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Skeletal units of the human embryonic mandible

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The development of the mandible was traced on serial sections of 20 human embryos aged 5–8 weeks (developmental stages 13–23). Special consideration was given to the differentiation of skeletal units proposed by Sperber. The first skeletal units, namely the mandibular body, the alveolar unit and the condylar unit, may be distinguished in the 7th week. The primordia of all units are identified by the end of the embryonic period (8 weeks).

Key words: human embryonic period, facial skeleton, mandible, skeletal units

INTRODUCTION

The mandible and the maxilla are the most important bones in the development of the orofacial structures. Although the mandible as the movable bone is antagonistic to the maxilla [3], these two bones show similarities during development [1]. They reflect developmental analogies based on:

— origin from the ectomesenchyme migrating into first pharyngeal arch;
— the requirement for epithelial-mesenchymal interaction prior to ossification;
— the developing dental apparatus;
— the close relation of ossification centres to bifurcation of the main branches of the trigeminal nerve;
— the relationship to the primary cartilaginous selection, Meckel's cartilage, and the nasal capsule for the mandible and maxilla respectively;
— the presence of secondary or accessory cartilages.

It was found [7, 8] that the head and neck have a number of independent but integrated functions, which are carried out by functional components. Such components consist of soft tissues responsible for function, and a skeletal unit supporting and protecting the soft tissues. Symons [11] and Moss [7] described five regions in the mandible viz. a basilar region related to the inferior alveolar bundle, as well as the alveolar, coronoid, condyloid, and angular regions. Sperber [10] included the chin as a mandibular skeletal unit.

The aim of the paper is to trace the development of the mandible in human embryos aged between 5 and 8 weeks with special attention to differentiation of the primordia of skeletal units.

MATERIAL AND METHODS

For the study 20 embryos were used from the collection of the Department of Anatomy, Poznań University of Medical Sciences. The embryos were staged according to 23 developmental stages. Serial sections of the embryos were made in the frontal, sagittal and horizontal planes. Sections of 10 μm in thickness were stained according to the Mallory method with haematoxylin and eosin and cresyl violet and impregnated with Bodian's protargol.

RESULTS

In this section the differentiation of particular units will be described.

The basilar unit develops laterally to Meckel's cartilage. The primary ossification centre in this unit appears at stage 18 (44 days). This centre is closely associated with the inferior alveolar nerve and is

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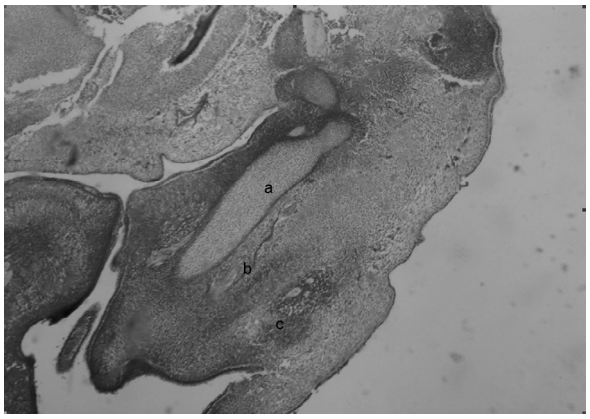

Figure 1. Frontal section of embryo at 18 stage. H+E.
a — Meckel's cartilage, b — nferior alveolar nerve, c — ossification center.

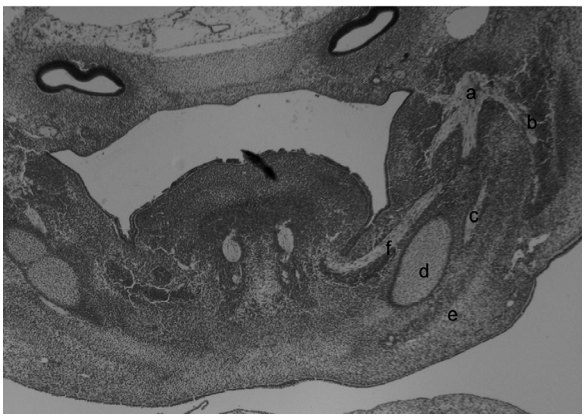

Figure 3. Frontal section of embryo at stage 21. H+E.
a — mandibular nerve, b — masseter muscle with nerve, c — inferior alveolar nerve, d — Meckel's cartilage, e — ossifying mandible, f — lingual nerve.

