Neural Science for Engineers
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Lecture - 19
Brain Anatomty 3D - I

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So, when I wanted to describe anatomy, the conventional method of describing anatomy is in a cadaver in which you dissect a cadaver and show stuff; obviously, a course like this I do not have the luxury nor the infrastructure to do something like that. And then that gives rise to a problem. A fully text bookish description would not be fulfilling especially for an audience like this.

Now, if you remember the title of the set of classes I have described for anatomy start that I started as build brain. Now, the idea is that, show and tell is easy say for example, in the skull I showed a couple of structures and told what is associated with that.

It is basically saying that you know there is some entity and then there is a name to it, but what happens with that is a retention of that of the topic is not there. So, when I describe the skull, the major problem is with my inability to do something complex with something which is as complex as the skull petrous bone.

When it comes to the brain, I had a lot more options and it is with that set of options I am trying out this. So, when I talked about building a brain. So, using material to build various parts of the brain and thereby explain their relations with respect to each other and some aspect of the function. Because that would help in better attention is what I feel.

It is not a very conventional technique, but in some other places where I have used this same technique has been found to be useful. It's the first time I am trying something on clay, which is the material which I am using. So, please do pardon me if you find it not up to the mark, but I hope that the message gets conveyed rather than the material being reviewed, ok.

So, we will switch on to the other video. So, I will start with a structure which is morphologically very simple so, that would be the brain stem. The human brain stem is just about this much. So, you know my hand is here and this is just about the length at length of the brain stem, and I have already told the approximate subparts of the brain stem. So, you can divide the brainstem into three individual parts.

So, that is what I am trying to show over here. So, the bulge in the center is the pons ok. And there are multiple views in which you can see the brainstem. So, this is the front of the brainstem, and this is the back of the brainstem. So, to explain some of the gross structures I think I will use this model whereas, I will use a different model to explain the more intricate structure.

So, if we look at the pons, the pons is the most visible part of the brainstem. Visible in the sense its easily identified identifiable because it is fairly broad in relation to the other parts of the brainstem and it has got a bulge in the front when compared to the other parts, both the mid brain which is above and the medulla which is below.

So, this is top, this is superior, inferior, this is anterior posterior midline structure. So, this would be lateral medial and midline so, that is the nomenclature. So, when we look at the pons it is easy to identify because all of these are smooth surfaces. I would be able to show only parts of these structures on in surgical videos because there is a problem with surgical videos. Surgical videos are microscopic videos, and they are taken from an operative microscope.

So, if I were to show you a video of the pons, only so much of the pons would be visible. It would not even show larger areas of the pons. So, the understanding which you have should be based on this. So, there is a superior very sharp margin to the pons and there is also a similar inferior sharp margin to the pons.

It bulges more than the medulla and the midbrain above. So, that is how it looks like and in the center of it, unlike most other places you will have a very gradual sulcus. So, sulcuses, it is a slight depression. So, the depression is only slight, and you cannot make it really different from the surrounding pontine tissue.

So, that is how it looks like, and this is just about the size which should be for the normal brain stem. The medulla on the other hand is more slender. It is almost as slender as it would continue into the spinal cord. Again, remember this is inferior towards the leg, superior that is towards the eye. So, pons broader, medulla thinner. The medulla has several features in it. So, the important features are one is a midline fissure then you have two bulges.

So, one is called the pyramid, which is situated on either side of the midline and it is called as the pyramid because pyramidal decussation. So, pyramidal decussation is a set of fibers, which cross across from one direction to the other direction. So, pons medulla and you have the first bulge, which is the pyramid and the lateral bulge which is called as the olive.

So, upper part is like this and in the lower part you would have the same thing continuing, but without the pyramidal crossing over completes and you just have it continuing into the spinal cord. So far I think the concept is ready but my model does not look all that great; midline, pyramid, pyramid, olive, olive.

So, each of these places you will have nerves which come out and that is one of the reasons why you need to remember these landmarks and understand that. So, ninth and tenth and eleventh nerves come out from here. So, that is the medulla.

