

The vomeronasal organ of Jacobson and its implications in nasal pathology and surgery

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Abstract

Ludvig Jacobson published a scientific work in Danish in 1813, entitled "Anatomical description of a new organ in the nose of domesticated animals" but Kolliker can be considered the discoverer of the vomeronasal organ in humans. Potiquet described in 1891 the possibility of locating and identifying the Jacobson channel in the living man and hypothesized its possible role in the pathogenesis of some nasal septum lesions. The purpose of this study is to recognize the presence of vomeronasal organ in Italian patients and to discuss the importance of this anatomical structure in nasal pathology and nasal surgery by providing guidelines for a surgical respectful of this important anatomical structure.

Key Word: Jacobson, vomeronasal, nose, surgery, pheromone.

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INTRODUCTION

The discovery of the so-called Jacobson vomeronasal organ is attributable to the Dutch anatomist Ruysch¹ who in 1703 presented an image of the nasal septum of a 2-year-old child, describing a nasal canal to which he did not give a specific name and of which he did not indicate the function. These studies are published with Ruysch's original drawings in the Thesaurus Anatomicus. In 1809 Sommering¹ described the lateral view of a nasal septum of an adult describing the entrance to the canal that was later referred to Jacobson and which at that time had not yet been histologically defined

Ludvig Jacobson (1783-1843), a Danish anatomist who was greatly admired in his time, published a scientific work in Danish in 1813, reporting his research on the

vomeronasal organ^{1,2}. Being a pupil and admirer of George Cuvier¹) he sent him a French writing for publication in a French magazine, but it was not published before his death, while in 1811 Cuvier published a note with superficial considerations on the organ in his name of this organ and without anatomical tables. We owe Trotier^{2,3,4} the English translation of the original Danish publication by Jacobson² entitled "Anatomical description of a new organ in the nose of domesticated animals". In this publication Jacobson describes in detail with the aid of anatomical tables that he himself designed the location and structure of this new organ in the horse, ruminants, pachyderms, pigs, dogs etc. The Danish scientist describes the microscopic anatomy of the vessels and nerves of the vomeronasal organ, concluding that it is a secretory organ; however, considering the exceptional abundance of nerve endings, he hypothesized that the new organ was a type of sensory organ sensitive to stimuli of which human beings have no knowledge. On the other hand, Jacobson writes that humans possess only a rudiment of the organ, and for this reason he affirms that he had not the opportunity to make further investigations in man; it also states that, in the animals studied, this area of the nasal septum is probably the seat of a sense organ of which it is still not known and which needs to be deepened with further studies. These truly prophetic considerations, together with the

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meticulous anatomical description of the structure caused the attribution to the vomeronasal organ of the eponym Jacobson's organ with which it is universally known in scientific circles, even though the first description in man is not attributable to Danish scientist. Rudolf Albert von Kolliker (1817-1905), German professor of histology, was the first to identify histologically in 1877 an opening in the mucosa of the nasal septum of 4-month fetuses and to identify its confluence with the tubular cavity of the vomeronasal organ¹. He wrote "from now on I will call this structure organ of Jacobson". He also identified the so-called "paraseptal cartilage" a bar-shaped cartilage located below the vomeronasal organ subsequently described in detail by other Authors^{5,6}. He cites Ruysch's studies, but Ruysch identified the opening of the duct don't functionally connecting it to the vomeronasal organ¹. Considering all this, according to Bathnagar and Smith, who have translated the scientific work into English¹, Kolliker can be considered with full reason the discoverer of the vomeronasal organ in humans. Potiquet⁷, whose work was recently translated into English by Stoyanov et al.⁸, described in 1891 the possibility of locating and identifying the Jacobson channel in the living man and hypothesized its possible role in the pathogenesis of some nasal septum lesions. The French rhinologist after describing the anatomical landmarks of the vomeronasal organ in humans and the technique for detecting it in anterior rhinoscopy, states that with careful research it is possible to find Jacobson's organ in a significant percentage of living organisms. Potiquet believes that some injuries of the nasal septum such as iatrogenic and non-iatrogenic perforations, Hayec's ulcer, syphilitic and lepromatous lesions are located preferentially in the anatomical area of the vomeronasal organ and hypothesize that this may be a locus minoris resistentiae therefore its presence and its pathologies must be searched routinely in the clinical rhinoscopic investigation. Fawcett in 1911 describes the development of the human jaw and of the paraseptal cartilages⁵. Beck renews and expands such concepts in a thesis of 1963⁶. In more recent times we owe our knowledge on the vomeronasal organ to the study groups directed by Kunwar Bathnagar (University of Louisville) and by the French Didier Trotier. The Bathnagar group^{19,10,11,12,13,14,15,16,17,18,19} has not only historically framed the contributions to the knowledge of the vomeronasal organ, has investigated the prenatal development of the organ in the human fetus, has studied its histological characteristics in the chimpanzee and in man, has investigated the ultra structure and the endoscopic characterization of the organ and the epidemiological distribution of its presence in humans. We owe Trotier^{2,3,4} the English translation of Jacobson's

