P50-53 PRENATAL FORMATION OF THE MAXILLARY AND MANDIBULAR ALVEOLAR BONE IN HUMANS

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Introduction

There is a mutual relation between teeth and bone, not only in postnatal life, but also during stages of initial and early formation of teeth and alveolar bone [1]. It is unknown how the interdental ridges and the bony crypts form, while the dental primordia develop. The crypts may form due to bone resorption underneath the expanding dental primordia, and the interdental bony ridges may be remnants of adjacent bone resorption, or the ridges may be active outgrows of the maxillary and mandibular bone.

Although the prenatal development of the maxillary and mandibular bone has been summarized recently [2], the morphology of the peridental bony structures during the stages of dental morphogenesis is not known in detail. Therefore, the development of the human maxillary and mandibular bone, together with the developing tooth primordia was examined for the prenatal stages with special reference to the regions of bone resorption and apposition.

Materials and Methods

Human embryos and fetuses, ranging from 19 – 270 mm CRL, were prepared as serial histological sections, stained H.E. and TRAP. Regions of bone remodeling were identified referring to the cell types and marked. 3D-reconstructions were made using the software analySIS (Olympus, Berlin).

Results

3D reconstructions from serial sections showing regions of bone remodelling revealed that the formation of the dental crypts, the interdental and the interradicular bone is a result of a mixture of resorptive and appositional processes. The peridental bone arises by apposition between the dental primordia, while underneath the growing dental primordia, there is bone resorption.

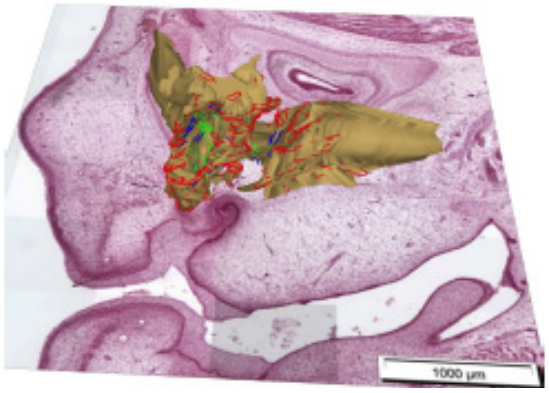


Fig. 1: Histological section through the primordium i1, sagittal-vertical plane. Human fetus, 54 mm CRL. Stained H.E. Maxillary bone (ocre) with regions of remodeling superimposed. Apposition (red), resorption (green), inactive regions (dark blue).

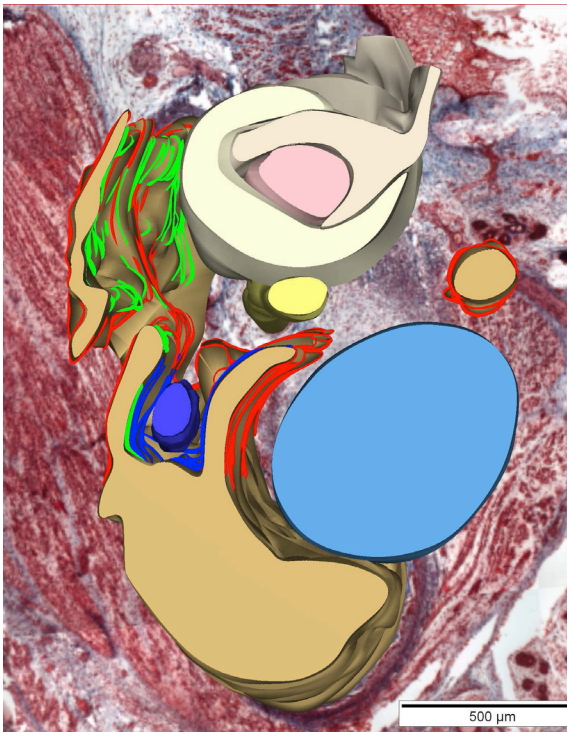


Fig. 2: Partial reconstruction of the mandible of a human fetus, 117 mm CRL, right half, frontal view, region of primordium m_1, 3D-reconstruction superimposed on histological section, stained trichrome. Dental primordium (gray), bone (ocre). Apposition (red), resorption (green), Inactive lining cells (dark blue). Meckel's cartilage (light blue), N. alv. inf. (yellow), V. alv. inf. (dark blue).

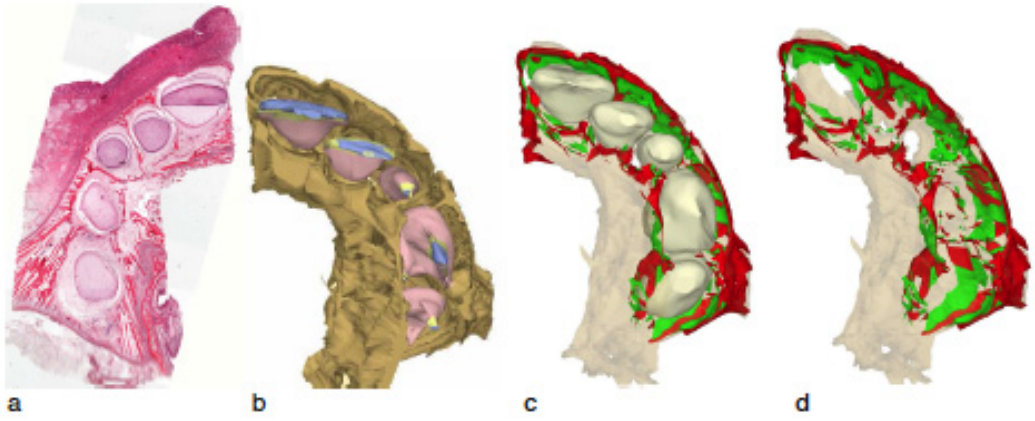


Fig. 3a: Maxillary bone with dental primordia, horizontal section, stained H.E. Fig. 2b: Interdental ridges and bony crypts around the dental primordia. 2c: Maxillary bone with dental primordial. Apposition of peridental bone (red), resorption (green). d: Dental primordia removed to show the remodeling sites underneath.

