Applied Anatomy and Physiology of Nose

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9.1 Applied Anatomy of Nose

Nose contains external nose, nasal vestibule, proper nasal cavity and sinuses.

9.1.1 External Nose

External nose protrude from the center of face (Fig. 9.1). Its upper end rises up between two eyes, this is called nasion. Where the most prominent part of the lower exterior nose is called nasal apex. The interconnection piece between them is called Rhinal Bridge, whose bevel is called nasal dorsum. There are two anterior naris separated by the nasal column and their upper and lateral profiles are constituted with the nasal alar. The nasal alar is a round hump and the nasal alar flap mostly occurs in dyspnea.

Shapes of the external nose depend on the bone and the cartilage support. Upper 1/3 of the external nasal support is bony, mainly constituted with nasal bone, and lower 2/3 is formed with several cartilages. Upper nasal bone is narrow and thick, lower is wide and thin, so nasal fracture mainly occurs in the lower and it manifestates as rhinal dorsum collapse of the suffered side.

The nasal skin is thicker at the nasal apex and the nasal alar, containing plenty of the sebaceous and the sub-oriferous glands, which is also the leading sites for the nasal furuncle. The sub epithelium tissue is dense so swelling of the skin cause severe pain due to compression of the nerve endings during inflammation process. The external nose facial veins afflux at the angular veins and the venae facialis anterior. The venae facialis anterior opens to the cavernous sinus through the venae ophthalmica superior and inferior, and there aren't any venous valves, what makes the up and down circulation, such as the oppression on the nasal furuncle causes the risk of the congestion cavernous sinus thrombophlebitis. And the patients will experience headache, rigor, high fever, eyelid and tunica conjunctiva edema, protopsis, and the severe form could cause death.

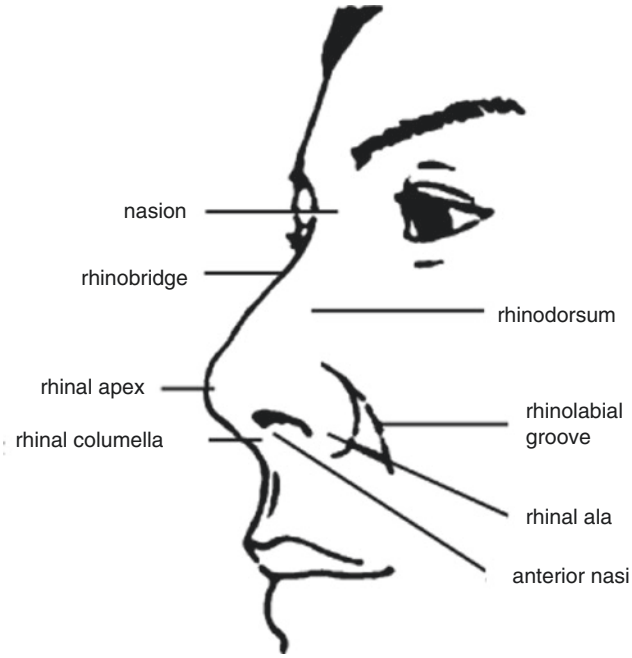

Fig. 9.1 The external nose anatomy

9.1.2 Rhinal Vestibule

It starts at the anterior naris and ends at the inner nostril, which corresponds to the field surrounded by the nasal alar. The nasal column divides it into right and left parts. The rhinal vestibule is lined with skin abundant in sebaceous glands and has nasal hair (rhinothrix).

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9.1.3 Proper Rhinal Cavum

It's also called rhinocavum (nasal cavity), which originates from the inner nostril and ends at the posterior nostril (choana). The internal wall is the septum nasi and divides the cavum nasi into the right side and the left side. The anterior and inferior parts of the nasal septum are composed of nasal septum cartilage, and the upper and posterior parts are bone osteone. Most at times, the septum nasi is slightly frank curveted or locally protruded without any symptoms to be dealt with.

