Age-related CT appearance of sphenoid sinus in infants and children.

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Purpose

To demonstrate the pneumatisation process of the sphenoid bone in children of all age and establish anatomical age-related standards of reference for evaluation of sphenoid sinus disease.
Methods and Materials

Development of the sphenoid sinus was retrospectively reviewed in regard with the ossification process of the sphenoid bone. Age-related patterns of pneumatisation were identified. In this study 104 patients were included aged from 6 days to 15 years that underwent cranial CT examination in our department during the last 2 years (2008-2010).
Results

The postnatal development of the sphenoid bone is a complex dual process that involves:

- the forming of a single sphenoid bone through the rapid fusion of 5 separate ossification centers and 12 synchondroses that are present in the newborn. [1][2][3][4]
- the pneumatisation of the sphenoid bone.

Non-pneumatised sphenoid sinus.

At birth the sphenoid bone is devoid of air. [1]

In our study 8 newborns or infants aged from 6 days to 6 months had completely solid sphenoid bones. The mean age of infants without pneumatisation was 2 months. (Fig.1) on page 6 (Fig.2) on page 6

Conchal or fetal pneumatisation.

The first step in pneumatisation is the development of the sphenoidal conchae from the paired ossicles of Bertin that fuse to the rostrum at the anterior end of the presphenoid bone, at the site of the homonymous synchondrosis. During or after this process, nasal mucosa invaginates into sphenoidal conchae bilaterally and they progressively become aerated. This is the most rudimentary pattern of sphenoidal pneumatisation called conchal or fetal and is confined in the rostrum. [1][3][5][6][7]

In our study beginning of aeration was identified as a single aerated sphenoidal concha in a 2-month-old male infant (Fig.2) on page 6. The youngest infant with bilateral complete aerated sphenoidal conchae was a 7-month-old female (Fig.3) on page 7. Conchal pattern of aeration was identified in 43 children with ages ranging from 7-months to 8 years and mean age 2,5 years. (Fig.4) on page 8

Presellar or juvenile pneumatisation.

Pneumatisation continues in the presphenoid bone in a posterior direction extending as far as the intersphenoidal synchondrosis (anterior sella turcica wall). This pattern is called presellar or juvenile. The bone formed at the line of fusion of two bony centers, in this case the presphenoid and postsphenoid centers, is believed to be denser and more resistant than the tissue on either side of that line. This fact would account for the restriction of the sinus to the pre-sphenoid during childhood. [1][3][4][5][6][8]
In our study the presellar pattern was observed in 21 children aged 3-9 years, with mean age 5.4 years. The craniopharyngeal canal remnant served as an indicator for the position of the intersphenoidal synchondrosis, in order to establish the pattern. (Fig.5) on page 8

**Sellar or adult pneumatisation.**

Sphenoid sinus continues to expand posteriorly in the postsphenoid bone. It lies under the sellar floor and is considered to have taken the adult, mature configuration. Thus this pattern is called sellar or adult. As with the presellar pattern and the barrier of the intersphenoidal synchondrosis, the sellar pattern extends to but not beyond the spheno-occipital synchondrosis. [1][3][5][6][9][10]

The sellar or adult pattern was found in our study in 32 children aged 6-15 years, with mean age 10.5 years. All children #10 years showed adult pattern of pneumatisation. (Fig.6) on page 9

Aeration beyond the postsphenoid bone was observed in 13 children aged 6-15 years old. The sphenoid sinus extended to the lateral recess (greater sphenoid wing) in all children and additionally to the pterygoid process in 3 children and to the anterior and posterior clinoid processes in 1 child. Extension of the sinus to the basioccipital bone has been known but could not be as evaluated due to the age range of our study group and the time of closure of the spheno-occipital synchondrosis. Our study was restricted to the pediatric population and the spheno-occipital synchondrosis showed complete closure the earliest at the age of 12 and the latest at the age of 15. (Fig.7) on page 10

**Pathology**

The most common pathology that was observed incidentally was sinusitis, which was observed independently of the pattern of pneumatisation. The younger patient with opacified sinus was 3-years-old and had conchal sphenoid sinus.
**Fig. 0:** Non-pneumatised sphenoid sinus in a newborn a) male 6-days-old, b) female 11-days-old. Ossicles of Bertin (arrows) are clearly depicted in the anterior part of the presphenoid bone. Pneumatisation begins at this location with the fusion of the ossicles of Bertin to the rostrum at the homonymous synchondrosis and the development of paired sphenoidal conchae, which become aerated.

