The Maxillae as the Inner Bridge Between Neurocranium. and Viscerocranium.

The Lightweight Construction of the Maxillae and Its Significance for SI

By Peter Schwind, Certified Advanced Rolfer™, Advanced Rolfing® Instructor

Note: The author shared his view of the temporomandibular joint (TMJ) when interviewed by Christoph Sommer in "The Temporommldibular Joint in the Context of StTllcturaIIntegration," published in the December 2008 issue afStructural Integration: The Journal of the Rolf Institute. *Here he adds to that foundation. Schwind's COIlCept of the treatment of cranial strain has its base in a long-term dialogue with Dr. med. Sebastian Schmidinger, a Gemlan dentist with extensive experience in the field of oral surgery and implantology. Besides being an Advanced Rolfing Instrllctor, Schwind also teaches his concept of fascial and membrane technique for the Barral Institllte (www.barralinstitute.com).withspecialemphasistothecranialsystem. This fall he will start teaching his cranial concepts for the BarralInstitute in Mexico, and in June he will be one of the key speakers at the annual meeting of the Gennan Association of Oral Surgery and Implantolog1j.*

Introduction: Looking Back at the History of the Human Cranium

While our ancestors were on their long trajectory from quadruped to biped, their musculoskeletal system had to go through a tremendous change. Not only body contour, but also the proportion of body segments and the size of muscles had to find a new order as the force of gravity put a very different demand on the body as a whole. This also required a new inner system of organization. We can see, for example, how ligamentous elements started to replace muscular units inside the foot, a process, a change that was necessary to allow further development of arches within the foot. And it can be observed at the level of the low leg that, as soon as our ancestors started to stand and walk upright, the tibia had to develop more strength and develop more density of boney material in its upper part so that the full weight of the body could be carried on only two feet. These developments have been considered and are well-documented in paleoanthropological research - work that was possible because there were enough findings available that showed the shape and density of bones.

Although there is no tangible record available for soft tissues, it would be interesting to risk some speculative follow-up on the connective-tissue changes that likely accompanied changes to bones. We can also consider what it meant to the body's cavities, how they had to relate differently to the vertebral spine and the back (with all its different layers) as soon as the hominid structure was on its way to uprightness. Here we would have to speculate about the very different dynamics of the respiratory diaphragm with the organs above and below it: as long as the human animal had four legs to support its movement, the diaphragm was separating two cavities that enveloped organs that were more or less hanging from the front side of the back, giving only a little support to the back. Immediately with a shift to uprightness, the dynamic changed towards a balance of cavities, where each organ contributed with a limited range of motion during breathing to stabilize the different spinal curvatures. At this moment of human evolution, the column of organs starts its interplay with the vertebral column.

At this time of beginning uprightness, the shape of the cranium also had to adapt to the new dimensions of the brain. The head of the hominid ancestors and early hominids was dominated by a large and heavy mandible and dense construction in the viscerocranium to be able to withstand enormous pressure in biting and chewing activities. (We find similar structures still in primates whose diets require very forceful biting and chewing.) In contrast, the head of the developing hominid biped had to meet different challenges. While the neurocranium was expanding and taking its place at the very top of the curvatures of the vertebral spine, the viscerocranium lost quite a bit of its former size and weight. Different functional demands allowed for a change towards lightweight construction of its most important parts, especially the development of an extremely fine bone to separate the cavities of the nose and mouth.

It is exciting to investigate the density of all the cranial bones of the pre-hominids and compare them with the development of the hominidlhuman cranium. For the time being we can only speculate about the details of this process, which the French scientist A. Dellatre called "L'hominisation du crane." Certainly we would have to look at the role of the tongue in shaping the new maxillae as speech became an important activity for our ancestors. And we would have to appreciate new relationships between teeth and maxillae as well as teeth and mandible within the new shape of the early hominid cranium.

Differing Construction Principles in the Human Mandible and Maxillae

When we look at paired bones within one segment of the body we frequently find one bone that has a "sister" or "brother" within the same segment. One of them shows more boney substance than the other, or is in some way more dense or more strongly developed. We find this clearly in the distal parts of the extremities, where paired bones serve together as a functional unit and develop in response to the repeated transmission of force or to a more or less permanent weight transmission. A simple example, one mentioned earlier, is that the move to a hominid bipedal stance required much more development of the tibia, with its new dense bony shape in contrast to the diameter and resilience of the fibula.

