The buccinator muscle: an original morphogenetical study

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Summary

The buccinator muscle, a cutaneous muscle derived from the second arc, is innervated by the facial nerve. It is made of 3 bundles extended into the cheek, from the pterygo-mandibular ligament to the modiolus. It is used for diverse buccal functions. This study attempts to give a better insight of the embryogenesis and the development of the muscle. After taking samples by microdissection under binocular microscope, of the genien region of embryos and foeti, we performed histological sections. They were then coloured by Masson’s trichome for their observation under photonic microscope.

From seventeenth week we observed the presence of a peri-mucous mesenchyma between the cartilaginous condensation of the "pre premier arc" and Meckel’s cartilage. Buccinator present an insertion on the modiolus, sliding under the latter it runs forwards, it is at the origin of the formation of the orbicularis internus of the lips (musculus orbicularis oris). This muscle displaces its posterior insertion downwards, with the development of the face in the child and the adolescent, notably with the modification in vertical dimension due to the arrival of the deciduous teeth before the permanent dentition. Furthermore it appears that buccinator does not as a sphincter in the secretion of the parotid glands.

Key words: M. buccinator, M. orbicularis oris. Skin muscle. Ligament pterygomandibularis. Modiolus.

Résumé

Le muscle buccinateur est un muscle peaucier issu du deuxième arc branchial, innervé par le nerf facial. Il est constitué de trois faisceaux qui se dirigent d’arrière en avant sur la face interne de la joue depuis le ligament pterygo mandibulaire, les procès maxillaires et mandibulaires, jusqu’au modiolus . Il intervient dans diverses fonctions buccales. Ce travail tente d’améliorer les connaissances sur l’embryogénèse et le développement de ce muscle.

Après avoir prélevé par microdissection, sous loupe binoculaire, la région génienne de 40 foet et embryons ; nous avons réalisé des coupes histologiques colorées à l’aide d’un Trichrome de Masson pour les observer au microscope photoinique.

Dès la 7e semaine nous avons constaté la présence d’un mesenchyme périmuqueux se développant en même temps que les condensation cartilagineuse de pré premier arc et du cartilage de Meckel . Le muscle buccinateur ne présente pas d’insertion sur le modiolus, mais coulisse sous celui-ci et s’étend en avant ou ses fibres se confondent avec celles de l’orbiculaire interne des lèvres : muscle orbicularis oris.

Les fibres postérieures de ce muscle très haut situées chez le fœtus, descendues en bas et en arrière chez l’enfant et l’adulte, avec notamment l’augmentation de la dimension verticale buccale, due à la mise en place de la denture déciduale puis de la denture permanente.

Par ailleurs, il n’y a pas de sphincter constitué par le muscle buccinateur autour de l’orifice de sécrétion des glandes parotidées.


INTRODUCTION

The buccinator muscle was named by Couper and Myot (1694). It was described by Albinus and was known to Galen, Vesale and Eustachi (as quoted by Portal 1770). It originates from the hyoiden arc (2nd branchial arc) innervated by the facial nerve. It acts upon the cheek and the angle of the labial commissure. It extends within the cheek and is constituted of three muscular bundles (Grasse, 1971; Agur A.M.R.1991): maxillary, longitudinal and mandibular.

It inserts posteriorly on the pterygomandibular ligament and extends forward onto the modiolus, a retro-commisural zone of insertion of the peri-buccal skin muscles. The fibres of the mandibular bundle are arranged facing the mandibular alveolar processes (Netter F.H.1990).

This muscle is present exclusively in mammals (Grasse 1971). Throughout the evolution numerous variations in the number of bundles as well as in the number of layers developed. This muscle is a fundamental structure constituting the jowls in certain mammals.

The term buccinator derives from two origins:

– “Buccale”: as it is a buccal muscle. Notably serving to bring food in between the grinding surfaces of teeth or into the buccal cavity.

– “Buccina”: wind instrument used by the Romans announcing the gladiators entry into the arena. Sounds pro-
duced by buccina need intrabuccal pressure developed by this muscle. Buccinator also participates in the expression of emotions in our relationship with others and contributes to phonation.

The aim of this study is to improve our knowledge of the embryogenesis and the development of this muscle and to argue these peculiarities:

– this muscle defined as skin muscle has no cutaneous insertion but inserts directly on the mucous membrane;
– orbicularis oris muscle seems to be an extension of the buccinator muscle present in man like in all other mammals.

In addition to the relations between buccinator muscle and modiolus, and the formation of the angle made by buccinator and platysma (skin muscle of the neck inserting superiorly and anteriorly on the modiolus) are considered.

Finally we’ll try to observe the relations between parotid duct and this muscle.

**Material and methods**

**Material**

The human embryos used in this study came from the Anatomy Laboratory of the Bordeaux II University (Faculty of Medicine Victor Pachon – Pr. Ph. Caix).

We examined 40 embryos and foeti (issued from miscarriage), embryos presenting malformation were eliminated from our study.