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**Fig. 0:** Axial CT images of five infants less than 1-year-old with non-pneumatised sphenoid sinus (images a,c) and beginning of aeration with the development of single aerated sphenoid concha (images b,d,e). In image c, sphenoidal conchae have developed but are not yet aerated. The children are two 2-month-old boys (a,b), a 3-month-old girl (c) and two 6-month-old boys (d,e).

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**Fig. 0:** Three female infants with conchal pattern of pneumatisation aged a) 7 months, b) 8 months and c) 9 months. The fused synchondroses of the ossicles of Bertin with the presphenoidal rostrum is shown (yellow arrows: ossicle of Bertin, asterisk:rostrum).
The white arrows depict paired aerated sphenoidal conchae in various degrees of development and expansion in the rostrum.

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**Fig. 0:** Axial CT images of children with conchal pattern of sphenoid sinus pneumatization. The rostrum (asterisk) has been demineralised in various degrees depending on the expansion of the sinus. Ossicle of Bertin (arrow). Sinusitis of ethmoid cells and sphenoidal conchal sinus (image d). Children shown above are 1 (a), 2 (b), 3(c), 5(d) and 8(e) years of age.

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**Fig. 0:** Images of children with presellar sphenoid sinus in various degrees of expansion. The sphenoid sinus "invades" the presphenoid bone but remains restricted by the intersphenoidal synchondrosis at this time of development. The site of the synchondrosis is identified by its hyperdense vestige (white arrow in image f) or the location of the craniopharyngeal canal (white arrows in images a,d,e). Ages of children are: 3(a), 5(b),5(c), 6(d), 7(e) and 9(f) years.

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Fig. 0: Children with sellar pattern of aeration of sphenoid sinus. The sphenoid sinus extends into the postsphenoid bone, expands more and becomes the floor of the sella. It does not expand beyond the spheno-occipital synchondrosis (still open synchondroses shown in images a,b,d: arrows). Image: a (6-year-old male), b (10-year-old male), c (12-year-old male), d (14-year-old female) and e (15-year-old female).

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Fig. 0: Images of children with adult sinus configuration and expansion to other sphenoidal bones: to the greater wings (lateral recess of the sphenoid sinus in images a1, b1,c2 - asterisks), the pterygoid process (pterygoid recess in images a2, c1 - asterisks) or the anterior and posterior clinoids (image c4 -asterisks). Ages of children: 10-year-old male(images a1-a2), 11-year-old male(images b1-b2), 14-year-old male(images c1-c4).

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Conclusion

Our results (Fig.1) on page 13 are consistent with previous studies that also show that aeration of the sphenoid bone begins at the anterior border of the sphenoidal body as a doublet as early as 6 months of age, continues posteriorly and reaches maturity at the age of 10. This means that children older than 10 years of age should have a mature sphenoid sinus, otherwise an occult pathology should be considered, usually chronic anemia with bone marrow conversion or hypoplasia due to trauma, infection or irradiation. [9][11][12][13]

The rudimentary conchal pattern was the prevailing pattern until the age of 5 years and children >5 years had easily identified juvenile pattern of aeration.

Sinusitis was found even in children with premature sphenoid sinus confirming the fact that pediatric sinusitis, once thought uncommon, is independent of the size of the sinus.

Sphenoid sinus development is linked with the development of the sphenoid bone and skull base. The results of our study can be useful to the radiologist as a reference for normal age-related development of the sphenoid sinus, so as to accurately manage the challenging problems of pediatric sinus disease and skull base pathology.
Images for this section:

**Fig. 0**: Diagram of our results in which the age-related development and progressive expansion of the sphenoid sinus can be appreciated.

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References

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