Now, if you look at what happens superiorly, the mid brain is the smallest part of the structure. So, small as in it is smaller than that of the pons so, it sort of is like this. Then apart from that it has a big V shape depression over here. So, I think I will go on to the larger model because it is difficult to show the features with smaller stuff.

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So, this is the pons, the medulla, fissure in the center this is the pyramid, the olivary bulges; olivary bulges lateral to the pyramid and that is about it. So, that would be the two bulges on the medulla and that is how it is. So, pons upper part, midbrain is the smallest structure I told you. You have a central place here which will split it into two parts, not completely of course, but these two things are called the cerebral peduncle.

So, we are in the midbrain so, midbrain, pons, medulla. Midbrain is like this. So, there are two structures here with the central. So, this is called inter peduncle. So, this is the peduncles, there is this steep opening over here, where it is almost a shelf. So, that is the shelf, that is the midbrain, that is the pons.

So, that sort of depicts what I needed to convey. So, brainstem is somewhat the easier part of the story. So, the external features of course, are definitely easy. You got pons, medulla and the midbrain. The midbrain the front part of it shows the cerebral peduncles, the pons is fairly featureless accepting for the central sulc depression over here a very subtle depression that is not very obvious.

Here when it comes to the medulla it is very prominent, but the bulges on either side are also very prominent. So, the first bulge is the pyramidal bulge, and the second bulge is the olivary bulge. So, olivary bulge is due to the olivary nucleus which is there. The pyramidal bulge actually is important to understand. Now, these are two, what are called

as long tracks. So, these are fibers, these are axons, which come all the way from the same motor cortex down up to the spinal cord and to individual nerves.

So, we will discuss those things in greater detail, but do remember that it is one single connection. So, this fiber goes all the way from here goes deep in the pons and then comes over here to go to the opposite side. So, the crossing over of this fiber is in the medulla and that is the basis of this swelling called as the pyramid, which is there within the medulla.

So, the right sided fibers go come up to the below the pons and then go to the left side, the left side fibers come all the way down up to the pyramid and go to the right side. So, that is where the actual crossing of, these are called long tracks and long track crossing happens within the brain stem. So, that is part 1 of the story. Part 2 of the story is what happens on the posterior surface.

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So, posterior surface is why I had to actually use a larger anatomical structure than this one because if I make it to scale it is not feasible to do that. So, what actually happens in the posterior surface? So, we will look at it like this. So, this is where the pons is, the half of the pons and the upper half of the medulla actually form something called as the ventricle.

So, the ventricle is basically a rhomboid structure. So, rhomboid structure which has got a depression in the center and that depression is important for several reasons. Now, , cranial nerve nuclei are; see this is actually exaggerated if you see my surgical videos you will find that this is not so prominent.

So, it is like this. So, there is a cavity called as a ventricle on the back. So, this is the first of the ventricles which you are dealing with. We need to make opening into the ventricle. Exaggerated of course, see please do remember that these are exaggerated larger structures.

So, the shape of this is described as rhomboid. Rhomboid in the sense, you have got an apex and apex over here and you have two boat shaped entities on either side. And the upper half of the medulla forms the, this is called floor of the lateral ventricle. So, this is the fourth ventricle.

We will go back into the other ventricles as we progress. So, all the ventricles are the places where CSF is generated a part of the CSF is also generated in the fourth ventricle, but we are still now in the floor of the fourth ventricle. So, let us see what all happens within the floor of the fourth ventricle. Floor of the fourth ventricle again as in the anterior case has got a depression. So, that is the midline.

Now, when we come over here, we have two entities. So, that is called the the forum fasciculus gracilis and cuneatus. Not of great importance for somebody who is not learning anatomy for the sake of anatomy, but you can remember that these two bulges are there. This is at the upper part of the upper part of the junction between the ventricle and the medulla, this lower half of the ventricle is also in the medulla, but it like this.

So, part of the ventricle extends on to the medulla. So, you got a midline sulcus then there is something called as striae. So, striae are features on the floor of the ventricle, which go from medial to lateral. You can see this in operative videos and it is exactly like what I am drawing. Now, here what happens is we have further sulci, which are on the surface of here, which are called triangles.