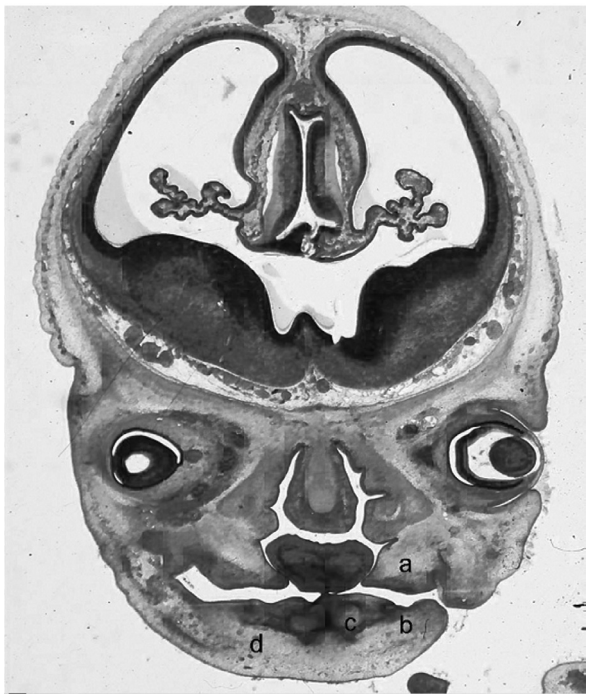

Figure 2. Coronal section of embryo at stage 20. Mallory.
a — palatine process of maxilla, b — tooth bud, c — Meckel's cartilage, d — ossification center.

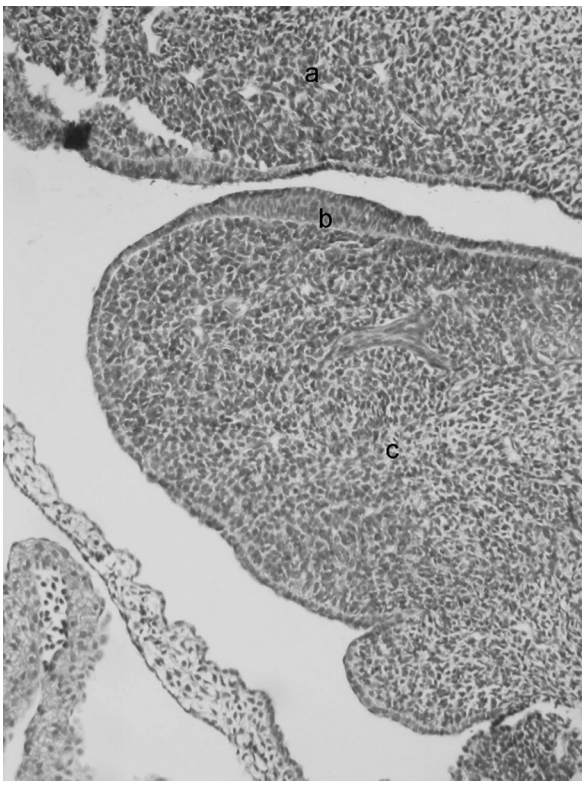

Figure 4. Sagittal section of embryo at stage 15. H+E.
a — maxillary prominence, b — dental lamina, c — mandibular process.

below the formation of the future mental foramen (Fig. 1). During weeks 7 and 8 (stage 19–23) in embryos the bone spreads from this centre medially and posteriorly, lying below and lateral to the inferior alveolar nerve (Fig. 2, 3).

The primordium of the alveolar unit appears as a dental lamina in embryos at stage 15 (36 days) (Fig. 4). With the growth of the mandible and the development of dental papillae and teeth buds, the alveolar unit fuses with the mandibular body (Fig. 2, 5). The upper part of the body divides into two laminae, which embrace the developing alveolae.

The angular unit may be distinguished at stage 19 (46 days). Its development is related to the growth of the masticatory muscles and proceeds through apposition of the periosteum (Fig. 6).

The coronoid unit can be observed in embryos at stage 20 (50 days) and is closely related to the temporal

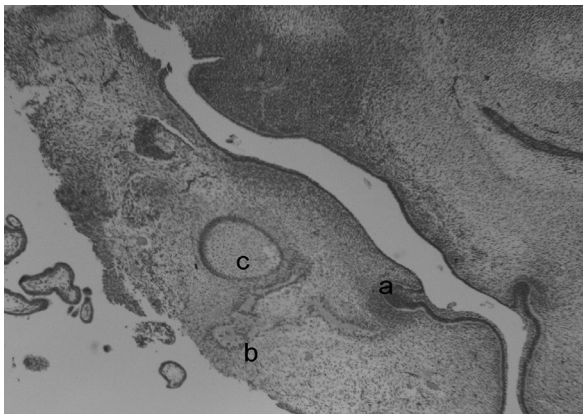

Figure 5. Sagittal section of embryo at stage 21. H+E. a — dental lamina, b — ossifiacyion center, c — Meckel's cartilage.

Figure 6. Frontal section of embryo at 20 stage. H+E. a — tooth bud, b — ossifying body of mandible in region of angle, c — Meckel's cartilage, d- ossification center.

muscle (Fig. 7). In this early development it is a fibrocellular mesenchymal condensation. It differentiates as a separate bony structure related to the temporal muscle.