We find this contrast also when we compare the boney substance of the mandible and maxillae. However, evolution arrived at an almost paradoxical situation with the construction principle of the bony units of mandible and maxillae. The mandible is connected to the neurocranium by a suspended hinge - it is literally hanging off the container of the brain. One would think that this adjunct to the container of the brain should be as light as possible, as the TMJ is (after the shoulder joint) one of the most mobile joints in the body. However, evolution has shown that the opposite works well functionally. The head of *Homo sapiens,* elegantly replacing the earlier hominid head, maintains some of the heaviness of the mandible and shapes a new pair of maxillae out of extremely thin, fine bony elements. TI,e roof of the mouth can have a very thin bony structure as it has developed into the form of an arch, a shape that almost perfectly distributes strong pressures. Dense bony substance had to be replaced by the economy of appropriate shape.

Collecting Empirical Data Using Digital Volume Tomography

Models of the human skeleton may help communicate our view of the cranium, but even actual human bones, when they are from dead bodies, do not allow us to truly see and feel the differences that make a bone "lightweight" or "heavyweight" in its construction. We have to look inside the head of a living person to see what our "thinking fingers" are meant to sense.

Dr. Sebastian Schmidinger and I recently started to document the manifestation of "lightweight construction" within the living organism llsing digital volume tomography. This kind of imaging system, which compared with conventional systems uses only a low percentage of radiation, allows us to get pictures of living bones, opening the door to very detailed documentation of differences in bone density and shape.

Figure 1 shows the thin bony construction of the maxillary sinuses. The bones are visible in white, while the cavities show in black and an irritated part of Sclmeider's membrane shows in grey within the sinus (visible on the upper right). We benefit from this kind of imaging system in the sense that we are able to clearly distinguish bony and membranous structures.

In Figure 2 we see how the teeth meet the maxillae at the level of the second cervical vertebra and the foramen magnum. It documents the plane where the inferior border of the maxillae meets pressure from chewing.

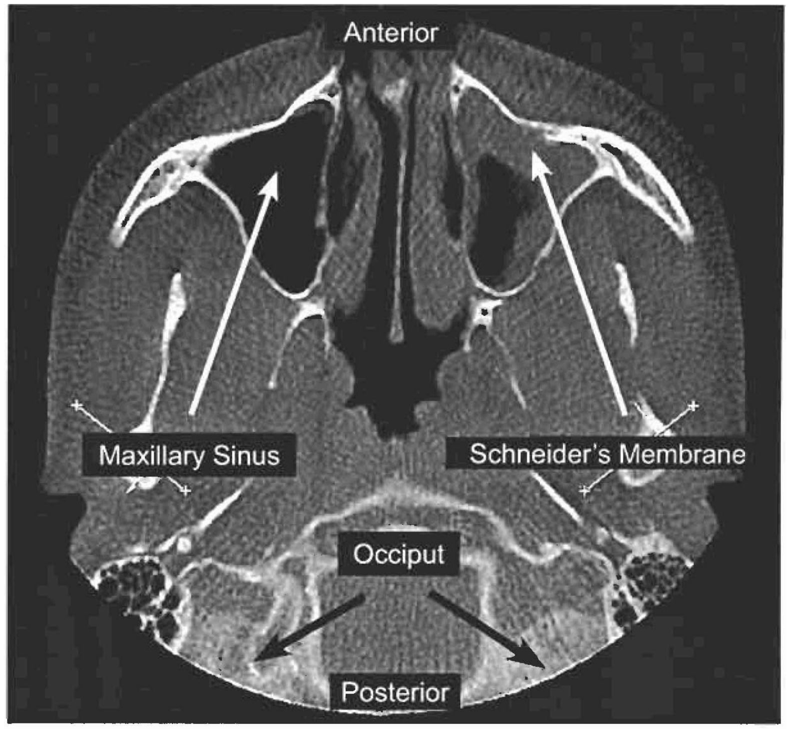

Figure 1: Transverse cut through the living human cranium at the bottom of the maxillary sinuses. *All images courtesy of Dr. Sebastian Schmidinger.*

