Experimental and clinical considerations regarding the development and structure of the vomeronasal organ

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For many decades research concerning the various components of the nervous system has been one of the main interests of scientific interest. As a key component of intraspecific and interspecific communication, chemoreception is an especially important field in this type of research. Lately the accessory olfactory system has received much attention, and it has been established as a distinct research area alongside the main olfactory system.

Numerous papers have been published reporting on various aspects of the vomeronasal system of different species of animals and man. The structure and function of the mammalian vomeronasal system has been clarified, and emphasis has been placed on the major role of this system in intraspecific communication, especially in case of reproductive functions. As for the human vomeronasal system, contradictory results have been obtained and published regarding all aspects, i.e. vomeronasal organ frequency of occurrence, morphology, function and importance.

The author’s contributions are presented in several chapters, each of these containing the results of a distinct research phase. The first chapter establishes the criteria for a functional vomeronasal organ model, by examining the vomeronasal organs of laboratory animals (mouse, rat and cat) using histology, electron microscopy and immunohistochemistry, for later comparison with the human organ.

The second chapter is dedicated to the human fetal vomeronasal organ, describing its histological structure, and changes in length and volume during fetal development. 107 human fetuses have been processed, and the frequency of occurrence of the vomeronasal organ has been established in this material. Serial sections have been performed that were used for three dimensional reconstructions. Length and volume calculations have been performed, and the obtained values have been plotted against fetal age, thus obtaining growth curves of the organ.

The next chapter contains the results of a complex immunohistochemical study of the human fetal vomeronasal organ, aimed at pointing out the structures mandatory for a functional organ, established on the laboratory animals. Based on the above, the antibody panel has been clearly established, and contained neuronal, glial, epithelial, mesenchymal, endothelial and cellular turn-over markers. Each marker’s immunopositivity is followed up during the course of the examined fetal
periods, by establishing a digital percentile quantification method for immunopositivity, and plotting the obtained values against fetal age.

The last chapter is a complete investigation of the adult human vomeronasal organ. It comprises a prospective clinical study enrolling 111 volunteer subjects (aged between 17-67 years) examined by nasal endoscopy. This study established the frequency of occurrence of the vomeronasal organ in the studied population, and performed a classification of major clinical importance of the endoscopic aspect of the vomeronasal pit. Another part of this investigation consisted of the histological and immunohistochemical characterization of the adult human vomeronasal organ. A similar antibody panel has been used as in case of the fetal organ, and the obtained results have been compared to those obtained from the fetal material.

The main conclusions of the thesis are the following:

1. The rodent vomeronasal organ is a prototype of the mammalian vomeronasal organ, so these laboratory animals are best suited for the study of this system.
2. In case of laboratory animals the most important characteristics of a functional vomeronasal organ have been established: the presence of a neuroepithelium (using immunohistochemistry and electron microscopy), a vascular pump facilitating odorant access into the tube, a supporting cartilaginous capsule, and vomeronasal nerve connections.
3. In man, frequency data demonstrate an inconstant presence of the vomeronasal organ during fetal development (42%), as well as during adult life (57%), which suggests the idea of total or partial regression of the organ.
4. The neuronal population present during the early stages of human fetal development is gradually replaced by epithelial cells, a fact confirmed by neuronal and epithelial markers studied in evolution in fetal life and in the adult man.
5. There are no connections to superior nervous structures, a fact confirmed by the glial marker (S100) neither in the fetus, nor in the adult human.
6. The absence of a vascular pump (confirmed by CD34) both in the fetus and adult man, suggests lack of odorant access into the organ.
7. The above mentioned evidence suggest that the human vomeronasal organ is a phylogenetic vestigial structure that initially has the potential of a functional organ, but during fetal development this potential is lost.
8. Demonstration of vomeronasal pit endoscopic variability has a major clinical importance, aiding the ENT specialist in the differential diagnosis of various septal pathological processes.