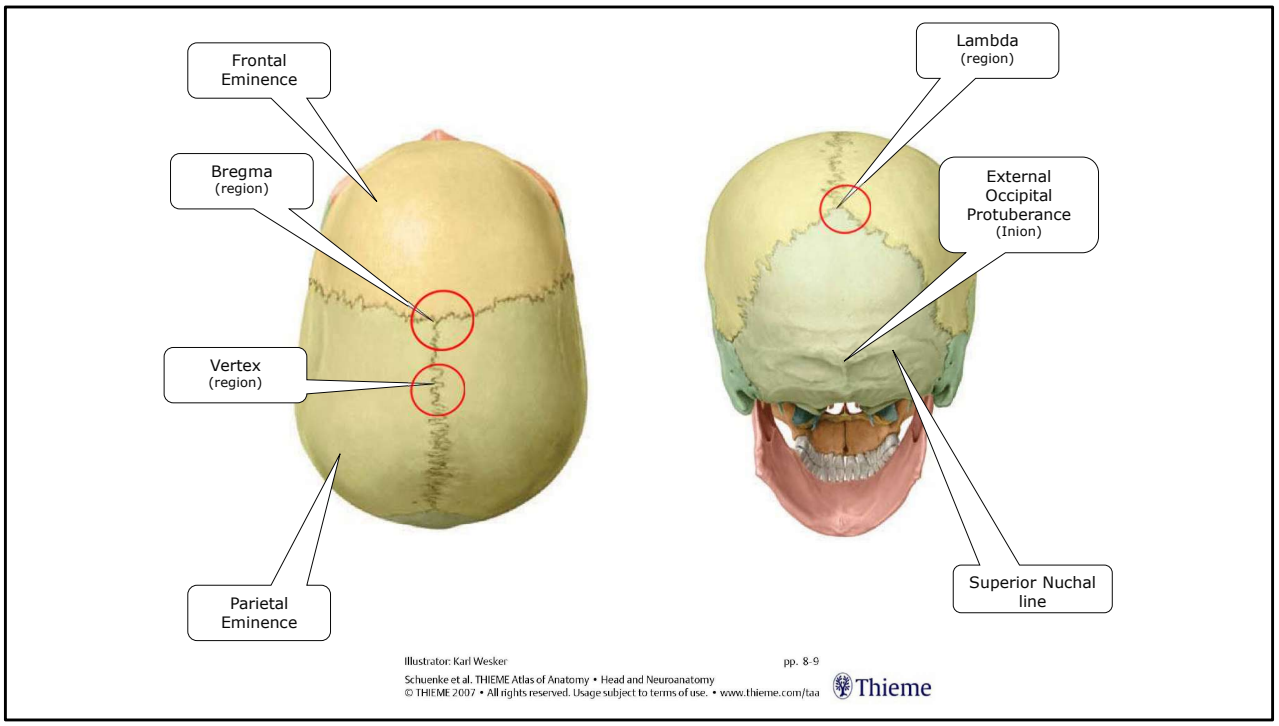
So starting with our anterior view of the skull, this region here is called the glabella. That's between the orbital ridges on the frontal bone and just anterior to that where the frontal bone meets the nasal bones is nasion. So that's a region you might be asked to palpate and identify it as well. The yellow bone on top here is our frontal bone forming the superior border of the orbit, which are actually made up of seven unique bones, but more to come on that later. And the inferior border of that frontal bone is the supraorbital ridge which contains the supraorbital foramen. And there's an important nerve coming through there that again, we'll be covering more on that later.

You can see that to midline bones that make up the nose or the nasal bone, but just lateral to that are the frontal processes of the maxillary bone. These are the maxillary bones here And remember that you have two maxilla and our upper teeth are coming out of these bones.

Next to the maxillary bone, moving laterally, a slightly darker shade of orange is the zygomatic bone. And if you move superiorly along that orbital surface here you can see this fronto-zygomatic articulation

coming back inferiorly onto the maxillary bone you can see the anterior, inferior nasal

spine. Just another landmark for you.



Now moving on. On our left here we have a superior view of the skull. So again, this is our frontal bone, that's our nasal bones right there. This is probably zygoma coming out laterally. And these two bones are parietal bones.

What we see here are some major sutures along here is our coronal suture and then our sagittal suture along this midline. The region where the coronal and sagittal sutures overlap is known as the bregma.

And another region on the top is vertex. So the vertex is, if you think about the skulls that are hung up and lab hanging from that kind of midline point on the skull That's vertex. So that's kind of where the bolt in all of our skulls would go to hang us up. A morbid way to think about it.

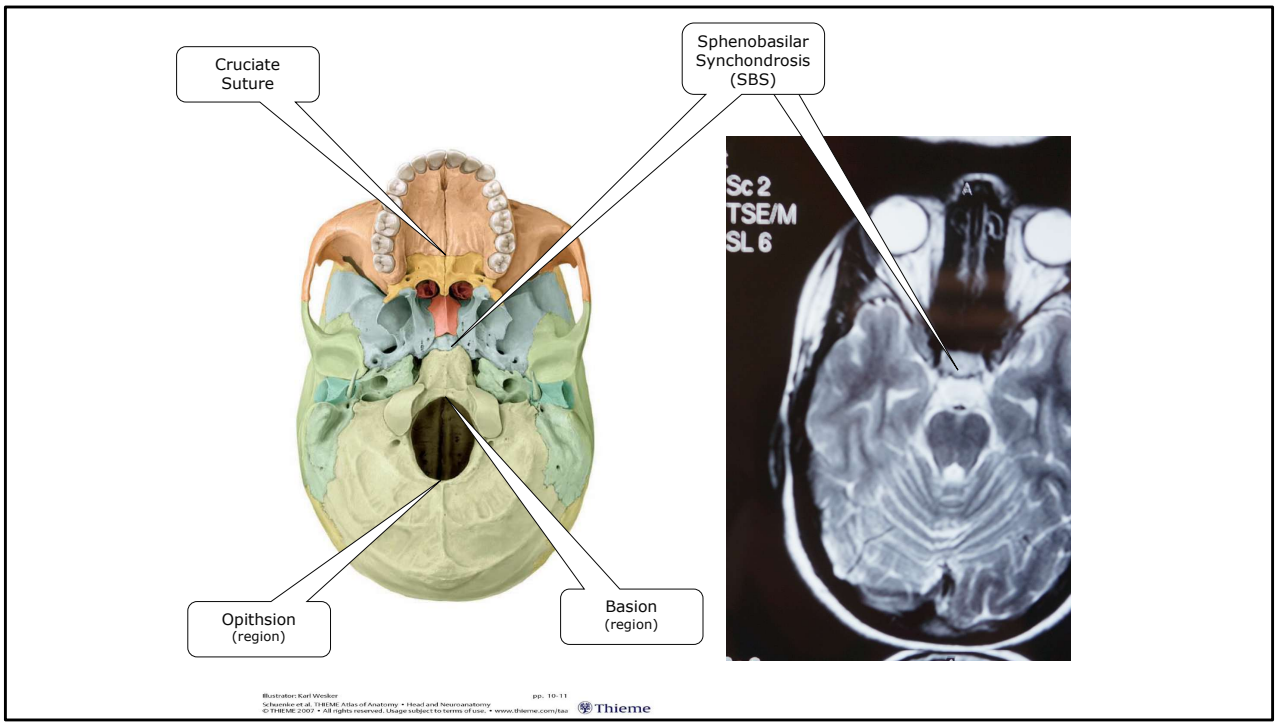
The other thing you can notice from this superior view are the frontal and parietal eminences. So these are these slight protuberances or prominences. in each of those bones, and remember that at birth you have two frontal bones. So these are actually paired bones. And this is an important concept when we get into the motion of cranial bones later on. But each of these eminences actually represents a previous ossification center that existed.

Looking posteriorly again here those parietal cells.

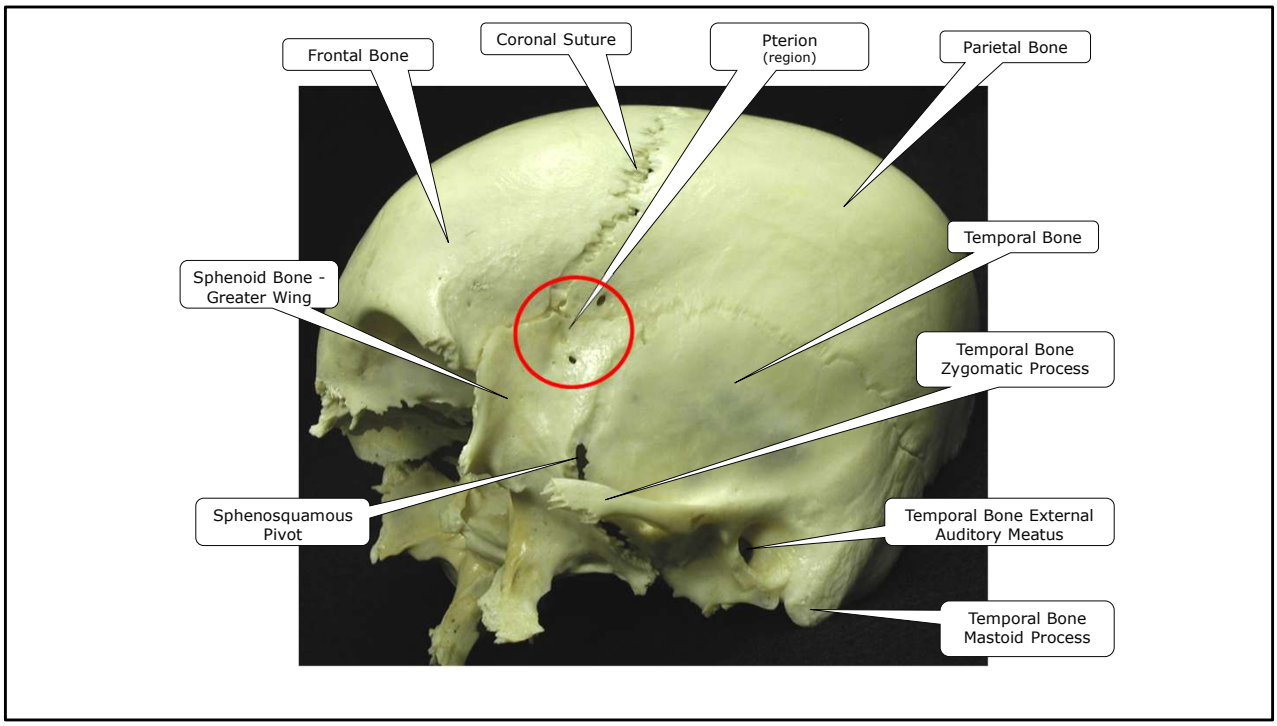
And this is your occipital bone. These are temporal bones.