The primordium of the condylar unit is seen in embryos at stage 19 (46 days) (Fig. 8) and is responsible for the longitudinal growth of the mandible.

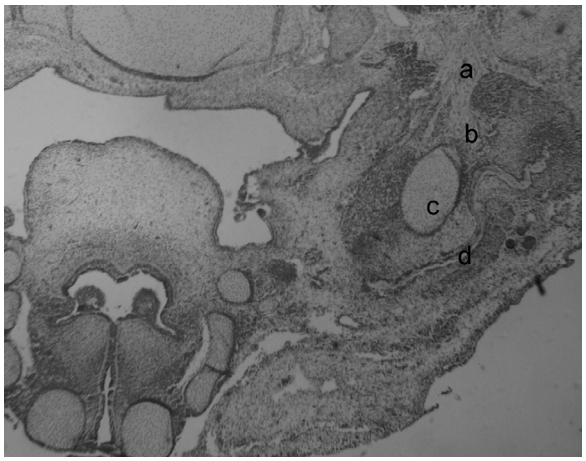

Figure 7. Frontal section of embryo at stage 23. H+E. a — mandibular nerve, b — inferior alveolar nerve, c — Meckel's cartilage, d — ossifying mandible.

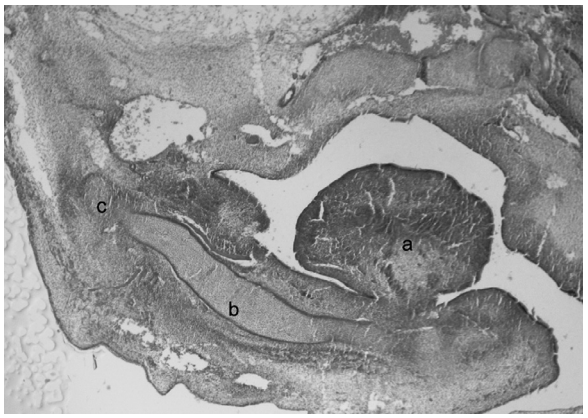

Figure 8. Frontal section of embryo at stage 19. H+E. a — tongue, b — Meckel's cartilage, c — primordium of condylar process.

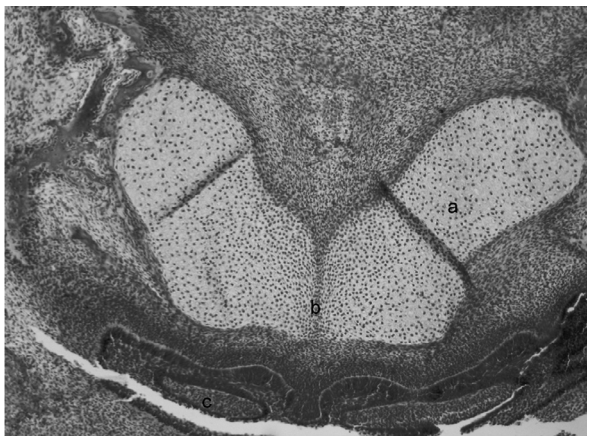

Figure 9. Horizontal section of embryo at stage 23. H+E. a — Meckel's cartilage, b — symphysis, c — dental lamina.

It growths superiorly and laterally and is in contact with the lateral pterygoid muscle (Fig. 9).

The mental unit in the embryonic period is represented by a mandibular symphysis in the midline.

It may be concluded that all the skeletal units of the mandible are evident by the end of 8th week.

DISCUSSION

Many studies have been dedicated to the prenatal development of the human mandible and Meckel's cartilage [3–5, 9]. Meckel's cartilage influences the ossification of the mandible. Lee et al. [3] found that the ossification of the condylar blastema is closely associated with Meckel's cartilage, which is also important in craniofacial morphogenesis [4]. Lee et al. [3] distinguished three stages which are crucial during mandibular development: stage 16 (appearance of Meckel's cartilage), stage 19 (beginning of ossification) and stage 23 (changes in muscular attachments). In the present study we observed the primary ossification centre at stage 18.

The development and growth of the mandible depends upon several factors [2, 6]:

— epitheliomesenchymal interactions between the oral epithelium and underlying mesenchyme;
— prenatal activity of the masticatory muscles;
— growth of the tongue;
— the inferior alveolar nerve and its branches;
— development and migration of the teeth.

In the present study, which describes the primordia of the skeletal units in the embryonic period for the first time, it was shown, that these units are characterised by the following features:

— the appearance of the alveolar unit as a dental lamina and the relation of its development to odontogenesis;
— the very early differentiation of the basilar unit and its ossification as the first unit;
— growth of the angular and coronoid units closely related to the muscles of mastication;
— growth of the condylar unit dependent on secondary cartilage formation.

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