THE PHYSICAL CHARACTERISTICS OF THE VOMERONASAL ORGAN IN THE PAKISTANI POPULATION

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ABSTRACT

The vomeronasal organ (VNO) is an essential functioning organ in some animals. There are reports of its presence in humans as well. This study on the Pakistani population sets out to chart out the physical characteristics of this organ. A total of 503 subjects were recruited for this study with 258 (51.3%) males and 243 (48.3%) females. The organ appears on the nasal septum in different forms. On an average the VNO could be identified positively in 46.3% of the subjects. The organ was positively identified in almost half of the subjects. The presence of the organ was seen more on the right side of the septum. The minimum height of the opening of the VNO from the nasal floor came out to be 0.35 cm (average) and the maximum to be 2.5 cm (average). The nasal septum was found to be deflected towards the right most of the time (45.2%). The vomeronasal duct was found to be from 1 – 3 mm in length in most of the cases where it was present. Future research should focus on the functional aspect of the vomeronasal organ in the Pakistani population.

Key words: Vemeronasal organ, Jacobson's Organ, Vemeronasal Nerves pheromone, Olfactory pathways.

INTRODUCTION

Historically speaking, a number of scientists have shown interest in the Vomeronasal Organ (VNO) and its possible existence in humans. Right from the beginning of the eighteenth century researchers have been intrigued by the existence of this mysterious organ. Despite paucity of sophisticated instrumentation at the time, meaningful advances were made then, concerning the existence of this organ in animals and humans alike.

In the beginning of the 18th century Ruysch[1] attempted to find the opening of the organ and did so which he thought was an organ which expels mucous. Ruysch, some two hundred years later came under heavy criticism by Bhatnagar et al. 2003.[2] Bhatnagar and his colleagues insist that what Ruysch was observing was not the VNO at all but were various pot holes in the lining of the nasal septum known as "mucosal pits". These mucosal pits are small to large in size and also vary in their depths as well. Thus, Bhatnagar et al. state that the VNO is at a higher plane than the level suggested by Ruysch, which is too low a level for the VNO opening.

During the early 19th century Samuel Thomas Von Sommering (1755 – 1830)[3] also described the VNO. Ironically, Ludwig Levin Jacobson (1811),[2] with whose name this organ is associated with these days is said to have stated that the VNO had "vanished completely in man". Ironically, Jacobson is not the first scientist to discover this organ. It was Emil Dursy (1828 – 1878)[4] who recognized and documented its presence in the human head and named it "Jacobson' schen organe". However, it was Rudolf Albert Von Kolliker (1817 – 1905)[5] who studied human fetuses and named this organ the "Vomeronasal organ".

Embryologically, the VNO is derived from the olfactory placode (Bossy, 1980;[6] Garrosa, 1998).[7] Bhatnagar and Smith, 2000, strongly confirm that the human VNO is the homologue of the sensory structure observed in other mammals including the central connections of the vomeronasal nerves (Pearson 1942).[8] Its presence in the nose is noted throughout all three trimesters. However, some authors claim that the organ regresses with advancing age (Bossy, 1980;[6] Kreutzer and Jafek, 1980).[9] Rolinski et al, 2000,[10] claim that the human VNO is a large epithelial tube that was found superolateral to the bulbous inferior tip of the nasal septum and was within the same cross sectional region as the paraseptal cartilages.

It was Negus et al. in 1958[11] who described it to be present at the base of the nasal septum and begins as the VNO from which vomeronasal nerves terminate in the accessory olfactory bulb. And he stated that these organs detected certain chemicals called "Pheromones". Genetically, the two mammalian VNO genes detected recently by Ryba and Tirrindelli, 1997,[12] are closely similar to genes found in humans as well.

Therefore, we find the opening of the VNO in humans on the anterior nasal septum on both sides. This entrance into the VNO, if present, can be in the shape of a rounded opening or as a slit.