Over here you can see mandible anteriorly, a couple of landmarks posteriorly you

have the external occipital protuberance and the very tip of that is known as inion. Moving out laterally from the external occipital protuberance is the superior nuchal line, which is where a lot of our musculature attaches to. So this gets more prominent over time/aging.
Again, here's that sagittal suture coming down. This is our lambdoid suture. And where those meet is the lambda. So since I'm a pediatrician, I have to tell you your posterior fontanelle and anterior fontanelle are these points bregma and lambda. So the soft spots that you think of on a baby's skull.

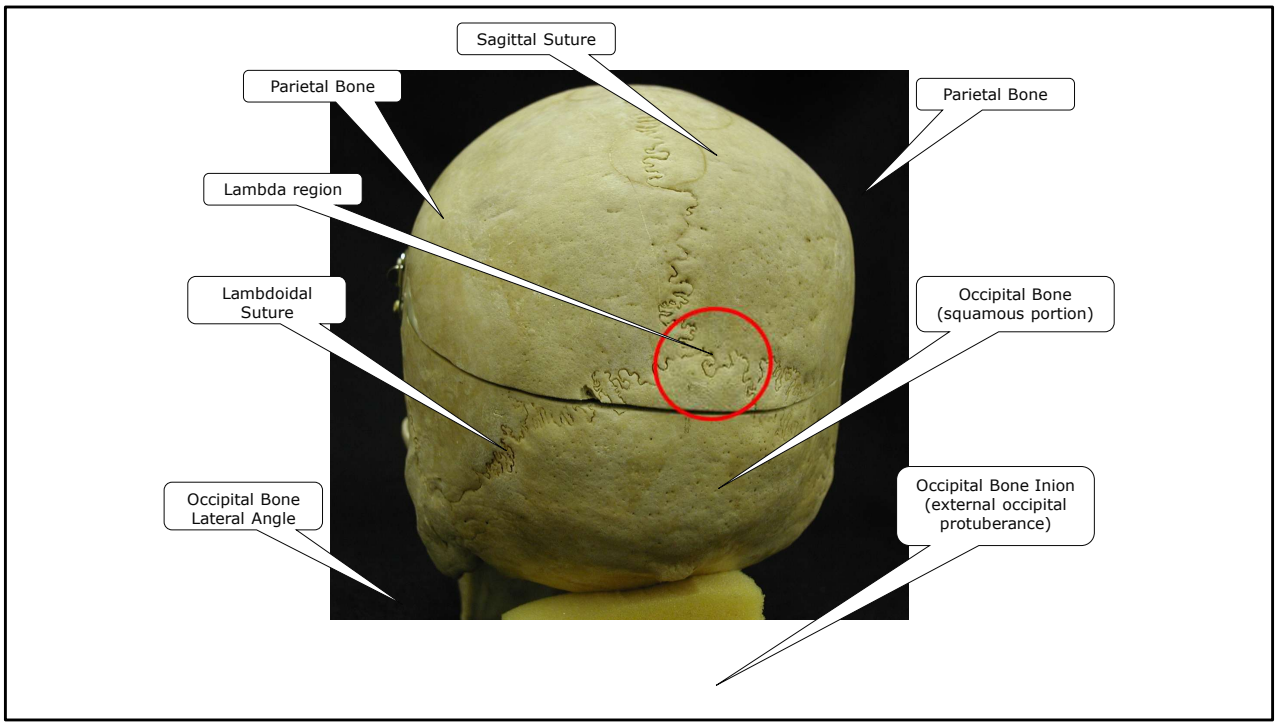


Now looking from an inferior view, sorry.
Inferiorly we have our two maxilla. And then there's palatine bones here, more posterior to that. And where are those neat, you can see this cross and that's why this suture is known as your cruciate suture. And you might even be able to reach up with your tongue and palpate on yourself. Some people have a bony prominence there that's known as a torus palatini If you can appreciate that on yourself.
Blue bone here is our sphenoid
gray greenish bone posteriorly is our occiput. And where those two are meeting is a major joint in the head, a major landmark known as sphenobasilar synchondrosis. And we'll be looking at this a little bit more closely later in this lecture. You can see this joint on CT. So that's what's represented over here.
This is foramen magnum within the occiput. And again, the anterior border of that is known as the basion region. And the posterior part is the opisthsion, neither of those are palpable externally.

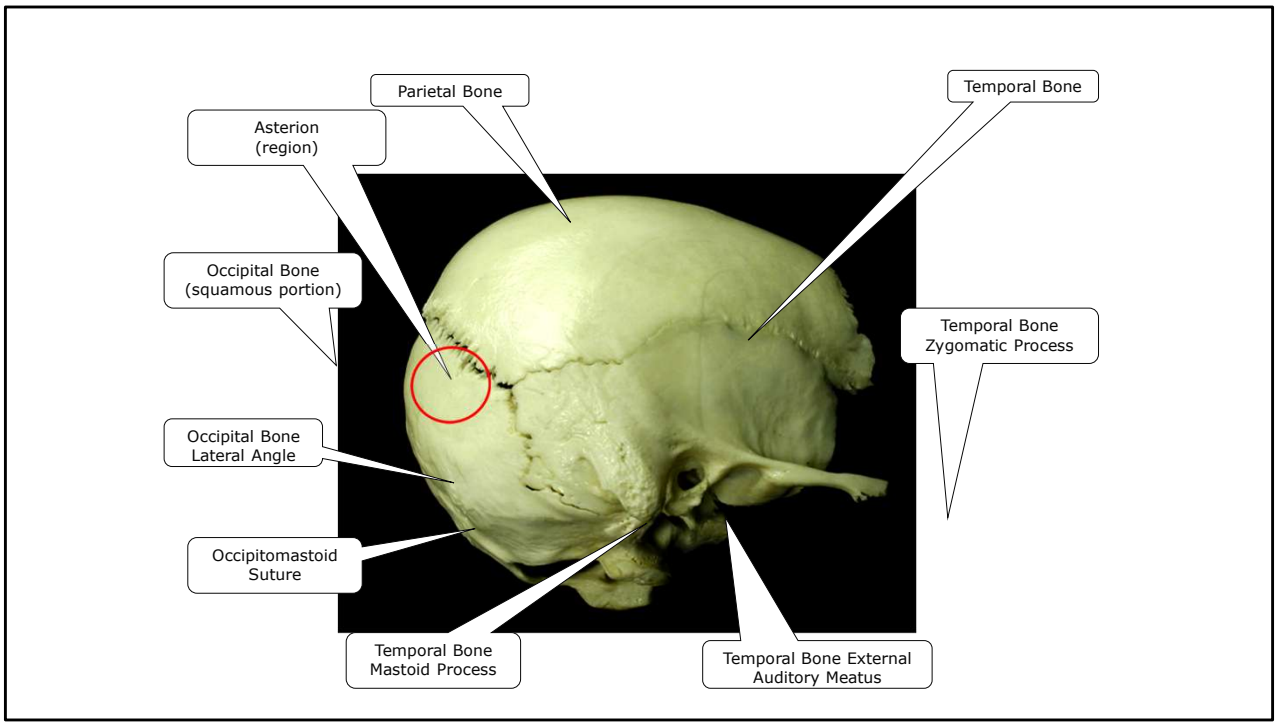


Now looking at a lateral view.
So to orient you, here's frontal bone, parietal bone, occipital bone back here. Here's our temporal bone.
We have our coronal suture and where our frontal, our temporal, our sphenoid, which is right here-this is the greater wing of sphenoid- and our parietal meet you get this region here, which is a very vulnerable region on the skull bones known as the pterion. And so if anyone ever asks you where you'd like to be hit in the head, the answer is not pterion. You're very vulnerable at that location in the skull because of the intersection of these four bones.
Again, Here's our temporal bone.
You have your zygomatic process of the temporal bone that's going to come anteriorly and articulate with the zygoma. And so that's why it's known as the zygomatic process.
Here you can see what's known as the sphenosquamous pivot point. We have some better images of this coming up later, but it's a point that's very clearly designed for motion, where there's a shift in the change of bevels from inside of the bone to outside of the bone.
You have your external auditory meatus. You all know where that is. But this is where it's located on your temporal bone.

And then posteriorly is very hard, palpable bony process posterior to the ear is the mastoid process. And remember that's one of the major landmarks that has missing in children because it develops over time with that SCM pulling on that developing skull.



So another posterior view.
Again, we've already talked about sagittal suture, lambdoidal suture. And those meet up at this point lambda because it looks like the Greek letter Lambda. Again, here's your two parietal bones, occipital bone down here.
We've already talked about the external occipital protuberance and the tip of that being inion.
And then we mentioned in our intro lecture that our fifth digits in the vault contact would be resting on the lateral angles of the occipital bone. And that's where these are - just posterior to that mastoid process on the occipital bone.



