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Approach to Abnormalities in Head Shape and Size Part 1: Head Circumference and Head Growth

Developed by Lindsey Logan and Claire McNiven with Dr. Melanie Lewis, Dr. Lauren Redgate, and Dr. Peter Gill for PedsCases.com.
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Introduction:

Claire: Hello, my name is Claire McNiven and I'm a Pediatrics Resident at the University of Alberta.

Lindsey: Hi, My name is Lindsey Logan! I am a Pediatric Neurology resident at the University of Toronto.

Claire: This podcast was developed with Dr. Melanie Lewis, a general pediatrician and Associate Dean at the University of Alberta, Dr. Lauren Redgate, a general pediatrician from the University of Calgary.

Lindsey: As well as Dr. Peter Gill, a general pediatrician at the University of Toronto.

Claire: Our aim for this podcast series was to give an approach to abnormalities in head size and shape.

Lindsey: In pediatrics, we see lots of kids with big heads, small heads, and heads with different shapes.

Claire: Up until kids are about 3 years old, we routinely track children's head circumference at every visit.

Lindsey: Yes! And it can be tricky to know how to properly approach this problem, or when and which other specialties or disciplines to ask for help!
But that being said, having a solid approach to head abnormalities is important: An abnormality may be the first sign of an underlying problem, especially in the brain.

Claire: Hopefully this podcast will help you become more confident in your knowledge. It definitely helped us as we worked on developing it.

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As we have a lot to talk about, we have split this topic into 4 podcasts:

The first podcast will address part 1, with the following objectives:

- 1) Describe how to measure head circumference,
- 2) Determine the parameters of normal vs. abnormal measurements.
- 3) Review skull structure and how it changes during head growth.

Part 2 focuses on abnormal head shape, including important items on history and physical exam.

Parts 3 and 4 cover approaches to head size:

- Part 3 discusses an approach to children with large heads, or macrocephaly, including important items on history and physical exam.
- Part 4 examines the opposite, small heads, or microcephaly, including important items on history and physical exam.

Objective 1&2: Head circumference measurement and normal/abnormal parameters

Lindsey: So, Claire, what do we mean when we say “head circumference”?

Claire: Head circumference, sometimes called occipitofrontal circumference, is defined as the greatest occipito-frontal circumference. When measuring head circumference, the measuring tape should go around the head 1-2cm above the glabella (which is the smooth part of the forehead between the eyebrows) and around the most prominent part of the occiput posteriorly. Basically, you’re trying to measure the biggest part of their head.

Lindsey: Yes! I have seen that. Sometimes it can be very tricky to get kids to sit still and allow us to get that measuring tape around their heads.

Claire: It certainly can be, especially with the toddlers! Helpful tricks sometimes include showing the child where the measuring tape goes on your own head- or their parent’s!- before placing it on theirs, or performing the measurement with the child in the parents’ lap.

Lindsey: I have also heard people say that they will measure a child’s head for a crown or a hat. That seems to work sometimes! And when do we usually measure head circumference?

Claire: Head circumference is measured at every periodic health visit until the age of 3 years, and plotted by age on a population-based curve. However, it is important to use corrected gestational age until the patient is 2 years old.

At birth, the average head circumference is 35cm. In the first year of life, head circumference increases an average of approximately 1cm/month, but the most rapid growth occurs in the first 6 months, when head circumference increases approximately 2cm in the first month and 6cm in the first 4 months.

Lindsey: A helpful “trick” I learned from a neurosurgeon for remembering head circumference trends is the rule of 3s and 9s, with increases of 5cm at each interval: at birth, mean head circumference is roughly 35cm, at 3 months, approximately 40cm, 9 months, 45cm, at 3 years, 50 cm, and at 9 years 55cm. This isn’t perfectly accurate, of course, but it does give ballpark numbers to keep in your head when seeing children (pun intended).

Claire: That is a helpful trick for sure! And as we mentioned earlier, just remember that corrected gestational age should be used for the first 2 years of life if a child was born premature. There are also growth charts available for specific medical conditions that are associated with different growth patterns (such as Down syndrome).

