

APPENDIX B: OVERVIEW OF HUMAN SKULL

This appendix contains a brief review of the development of the fetal skull. The goal is to provide a qualitative understanding of the location and ossification process of the principle features of the developing skull.

Anatomical Features of the Skull

The skull consists of many different bones, each engineered to provide support and allow for growth of the developing baby both before and after birth. These bones can be roughly divided into two major subdivisions which are the neurocranium and the viscerocranium [Carlson, 1994]. The neurocranium consists of the bones that surround and protect the brain and brain stem, whereas the viscerocranium surrounds the oral cavity, pharynx, and upper respiratory passages [Carlson, 1994]. Hence, for the purpose of heat related bioeffects on the developing fetal brain, only the neurocranium is of importance.

The major bones of the neurocranium are the frontal bone, the parietal bones, the occipital bone, the sphenoid bones, and parts of the temporal bones [Carlson, 1994]. The frontal bone extends approximately from the eye sockets to the top of the head and spans from one temple to the other as shown in Figure B.1. At birth, the frontal bone is divided into two halves separated by a suture [Gray, 1974] and has a typical thickness at the ossification centers of 396 μm [Ohtsuki, 1977]. A suture is a gap between the skull bones that allows the brain cavity to continue to grow, which will later fill in after growth has completed. In Figure B.1, additional sutures are shown as lines separating the bones. Behind the frontal bone are the two parietal bones which extend over most the top and sides of the skull [Gray, 1974]. At birth, a typical thickness for a parietal bone at the ossification center is 543 μm [Ohtsuki, 1977]. After the parietal bones, there is the occipital bone at the base of the skull that covers the transition from the cerebrum to the cerebellum protecting the brain stem [Gray, 1974]. At birth, the occipital bone consists of four separate parts that are later joined [Gray, 1974] and has a typical thickness at the ossification center of 1654 μm [Ohtsuki, 1977]. On either side of the head, there are the sphenoid bones and the temporal bones adjacent to the parietal bones, frontal bone, and the

viscerocranium as shown in Figure B.1. At birth, the temporal bone has a typical thickness of 328 μm at its midpoint [*Ohtsuki, 1977*].

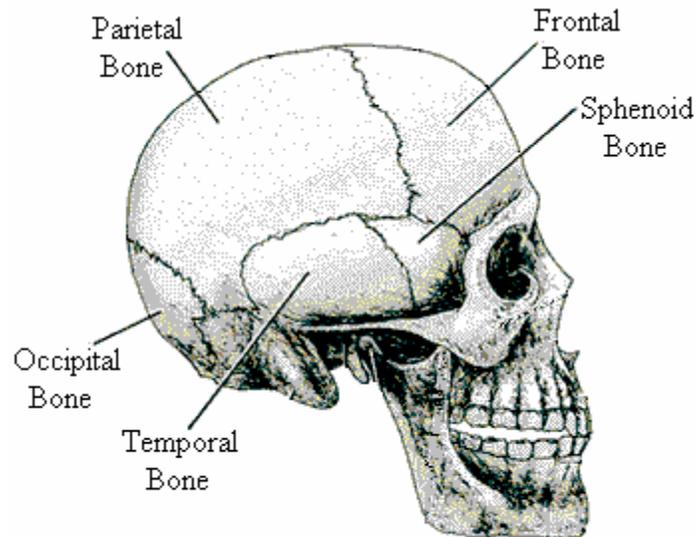


Figure B.1: Diagram showing position of important skull bones. [Modified from *MEDLINEplus Merriam-Webster Medical Dictionary*, National Library of Medicine, 2003]

Ossification of the Skull

In addition to the anatomical subdivision of the skull bones in terms of neurocranium and viscerocranium, the bones can also be classified in terms of how the ossification is accomplished. In one case, the “bones” begin as cartilage which is gradually replaced by bone [*Carlson, 1994*]. This is the same process by which bones in the limbs are formed. In the skull, most of the occipital bone, the sphenoid bones, and parts of the temporal bones are ossified by this process [*Carlson, 1994*].

The second method of ossification involves the direct formation of bone without the cartilage intermediate step [*Carlson, 1994*]. In the skull, the parietal bones, frontal bone, a small part of the occipital bones, and the rest of the temporal bones are ossified by this process [*Carlson, 1994*]. For this method, the ossification begins near the center of the bone and proceeds along branching tubules until the bone plate has filled in [*Nishimura et al., 1977*].