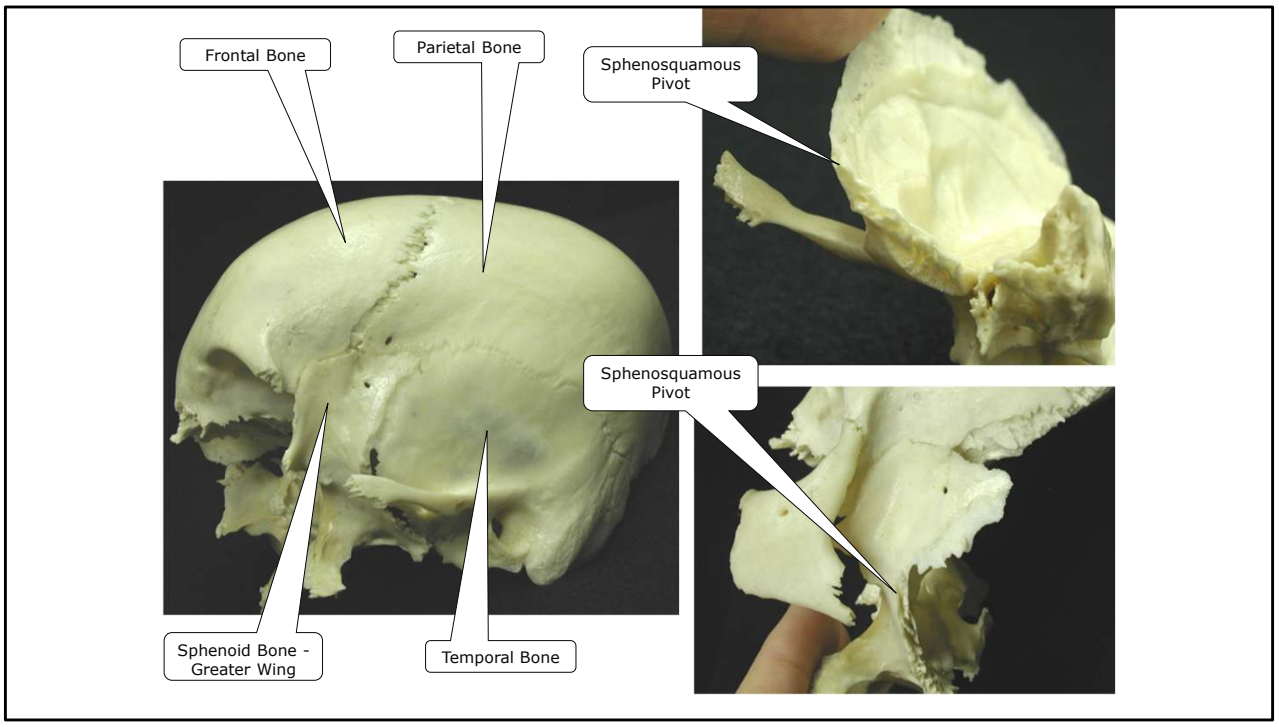
Here we have got a different lateral view, looking at a slightly oblique views. So to orient you, here's parietal, temporal and occipital bone.

The region where these three bones meet is known as asterion, so it's another vulnerable part in the skull.

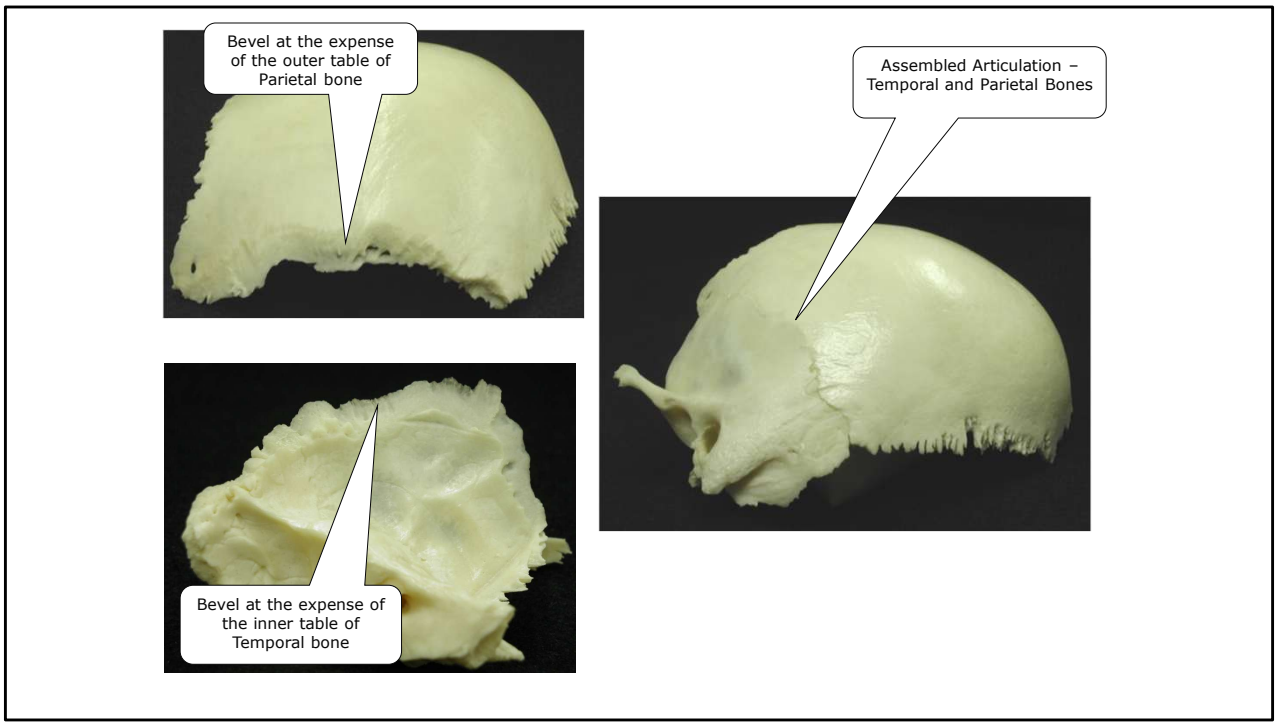
And on the occipital bone, we're going to see this a little bit more, but we have this squamous portion, which is a big, thinner portion posteriorly and superiorly on that occipital bone. And again, you'll see this better when we have images of just the occipital bone coming up later in the slides and then the lateral angle, and that's where your fifth digit will go when palpating in vault contact.

You have your occipital mastoid suture. So this is a suture between the occipital bone and temporal bone, but just posterior to that mastoid to it's known as the occipital mastoid or OM suture and we're going to learn a release for this in lab.

Again, there's that mastoid process, the external acoustic meatus, zygomatic process of the temporal lobe, reaching anteriorly.

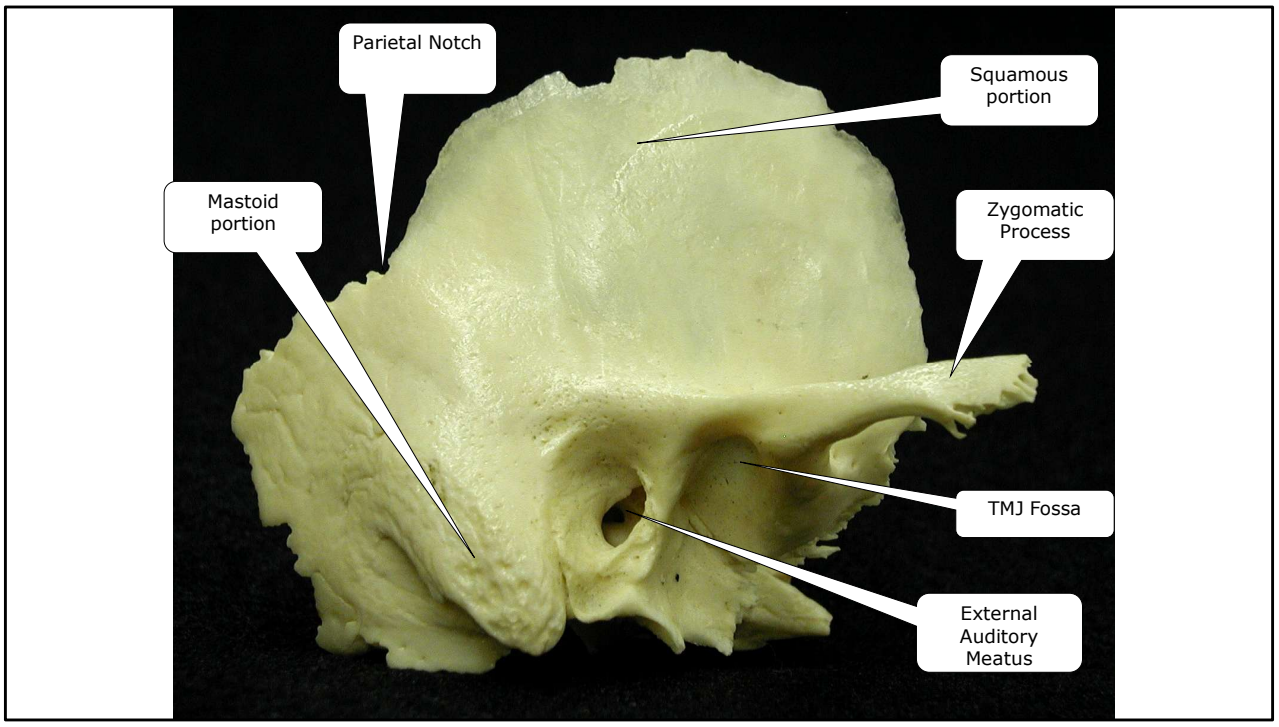


Again, here's, you've seen this image before when we were showing you pterion But just to reorient you, Here's frontal bone, parietal bone, temporal bone, and the greater wing of sphenoid. Again, pterion is where all of those are meeting.
And then here's looking at this temporal bone a little bit more closely. So here's the zygomatic process for, you know, that you're looking at an anterior surface of this and you can see this change in bevel where it changes from the bevel being on the inside to the bevel being on the outside. Which is why this is known as the sphenosquamous or SS pivot point, which is clearly designed for motion.
And so here's that view from another angle.



