The Egyptian Journal of Hospital Medicine (April 2024) Vol. 95, Page 1497- 1500

Physiology and Immunology of The Nasopharyngeal Tonsil: Review Article

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ABSTRACT

Background: The nasopharyngeal tonsil, or often just simply the adenoids, form a pair of lymphatic tissue foci that are a component of Waldeyer's ring and are situated on the superoposterior side of the nasopharynx.

Objective: This review's objective was to outline the anatomy and physiology of and immunology of the adenoids to understand the diseased states.

Methods: We searched Science Direct, Google Scholar, and PubMed for Nasopharyngeal tonsil and Adenoids physiology, immunology and anatomy. The authors also reviewed references from pertinent literature, however only the most recent or comprehensive studies from 1999 to 2023 were included. Documents in languages other than English were disqualified due to lack of translation-related sources. Papers such as unpublished manuscripts, oral presentations, conference abstracts, and dissertations that were not part of larger scientific studies were excluded.

Conclusion: Tonsillectomy and/or adenoids may be necessary for patient care if medical therapy fails. Even though tonsil and/or adenoidectomy are common operations, it is important to fully comprehend the architecture of these lymphoepithelial organs in order to reduce the possibility of uncommon but potentially dangerous consequences.

Keywords: Nasopharyngeal tonsil, Adenoids, Adenoids physiology and Adenoids immunology, Adenoids anatomy.

INTRODUCTION

The tonsils located at the intersection of the posterior wall and roof of the nasopharynx are subepithelial collections of lymphoid tissue that cause the mucous membrane to be flung into radiating folds [1]. Among the most popular surgical treatments in the US and other countries are tonsillectomy and adenoidectomy. ENT surgery treatments that are most usually performed include adenoidectomy and tonsillectomy, either performed separately or in combination. Children with aden tonsillar hypertrophy, otitis media with effusion, recurrent otitis, obstructive sleep apnea, media, and nasal blockage are usually the ones who undergo it [2].The nasopharyngeal tonsils (adenoids), the lymphoepithelial tissues that comprise the palatine tonsils, tubal tonsils, and lingual tonsils are known as Waldeyer's ring, following the German anatomist Heinrich Wilhelm Gottfried von Waldeyer-Hartz. Collectively, these components comprise the mucosal immune system. Their main job is to take part in the secondary immune system by utilizing immunological sampling to identify local infections and antigens. In order to provide a location for ongoing lymphoid stimulation, they are positioned strategically near the intersection of the respiratory and digestive processes [3].

Embryology of nasopharynx and nasopharyngeal tonsil: Mostly through the ventral expansion of the upper pharyngeal arches, the buccal cavity evolves [4].

The buccopharyngeal membrane and pericardial region land on the ventral aspect of the embryonic sac as a result of the embryo's rostral expansion and the development of the head fold. At the base of the basic buccal cavity, also known as the stomodeum, the buccopharyngeal membrane becomes depressed due to further dorsal growth of the forebrain, ventral bulging of the pericardium, and expansion of the facial processes laterally. The membrane of the buccopharyngeal dissolves near the end of the fourth week, allowing the stomodeum and the cranial end of the foregut to communicate (future nasopharynx and oropharynx respectively) [5] (Figure 1).

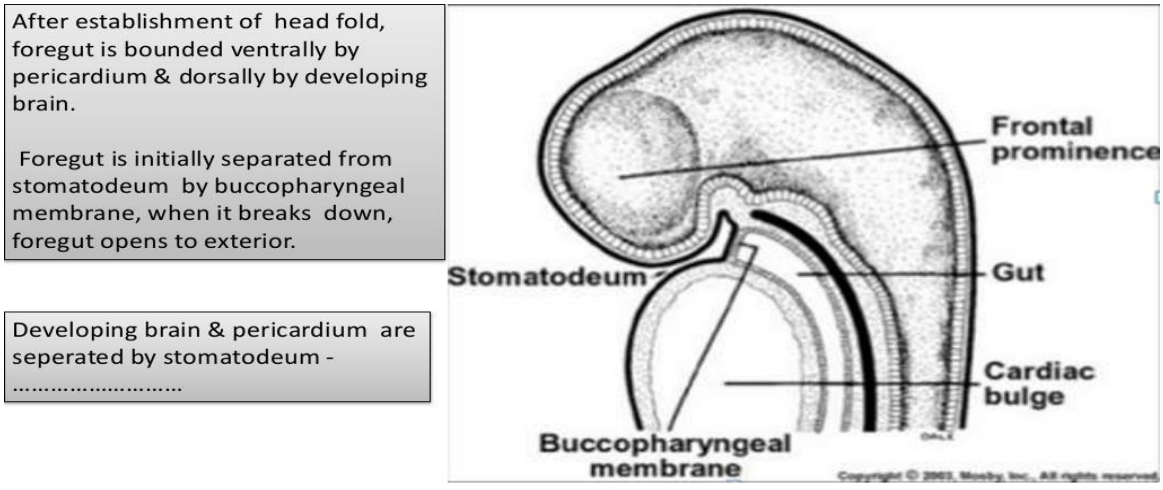

Figure (1): Embryology of nasopharynx and nasopharyngeal tonsil [6].