work as well as elegant studies on the structure and function of the vomeronasal organ in animals and humans²⁰. Trotier also studied the possible relationships between the vomeronasal organ and pheromones in animals and in humans by discussing the different patterns of response to molecular-symmetric molecules in heterosexual, homosexual and transsexual subjects thus opening an important window on the possible consequences on human sexual behavior in case of alterations of the vomeronasal organ originating from pathologies or surgical procedures. Various Authors^{21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36} have written case studies on the epidemiological distribution of the vomeronasal organ in the context of populations of various ethnic groups, with overlapping overall results; among these, Stoyanov³⁷ in 2016 studied the incidence in the Bulgarian population by analyzing a series of 966 rhinopharyngoscopies and highlighting the presence of the vomeronasal organ in 26.83% of the subjects examined.

Garcia-Velasco^{38,39} studied the incidence on a Mexican population of 1000 patients in 1991.

MATERIALS AND METHODS

We studied 1000 outpatients who underwent flexible fibroscopic rhinoscopy in the year 2018. The exams were videotaped and reviewed remotely in order to highlight the presence of the vomeronasal organ, either unilaterally or bilaterally. Patients had a gender distribution of 543 (54.3%) men and 467 women (46.7%). Of these patients, 70 underwent corrective surgery for congenital or acquired nasal septum deformities in the year 2018. Among the patients with septoplasty 56 (80%) were male and 14 (20%) female.

OBSERVATIONS AND RESULTS

On the 1000 patients studied the vomeronasal organ was found monolaterally on the right in 145 cases (14.5%), on the left in 123 cases (12.3%) and bilaterally in 22 cases (2.2%) for a total of 290 patients (29%) without significant differences between the two sexes. Among the 70 patients undergoing septoplasty the presence of the vomeronasal organ was found in 18 cases (25.71%) of which 7 on the right (10%), 8 on the left (11.43%) and 3 bilaterally (4.28%). None of the patients undergoing septoplasty presented postoperative complications such as bleeding, septal perforation, septo-turbinal synechia or significant residual deviation.

DISCUSSION

The data obtained by us are superimposable to those reported in the international literature^{37,38,39}. In particular, the percentages of finding the vomeronasal organ are very

similar to those reported by Stoyanov³⁷ on the Bulgarian population, while Garcia-Velasco^{38,39} in 1991 finds the vomeronasal organ in almost all the cases observed considering that among the cases in which the anatomical structure had not been highlighted, were many cases with septal deformities; after surgical correction of the septal deformity in almost all these cases it was possible to find the vomeronasal organ. In our experience we did not find any difference between preoperative and postoperative findings probably because the preoperative investigation performed with flexible endoscope is already sufficiently accurate and allows the vomeronasal organ to be identified even when it is hidden behind the nasal septum deformity that prevents its vision with the naked eye. It is evident that investigations on cadavers, especially if correlated by histological findings, give a much higher percentage of vomeronasal organ results than the purely clinical data of our series. For the identification of the vomeronasal organ we have followed the original indications of Potiquet^{7,8} which identifies a rhomboidal area of about 7 mm of height and 8 of depth in antero-posterior direction within which the vomeronasal organ can be searched; this area is located at about 23 mm from the angle formed between the cartilaginous septum and the upper lip. Based on anatomo-pathological and histological data, the finding of the vomeronasal organ has in man elevated percentages⁴⁰ similar to those of the animal species studied^{40,41,42,43,44} with the difference that in these the vomeronasal organ has a specific neurosensory function not specifically demonstrable in the human species in which the organ is probably a vestigial meaning as already hypothesized by the same Jacobson^{1,2}. Potiquet^{7,8} highlights the role of the vomeronasal organ in the nasal pathology, highlighting that the location of the organ corresponds to that where nasal diseases such as Hayek's ulcer, most of the perforations of the nasal septum of any origin and most of the nasal septum varices, are usually reperated; the normal zone of the vomeronasal organ of Jacobson corresponds for large lines with the locus Valsalvae or area of Little, seat of vascular anastomoses between the tributary nasal vascular territory of the external carotid artery and the tributary of the internal carotid where there are capillaries at subepithelial localization (Kubo capillaries) frequent site of anterior epistaxis; the same Jacobson highlights in the animal the abundant vascularization of this area which confirms what has been said so far. Electrical burning of nasal varices in this area should be limited and pinpointed as far as possible to avoid direct lesions of the vomeronasal organ. During a septoplasty the approach to this area must be as conservative as possible following an essentially extramucous technique as suggested by Garcia-