The lateral cavum nasi wall has complex structures, including three echelons lining bony tissues from up to down, the superior nasal concha, the middle nasal concha and the inferior nasal concha (Fig. 9.2). The inferior nasal concha is the biggest, and it previously ends at the internal cavum nasi, inferiorly ends at the choana and also 10–15 mm to the pharyngeal opening of the eustachian tube. Hence, the swelling of the inferior nasal concha during rhinitis can not only cause nasal obstruction, but also hinder the ventilation and drainage function of the eustachian tube, resulting in tinnitus, hearing loss and other symptoms.

Between the inferior nasal concha and the lateral wall of the nasal cavity is the inferior nasal meatus, which is dome-shaped and has an opening of nasallacrimal duct at the top. The lateral wall of inferior turbinate is the thinnest 1–2 cm away from the anterior end of inferior turbinate, which can be used as the needle entry site for maxillary sinus puncture. The middle rhinomeatus locates at the infralateral middle nasal concha and it is the drainage aperture of the frontal sinus, the anterior ethmoid sinus and the maxillary sinus. Because the anatomic structure abnormality and the pathologic change of the middle nasal concha, of the middle meatus nasi and on the peripheral area are closely attached to the nasosinusitis, there is an ostiomeatal complex, including the ethmoidal infundibulum, the processus uncinatus, the ethmoidal bulla, semilunar hiatus, the middle meatus nasi, the anterior ethmoid sinus, aperture sinus frontalis, the maxillary sinus aperture and other structures.

The gap between the middle nasal concha and the nasal septum is the olfactory fissure, which absorbs the airflow into the olfactory field. If the nasal septum deviates or the middle nasal concha swells it can causes the olfactory fissure obstruction and finally decreases the smell sense. The entire cavum nasi lining mucosa could be divided into the olfactory field and the respiratory region according to the mucosa features. The olfactory field locates at the middle superior cavum nasi, covered with the olfactory mucosa whose contents the olfactory glands, the olfacto cytes and the olfactory nerve, perform the olfactory function. The respiratory region is the sites under the horizontal fontal middle nasal concha in the cavum nasi. Most of the mucosa at this region is the ciliated columnar epithelium and is the continuity to the nasal sinus, the nasopharynx Eustachian tube and the middle ear cavum tympanum cavity. The nasal mucosa inflammation could spread to these corresponding positions above to cause the eustachian tube deformity and the otitis media.

There are abundant blood vessels in the nasal mucosa, especially the inferior nasal concha. There are plenty of the vascular sinuses, so it's also called the nasal concha cavernous body. Based on the main functions of these vessels, they can be divided into the capacity vessels (vein, vascular sinus), the resistance vessels (arteriole, arteriovenous ramus anastomosis) and the exchange vessels (capillary). Autonomic nerve branches innervates the blood vessels causing vasodilatation and vasoconstriction that regulate blood flow and change the volume of inferior nasal concha, which play an important role in the normal physiological function of nasal cavity (cavum nasi).

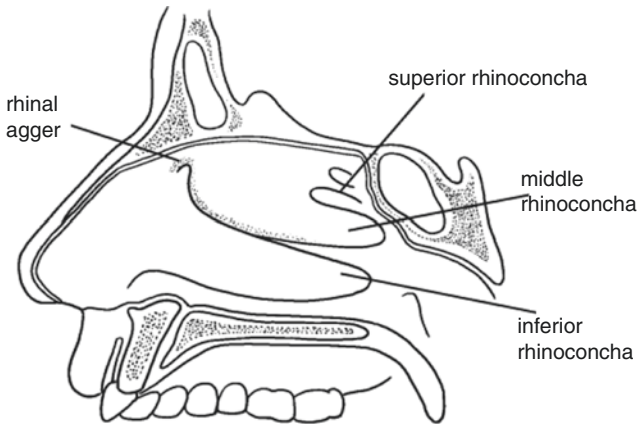

Fig. 9.2 The nasal fossa parries lateralis anatomy

9.1.4 Paranasal Sinuses

The paranasal sinuses are the air-containing cavities in the craniofacial bone surrounding the cavum nasi, all open to the aperture contained with the cavum nasi. The inter sinus continues through the aperture sinus and the cavum nasi mucosa, and the inter sinus secret expels from the aperture sinus. The nasal sinus is around in pairs at left and the right sides, summing to four pairs. The sinus mucosa continues with the nasal mucosa through the ostium of the sinus, and the sinus endocrine is discharged through the ostium of the sinus. There were four pairs of paranasal sinuses (Fig. 9.3).

