COMPARATIVE STUDY OF THE ONTOGENY OF MANDIBULAR CARTILAGE (MECKEL) IN SHEEP (*OVIS ARIES*) AND CAT (*FELIS DOMESTICA*)

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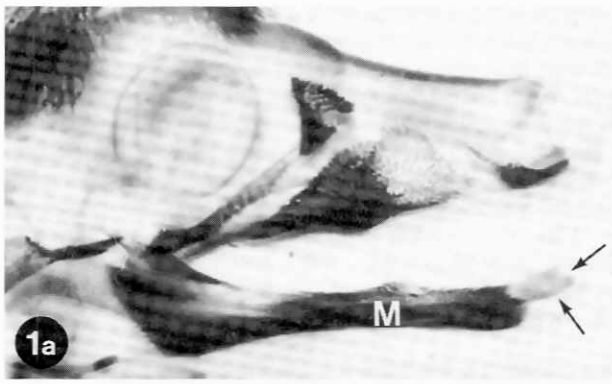
The investigation about comparative embryogenesis and anatomy indicates that the first arch cartilage (Meckel) forms the mandible in lower vertebrates. However, in mammals it is transient and develops only during the embryonic life, thus being the only support of the mandibular process and the only means of attachment of the mandible to the neurocranium.

In general it arises from neural crest cells that migrate towards mandibular arches and must interact with an embryonic epithelium before Meckel's cartilage can form. There are some evidences to show that the timing of these interactions varies from one vertebrate group to another, being earlier in birds and later in mammals. These variation in the timing of inductive tissue interactions is identified as one possible basis for evolution by heterochrony.

For many years the cartilage of the first arch was thought to be inductor of the mandibular bone, however, later studies demonstrated that the onset of mandibular osteogenesis is due to induction carried out by the epithelium that covers the first branchial arch. It has also been postulated that it has an active role in the mandibular growth in some species, like it is in the rat.

The aim of this study is to describe the comparative ontogeny of the first arch cartilage (Meckel's cartilage) and its relations with the mandibular osteogenesis. We also study the relative time of appearance of these character in two mammals (sheep and cat) which exhibit great phenotypic differences of the mandible.

Twenty one cat embryos and foetuses (12-49 days of gestational age) and 18 sheep fetuses (28-40 days of gestational age) were used. The ages of cat embryos and fetuses were determined considering the day of mating as day 0 of gestation. Pregnant females were hysterectomized at different gestational ages to recover the embryos.



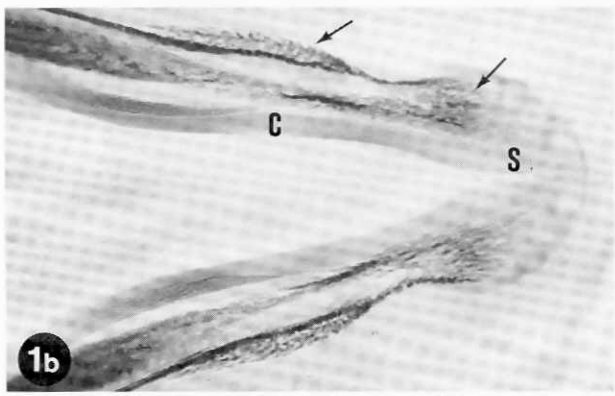


Fig 1 Sheep fetus, 35 days of gestational age. Double staining "in toto"
a) Symphysis of Meckel's (arrows), Mandible (M). 3.5X
b) Ventral aspect of the mandibular region: Symphysis (S), centre (C). Mandible (arrows), 8X.

The sheep embryos and fetuses were collected from the slaughter house (Lo Valledor) in Santiago, Chile. All fetuses were measured with a vernier calibre. The estimated ages of sheep embryos and fetuses are based on the comparison of crown-rump length and external morphological features as described by Bryden et al (1972).

The specimens were distributed into seven groups according to species and age. Cat embryos and fetuses and sheep fetuses were fixed in 10% formaldehyde and processed for double staining *"in toto"* according to Hanken and Wassersug (1981). This method uses Alcian blue and alizarine red to stain cartilage in blue and bone in red. The remaining embryos and fetuses were fixed in Bouin's solution, embedded in paraffin wax, serially sectioned in the sagittal and frontal planes at 7um thickness and stained with hematoxylin-eosin-Alcian blue. In order to compare the two species, considering their different gestational ages (62 days for feline and 150 days for ovine), the ages of the embryos were expressed as percentage of their respective gestational length, according to the expression: age of embryos at the time of the process/ length of gestation X 100 (Table 1.)

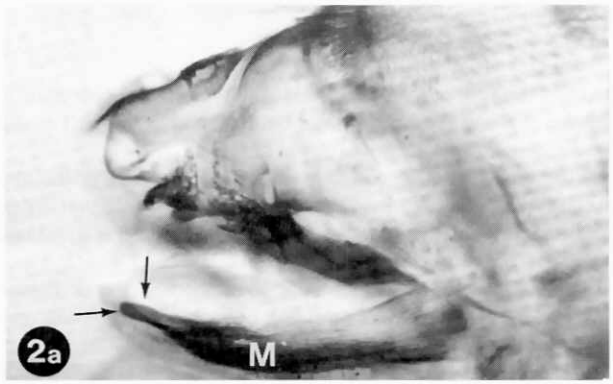
Table 1. Distribution of cat and sheep embryos and fetuses according to relative age or % of gestation.