Velasco^{38,39}; this allows not only to avoid injuries in the region of the vomeronasal organ which is often present even when clinically not visualized, but also to reduce the risk of iatrogenic perforations of the nasal septum frequently found especially in this area especially if the technique is not sufficiently delicate and conservative. Endoscopic septoplasty^{45,46} allows an even more conservative approach to septal deformity, allowing its correction with less morbidity and a lower risk of lesion of the vomeronasal organ. We know from the literature^{5,6} that the paraseptal cartilage is found beneath the vomeronasal organ; in case of its hypertrophy it is possible to find the so-called doubling of the quadrangular cartilage which poses some problems of intraoperative management of the septal deformity. A rare pathology of the nasal cavities is the ectopic olfactory neuroesthesioblastoma⁴⁷ whose finding, although not frequent, would suggest the presence of olfactory-like receptors in the nasal septum. Another important aspect to keep in mind is the possible function of the vomeronasal organ in the regulation of sexual behavior in the human species and the possible implications of a surgical alteration of the vomeronasal organ itself. Kaneko⁴⁸ points out that in the mouse the vomeronasal organ is a receptor for the male pheromone; the increase in uterine weight of the female exposed to the mouse male is inhibited by the removal of the olfactory bulb. Bathnagar and Smith^{1,9,10,11,12,13,14,15,16,17,18,19} studied the presence of the vomeronasal organ in fetal life and its role in the migration of secretive Gn-RH cells from the olfactory placode to the brain; they also highlighted the presence of the organ after birth and until late age in humans with probably vestigial functions. Trotier^{2,3,4} while agreeing with the vestigiality of the vomeronasal organ in humans, highlights the still not well known role of pheromone substances in humans leaving open the possibility of a pheromone receptor function of the vomeronasal organ. Mostafa⁴⁹ investigates the possible role of pheromones in sexual and reproductive function in humans, citing an extensive bibliography on these aspects. Oliva⁵⁰ comes to hypothesize that in some cases the homosexual behaviour in humans may be due to a functioning vomeronasal organ able to recognize pheromone molecules of the same sex. Meredith⁵¹ in 2001 critically reviewed the literature on the function of the vomeronasal organ. The positive evidences derive mainly from the studies of Monti-Bloch^{52,53,54,55} that report an electrophysiological response following the local application in the region of the human vomeronasal organ of small doses of steroids, recording a real "electrovomerogram (EVG)"⁵⁵. Meredith⁵¹ does not give a conclusive opinion but states that the EVG is evidence for a selective and sensitive response of the vomeronasal region to chemical stimuli of human

derivation. The responses of the autonomic nervous system and the emotional changes elicited by the stimulation of this region suggest a chemosensitivity even if the anatomical substrate is difficult to prove and the mechanisms are likely to be unconventional and require more reliable scientific evidence⁵¹.

CONCLUSIONS

From the data we elaborate and from the examination of the literature certainly derives the evidence of the need for greater attention to the vomeronasal region in nasal surgery. Surely this area constitutes an anatomical entity that is clinically detectable in many cases and is present histologically in an even greater number of cases in which in dealing with surgical procedures such as the electrical burning of nasal varices in this area or septoplasty we must take into account the presence of this anatomic entity that can constitute a locus minorisresistentiae favoring complications such as septal perforation or abscess or septal hematoma. If the pheromonic chemoreceptor role was demonstrated with the ability to condition sexual behavior in the human species, the anatomical respect of this anatomical structure would take on a fundamental meaning. While waiting for further scientific studies to clarify these aspects, we propose a prudent surgical approach based on the following fundamental points:

- In case of epistaxis interventions in the vomeronasal region, always perform minimal electric burnings, if possible with bipolar and low energy equipment with preservation of the underlying structures
- In case of traditional septoplasty, carry out essentially sub-pericondral and subperiosteal maneuvers with the least possible removal of cartilage and bone material in the region of the joint between vomer and quadrangular cartilage
- In case of endoscopic septoplasty locate the vomeronasal organ outlet and, if possible, making sure that the septal incision does not damage the vomeronasal structures and that these are not damaged by subsequent subpericondral and subperiosteal maneuvers
- These measures, beyond the respect of the vomeronasal structures, are however principles of conservative surgery that in any case are useful in preventing iatrogenic complications and that regardless of everything they have always returned to our surgical philosophy^{45,46}.

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