**Dating of specimens**

Mugnier’s Tables were used to compare the gestational age of the embryos from 7 to 20 weeks.

The macroscopic study consisted of an examination either with the optical analysis or with a binocular microscope, followed by a macrophotography of the embryos.

Embryonic dating is not as much based on measurements as on morphological criteria. The latter method allows a thiner evaluation of the developmental stage reached by the embryo (Hamilton, 1972; Mugnier, 1964).

**Histological study**

The fixation of the embryos, carried out before their macroscopic examination was performed with Bouin’s solution for a minimum of 48 hours.

Embryo heads were then taken out. They underwent the usual histological technique allowing their orientated processes in paraffin (aqueous alcohol-toluene-paraffin solution).

The specimens embedded in paraffin were sectioned with a microtome in different spatial planes (Table I).

These were 4 microns sections which were smeared, deparaffinized and stained on the slide following Masson’s microscopic technique. Slides were examined with an optical microscope and were then photographed with a photomicroscope.

| Table I. The specimens were sectioned with a microtome in different spatial planes |
|------------------|-----------------|----------------|----------------|----------------|----------------|
| 7 week embryos  | 2 month foeti   | 2 month foeti  | 2.5 month foeti| 3 month foeti  | 5 month foeti  |
| frontal planes  | frontal planes  | horizontal planes | frontal planes | frontal planes | frontal planes |
| Number of specimens | 5 | 5 | 5 | 5 | 10 |
| 28 |

**RESULTS**

Our results describe what we observed on the embryos and foeti in serial sections.

At 7 weeks (fig. 1) we observed, in frontal sections, the stomodeum and the ectodermic invagination which contributes to form this stomodeum.

This latter at this stage constitutes a unique cavity. The lateral palatine processes are unmesodermsed, the tongue is in place in the stomodeal cavity, laterally Meckel’s cartilage is observable.

In the middle of the mesenchymatous environment we were able to define two condensations, one which will become the buccal mucous membrane, and the second on the inside of the future epithelium.

This mesanchymatous condensation corresponds to the migration and the placement of myocytes and myotubes which will become the future skin muscle.

At this stage it is inserted inferiorly at the level of Meckel’s cartilage and superiorly facing the lateral palatine process: this is the origin of the internal musculo-aponeurotical system.

Thus we noticed the early appearance of an external musculo-aponeurotical system and an internal musculo-aponeurotical system. At 2 months (figs 2 and 3) on the horizontal sections we could observe a linking structure posteriorly, the pterygo-mandibular ligament. The superior constrictor pharyngeus muscle is situated further back. A conjonctive expansion extends perpendicolar to this muscle: the pterygo-mandibular ligament which runs laterally and inserts into an anterior muscle: the buccinator.

This intermediate structure between the two muscles is dominantly collagensous, because the coloring method shows a colour linked to collagen. This confirms the conception of the intermediary ligament between the superior constrictor pharyngeus muscle and the buccinator muscle.

Furthermore we can observe the buccinato-pharyngeal ring joined by the pterygo-mandibular ligament (fig. 4).

The ligament runs forwards towards the buccal mucous membrane.

These fibres run horizontally towards the front of the section in the direction of the modiolus.

We can see that these muscle fibres pass under the modiolus, without inserting into it, in the direction of the labial commisure.

We noticed no adherence on the muscular commissural hub (fig. 5).

This observation is confirmed by dissections that we undertook on foeti and on adults. (The Levignac’s description shows the surgical dissociation between modiolus and buccinator.)

This section also confirms the existence of an angulation between the buccinator and the platysma muscle. Then, on a frontal section (fig. 6) we were able to confirm that although the parotid duct goes through the buccinator, this muscle does not develop a muscular sphincter around the secretory canal.

As in the previous slide, we noted the intricacion between the Buccinator muscle and the buccal mucous membrane. The sections performed at 2.5 months, 3 months, and 5 months enabled us to confirm our observations (primordium continuing their development).This is the growth period; it enabled us to observe the development of the structures. It must be noted, however, that the most interesting growth period is after birth, during which the vertical, anterior dimension is modified by the arrival of the deciduous teeth and then a second period with the arrival of the permanent dentition.
DISCUSSION

The facial musculature is composed with myocytes and connective tissue. The para-axial, lateral and precordial mesoderm produces the myotubes and myoblasts that fuse and form myocytes.

The cells of these striated muscles, which derive from this mesoderm are the source of the narrow relation between the mesodermal and mesoectodermal cells (Jost, 1984).

When an embryo reaches the 14th day, the mesenchyme is denser in the medial and ventral regions of the second brachial arc and surrounds the facial nerve at its termination (Gasser, 1965).

Then the first signs of mesenchymatous condensation appear in the embryo of 15 days. An invagination of the ectoderm is noticeable, at the base of the cephalic portion of the embryo.

It will form a fold at the level of the base of the cephalic portion of the embryo in the direction of the pharyngeal intestine: the stomodeum.