So, there are upper triangles and then there are lower triangles. So, lower triangles and upper triangles. So, these triangles contain cranial nerve nuclei and surgically it is relevant for that purpose. So, upper triangles contain the fifth nerve fibers and the six

nerve nuclei; lower the medial contains the tenth nerve that is the vagus and the hypoglossal which is lateral.

So, that is how the architecture of the fourth ventricle is. I have described so far, the floor of the fourth ventricle and how it is organized into different structures. Now, if we go higher up into the midbrain part of the story, midbrain remember anteriorly we had the cerebral peduncles, it is exaggerated.

So, there is some changes in proportion when I made it exaggerated. So, what happens upper part is you have got two structures which are important. So, they are called the colliculi and they look exactly like this. So, there is one colliculi on this side. So, one more colliculi on this side, the lower ones are inferior and upper ones are superior.

We will be discussing this in detail especially when speaking about the visual pathways and the auditory pathways. These are important for that purpose. So, there are a lot of features in the brainstem. So, what I am trying to highlight is the relevant structure, see this is the outer part of the brainstem; inner part of the brainstem contains fibers; fibers which are local to the brainstem and fibers, which are coming far away from the brainstem either ending into some structure in the brainstem or going somewhere else. So, coming back over here.

So, this is the cerebral peduncles, pons and the brain medulla. Now, function wise if you look at it there are cranial nerves, which come out from multiple places within the brainstem. So, we will start only with the fifth, six, seventh and eighth, ninth, tenth and eleventh and twelfth nerve. I have not bought threads to mark through that, but anyway I do remember that these nerves come out from there.

The third now incidentally comes out from in between the cerebral peduncle. So, you would have a cranial nerve coming from here, here there is a fifth nerve comes from both these sides sixth, seventh, eighth, ninth, tenth, eleventh and twelfth. So, that would be the order of nerve fibers which are coming out from there.

So, what are the functions of the brainstem? The medulla part is something which most of us would have heard that it is the seat of life. So, the heart center, the cardiac center, respiratory center, which is the cranial control of respiration all of which resides over here and dysfunction at this place is almost always causes death.

Tumors within this are very difficult to operate. So, are also neurological diseases, which affect the, which affect the medulla very difficult to treat. But the pons has multitudes of functions mostly it connects to something the cerebellum. So, the cerebellum is actually attached on the posterior side of the story.

So, we will try to make this cerebellum is not very easy to make. I will see if I can just make a representation of the cerebellum rather than the whole cerebellum. Or maybe, I think I should have undergone formal training in clay to do that, but it is my own anatomical knowledge of seeing these structures on table, which I am trying to replicate and that is not actually connected to skills, it is connected to knowledge.

So, the cerebellum consists of two hemispheres. So, two hemispheres; one hemisphere ready and let us see what happens to the other hemisphere. So, cerebellum is two hemispheres. So, two hemispheres, but it has specific anatomy and surfaces, I am actually trying to get the surfaces right. So, that is the problem. So, we have cerebellar hemisphere and cerebellar hemisphere. So, two cerebellar hemispheres and it looks like this the cerebellar hemispheres.

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There are three surfaces here. So, this is the surface which if you can recollect the discussion in the skull, I showed you impressions on the skull where these surfaces are visible on the skull bone. So, this part the superior part is in relation to the tentorium and

the anterior part. Anterior part is in relation to the petrus bone. So, there are two halves of the cerebellum.

So, once there are two halves something has to join in between. So, the joining structure is called as the vermis. So, vermis is the joining structure. So, the vermis connects both the halves of the cerebellum, it is actually curved. So, curved as in like this and it is curved inwards. So, you would have a curved inward structure, which connects one cerebellum with the other cerebellum and that is actually what forms the roof of the fourth ventricle. So, that is the anatomy.

So, two cerebellar hemispheres connected by the vermis. Vermis is actually deeper you can make that out very easily. So, it goes deep here, and it goes like this and the last part of it is called uvula. So, the uvula is exactly like the uvula in your throat, which you say aaahhh to an ENT doctor and show if somebody has had a tonsil. So, they would be familiar with that.