According to the locating skull parts, it can be divided into maxillary sinus, ethmoidal sinus, frontal sinus and sphenoid sinus.

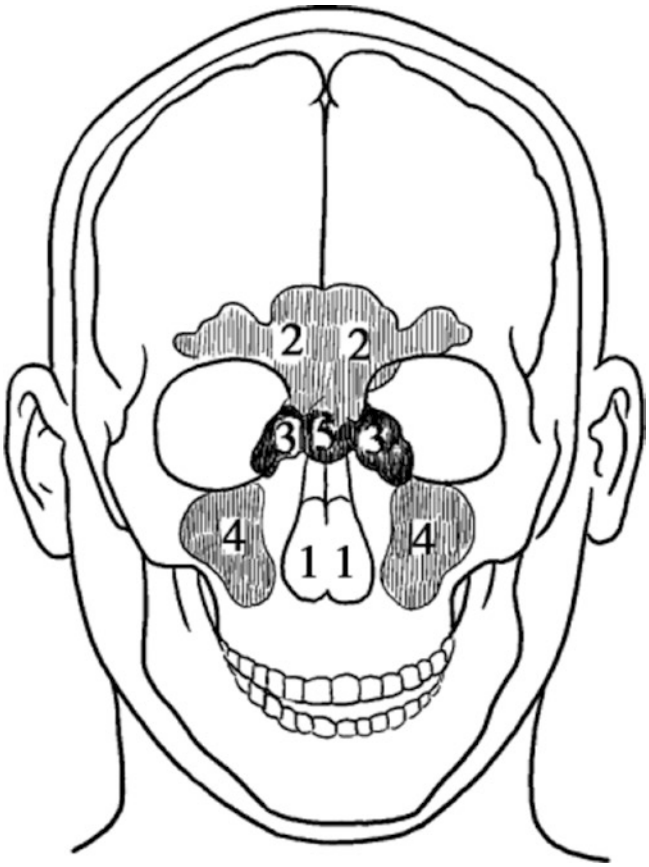

Fig. 9.3 The nasal sinus. 1. The nasal fossa; 2. The frontal sinus; 3. The ethmoidal cellules; 4. Maxillary antrum; 5. Sphenoid sinus

The maxillary sinus locates at bilateral profile of the cave nasal and is the biggest of the nasal sinuses. The maxillary sinus's superior wall is also the inferior orbital wall, it is also where the maxillary malignant tumor invades the orbital wall to cause the protrusion of the eyeball and fracture could cause the exophthalmos. The nasal sinuses' basic wall is the maxillary bone alveolar process. The first and second molars fang (root) inflammation could evoke the odontogenic maxillary sinusitis. The maxillary sinusitis originally occurs as the maxillary sinus carcinoma at the basic wall and symptoms at its early stage are the gomphiasis, the numbness and the toothache. The internal wall of the maxillary sinus is the lateral wall of the cave nasal and its aperture is in the middle meatus nasi. The aperture locates at a high sites and the sinus cavity base is lower to the cavum nasi base, so the structures cause the intrasinus secreta drainage abnormality and finally the maxillary sinus could be easily susceptible to infection. The post-lateral wall is adjacent to the infra temporal fossa and the pterygopalatine fossa, and it is the sites where the maxillary sinus carcinoma affect this wall and invades the medial pterygoid muscle resulting in limited mouth opening.

The ethmoidal sinus locates in the ethmoid between the orbital and the cavum nasi. Its lateral ethmoid papyraceous lamina wall is adjacent to the ethmoid paper like plate. The sinus ethmoiditis could evoke the intraorbital inflammation through the papyraceous lamina. The upper wall is the ethmoid apex and upwards the anterior cranial fossa.

The frontal sinus locates in the frontal bone upwards the nose and is around in pairs at left and right. The ethmoid sinus opens to the frontal fossa through the aperture of the frontal sinus and its base decides the frontal sinus drainage according to the processus uncinatus attachment.