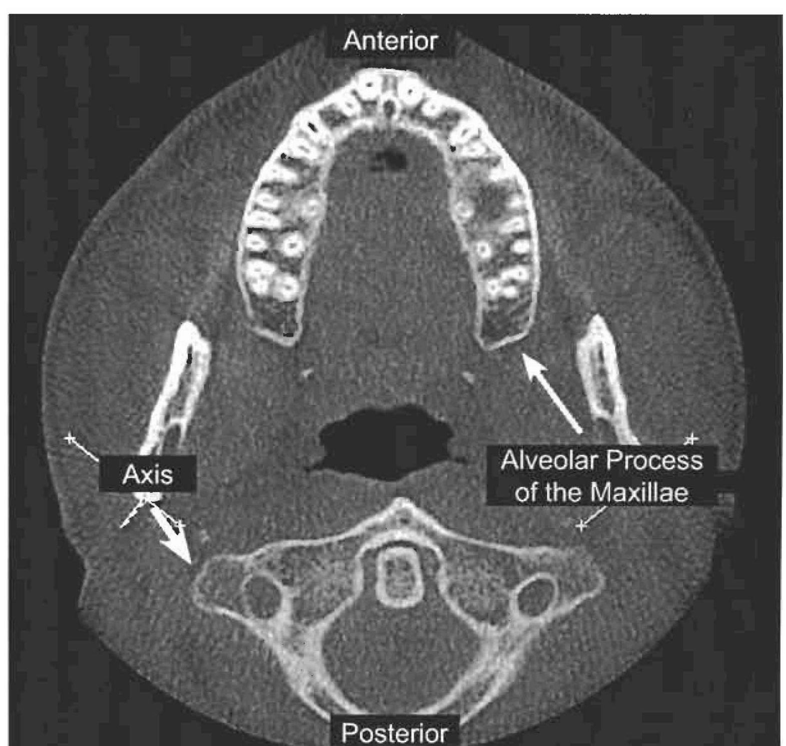

Figure 2: Transverse cut through the cranium and upper cervical area at the level of the axis.

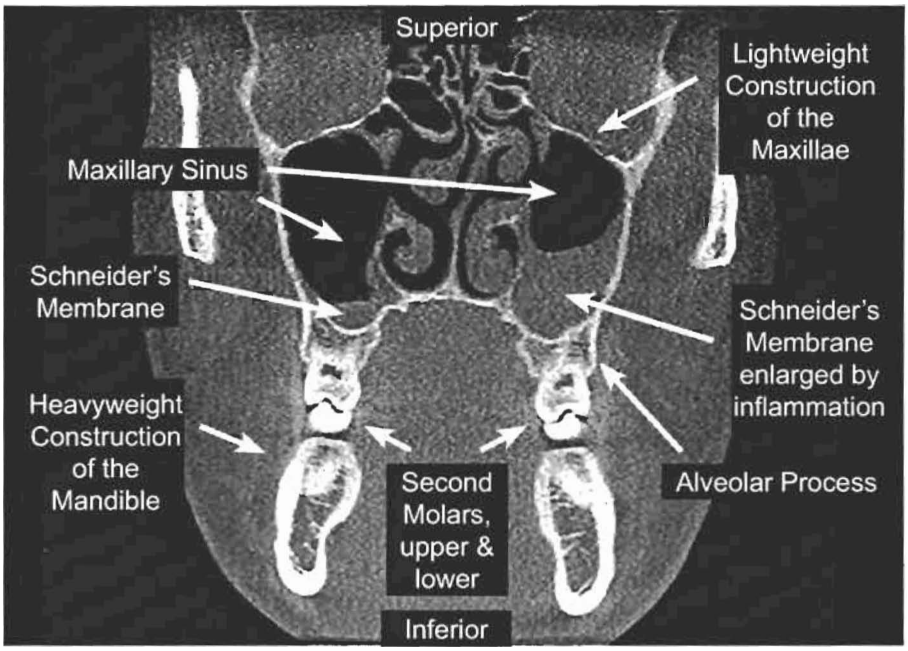

Figure 3: Frontal cut through the maxillary sinuses and - simultaneously - through the mandible at the level of the second molars.

In Figure 3 we see what "lightweight construction" means within a living organism, as it can be clearly seen how thin the lateral bony margins of the maxillae are. We are also able to recognize that the superior part of the maxillae - the "roof of the mouth" - is formed of an arch of extremely thin material (the bone here has a thickness of less than a quarter of a millimeter). In contrast to this we see the density and thickness of the bony structure of the mandible. Remember that with this imaging system bone shows as white and empty cavities (filled with air) show as black. Thus, during chewing activity the mandible is pressing (through its teeth) with tremendous force against the upper teeth embedded in the alveoli of the maxillae. The force arrives through the alveoli directly onto the thin bony structures of the roof of the mouth. Note also that in this picture we can see a different spatial arrangement of Schneider's membrane on either side of the maxillary sinuses.

Figure 4 shows the further bony connections of the maxillae to other bones above. From these relationships, we become aware of how forces are transmitted cranially through the maxillae to the bony elements surrounding the eye and cranioposteriorly towards the ear. Noting thin and thick bony (white) elements, we recognize the combination of lightweight and heavyweight construction.