Received: 03/11/2023
Accepted: 02/01/2024

Anatomy of Nasopharyngeal Tonsils:

"Tonsils" and "Nasopharyngeal tonsil" are general phrases used to describe the mouth cavity's lymphoid tissues. The nasopharynx and oropharynx, which serve as the entrance points to the upper aerodigestive tract, are surrounded by a ring of lymphatic tissues that includes them. Traditionally referred to as the Waldeyer's ring, this ring is composed of many distinct formations (figure 2). The nasopharyngeal tonsils are situated within the nasopharynx and represent the superior extension of the ring. They are a diffuse or nodular mass of lymphoid tissue that develops into many folds in the nasopharyngeal mucosa on the posterior wall and roof [6]. This ring of lymphoid tissue acts as a barrier to keep germs out of the nose. The Waldeyer's ring has a role in the growth of B and T cells as well as immunoglobulin synthesis [7].

A median mass of mucosa-associated lymphoid tissue (MALT) is the nasopharyngeal tonsil. It is located in the nasopharynx's posterior wall and roof [8]. The Danish physician Meyer originally characterized the nasopharyngeal tonsil in his work "Adenoid Vegetations in the Nasopharyngeal Cavity" published in 1868 [9].

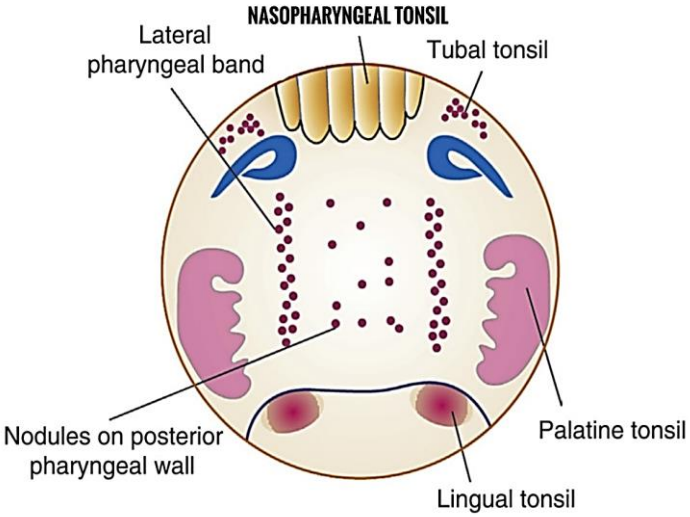

Figure (2): Waldeyer's ring [6].

Gross anatomy of the nasopharyngeal tonsil:

The merger of two lateral primordia, which become evident in the early stages of fetal life results in the development of the nasopharyngeal tonsil as a midline structure. Between four and six weeks of pregnancy, lymphoid tissue can be seen inside the nasopharyngeal posterior wall and roof mucous membranes. The nasopharyngeal tonsil reaches full development in the seventh month of pregnancy and grows until the child's fifth birthday. As with Gerlach's tonsil, the lymphoid tissue of the nasopharyngeal tonsil could spread to the Eustachian tube aperture and the Rosen muller fossa [10].

When completely developed, the nasopharyngeal tonsil resembles a truncated pyramid, with its apex pointed toward the nasal septum and its base located at the intersection of the nasopharynx's posterior wall and roof. It is not encircled by a recognizable capsule, nor does it has any crypts. The respiratory epithelium's vertical folds, where the Arey glands emerge, produce the nasopharyngeal tonsil. The pharyngeal bursa, also known as the Luschka bursa, is a median blind depression from which these folds extend laterally and forward [6].

Vascular supply of nasopharyngeal tonsil [6]:

The following arteries provide the arterial supply:

1. Pharyngeal artery ascending.
2. The palatine artery ascending.
3. Branch of the facial artery that is tonsillar.
4. Branch of the maxillary artery is termed the pharynx.
5. The Pterygoid canal Artery.
6. Basisphenoid artery.

The pharyngeal plexus receives venous drainage, which flows into the internal jugular and face veins after it interacts with the pterygoid plexus.

Nerve supply of nasopharyngeal tonsil:

The pharyngeal plexus supplies the nerve nutrition to the nasopharyngeal tonsil [7].

Lymphatic supply of nasopharyngeal tonsil:

Both pharyngeomaxillary and retropharyngeal space lymph nodes receive the lymphatic drain [11].

Physiology and immunology of the nasopharyngeal tonsil:

The tonsils in the nasal cavity are mostly B-cell organs. Of all nasopharyngeal tonsil plus tonsillar lymphocytes, B lymphocytes make about 50% to 65%, T-cell lymphocytes around 40%, and mature plasma cells 3%. They have a network of channels protected by specialized endothelium, which functions as a mediator of antigen uptake, much like the bowel's peyer's patches of epithelium. When subjected to airborne antigens, both the tonsils and nasopharyngeal tonsils are well positioned to mediate immune protection of the upper aerodigestive tract. The tonsils in particular are specially built to transfer foreign material directly from the outside to the lymphoid cells [12].