This is the parietal bone where the squamous portion of the temporal bone meets it. And so this is the temporal bones, but this is where it's going to meet that. And again, these bevels are just to show you that this is very clearly designed for motion.
This is from another oblique angle looking at that junction between the temporal, that articulation between the parietal and temporal bones

Going to be looking at temporal bone a little closer now.

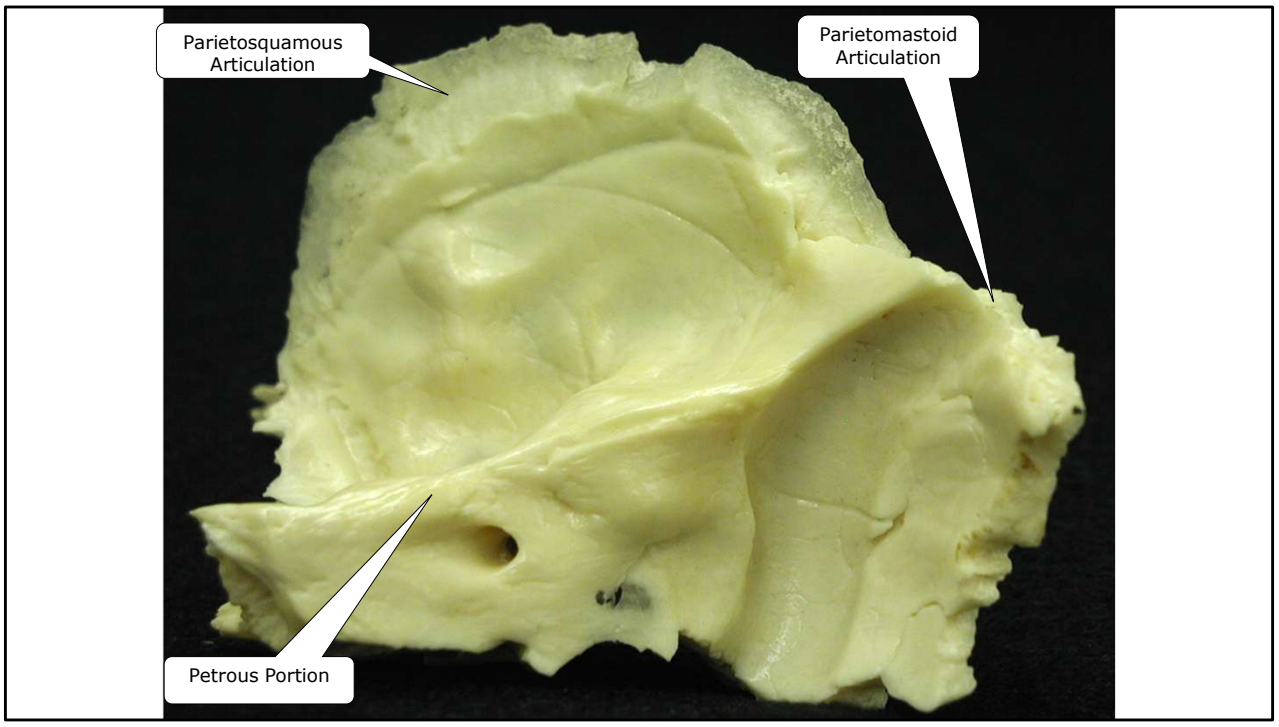


you have the squamous portion this is bone that is farmed in membrane up here. We'll be talking about this a little bit more later, but developmentally this bone is formed in membrane and formed from stretching of the bone during development as the brain is growing. Versus you can see on this inferior portion of the temporal bone. And the bone is thicker and harder and this is all formed in cartilage and formed from compression. So the weight of that growing brain on the developing skull causes that bone to develop differently.

The mastoid processes on the petrous portion of this temporal bone, which we have a better image of coming up with this inferior hard part that we know is petrous means rock in Greek. And so it's like that and actually doesn't have Haversian canals so allows for very little to no remodeling of the bone. So again, very different developmental components to these bones – squamous vs petrous portions.

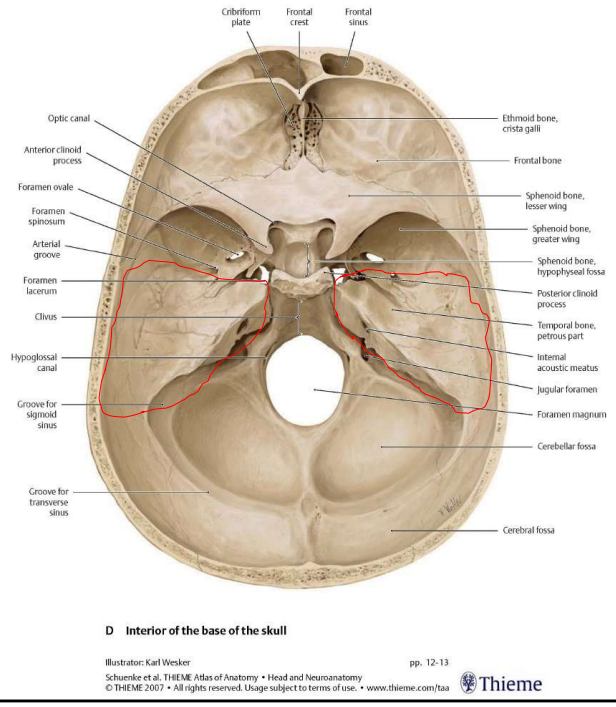
And since the parietal notch, where this articulation is happening with parietal up here moving in towards that occipital mastoid suture which is back here. Here's your mastoid process to external acoustic meatus.

Anterior to that is the TMJ fossa where your mandible will come up and articulate your zygomatic process reaching anteriorly.



Here's a view of the temporal bone from the inside. This is the petrous portion I was telling you about this hard rocky portion here. And here's that external acoustic meatus that will go out.
Here's the Pareto squamous articulation. You can see those bevels. So again, this is what Sutherland was looking at when he said this looks like it was designed for motion.
And then you can see the parietomastoid articulation here.
This big imprint, it's worth noting just because it's impressive, is the imprint for the sigmoid sinus. You can see just how big and powerful those fluid influences are on these developing bones. And each of these little impressions represents a nerve and artery or order some sort of other vasculature running along this development, this bone. And that reminds us that this bone is really developing, secondary to the developing CNS.

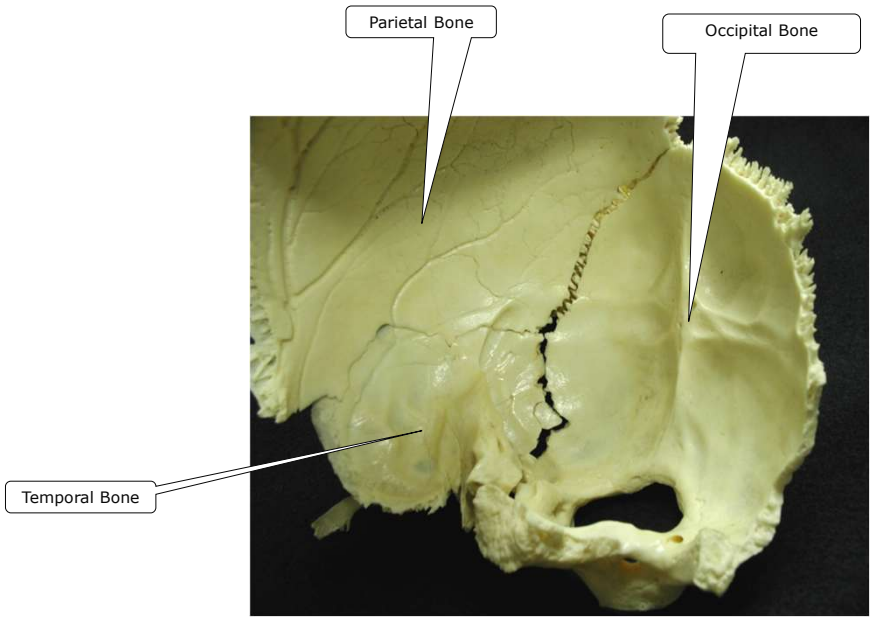
Location of the Temporal Bones in the Skull



D Interior of the base of the skull

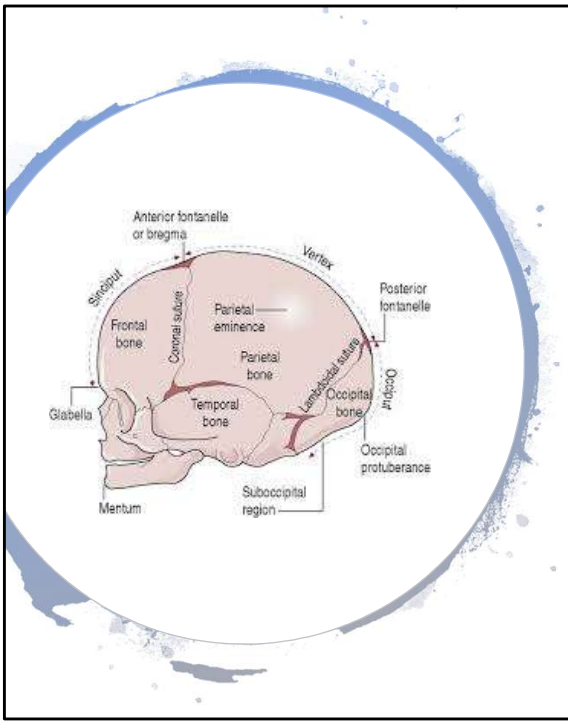
Illustrator: Karl Wesker pp. 12-13

So just to orient you where this temporal bone is in this call, this is looking at a superior view. So again, here's your occiput back here. And then our temporal bones are great here.



