

7. Summary

The aim of this investigation was to present the morphogenesis, the localisation and the form of the infraorbital foramen with consideration of the infraorbitalis canal and its vessels and nerves.

Nine human embryos and fetuses ranging from 19 mm – 250 mm crown-rump-length (CRL) have been prepared as histological serial sections of 10 µm thickness and were stained by haematoxylin-eosin or modified Masson-Goldner staining.

Four of these serial sectioned embryos were microscopically enlarged and reconstructed as three-dimensional graphics with a the software (Analysis©).

Results:

- The first condensation of osteocytes of the maxilla occurred at the stage of 19 mm CRL. They were located caudally, close to the infraorbital nerve, where the infraorbital foramen will develop and where the infraorbital nerve ends with its terminal branches.

At the stage of 25 mm CRL the further development of the maxilla proceeded caudally of the infraorbital nerve in anterior direction and bent midwards to the chondral anterior nasal spine. Not before the reconstructed stage of 117 mm CRL it has been obvious that the maxilla developed along the infraorbital and maxillary nerve in posterior direction. It was further recognizable that the maxillary bone-growth went in cranial direction where the frontal process will develop later. At the developmental stage of 250 mm CRL the infraorbital nerve and the anterior tooth buds were completely encircled by bone.

- First obvious signs of bone-formation of the infraorbital foramen have been seen at a stage of 25 mm CRL. At the bifurcation where the infraorbital nerve divided into its terminal branches the maxillary bone spreaded gutter-like in cranial direction. At this location the formation of the

infraorbital foramen started to develop. Because of the maxillary development in cranial and in posterior direction surrounding the infraorbital nerve, the infraorbital foramen and the infraorbital canal became to be a u-shaped gutter. At the stage of 117 mm CRL the gutter still was cranially open and had a long and drop-shaped form if viewed in the frontal plane. Conditioned by the described growth direction of the maxillary bone, the formation of the infraorbital foramen was displaced in anterior and medial direction to be located cranial of the first upper deciduous molar at the stage of 117 mm CRL. Later, at the stage of 250 mm CRL, it further shifted to the level of the upper deciduous canine.

- The first time where the infraorbital foramen was completely encircled by bone in the three-dimensional reconstruction was at a size of 250 mm CRL. The cranial bony surface was quite thin and the drop-shaped formation of the foramen became wider and more flat. At this stage of development, the infraorbital foramen was almost completely occupied by the infraorbital nerve and vessels.
- The horizontal diameter of the infraorbital foramen grew continuously during the developmental process. At the stage of 117 mm CRL the diameter measured 400 μm – 500 μm . No vertical measurements were possible in less advanced developmental stages, because the cranial vault of the infraorbital foramen had not been formed. At the size of 250 mm CRL the diameter showed 750 μm – 800 μm .
- Also the distance between the infraorbital nerve and the medial and lateral bony border of the infraorbital foramen decreased continuously. The distance measured 170 μm – 340 μm at the stage of 117 mm CRL and at the stage of 250 mm CRL it was reduced to 50 μm – 130 μm .

The distance between the infraorbital nerve and the caudal bony border seemed to stay stable. It showed 90 μm – 340 μm at the size of 117 mm CRL and 130 μm – 350 μm at the size of 250 mm CRL. Because of the close relation to the caudal tooth buds the bony layer could be very thin in this region.

The developmental formation of the infraorbital foramen in comparison to the *mental foramen* seemed to be similar. At both foramina the first osseous condensations have been seen close caudal the nerve fibers. Those ossification centers spread out gutter-like in cranial direction on both sides of the nerve-bundle and finally united cranially of the nerve to build a completely encircled bony foramen. In contrast to the infraorbital foramen a completely formed *mental foramen* was already recognizable at the stage of 19 mm CRL. The distance between the mental nerve and the *mental foramen* at this stage seemed to be significantly larger (the foramen was three times bigger than the diameter of the nerve) than the distance between the infraorbital nerve and the infraorbital foramen at the stage of 250 mm CRL.

It can be concluded that the infraorbital foramen develops in a different albeit similar way, and it is not clear, if there are any other factors beside the ones we know, which might control the development of foramen formation.

Therefore, further studies have to be done on the microbiological way to study and to verify those individual differences of boneformation in specific anatomical regions.