Lindsey: Ok! So now that we know how to measure head circumference and how to plot it, how do we know when it is normal or not?

Claire: An abnormal head circumference is defined as more than 2 standard deviations away from the mean head circumference in either direction for the corresponding age and sex of the patient.

Lindsey: Oh, interesting. I guess this means that 5% of individuals in the “normal” population can have abnormal head circumference!

Claire: That is very important to keep in mind. Also, a single time-point is often not enough to make a decision of whether a head circumference is normal or not. Measurement of a child’s head circumference must be repeated as they grow. Like all growth measurements, it is important to have serial measurements of head circumference. A growth velocity, or rate of growth, that is too high or too low is also considered abnormal. It is hard to make a diagnosis from a single measurement, which doesn’t tell you about the rate of growth or trend for the patient. It is also important to consider the parents’ head circumference, as a large head may simply relate to familial macrocephaly.

Lindsey: Awesome, now we know how to measure head circumference!
To recap: we always try to measure the biggest part of the head, and we do this routinely at every health visit until the age of 3. If a child is born prematurely, we use their corrected gestational age up to 2 years of age. Abnormal head circumference is

defined as more than 2 standard deviations away from the mean, and often it is helpful to visualize trends over time by collecting more than one measurement.

Objective 3: Head growth

Lindsey: Think about the jobs of our heads! Our heads are a protective case for our brains, which allow us to be who we are. Our brains dictate our personalities, our movements, and allow us to interact with and experience the environment. Our brain is an important organ, if I do say so myself!

Claire: When we are young, our brains are growing rapidly. In fact, they reach about 80% of adult size when we are only 2 years old! In order to accommodate our growing brains, the skull must expand and grow quickly as well.

Lindsey: Exactly! In order for this all to work, the skull isn't completely closed when we are born. Instead, there are spaces between the bones, held together by fibrous plates called sutures. Where more than 2 bones meet, these sutures are even larger, making "holes" or "soft spots".

Claire: Also known as the anterior and posterior fontanelles.

Lindsey: Precisely. As the brain grows, the pressure from inside the skull evenly pushes on the sutures and bones, allowing for our head to remain symmetrically shaped. If any of the sutures close, or "fuse" too early (before the brain is finished growing), this can result in an abnormal head shape!

Claire: Yes, and another important evolutionary reason why we need these bones to be disconnected is the birthing process. A baby's sutures allow the bones to move during the birthing process so the head can fit into the birth canal and the baby can get out!

Lindsey: That is so true. If the baby's head does not fit that can be recognized as another obstetrical problem called cephalopelvic disproportion. Thank goodness for our obstetric colleagues in these cases!

Claire: OK- Lets review the bones of the skull.

Everyone has 2 frontal bones, 2 parietal bones, and 1 occipital bone. As we mentioned, where these bones connect, there are a number of sutures:

Lindsey: The metopic suture is in the middle of the forehead and joins the two frontal bones, running all the way down between your eyebrows. Along the sides of the head, extending from ear to ear, the frontal bones are connected to the parietal bones in the coronal plane by none other than the coronal sutures! This is

easy to visualize by imagining a headband or crown on top of where the sutures are located.

Claire: In the midline but on top of the head, connecting the two parietal bones in a forward and backward direction is the sagittal suture.

Lindsey: Also cleverly named because it is in the mid-sagittal plane of the head.

Claire: Lastly, the lambdoid suture surrounds the occipital bone, connecting it to the parietal bones on both sides. It's called the lambdoid suture because it is shaped like the Greek symbol lambda, the one that looks like an upside-down Y.

Lindsey: And what is the name for the meeting place of these sutures?

Claire: The fontanelles!

Lindsey: You know it. The Anterior fontanelle is on the top of the head in between both ears. It is a diamond-shaped junction where the 4 sutures between the two frontal and two parietal bones meet. Can you name those 4 sutures?