The VNO is at times, seen as a duct in humans and at others as just an impression or a dimple on the nasal mucosa. Various authors have tried to measure the length of the duct, if present. Stensaas et al, 1991[13] examined the VNO and described its length to be about 5 – 10 mm. while Ishimitz K, (1958)[14] noted it to be 2.52 mm. In their study of the location of VNO, Bhatnagar and Smith 2001,[15] described it as a recognizable surface feature of the anterior septum as small fossae. According to these authors it was situated on both sides and is quite constant in its position of about 3 – 5 mm posteriorly and having a "small, slanting variably sized duct". They further describe a 'rarely wide opening of the VNO' which was about 1 mm in diameter according to them.

Certain other researchers such as Winstead et al, 2000[16] were unable to find the openings but did observe septal fossae consistently located 7 – 10 mm above the palatal mucosa and 10 – 20 mm posterior to the anterior nasal spine. Zbar et al, 2000[17] have proposed a classification system dividing into four classes ranging from absent VNO through to lumen size of less than 2 mm to more than 2 mm and multiple lumina. The observations of the above researchers including Stensaas and Winstead alike, is consistent with what we found in our study. At times the existence of the VNO is very certain while at other times it is not so clearly identifiable. It is however, consistently present and identified in one particular individual on repeated examinations.

Karlson and Luscher,[18] in 1959 described the pheromone as "a substance secreted by an animal to the outside of that individual, which is than received by another individual, classically of the same species, which then elicits some behavioral or developmental response in the latter". The pheromones are thought to act through the VNO. That makes it the most useful organ in lower creatures such as the silk worm moths and animals such as rodents and reptiles such as the snake which use pheromones to communicate with the members of the same species. These animals use this organ and the pheromones as chemomessangers.

Pheromones have been demonstrated in humans and have been used in the cosmetic industry as a sex attractant (Knowlton, 1994).[19] Cutler et al, 1998,[20] after experimentation concluded that the human male pheromones did increase the sexual attractiveness of men to women similar to their action in lower animals.

In order to prove a functioning VNO in humans or an actual effect of the pheromones several researchers have looked into the microstructure of the VNO. Berliner et al, 1996[21] have claimed to have found the existence of a functional pathway connecting the VNO and the pituitary – hypothalamic regions. Similarly, Grosser et al, 2000,[22] claim to have achieved various autonomic physiological responses (such as in cardiorespiratory rates, EEG tracings and skin responses) at various time intervals. This hints at the fact that the pheromones and the VNO do have an actual physiological effect in humans.

The present study sets out to evaluate the existence of the VNO in the Pakistani population and certain of its basic physical characteristics.

SUBJECTS AND METHODS

All subjects coming in for a nasal endoscopy in the ENT department of Shalamar Hospital were possible recruits with the following selection and exclusion criteria.

The Selection Criterion was as under:

1. All patients coming into the endoscopy unit for a nasal endoscopy were recruited.
2. There were no age limits.

The Exclusion Criterion was as under:

1. Subjects with an active nasal discharge or infection.
2. Subjects with nasal tumours.
3. Subjects with epistaxis.
4. Subjects who had suffered nasal trauma recently or in the past.
5. Subjects who had any nasal or plastic surgery carried out on their noses recently or the past.

A regular consent for the above procedure was sought and in addition subjects were informed of the various measurements to be taken from inside of the nose.

The ethical committee of the hospital gave their permission for the above study.

To examine the patient for the VNO the patient was explained in detail about the procedure and the consent taken for the endoscopic examination. The nose was prepared with the local anaesthetic (4% lignocaine solution). Occasionally, when the inferior turbinates were too enlarged obscuring the anterior nasal septum a local decongestant such as the xylometazoline spray (2 puffs as required) was used. This is important with enlarged inferior turbinates as the opening of the vomeronasal organ is on the part of the nasal septum which is medial to the anterior end of the corresponding inferior turbinate.

Once the patient had been sitting for 10 minutes after the nose had been prepared, they were asked to lie down on the examining couch with the head slightly turned towards the examiner for the nasal endoscopy to proceed. An initial general limited insertion of the tip of the endoscope in either nostril and some words of encouragement gained the confidence of the patient, especially the apprehensive ones, allowing the detailed examination to safely proceed.