Specie	n	% of gestation	Age days	CRL mm
Sheep	6	20	30 ± 2	20-22
Sheep	6	25	33 ± 2	20-28
Sheep	6	30	37 ± 3	32-37
Cat	3	20	14 ± 2	0.80
Cat	6	35	20 ± 3	13-20
Cat	6	50	32 ± 2	34-36
Cat	6	75	46 ± 3	87-95

In sheep with 20% of gestation advanced (30 ± 2 days) and in cat with 35% of gestation advanced (20 ± 3 days) a condensation of prechondrogenic mesenchyme was observed. Later, when 25% of gestation has elapsed in sheep (33 ± 2 days), and 50% in cat (32 ± 2 days), the cartilage is well differentiated in symphysis, centre and caudal component. The caudal component is divided in two

subcomponents: malleus and incus.

In sheep, the centre of the cartilage is very long and does not contribute to mandibular osteogenesis. (Fig 1 and 3). The intramembranous ossification corresponding to the mandible is peripherally located to the cartilage, does not involve it and the perichondrium is intact.



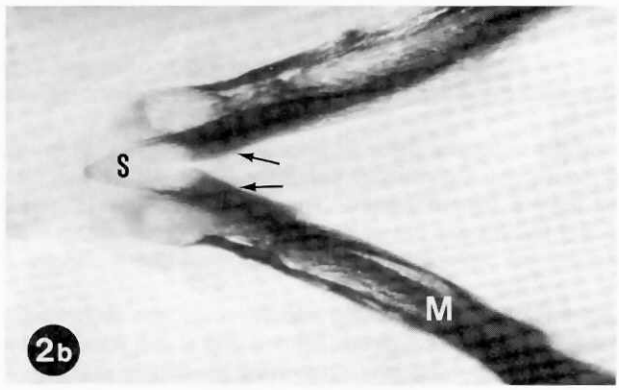


Fig 2. Cat fetus, 32 days of gestational age. Double staining "in toto".
a) Symphysis (arrows) Mandible (M). 5X.
b) Ventral aspect of the mandibular region. Mandible (M), symphysis (S), centre (arrows), 8X.

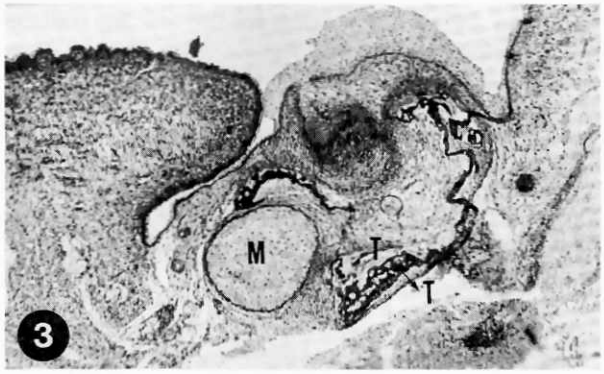
In the cat the centre of the cartilage undergoes ossification anteriorly to canine area (Fig 2 and 4), but posteriorly to this area it does not contribute to ossification of the mandible. Intramembranous ossification takes place at the periphery.

In the sheep, the symphysis maintains the same diameter of the centre and it extends forward to form the rostral process (Fig 1). In cat, the cartilage reduces its diameter at the symphysis (Fig 2).

Both, timing of onset and duration of condensation vary between cat and sheep. The onset of cartilage differentiation is delayed in cat (50% of gestation). On the contrary, in ovine this period is reduced to 25%. Both cases are very different from the condition in humans, where chondrogenesis occurs at 16% of gestation.

The fact that, in sheep the centre of the Meckel's cartilage does not undergo endochondral ossification and the symphysis growth forward to form the rostral process shows that it promotes the enlargement of the mandible. In the cat the symphysis is poorly developed and the anterior part of the centre undergoes endochondral ossification. This implies that the cartilage chiefly contributes to the widening of the mandible so that the transverse distance between the right and left mandible increases. It contributes less to the lengthening of the mandible.

Our results indicate that architectural differences of the cartilage of the first arch are related to the definitive shape of the mandible. This view is reinforced by the observation that the administration of corticoids inhibits growth of the mandibular cartilage in laboratory rodents, thus inducing retrognathia. Moreover diazo-oxo-norleucine which is an inhibitor of the synthesis of glycosaminoglycans retards the mandibular growth since it reduces the length of the mandibular cartilage. It is also shown that the timing of the onset of condensation, chondrogenesis and probably the epithelial-mesenchymal interaction varies not only from one vertebrate group to another, but also among different mammals.



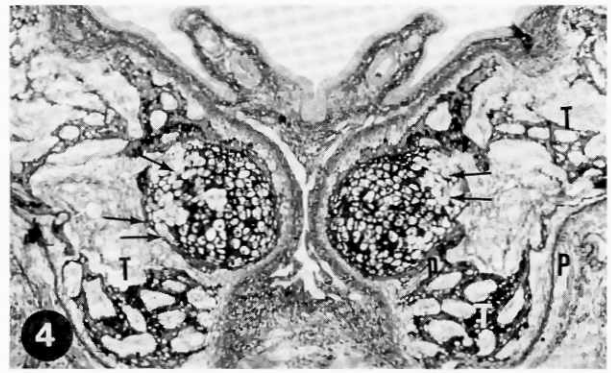


Fig 3. Frontal section of mandible of 35 days old sheep fetus. Cartilage of the first arch (M), intramembranous ossification (T). H-E Alcian blue staining, 400X.
Fig 4. Frontal section of mandible of 39 days cat fetus. Ossification of Meckel's cartilage (arrows). Perichondrium (p), Intramembranous ossification (T). Periosteum (P).H-E Alcian-blue staining. 400X.

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