The sphenoid sinus is located in the sphenoid bone postsuperior to the cavum nasi. Its lateral wall is adjacent to the cavernous sinus, the internal carotid and the optic canal. In the well gasified sphenoid sinus, the internal carotid and the optic canal produce the promontory, such as the sclerotin thinness and loss. The endoscopic surgery could injure the optic nerve or the internal carotid and finally causes blindness or fatal hemorrhage. Its top wall is the middle cranial fossa base and its saddle shaped, so it's also called the sella turcica. The sella turcica supports the pituitary gland. The superior wall participates in constituting the posterior part of the cavum nasi top and the posterior wall of the ethmoid sinus (sphenoid-ethmoid plate), the superior close to the septum nasi is the natural aperture of the sphenoid sinus (Fig. 9.4). The posterior wall has thicker sclerotin and is adjacent to the occipital clivus. The inferior wall is the choana upper ridge and the nasopharyngeal apex. And the pterygoid canal neuropore locates at the ossa pterygoideum roof at lateral inferior wall [1, 2].

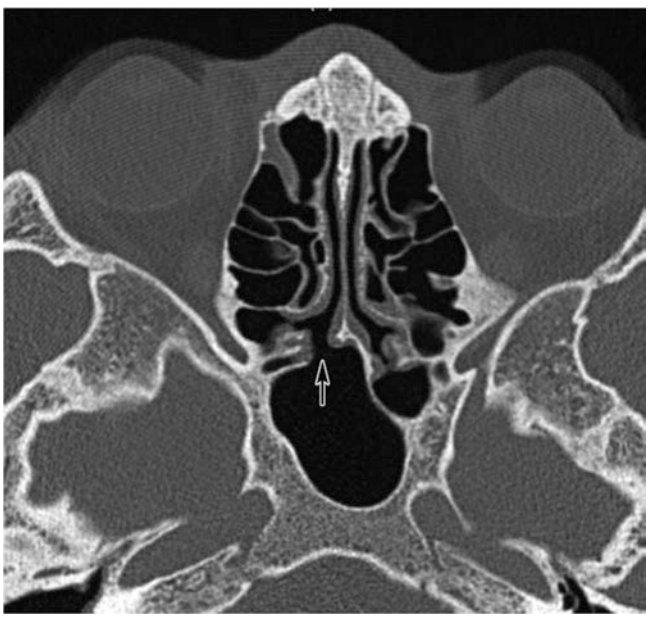

Fig. 9.4 The nasal sinus axial CT scan. Sphenoid sinus aditus could be seen (arrow)

9.2 Physiology of Nose

9.2.1 Nasal Physiology

The nose has respiratory, olfactory, and vocal resonance functions, and it can also help in the reflex, absorption, immunity and other functions [2].

1. Respiratory

   The cavum nasi is the portal of the human respiratory channel and it helps much on the contact with the external environment.

   (a) Nasal Airflow

   The air flow into the cavum nasi is obstructed at the nasal orifice which is divides into the laminar flow and the turbulence flow. Laminar flow arcs from the upper part of the nostril to the back nostril, which is the main part of the air flow in the nostril. It is related to the air flow. It is the main part of the gas exchange in the lungs and the main air flow in the nasal cavity to regulate the temperature and humidity. Turbulence is an irregular and swirling flow formed behind the nostril. It increases the contact between the air and the nasal mucosa, which is conducive to the deposition of particulate matter such as dust on the surface of the mucosa. Laminar flow and turbulence often coexist together, but only laminar flow occurs during calm breathing.

   (b) Nasal Resistance

   The nasal resistance is produced at the nasal flap area, occupies 40–50% of the total respiratory tract resistance, helps to produce negative pressure (vaccum) at the thoracic cavity, which lengthens the air's remaining time in the alveoli during exhalation, thus increase the air exchange time. The nasal resistance is vital factors ensure the air exchange. The nasal circle changes the bilateral nasal resistance but the total resistance power keeps still. If nasal resistance decreases, such as atrophic rhinitis, lung function decreases, while increased nasal resistance, such as chronic rhinitis, can lead to inadequate nasal ventilation, affecting respiratory and circulatory functions.