The final image, Figure 5, shows only one maxillary sinus together with the nasal cavity, adding to that which we could already observe in Figure3. We see that the space of the cavities is maintained only by bones that are extremely thin and by that very lightweight. Again we see the superior bony margin of the sinus with a diameter of less than a quarter of a millimeter. Also, we can recognize the very fine, delicate structure of the bone separating sinus and nasal cavity.

Conclusion

The separation of the viscerocranium into different cavities is essential for all mammals. Without this separation, sucking, swallowing, and breathing would not have their necessary differentiation.[2] The primary function of the maxillae is to stabilize this necessary separation of cavities. The bony maxillae act together with membranes to create a very stable yet lightweight construction that can resist tremendous forces without undergoing deformation or fracture. In contrast to this, the thick bone of the mandible is easily deformed by mechanical impact.

We see the maxillae and related membranes as an area of major importance, the inner bridge where the neurocranium and viscerocranium "articulate." The author speculates that this inner bridge, with its potential for micro movement, is a keystone for structural integration (51) of the neck and the craniosacral system as a whole when balanced in its relationship to the neurocranium.

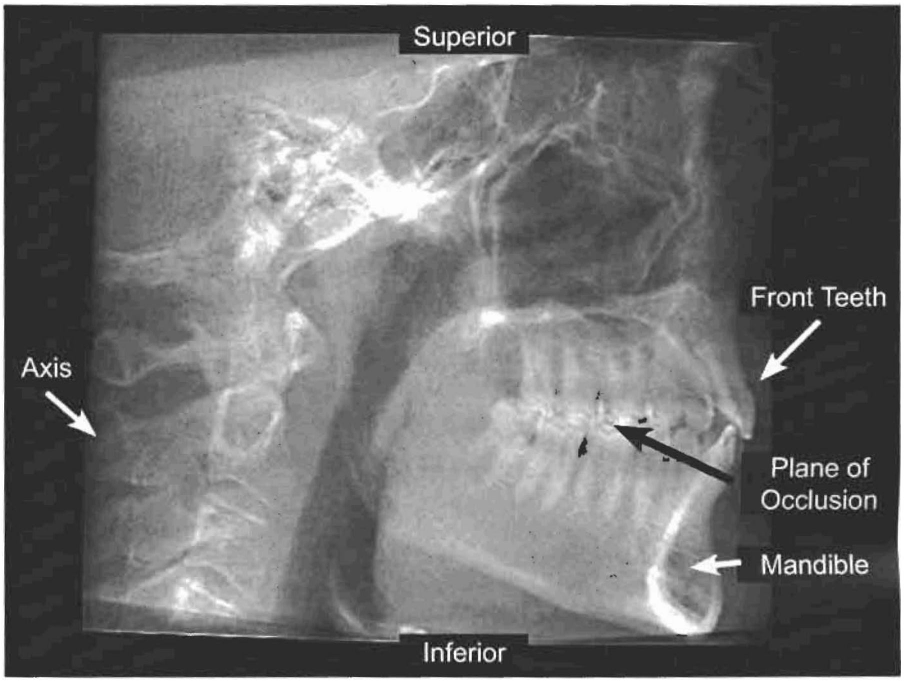

Figure 4: Sagittal cut through the cranium to illustrate the relationship between the level of the second cervical vertebra and the alveolar level, as seen from a different view in Figure 2.

Implications for 51

When I go through my notes taken more than thirty years ago as a student during my first Basic Training in Rolfing® Structural Integration, I find plenty of reference to the significance of the roof of the mouth for the concept of the seventh hour of the ten-session series. My first instructor, John Lodge, used to say, "touch the restricted half of the maxilla, and wait until it comes towards your finger." Talking like that, he gave a helpful metaphor for the indirect method we have to choose in this territory, before we change gears and use directive touch (Le., whatever we want to make more mobile or more resilient within the adult cranium, we first have to follow into the restriction to its very end, and then support the hidden potential of the system to find a larger range of motion and integration.)

Unfortunately, as Rolfers we have not always traveled on this safe avenue. We sometimes tried to push things - structural relationships of the cranium - directly "where they belong" without listening to the tissues. That was not such a good idea, as some of us experienced personally. It is not surprising that so many SI practitioners seek an esoteric form when pursuing an interest in the cranial field. However, it may be worthwhile to explore physics a little bit more - and there really is a lot to be explored - before we venture into metaphysics.

Endnotes

1. Dellatre, A., *L'hominisation du crane*. Paris: Editions du Centre National de la Recherche Scientifique. 1960.

2. Schwind, Peter, *Fascial and Membrane Technique.* Edinburgh: Churchill Livingstone Elsevier, 2006, p.190.