The thirty degree endoscope was used to highlight the opening of the VNO if present. Once the opening was picked up, the process of measurement and documentation was completed.

A specially marked (in mm) stainless steel rod (2 mm diameter), was used to measure the site of the opening from the anterior nasal spine (this is the fixed bony point nearest to the opening, taken as the reference point). The steel rod was held in the right hand, so that the right index finger rests above the length of the rod and the right middle finger was below this rod. The right thumb stabilized the rod between the index finger and itself. The middle finger rested along the lower surface of the rod and stopped at the anterior nasal spine and remained at this fixed spot on the rod, so that the tip of the rod rested at the opening of the VNO, while the proximal end was the spot marked by the middle finger on the rod at the anterior nasal spine (Fig. 1).

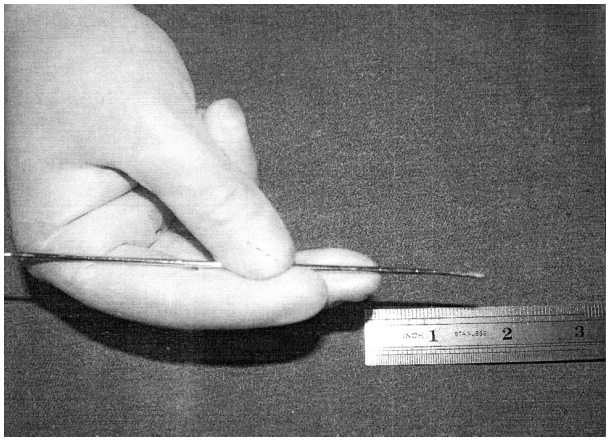

Fig. 1: *Probe used to measure the distance of the vomeronasal organ from the anterior nasal spine.*

The rod and the right hand complex was removed once the two points of the opening of the VNO and the anterior nasal spine were determined and held marked on the rod. This complex was transferred to a metal rule, and the length of the rod from its tip to the fixed point of the middle finger were measured on the mm scale and noted. This was the horizontal distance from the anterior nasal spine to the opening of the VNO. Thus, this length measured the horizontal position of the VNO from the anterior nasal spine to the vomeronasal opening.

The height of the opening of the VNO from the nasal floor was measured with the modified eyelid retractor. There is a screw mechanism at one end which allowed the legs of the retractor to open or close as the screw was turned one way or the other. With the retractor turned on its side, the legs of the retractor, were opened, in the vertical axis to allow the height of the VNO opening to be measured from the nasal floor. One end of the vertically positioned retractor touches the nasal floor lightly and the other is along the top edge of the opening of the VNO as the screw is turned (Fig. 2). Once the correct position was reached as seen with the endoscope on the monitor, the retractor was removed from the nostril and transferred to the metal rule scaled in millimeters. The distance between the opened legs of the retractor were measured making sure that the outer borders of the leg surfaces were taken as the measuring surfaces. This distance is thus the height of the VNO from the nasal floor. If there was a tract found with the blunt ended eye probe, it was measured in mm with this specially marked probe and noted. The direction of this tract was also noted using the probe.

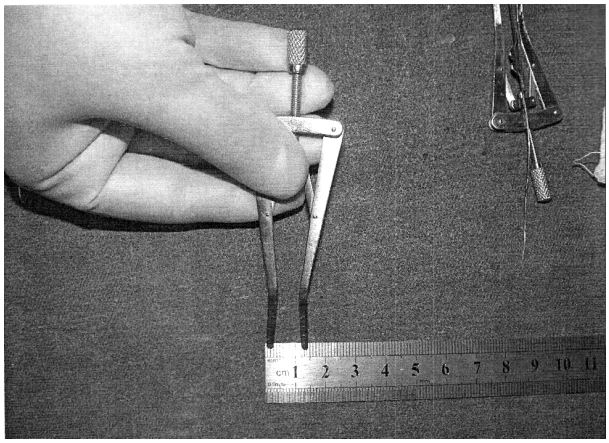

Fig. 2: *Modified eyelid retractor used to measure the height of the opening of the vomeronasal organ from the floor of the nose.*

The marked eye probe was also used to measure the diameter of the opening or impression of the VNO. The general shape of the VNO on appearance under the endoscope was also measured. These opening shapes were variously classified depending on appearance alone. In addition to these measurements, the deflection of the nasal septum, if present at the area where the VNO opening is present on the nasal septum, was also noted.