   (c) Nasal Cycles

   It means the alternative contraction and expansion of the normal bilateral nasal concha mucosa capacity vessels and manifest as the corresponding alternant change at the bilateral nasal concha size and resistance. The change turns each 2–7 h but the total concha resistance remains, so the nasal cycle is also called the physiological nasal concha cycle. The cycle exists for evoking the repeated asleep turning over to help relieve the sleep tiredness.

   (d) Temperature Adjustment

   It relies on the circuitous and wide cavum mucosa surface and abundant blood supply. The cavum mucosa could adjust the inhaled air temperature similar to the common flesh to help protect the inferior respiratory channels.

   (e) Humidity Adjustments

   Glands in the cavum mucosa could secrete about 1000 mL liquid within 24 h and 70% of the liquid is used to increase the inhaled air humidity to benefit on the cilia motion.

   (f) Filtration and Clearance

   Vestibular rhinothrix resists and filtrate the large dust particles and the bacteria in air. The turbulence flow and the laminar flow both can settle the wee dust particles on the cavum mucosa. The water soluble granules are melted and the insoluble particles will move to the posterior nasal hole by the cilia motion, enter the pharynx and then are swallowed or spitted.

   (g) Mucosa Cilium System Function

   The cavum sinus mucosa is pseudostratified columnar ciliated epithelium, each of which contains 250–300 cilia whose length is about 5–6 μm and average diameter is 0.3 μm. The cillium surface covers a mucosa carpet made with the inorganic salt, the mucopolysaccharid, the macroprotein, the muramidase and water. The carpet moves posteriorly by 5 mm/min to protect the cilia and help cilia motion.

2. Olfactory Function (Sensation Odor)

   It mainly relies on the nasal olfactory mucosa and olfactory cells to play a role such as recognition, alarming, influences the appetite and emotion.

3. Vocal Resonances

   It relies on the cavum space, the sound can resonate and produce a nice sound.

4. The Nasopulmonary Reflex and the Sneezing Reflex

   Nasopulmonary reflex arc is made with the cavum mucosa trigeminal nerve as the afferent branch, the trigeminal nerve nucleus and the vagus nucleus as the central nucleus and the bronchus smooth muscle vagus nerve as the efferent branch. It is the main factors to cause the nose evoked bronchopathy.

   The sneezing reflex is a kind of afferent branch of the trigeminal nerve. When the trigeminal nerve is stimulated, series of reflex motions, such as the deep inhalation, the lifted tongue root, the severely contracted abdominal muscle and diaphragm, the abruptly opened glottis etc. These reflex causes the air abruptly emitted through cavum nasi to clear the foreign matter or stimulators in the cavum and play a protective role.

5. The Specific and Nonspecific Immunity of the Nasal Mucosa

   The substance cavum mucosa cells and glands compound and secret and the blood vessels exudate constitute the cavum mucosa immunity system, including the muramidase and the lactoferrin who has nonspecific

immunity function and the immunoglobulin A and G who have specific immunity functions.

6. Nasal Mucosa Absorption Function

   The cavum mucosa membrane is about 150 cm^2. The subepithelial layer is rich in capillaries, venous sinuses, arteriovenous anastomotic branches and lymphatic vessels, which help to rapidly absorb the medicine into the blood circulation.

7. The Lacrimal Gland Excretory Function

   The tear could reach to the inferior meatus nasi through the lacrimal puncture, the lacrimal canaliculi, lacrimal duct, lacrimal sac and the nasolacrimal duct.

9.2.2 Nasal Sinus Physiology

There is still some dispute for the nasal sinus physiology; however some consensuses are also accepted as following:

1. Increase the area of respiratory mucosa, promote the warming and humidifying effect of inhaled air, and enhance the defensive function.
2. Sound resonance.
3. Lighten the head increase the buoyancy.
4. Protect important organs.
5. Preserve heat loss and adiabatic.

References

1. Li Y, Zhou B. Practical endorhinoscopy surgery technique and application. Beijing: Peking People's Medical Publishing House; 2009. p. 1016.
2. Dalgorf DM, Harvey RJ. Chapter 1: sinonasal anatomy and function. Am J Rhinol Allergy. 2013;27(Suppl 1):S3–6.