This is looking at the articulation between parietal, temporal and occipital from an oblique angle. So just to orient you again, here's foramen magnum. Here's the basal portion of the occiput. So that's going to be the posterior part of that SBS articulation we talked about earlier. Here's our occipital, parietal and temporal, and you can see how they fit together.

Now looking at the occiput



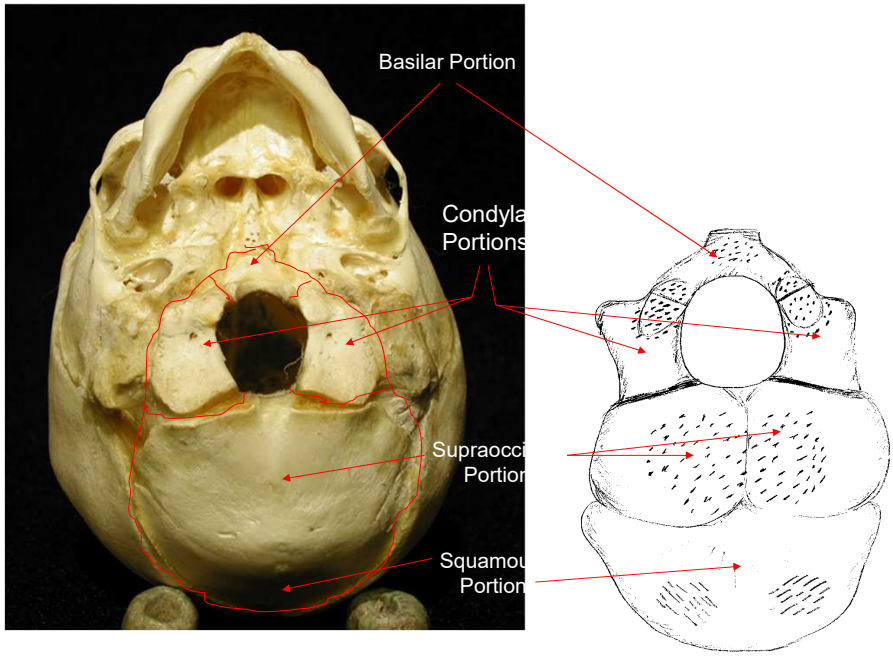
Occiput Developmental Considerations

- At Birth the Occiput is formed is typically in four (4) distinct embryological parts
  - Squamous portion with subparts:
    - Interparietal
    - Supraocciput
  - Two (2) Condylar portions
  - Basilar portion
- *These parts are united* by cartilage and develop both in:
  - *membrane* (interparietal)
  - *cartilage* (supraocciput, condylar and basilar occiput)
- *The Occiput fuses* generally by the 7th to 8th year of life

- Membrane – grew out between 2 layers of dura mater. Traction/stretching encourage this development
- Cartilage – develop by compression

- the occiput is really important for me as a pediatrician, especially because I see a lot of these manifestations in the children I see in my clinic. So at birth, the occiput consists of four distinct embryological pieces. The squamous portion is the again, the bigger, thinner portion posteriorly and superiorly on the bone. And it has the intraparietal portion up here and then the supraocciput. There's two condylar portions which you can't really see in this image. I've got plenty coming up.
- And then the basilar portion, which is anterior to the foramen magnum and articulates with that sphenoid.
- These parts are united by cartilage and they developed both in membrane that intraparietalportion and cartilage, the supraocciput, the condylar portions. So similar to that temporal bone, you've got these two different embryological developmental things happening. The membrane will form that thinner stretched bone because again, that is developing through stretching and that growing brain versus the cartilaginous harder thicker bone, which is developing in cartilage and assisted by compression. And this occiput fuses generally by seventh to eighth year

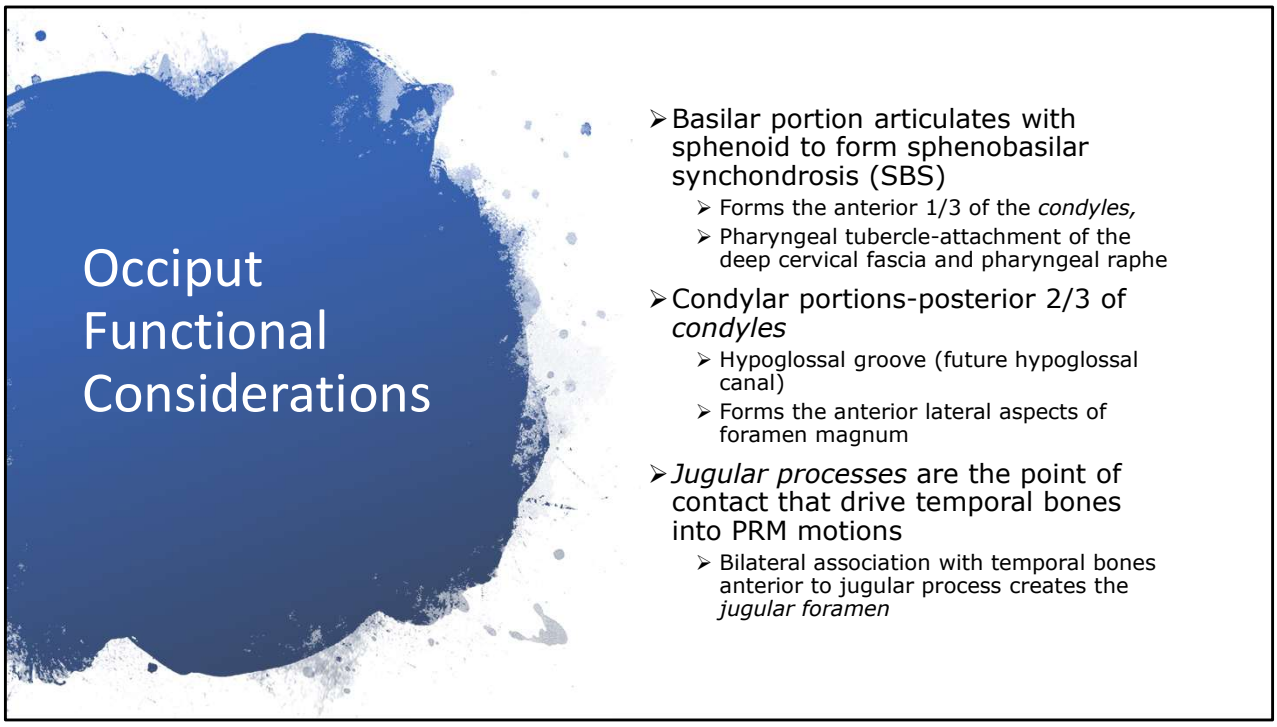
of life. So again, the patients I'm still seeing in my clinic are very flexible with our bones.



Where is interparietal portion
Foramen magnum – clinical consideration especially if deforms
Condyles – 2/3 in condylar and 1/3 in basilar. Groove that's open at birth and over time closes to form hypoglossal foramen

This is a view of the developmental occiput, so you can see the basal portion is anteriorly, the condylar portions are beside of foramen magnum. The anterior 1 third of the actual occipital condyles is located on the basilar portion and the posterior two-thirds are on the condylar portions or lateral masses sometimes you'll hear it referred to as. And then the supraocciput portion is right here posteriorly differentiated from the squamo which is that posterior superior portion. So functional considerations because of these changes in development, the basal portion articulates with the SPS as we talked about. And as I said before, you see the anterior 1 third of this portion forms but condyles. And then there's also the pharyngeal tubercle, which is the attachment of the deep cervical fascia and pharyngeal raphe. Then the cognitive portion, the actual posterior two-thirds of what will become our adult occipital condyles is there. And this contains the hypoglossal grew, which will ultimately become the future hypoglossal canal. And since this is in cartilage that can often be compressed with birth trauma or other traumas and, and lead to problems

with sucking, swallowing, etc. And this also forms the anterior and lateral aspects of foramen magnum. The jugular processes are the point of contact that drive the temporal bones into PRM motion. And again, we have pictures of these to help you orient.



All have clinical considerations
Jugular foramen – 9-11 plus vascular structures

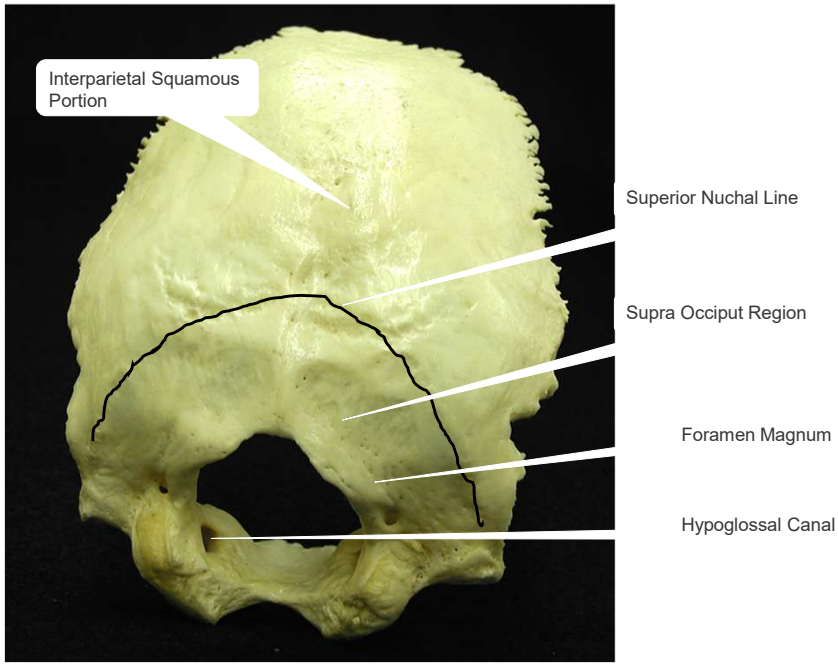
So functional considerations because of these changes in development, the basilar portion articulates with the SPS as we talked about. And as I said before, you see the anterior 1 third of this portion forms the condyles. And then there's also the pharyngeal tubercle, which is the attachment of the deep cervical fascia and pharyngeal raphe. Then the condylar portion, the actual posterior two-thirds of what will become our adult occipital condyles is there. And this contains the hypoglossal groove which will ultimately become the future hypoglossal canal. And since this is in cartilage that can often be compressed with birth trauma or other traumas and, and lead to problems with sucking, swallowing, latch, etc. And this also forms the anterior and lateral aspects of foramen magnum.
The jugular processes are the point of contact that drive the temporal bones into PRM motion. And again, we have pictures of these to help you orient coming up The bilateral association with the temporal bones anterior to the jugular process creates the jugular foramen where cranial nerves 9, 10, and 11 are exiting the skull. So you can begin to think of the clinical implications of compressing cranial nerves 9, 10, 11, especially cranial nerve 10 with its far-reaching innervation.