The senior author (SA) developed a new classification system for the VNO opening depending upon the shape of the opening and its depth (Fig. 3).

The classification of the shape of VNO employed in this study (Fig. 3).

1. Impression.
2. Shallow impression.
3. Superficial pit.
4. Deep pit.
5. Slit.

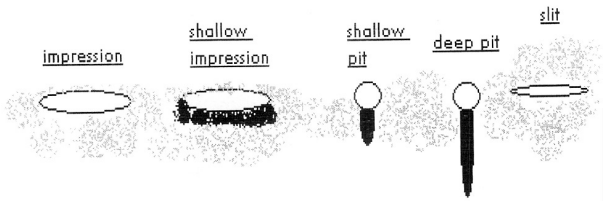

Fig. 3: *Visual shapes of the openings of the vomeronasal organ.*

In the classification above, the:
"Impression" describes a pale area of the nasal mucosa at the expected site of the VNO. This may be slightly pigmented, but the area is at the same surface level as the rest of the nasal mucosa. It is not depressed either. The area is round or oval in circumference. *"Shallow Impression:* describes the area of the VNO which is slightly depressed, as compared to the rest of the surrounding nasal mucosa. This is also round or oval in its outline.

"Superficial Pit" describes the opening of the VNO, which in appearance presents a narrow opening, but does not seem to be too deep in its vertical axis.
"Deep Pit" is the opening of the VNO which in appearance presents a narrow opening but which also seems to be deep in its vertical axis.
"Slit" is a usually horizontally disposed slit of varying length. It can also be vertical in axis but very rarely. This slit may or may not have a channel.

RESULTS OF THE STUDY

Number of subjects recruited (N): 503.

The males subjects were 258 (51.3%), while the females subjects were 243 (48.3%). Two subjects requested omission from the study.

The age range of the subjects recruited was 4 years to 75 years with a mean age of 28.54 years (S.D ± 15.1).

The mean age of the males recruited was 29 years and of the females was 28 years.