Claire: Metopic, Sagittal, and then both coronal sutures?

Lindsey: Yup! The anterior fontanelle is fairly large and provides a window into the underlying tissues of the brain and meninges. When you put your hand over it, you can feel the underlying pulsations of the arteries. One of the things I got in the habit of doing when examining babies was feeling their fontanelle - that way you have a good baseline from which to tell when it is abnormal.

Claire: Usually it feels soft and flat, with a slight inward curve when you run your hands over it.

Lindsey: The fontanelle also changes depending on if a baby is laying down, sitting up, or if they are coughing or straining. Feeling the anterior fontanelle helps determine a number of things. What does it mean to you if I told you I saw a child and their fontanelle was "sunken"?

Claire: If it is sunken, to the point where there is a noticeable and palpable inward curve with less obvious pulsations, this often signifies dehydration.

Lindsey: Exactly! And, if the fontanelle is bulging, it is often a signal of increased intracranial pressure in the brain and meninges.

Claire: Some of you listeners have probably examined some one year olds and noticed that they also still have soft spots. So, let's review: how long can the anterior fontanelle be felt?

Lindsey: The anterior fontanelle is the larger of both fontanelles, and it usually closes by 12-24 months of age. So you may even be able to palpate a "soft spot" in a child that is nearly 2 years old!

Claire: The anterior fontanelle can also close much earlier, as early as 3 months, and still be within normal limits. Early closure can also be a sign of craniosynostosis (which we'll talk more about later) or abnormal brain development. It is important to ensure the baby is otherwise healthy, has a normal head shape, and normal head circumference growth before ruling early closure as benign.

Lindsey: Interestingly, there is also wide variation in size of the anterior fontanelle! It is usually measured by taking the sideways and the front-back diameter, adding them together, and dividing by two. The overall size varies from 0.6-3.6 cm at birth (and has been reported to be even larger for black infants, up to 4.7cm). If the fontanelle is abnormally large or if there is a delayed closure (no closure by 24 months), there are a number of potential differentials to keep in mind, including: achondroplasia, hypothyroidism, Down syndrome, rickets and increased intracranial pressure, among others.

Claire: The second fontanelle - the Posterior fontanelle - is usually much smaller than the anterior fontanelle. It is triangular-shaped because it only joins three bones, the two parietal bones and the occipital bone. It closes in the first few months of life.

The sutures on the baby's head are kept open by the pressure applied by the growing head. If the head is too enlarged or grows too quickly, it can even cause the sutures to "splay" open.

Lindsey: That makes sense! Another thing I have heard parents ask is whether they need to take any precautions with the fontanelles. The answer is - nope! They are just a regular part of a baby's head - obviously, we want to avoid trauma directly to the fontanelle, but there is no harm in feeling it or having it exposed.

Claire: Exactly. And that concludes part 1 of our podcast, discussing the measurement of head size, the bones of the head, and how kids heads grow.

Let's quickly review what we discussed!

Review

- Head circumference is defined as the greatest occipito-frontal circumference and is routinely tracked until a patient is about 3 years old.
- For children born prematurely, we use corrected age until 2 years old.
- Remember to use specific charts if a child has a known syndrome, such as Down syndrome (trisomy 21) or achondroplasia.
- An abnormal head circumference is anything outside of 2-standard deviations away from the mean - or the 95% normal range. It is helpful to track over time with multiple measurements.
- To fit through the birth canal and to allow for rapid head growth, children's skull bones have gaps (sutures) and holes (fontanelles).
- The anterior fontanelle usually closes between 12-24 months of age, but it can close earlier, too! The anterior fontanelle can also be quite variable in size. It is helpful to use as a marker of hydration status, or raised intracranial pressure.
- The differential diagnosis for an enlarged anterior fontanelle includes conditions of bone growth such as rickets, genetic conditions like down syndrome, and also conditions that prevent the closure, such as anything causing raised intracranial pressure.

Thanks for listening! Stay tuned for parts 2, 3, and 4 on approaches to abnormal head shape and size!

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