The Occiput Infant to Adult

Posterior aspect

Point out overriding sutures – allows for birth. Should pop out with first breath/big cry → increased ICP
Membranous association vs true suture in adult
Stretching/compression – caused by brain growth and expansion and increased weight

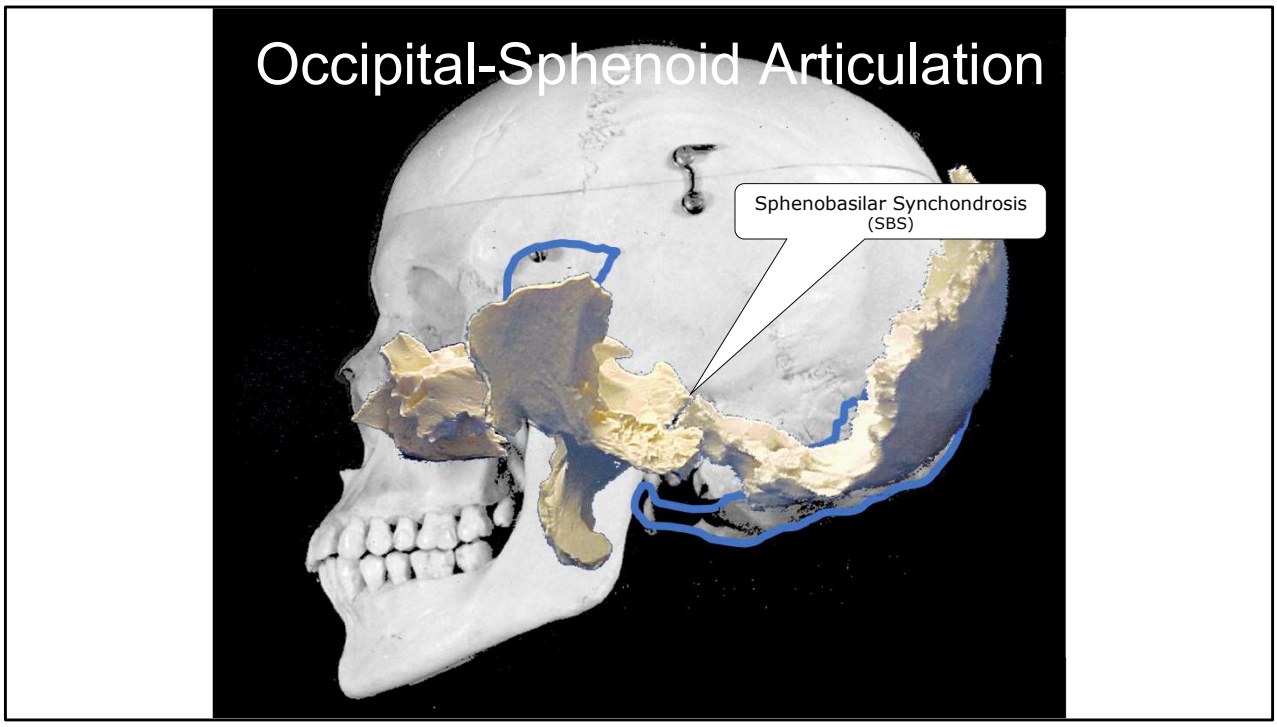
So just to show you that are from between the infant occiput on the left here again, you can see all these features is just the Lambda or the posterior fontanelle versus our adult occiput.



Basion and ophistion

So looking at occiput a little bit more closely, bear the intraparietal sqaumous portion of the occiput. And then the supraocciput region down here. This is the superior nuchal line, again extending laterally from the external occipital protuberance and the tip of that being the inion.

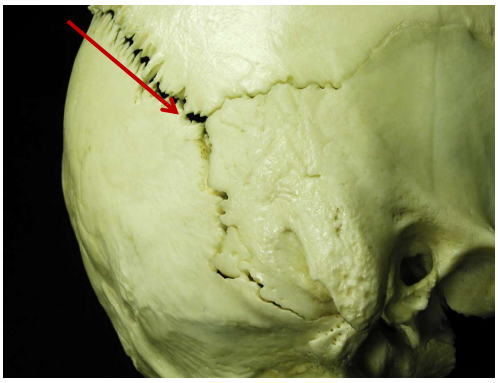
foramen magnum, we have the hypoglossal canal. Again in infants, hypoglossal groove in that condylar portion and so can easily be compressed.



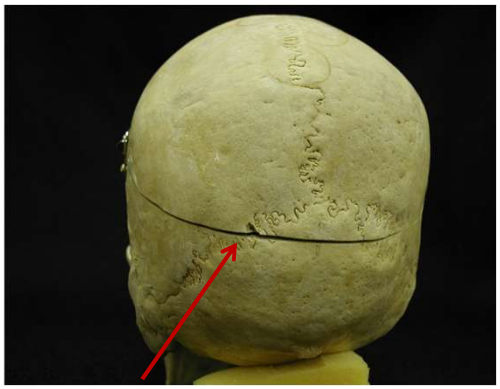
Looking at the occipital sphenoid articulation. So we talked about the greater wings being up here near pterion and the occiput posteriorly. And so that's sphenobasilar synchondrosis is happening kind of in the middle of the skull. And that's that major joint we talked about and we'll be referencing a lot as we teach you diagnosis of the cranium.

Occipital-Parietals Articulation

Asterion

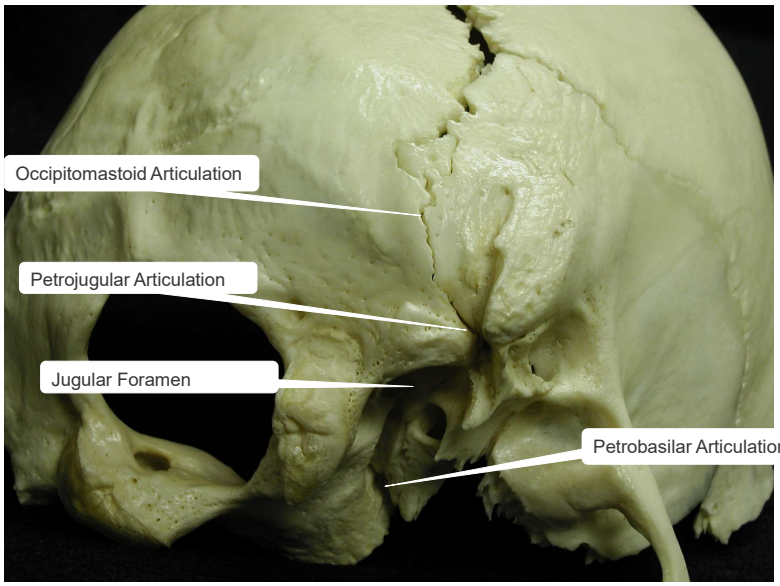


Lambdoidal Suture



OM suture
Mastoid
Temporal bone
Jugular process

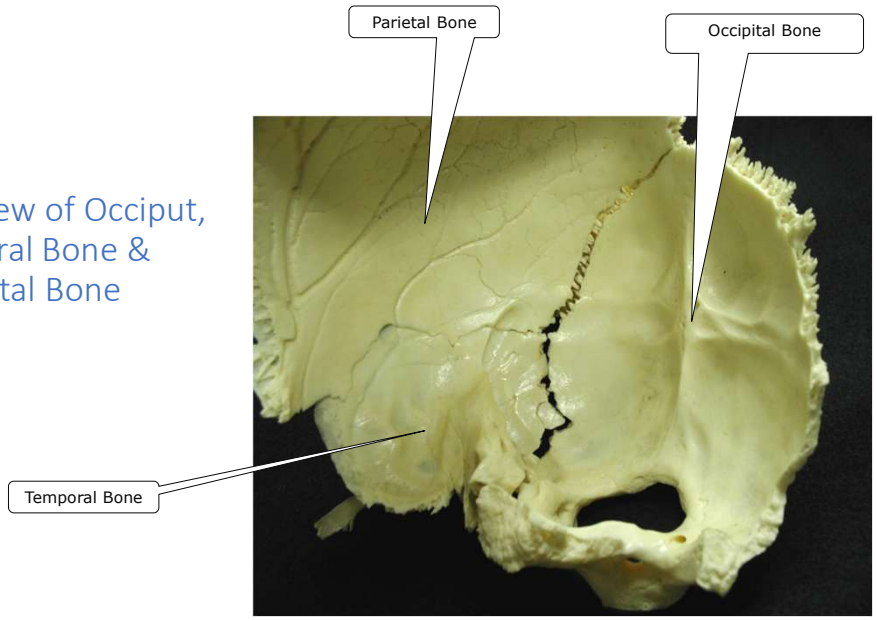
We've already talked about asterion, the union between accept, occipital, parietal and temporal, and then the lambdoid suture between the parietal and occipital.