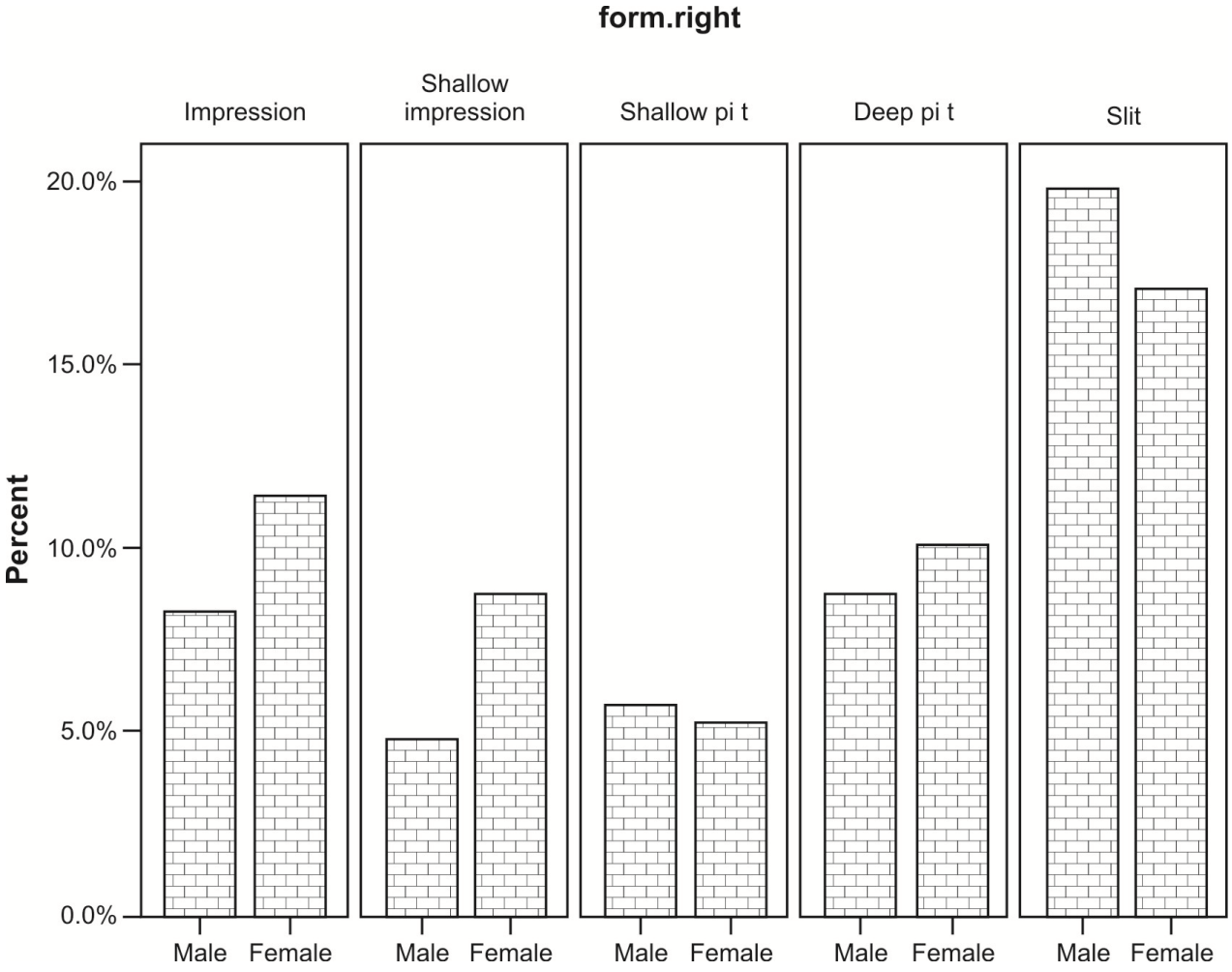

Fig. 4: *The shape of the opening of the vomeronasal organ on the right side of the septum according to gender.*