This ectodermic invagination will draw with it the underlying mesenchyme, that is to say the cells of the mesoderm and of the ectoderm forming an internal structure that we divide into orbicularis oris and buccinator but in fact, it is the same structure.

The invagination is limited by the pharyngeal membrane, a frontier region which constitutes the velum, posterior border of the buccal cavity.

This invagination also explains how a supposedly skin muscle, never inserts cutaneously but only on the buccal mucous membrane. Buccinator, due to its position, is a submucal skin muscle.

According to Gasser (1965) at the 15th day stage, a fusiform condensation appears superficially at the latero-caudal part of the mandibular arc.

This condensation develops two extensions during the 18-19th day stages, towards the caudal region of the mandibular arch. The ventral part develops in the upper cervical region, and is named the cervical lamina. Some cells
reach the region of the mandibular arc and are identified under the name of mandibular lamina.

The cervical lamina and the mandibular lamina unite at the 20-21th day stage.

The sub orbital lamina will also come into contact with the mandibular lamina.

It is at the 20th day stage that the buccinator muscle begins to appear. The emergence of all the elements of the muscular envelope is now in place. At the 24th day, the stomodeum is surrounded by the facial buds, the maxillary bud forming the maxillary bone; the mandibular bud forming the mandible. The buds develop in a latero-medial, and antero-posterior direction. Their anterior reunion will enable the formation at a distance of the commissural furrow.

It is during this event that the different bundles of buccinator develop.

The maxillary bud corresponds to pars maxillaris and the mandibular bud to pars mandibularis.

The anterior part of these maxillary and mandibular bundles contribute to the constitution of orbicularis oris. It is no longer a question, therefore, to consider as it is stated in the literature, that buccinator only inserts on the labial commissure. The horizontal fibres have no bony insertion, they run along the commissural angle and are therefore in relation with the commisural furrow and, at a distance, with the modiolus (Zhao 1999).

During our studies on the fetus, the appearence of Buccinator seemed very different from that of adults. The muscle runs very high, posteriorly facing the maxilla, it presents a large posterior angulation due to the presence of the underlying maxillary tuberosity. Likewise, it seems to be situated at 90° a little posteriorly, to the bony insertion of the superior constrictor pharyngeus muscle which is in adults relatively aligned with buccinator.

Horizontal sections performed on a fetus of 26th day confirmed our anatomical views.

The formation of the pterygomandibular ligament is obviously, specific to human species, resulting from the process of hominisation and due to the upright posture of the individual.

This upright posture has brought the buccinator and the superior constrictor pharyngeus muscles close together; it enables the formation of a neuromuscular “orbiculo-buccinato-lingo-velo-pharyngo-oesophageal” ring.

Thus the buccinator muscle enters the masticatory process, and is active during swallowing.

In the fetus, the absence of the vertical dimension of the buccal cavity and the horizontality of Meckel’s cartilage explains why Buccinator has a high insertion at the beginning of its development.

The righting of the individual, the modification of the cavity and of its pharyngeal structures pulls this muscle inferiorly, drawn by the formation of the pterygomandibular ligament.

The different observations, both anatomical and embryological make us think that posterior traction linked to the procedure stated above, draws buccinator from its superior position to its medial familiar position in adults.

We were unable to study this on babies or even on young children (Tamora, 1998), but all evidence leads us to believe that this development occurs gradually even following birth and even during adolescence.

The modiolus is a muscular para-commisural structure, having the aspect of a wheel hub.

It is the anchoring point of many skin muscles that allow the tensing of lips. This is a strategic region: it is the location of the junction of the canine muscles, zygomaticus, risorius, platysma, triangularis, orbicularis oris externus etc.

Buccinator was inserted on the modiolus (Tallgren, 1998). The embryological study that we have undertaken enables us to put in question the reality of these insertions on the modiolus. We consider that the unique deep structure divided into orbicularis oris and buccinator possesses a cleavage plane with the external S.M.A.S (superficial musculo-aponevrotic system) formed by the orbicularis oris externus, the modiolus and the muscles inserted into it.

Thus we can think that this muscle has lost all functional connection with masticatory and deglutitional rings.

The skin muscles play a role in human relations through facial expression, buccinator and orbicularis oris conserve their role in human relations, since they intervene in articulation of phonemes.

Concerning the relationship between buccinator and the parotid duct we have to consider that during ectodermic invagination, the skin enters the interior of the stomodeum and becomes the buccal mucous membrane. Moreover sweat glands are modified and become the salivary glands. Therefore the parotid duct must be considered as the duct of an “ex sweat gland”.

This duct (Arrigao, 1990) runs from the mucous membrane; opens into the buccal cavity facing the first molar; traverses the buccinator muscle roughly a centimetre anterior to the Masseter muscle, then goes around Bichat’s fat pad to terminate in the parotid gland.

Histological study enables us to affirm that Buccinator does not play a part as a sphinciter acting on the parotid duct.

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