Temporals driven by petrojugular articulation

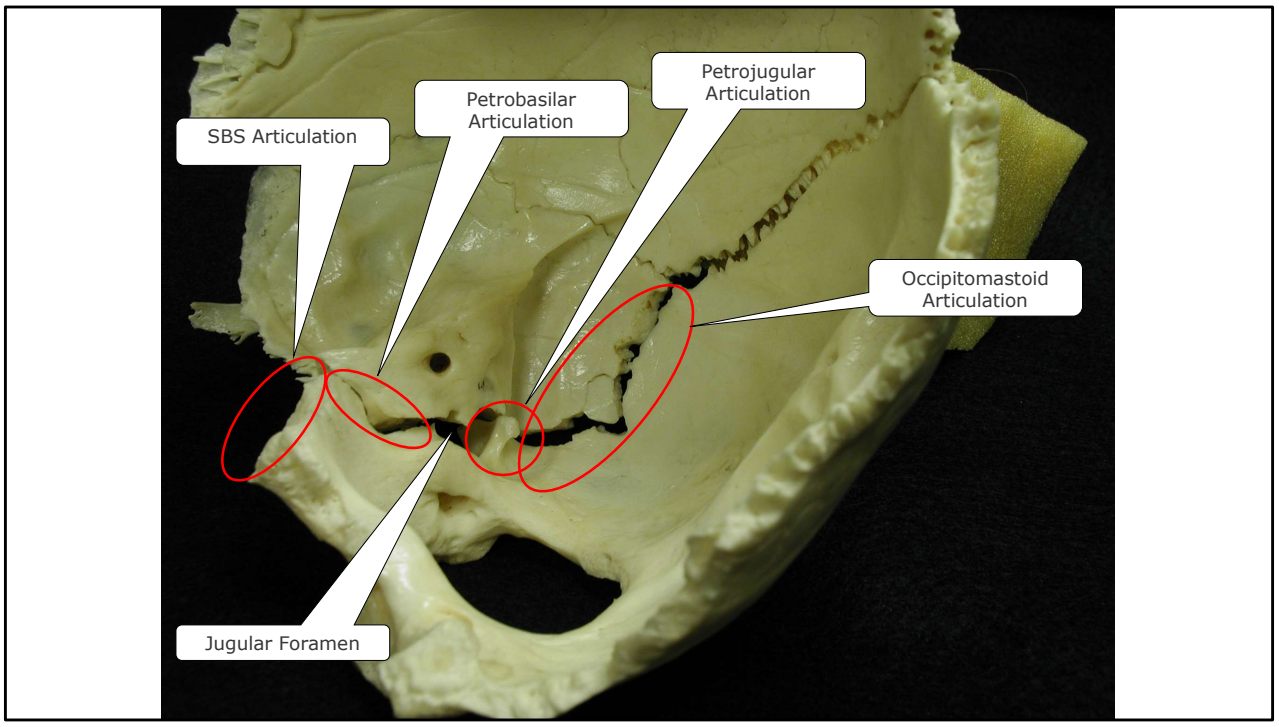
And then this is a more oblique posterior view. So this is the occipital mastoid articulation. Again, here's temporal bone with mastoid process, Here's occiput. You also have your petrojugular articulation. So between the petrous portion of the temporal bone and the jugular process of the occipital bone, and then that's forming the jugular foramen. So again, this jugular process is what actually drives these temporal bones during cranial motion. And then you have your petro- basilar articulation. So again, that's from the basilar portion of the occiput. Again to anterior foramen magnum, articulating with the petrous portion of the temporal bone.

Internal View of Occiput, Temporal Bone & Parietal Bone



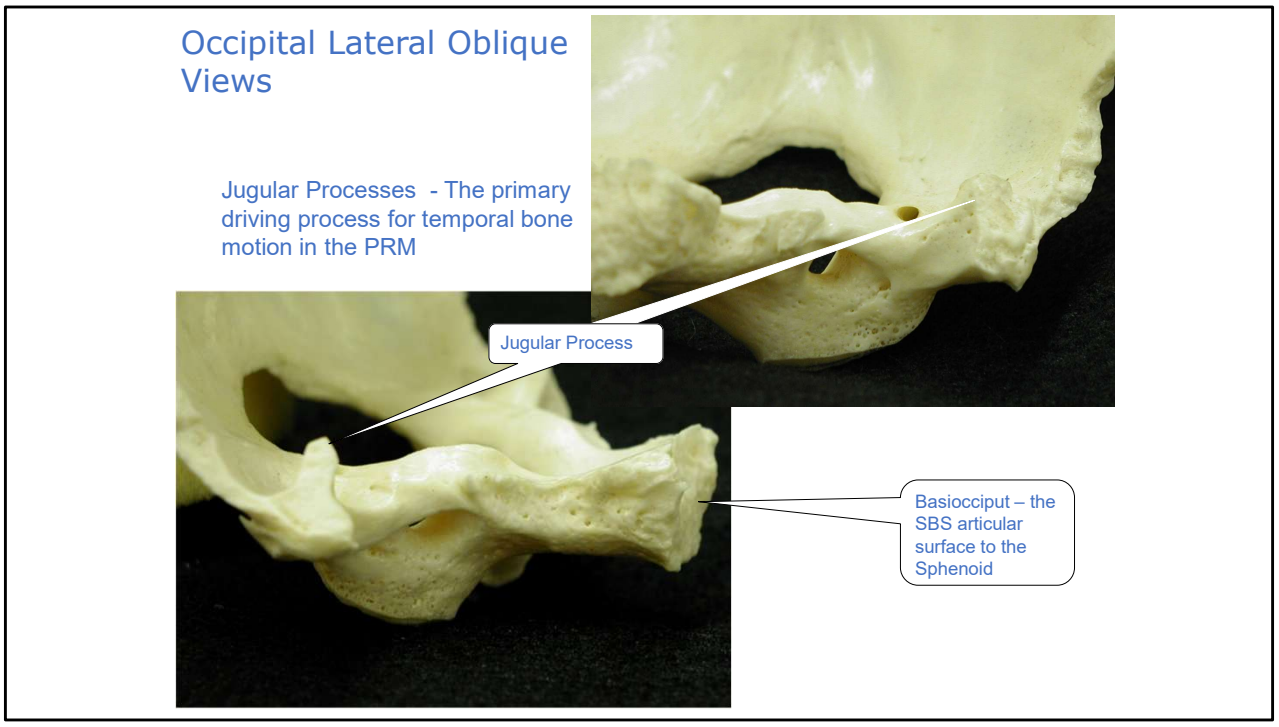
Looking from inside out
OM suture
Lambdoid suture
All this develops secondary to development of nervous system
Confluence of sinuses
Transverse sinuses
Sigmoid sinus – out through jugular foramen
Superior sagittal sinus
Occipital sinus

Here's an internal view of that. You've already seen this previously, but just now as you're getting more oriented, here's that view froma different angle. So we've got our parietal bone, temporal bone, occipital bone. And so this is looking laterally at the inside. This is the occipital mastoid suture. Of note. This is these little enclosed bones along sutures are known as Wormian bones. Just something for you to note, nothing you'll be tested on.



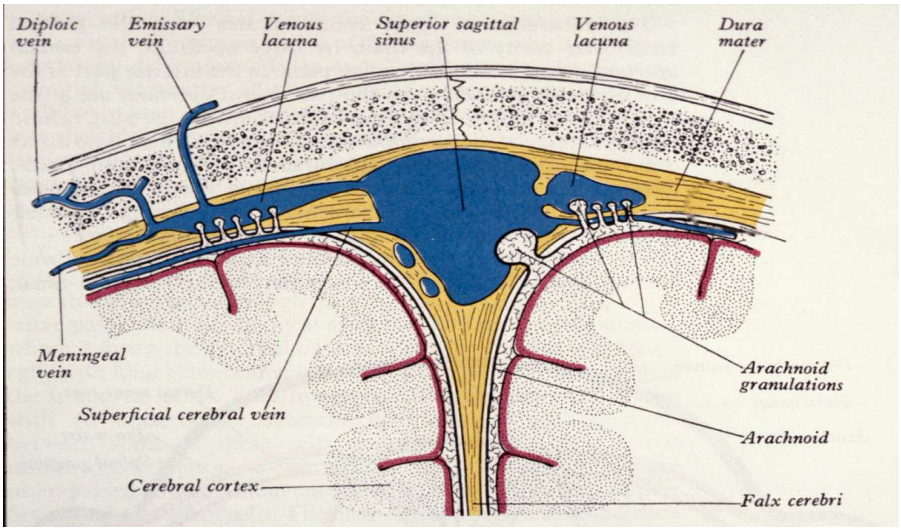
SBS – sphenoid absent here

This is the petro jugular articulations. But again, this is the jugular process of the occipital bone meeting with that petrous portion of the temporal bone. Here's your jugular foramen where cranial nerves 9, 10, and 11 coming out. This is your basilar portion of the occipital bone anterior to the foramen magnum, and this articular surface Anteriorly is where the SBS or sphenobasilar synchondrosis is happening with sphenoid. And then again, this is where the petrous portion of temporal bone is articulating with that basilar portion, which was known as the petrobasilar articulation.



This is a slightly different view of just the occiput from this kind of oblique view. So this was foramen magnum jugular process, which is again anterior to what's going to form that jugular foramen when when articulating with the temporal bone. And that jugular process is what drives the temporal bones with this cranial motion.