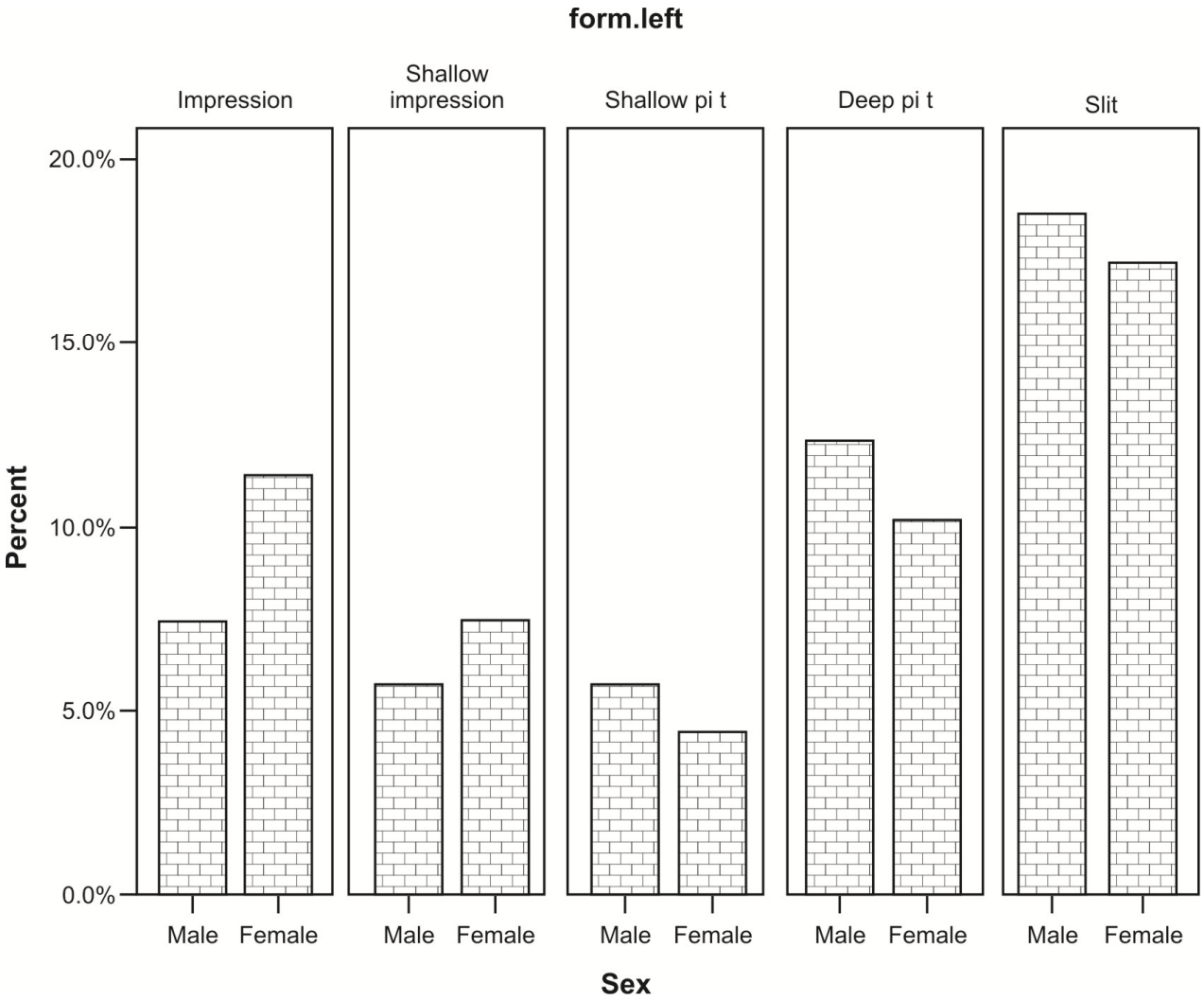

Fig. 5: *The shape of the opening of the vomeronasal organ on the left side of the septum according to gender.*

Total no of times seen on left and right.

The VNO was clearly seen on the left in 45.9% and on the right in 46.7% of the subjects. On an average the VNO could be identified positively in 46.3% of the subjects.

The VNO was seen more in males on the left side (n = 117), while it was seen more on the right side in females (n = 125).

Overall the ENO was seen more in females (n = 239) and more on the right side (n = 235).

Form of the VNO seen on nasal endoscopy

Of all the subjects, on the left side, the commonest form of the VNO appearance was in the form of a slit (35.5%), followed by a deep pit (10%). Similarly on the right side as well the commonest appearance was in the form of a horizontal slit (36.8%), followed by an impression of the VNO (19.7%).

On the *left* side, the commonest appearance of the VNO in males and females was of a slit (37.7% and 33%, respectively).

On the *right* side the commonest appearance of VNO was again of a slit in males (42%) and the females (32%).

Distance on the nasal septum of the vomeronasal opening from the anterior nasal spine

In the *majority* of males on the *left* and the *right* side the distance from the anterior nasal spine to the VNO opening was found to be 2.5 cm. This distance was 2 cm in females on the right side and 2.5 cm on the left.

As far as the VNO opening distance (from the anterior nasal spine) is concerned, the minimum distance noted was 1 cm and 1.4 cm respectively on the right and left sides. The mean distance was the same of 2.3 cm on the left and the right side.

The maximum distance (VNO opening distance)

was 3.7 cm (left) and 3.8 cm (right).

Height on the nasal septum of the VNO from the nasal floor

The *minimum* height of the opening of the VNO as measured from the nasal floor came out to be 0.4 cm (mean), on the left side and 0.3 cm (mean), on the right side.

The *maximum* height of the opening of the VNO from the nasal floor came out to be 3 cm on the left side and 2 cm on the right side.

The mean height on the left side was 1.2 cm and on the right side it was 1 cm.

