Health Care Industry

0 Comments

When is a fissure not a fissure?

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Dear Editor:

I enjoyed reading the anatomical review by Anagnostopoulou, et al. in the April '08 issue of CRANIO. However, I believe it would be prudent to also review the developmental and functional significance of these fissures.

First, the term fissure might be a misnomer. A fissure (such as a crack, split, crevice, gap, fracture or cleft) presumes that a unified entity is in the act of partial decomposition. The term fissure derives from an age when neither molecular biology nor 3-D ultrastructural techniques were available. Using descriptive terminology the early anatomists described what they saw, and so the term fissure was adopted. Anagnostopoulou, et al. take this process a small step further by trying to quantify their observations. One of the disadvantages of their approach is using simple 2-D linear measurements of a nonlinear, 3-D entity. Despite this deficiency, some useful information is gained. Nevertheless, similar to early investigations on craniofacial sutures, pertinent information might be inadvertently lost through reductionism. Therefore, I believe a brief discussion of the developmental anatomy of these bony fissures is required.

Human skeletal tissue is unique as the same tissue (bone) can be formed through two very different developmental mechanisms. On the one hand, endochondral ossification permits a cartilaginous anlage (precursor) to convert into bone. On the other hand, intramembranous ossification permits the biosynthesis of new bone without any cartilaginous deposition. Generally speaking, the primary cartilaginous skeleton undergoes endochondral ossification, while phylogenetically-new bones, such as the calvaria, facial skeleton, and clavicle undergo intramembranous ossification. One exception, of course, is the condylar cartilage of the temporomandibular joint; and there are several others. Interestingly, the ossification centers that the early anatomists described are likely sites of signal transduction where, through temporo-spatial patterning, genes are first expressed to initiate a cascade of events that eventually leads to the deposition of bone de novo.
Despite developmental differences, all bone is derived from embryonic connective tissue (mesenchyme); and mesenchyme is sticky. What would happen if two bones that develop by intramembranous ossification were to come into close approximation during development? This would lead to the formation of a suture. The early anatomists used the term suture because it looks like the sutures of the cranium have been stitched together.

Phylogenetically, these new, flat, cranial bones form a syndesmosis, and it was thought that when these syndesmoses fully ossify or fuse, they form a synostosis. Recent evidence, however, suggests that sutures rarely ossify completely, and most remain potentially active throughout life, subject to sutural homeostasis. In contrast, fusion is a developmental process by which epithelial tissues interact. The resulting programmed cell death (apoptosis) leads to the coalescence of the underlying (sticky) mesenchymal tissues. But, as sutures do not possess any epithelial cells, they cannot undergo fusion in the currently understood processes of epithelial developmental biology.

What would happen if two bones that develop by endochondral ossification were to come into close approximation during development? This would lead to the formation of a synchondrosis. The early anatomists used the term synchondrosis, because it looks like a joint is formed from cartilage. An obvious example of a synchondrosis is the sphen-o-occipital synchondrosis. Some refer to the sphen-o-occipital synchondrosis as the sphen-o-occipital symphysis. This is erroneous, as there are only two synphyses in the human body: the pubic symphysis and the mandibular symphysis. The developmental history of the mandibular symphysis involves remnants of Meckel's cartilage and will not be discussed in detail here. Suffice to say that when two cartilaginous anages come into close approximation during development, a synchondrosis is formed. In addition, in some cases a bone formed by intramembranous ossification comes into close approximation during development with another bone formed by endochondral ossification.

Returning now to the original question: When is a fissure not a fissure? Putatively, a fissure presumes that a unified entity is in the act of partial decomposition. In contrast, the human cranial base starts as series of primary cartilages, which appear to coalesce. As these cartilages undergo ossification, they appear to unite into a unified cranial base. Thus, the foramen lacerum of the dried skull represents the unossified apex of the petrous part of the temporal bone. Specifically, the otic capsule is initially continuous with the basioccipital cartilage, but the synchondrosis converts into the foramen lacerum (and jugular foramen). The lacerations represent the microscopic, chondroblastic palisades. Furthermore, the boundaries of the perichondria that enclosed each individual cranial base cartilage persist, and were described as fissures by the early anatomists. Specifically, the petrous part of the temporal bone ossifies endochondrally in the otic capsule from some 14 ossification centers (at about 16 weeks in utero). At 22 weeks in utero the petrous part of the temporal bone and (intra-membranous) tympanic ring juxtapose incompletely; forming the petrotympanic fissure through which the chorda tympani nerve and remnants of the disko-malleolar ligament pass. At birth, the tympanic ring incompletely approximates the squamous part of the temporal bone; forming the persistant squamo-tympanic and petro-squamous fissures. In vivo, these synchondroses might provide a developmental basis for cranial adaptation, adjustment and remodeling.