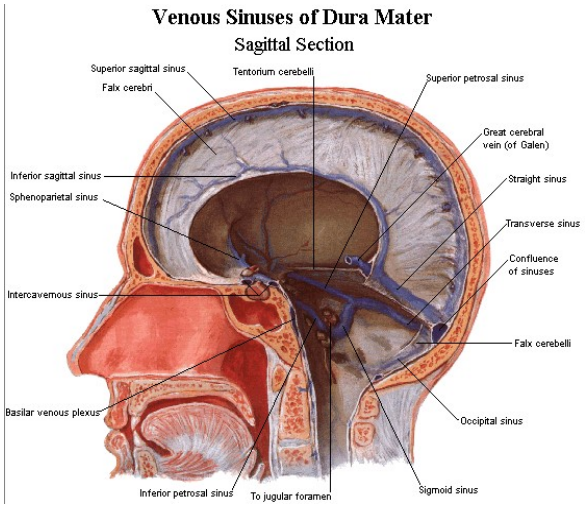
Superior Sagittal Sinus Schema



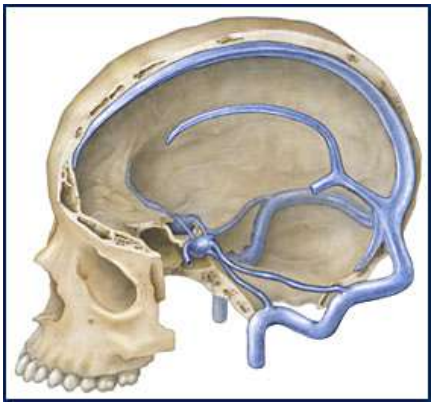
Periosteal layer of dura is continuous through the suture to the external periosteum and not shown in this picture

The last thing we'll cover in this lecture is the sinuses because we will be learning shortly the venous sinus drainage technique in lab so you want to keep in mind the anatomy that will be under your hand and where these are located in the skull relative to each other.
So just a reminder that you have these sinuses enclosed in dura. And so that's what you're influencing under your hands and then leading in to the parenchyma of the brain. So these are those close contacts and here's your bone.

Occipital Contributions to the Venous Sinuses

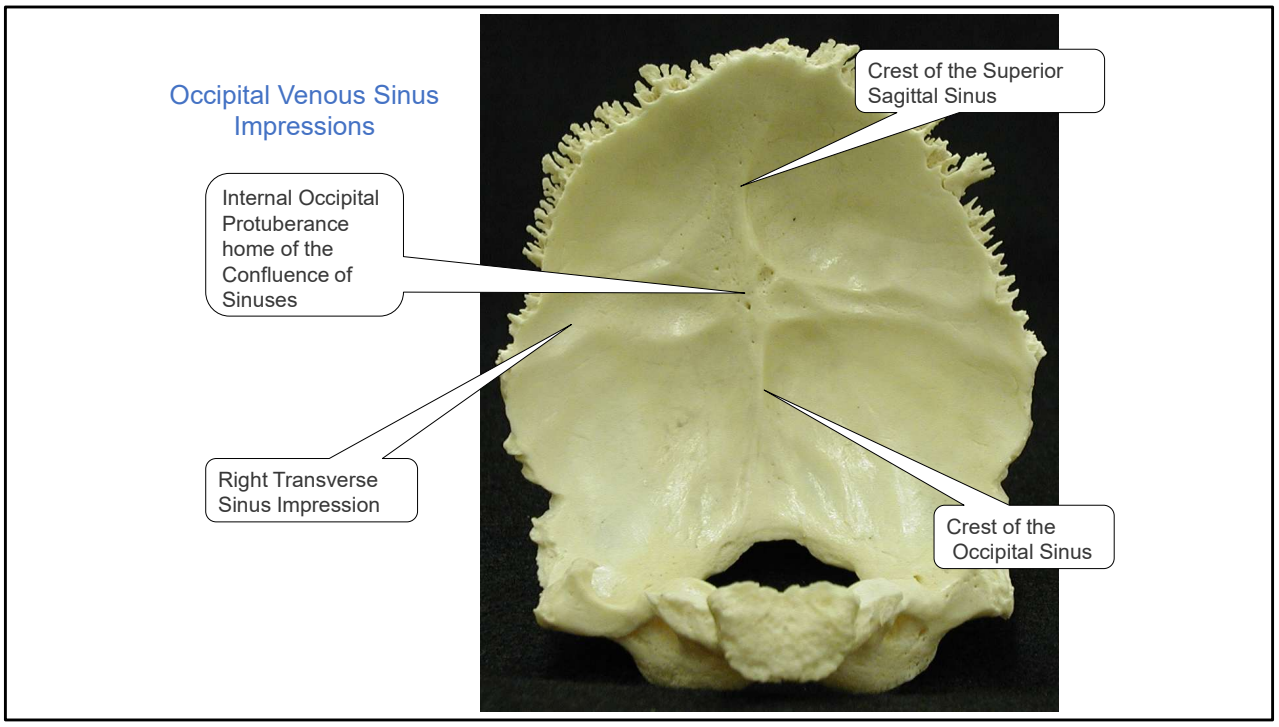


Confluence of Sinuses
Transverse Sinuses
Sigmoid Sinuses (portion)
Occipital Sinus
Superior Sagittal Sinus



Superior attaches near cristal galli
Straight sinus projects forward to great vein of Galen – towards vertex in real life
Inferior on falx cerebri
Greater petrosal sinus

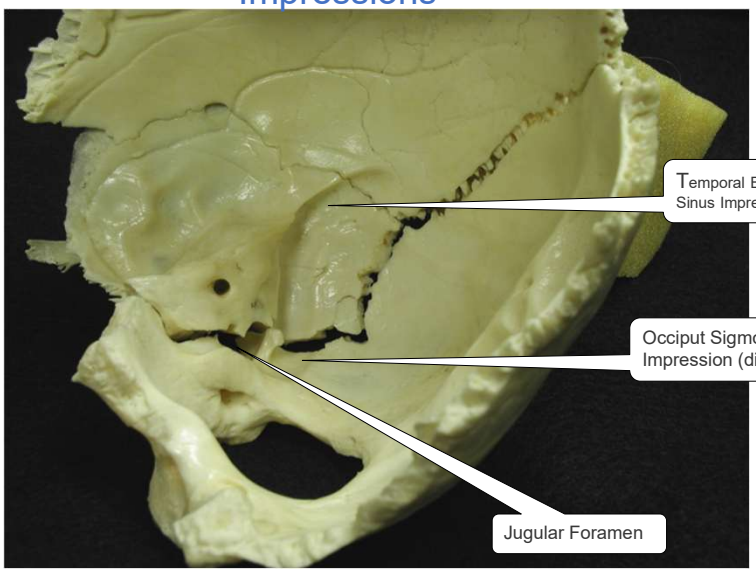
Again. Here's the superior sagittal sinus, just inferior to that superior sagittal suture. That will be palpating along when we treat this. Again, make sure you take some time to study these and familiarize yourself with these. But here's your superior sagittal sinus. Under that superior sagittal suture. And you have your straight sinus jetting anteriorly towards vertex. And then your inferior sagittal sinus here. This point right here where all of these sinuses converges, known as the confluence of sinuses. And that's on the, on the interior surface of the external occipital protuberance or inion that we talked about earlier. Extending out laterally on either side are your right and left transverse sinuses. And then extending inferiorly from that is your occipital sinus coming out laterally and around to the temporal bone because remember I talked about that imprint on the sigmoid sinus earlier. That's a sigmoid sinus that comes around and curves. And that's going to ultimately exit that jugular foramen.



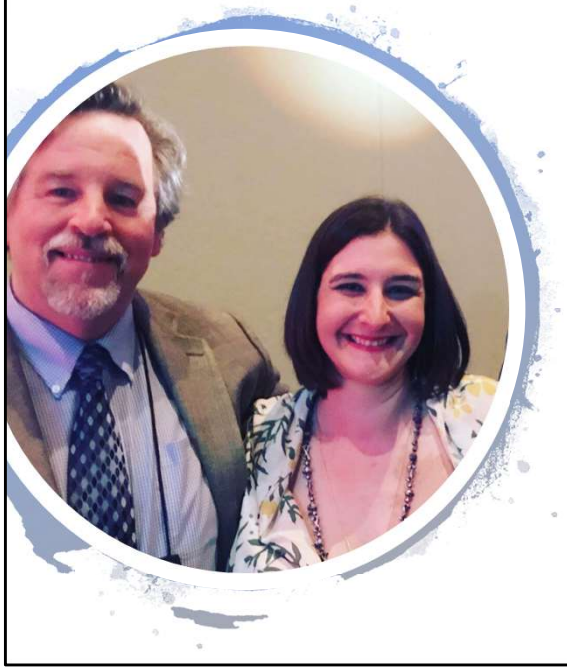
Impressions of sinuses

Looking at an occipital bone from an interior view, we can see the internal occipital protuberance, which are on the outside, is the external occipital protuberance. A confluence of sinuses is going to be, this is where we start our treatment for the venous sinus drainage externally on the external occipital protuberance. And then we move inferiorly to the occipital sinus. And then we can come out laterally and treat the transverse sinuses. So there's the right and the left. And then we'll treat straight sinus which you can't see an imprint of because it’s in dura not on bone. And then move ultimately up to this superior sagittal sinus along that superior sagittal suture.

Occipital Venous Sinus Impressions



So again, just a different angle. This is the temporal bone, the sigmoid sinus. You can see where it's gonna go exit that jugu;ar foramen. And, and then the occipital imprint of that sigmoid sinus as well.



Acknowledgments

- Special thanks to R. Mitchell Hiserote for assistance with slides and images

And that concludes this lecture on landmarks. Again, I know that was a lot of landmarks, but it's more meant to introduce you and hopefully be a good reference for you to go back and look. I want to give a special thank you to Dr. Hiserotefor especially all of these wonderful images of the real bone that we have featured here that shows such great imprints of all these sinuses. I look forward to our next lecture.