Nasal septum deviation

The nasal septum was deflected the most towards the *right* in the males (51% of the total number of males) and the females (39.4% of the total number of females subjects).

However, it was found to be in the *midline* in 20.7% of the total number of males in the study and 31% of the total number of female subjects.

The vomeronasal duct

A duct of the VNO was detected in 137 (27%) subjects out of a total of 503.

In the subjects in whom the duct was detected about half were males and half were females.

On the left side, the length of the duct in the males was in majority 3 mm and in the females was 1 mm. on this side the majority of the ducts were of 1 mm length.

On the right side, in the males the length of 1 mm (23%) and 3 mm (23%) were the commonest. While in the females on this side the length of 3 mm was in majority (32%) of all females on the right side).

DISCUSSION

Various methods have been used in the past to visualize the VNO. Anterior rhinoscopy has been used by several authors (Zbar et al, 2000;[17] Gafar et al, 1998;[23] Johnson et al, 1985;[24] Moran et al, 1991;[25] Garcia – Casas, 1995)[26] and were successful in locating the VNO to a varying degree (6%; 16% 39%; 100% and 100% respectively). Microscopic examination in cadavers was conducted by Johnson et al 1985[24] and achieved 70% success. These researchers found the VNO one side or both to a varying degree (i.e. Unilateral in 27.3%; Bilateral in 31.8%; Absent in 40.9%). This, they concluded that the VNO was '1.8 cm posterior to the nasolabial angle and 0.77 cm from the nasal floor'.

Nasal endoscopy, done by Won et al, 2000,[27] achieved a somewhat lower success rate of 28.2%. They measured the VNO by imagining a vertical line through the nasolabial angle to the centre of the suspected VNO. The vertical height was measured from the nasal floor to the centre of the organ. A VNO was considered 'positive' if there was a mucosal depression significantly deepened toward the perichondrium. As far as the endoscopically examined patients were concerned there were Unilateral VNO openings seen in 20.5%. Bilateral VNO seen in 7.7% and an absent VNO in 71.8%.

Abolmaali et al, 2001[28] have shown a high variability in the appearance of the VNO on MRI. Sometimes the opening of the nasopalatine duct can be misinterpreted falsely as the VNO as well.

Stensaas et al, 1991[29] were able to identify the VNO in 93% of the plastic surgery patients whereas Mondragon, was able to identify a 'positive pit' in 91% of rhinoplasty patients. These authors concluded that the VNO was present in most humans and that magnification was required to see it.

The Hopkins rod telescope was used to visually recognize the opening of the VNO in the present study. The VNO was seen, at least visually, in almost half the patients examined.

Future Pakistani studies should include histological methods also for detection of the VNO. The physical characteristics measured in this study are consistent with the values presented in the world literature. We have found the method of measurement that was adopted well suited to the task. This method was a quick and an accurate way of measuring the VNO. It has shown consistent results. The instruments of measurement are cheaply available and are also quite durable.

The determined figure of the length of the VNO in the present study falls within the range of numbers provided by Bhatnagar et al. 2001[15] However, they used histological methods to positivity identify and measure the length of the VNO. In contrast, we found that the it was possible to correctly and clearly identify the VNO by endoscopic means.

The nasal septum was deflected the most towards the right in the present study at the particular area of the septum.

There is a distinct difference between the deflections on either side, nature being more in favour of the right side. The reason the deflection of the nasal septum was included as an item in the data collection was that the senior author (SA) was trying to ascertain if there was a connection between the deflection of the septum and the presence or otherwise of the opening of the VNO. As has been discussed above, almost half the subjects had evidence of the presence of the VNO, however, there was no correlation between the side of the deflection of the nasal septum and the positive presence of the opening of the VNO.

It is *concluded* that future research into the Pakistani VNO needs more sophisticated instruments

for examination and detection of the organ. Perhaps, a detailed histological or radiological study on the Pakistani nose is required to definitely identify the organ's presence.

Physiologically, further study is also required on the functionality of the organ in Pakistan.

Another area of possible future research will be on its genetic aspect and the possibility of switching on and off the VNO genes.

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