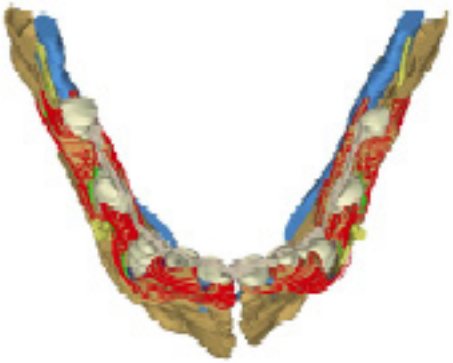


Fig. 4a: Mandible of a human fetus, 68 mm CRL, cranial view. Dental primordia (gray), bone (ocre), apposition (red), resorption (green).

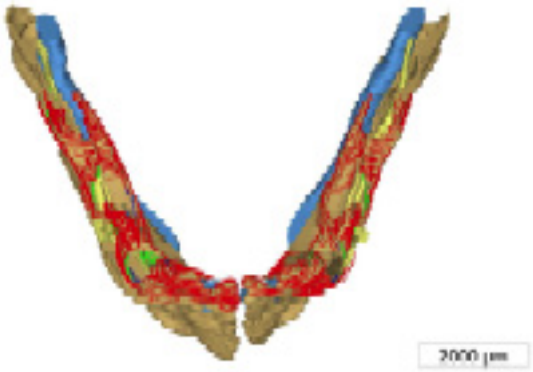


Fig. 4b: Same reconstruction with dental primordia removed: Regions of bone resorption (green) can be seen in the depth of the crypts

Fig. 6: Mandible of a human fetus, 117 mm CRL, right half, medial view. Dental primordia (gray, transparent), bone (ocre), apposition (red), resorption (green), inactive lining cells (dark blue), Meckel's cartilage (light blue).

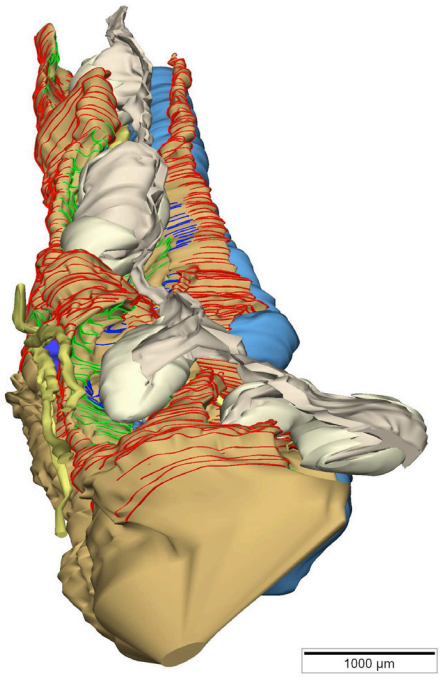
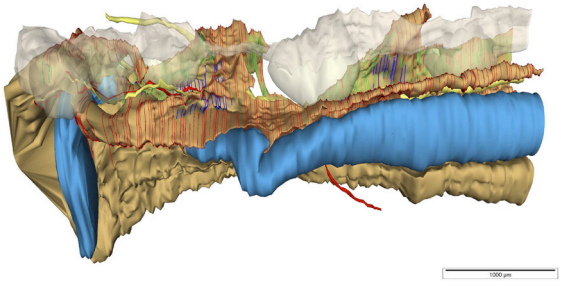


Fig. 5: Mandible of a human fetus, 117 mm CRL, right half, frontal and 45° cranial view. Dental primordia (gray), bone (ocre), apposition (red), resorption (green), inactive lining cells (dark blue), Meckel's cartilage (light blue).



Discussion

In adult patients, reduction of the alveolar bone height seems to be a common and an inevitable condition. There are many approaches, e. g. periodontal surgery with the assistance of enamel matrix proteins, to heal and to regain alveolar bone height [3]. In order to understand better the biology of the alveolar bone, it is interesting to understand its origin during the stages of dental primordial formation. Bone, in general, forms in regions of tissue interaction, where distraction forces are assumed [4] and under the influence of a signalling cascade, with Runx-2 as the master regulator [5]. Bone is being resorbed when pressure is the trigger, as we know from orthodontic tooth movement. Our results indicate, that the dental primordia create their bony crypts by resorption of the underlying bone, when they enlarge in size. The signalling interaction has not been elucidated so far. We may assume a general process, however, that is similar to the processes of bone resorption during tooth eruption [6-9]. The interdental septa are being the dental primordial are formed by active outgrowth of bone. The mechanisms, which lead to this active bone formation, are not clear yet. As the dental primordia do not only increase in size, but also change their position along the arch, shearing forces as a primary trigger may be assumed as a primary trigger. The tooth-bone-interface is an interesting region, where general interactions between different tissues can be studied [1]. These results serve as a basis for further research focused on the mechanical and molecular control mechanisms leading to formation of bone form.

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