Now, attached to this is two smaller things these are called tonsils. If you have a uvula you have to have tonsil. So, this is tonsil here. So, that completes the brain stem. So, this is the architecture. Now there are lot of holes over here as you can see there is a hole sitting over here and then there is a hole sitting over here and even if we look at it laterally you know there is a connecting hole over here.

So, this is better seen. So, which is one of the reasons why I wanted to build the brainstem rather than show the brainstem. So, each of these openings have relevance now this opening is actually close. It is close with the membrane and it is called as the superior medullary velum.

So, it is just a membrane it is thin, and I think we can get away with this. That is close. So, that is close, but these are open. So, these foramina are responsible for the aggress of CSF from the ventricles to the outside. So, this is where the ventricles communicate with the CSF space that is the subarachnoid space. This is foramen of Magendie, and these are the foramen of Luschka.

So, one here and one here from the foramen of Luschka, foramen of Magendie over here, pons over here I think it is gone down a bit too much. So, pons is over here, pons is over

here, pons is over here, pons is over here, medulla, midbrain, cerebral peduncles. Now, how does the ventricle communicate with the other ventricles.

So, the other communication is over here. I made an opening here. So, that is the aqueduct of Sylvia. So, the aqueduct of Sylvia is an aqueduct,which is a tunnel. So, the tunnel connects the fourth ventricle, which is underneath the structures to the other ventricles, which we will discuss subsequently.

So, that constitutes the anatomical description of the brainstem. Exaggerated, cartoonish I agree, but serves the purpose because there is the posterior surface of the cerebellum, tentorial surface of the cerebellum, petrosal surface of the cerebellum. The brain stem as such has pons medulla and midbrain. Midbrain is the smallest, pons is the largest medulla is the smallest and the cerebellum has these openings over here.

So, the seventh eighth nerve comes out somewhere around here in relation to the foramen of Luschka where the choroid plexus comes out. Fifth nerve comes from somewhere here, lower cranial nerves from the sides of the medulla. So, that constitutes the anatomical description of the brainstem. Now, for the remaining, I started out with the brainstem because this is relatively easier to explain when compared to the next set of stuff, which I have to describe.

So, when we look above, I have spoken about deep gray and superficial gray. So, the next step of anatomical description is in describing the deep gray matter of the brain. So, we will start with something called as a thalamus. Now, thalamus is sort of an egg-shaped nucleus and thalamus is one of the most important areas of the brain.

So, it would form something like that. Thalamus is basically called it is a relay station ok. So, relay station has an important train station junction, it is the important signaling station for anything within the head. So, signals have to most of the signals have to pass through the thalamus and a breakdown in thalamus literally causes a systemic breakdown. So, systemic breakdown is loss of consciousness. So, that is the relevance and the importance of the thalamus.

So, we will have to make the thalamus a bit bigger because of the other structures have to be explained, I am going to explain in relation to the thalamus. So, I told you egg shaped, but it is not symmetrical as an egg, it is anterior pointed part and the posterior

flattened part. This is the posterior flattened part is called pulvana pulvinar and it is closely related to the colliculi which is just down.

So, where are the colliculi, colliculi are there. So, the thalamus would come sit over here. So, one thalamus on each side. So, egg shape, egg shape, egg shape, egg shape, egg shape. You will see the other side of the thalamus is, it is better to make both because the next set of descriptions are based on the thalamus. So, I would want you to understand the structures on in this basis because if you try reading it and trying to figure out what goes where and how you would get lost.

So, this is a methodology I feel would be easier to understand and not only understand, but you know you can relate to this stuff even when you are doing something else. So, it is important also to interpret imaging. So, I do plan a session on interpreting imaging where I will showcase all of these structures in the brain, and you need to remember what is in association with what.

So, there are two thalami. So, there are there is one thalamus on either side and both sides are communicated through something called as the inter thalamic adhesion. So, there we are so, two thalami connected to each other looks symmetrical and now you see that there is a space, which is coming out between the two thalami. So, that would actually form the next part of the part of the story.