Especially the secondary lymphatic organs are the tonsils and the nasopharyngeal tonsils. The nasopharyngeal tonsil produces the immunoglobulins (Igs) IgG, IgA, IgM, and IgD. Between the ages of 4 and 10, the human tonsils along with nasopharyngeal tonsils are immunologically active. While tonsil involution occurs after puberty, the nasopharyngeal tonsil begins to involute by the age of eight. The population of B cells declines as a result of this involution, but the ratio of T to B cells somewhat rises [13].

The reticular cell epithelium, the extra follicular region, the mantle zone and the germinal center of the lymphoid follicle are the four unique locations of the immunoreactive lymphoid cells of the nasopharyngeal tonsil **(figure 3)** [14].

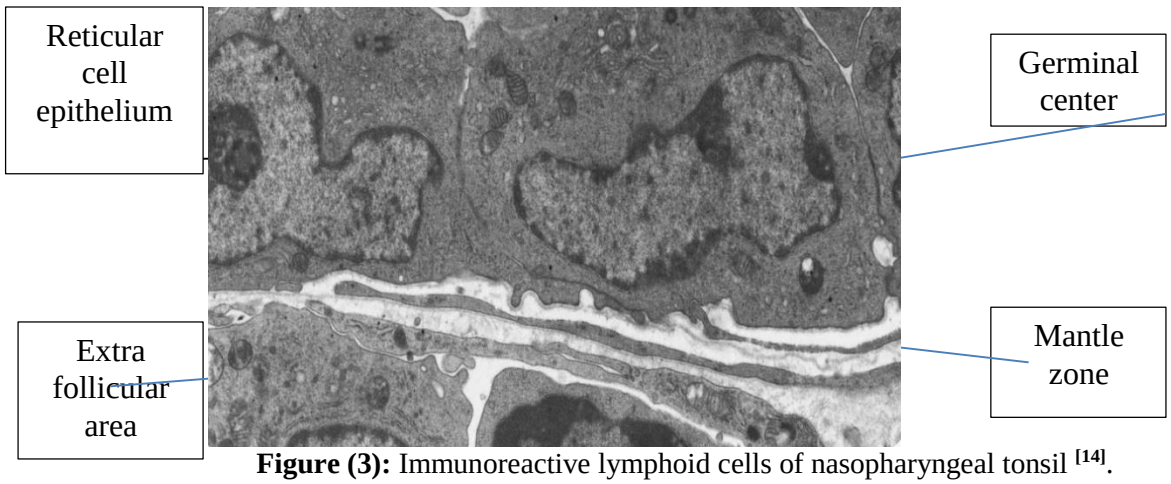

Figure (3): Immunoreactive lymphoid cells of nasopharyngeal tonsil [14].

Bacteriology:

From birth, the upper respiratory tract's typical flora is established. By the age of six to eight months, Actinomyces, Fusobacterium, and Nocardia are acquired [15]. Later, it is also determined that Bacteroides, Leptotrichia, Propionibacterium, and Candida are a component of the oral milieu. Following dentition, fusobacterium populations increase and reach their peak at one year of age [16].

There are significant variations in the kind and quantity of aerobic bacteria detected in sick and non-diseased adenoids in healthy children up to the age of five. These youngsters can contain recognized aerobic pathogens [17].

75% of children who were comparatively free of upper respiratory tract infections, otitis media, and signs of adenoid blockage showed neither bacterial growth on culture nor bacteria that are thought to be part of the normal flora, according to the core samples of the nasopharyngeal tonsils. In contrast, the bacteria detected in children with chronic adenoid infection (45%) and obstructive adenoid hypertrophy (39%), were more probable to be β-lactamase producers [18].

Viruses:

Numerous viral infections, such as adeno, parainfluenza, rhino, influenza, coxsackie, echo, roe and respiratory syncytial viruses, have been linked to the development of adenoiditis. Human adenovirus (47.1%), human enterovirus (40.5%), human rhinovirus (38%), human bocavirus (29.8%), human metapneumovirus (17.4%), and human respiratory syncytial virus (15.7%) are the most often found viruses. Certain viruses selectively infect particular tissues more often than others, and their latency or persistence can cause chronic adenotonsillar illnesses [19].

Pathological effect of the adenoids

When sepsis or partial blockage of the nasal choanae occur, the adenoid may be involved in upper respiratory tract illness. Adenoiditis, either acute or chronic, rhinitis, rhinosinusitis, otitis media with or without effusion are examples of pathological symptoms [19].

Adenoiditis:

Adenoid hypertrophy, the primary cause of which is infection, manifests clinically as recurrent sinusitis, mouth breathing, nasal obstruction, nighttime snoring, auditory tube dysfunction, otitis media, diminished taste and smell perception, difficulty speaking, abnormalities in facial development and behavior, and/or more severe issues like obstructive sleep apnea syndrome. Obesity, allergies, asthma, GERD, anomalies in the physical structure of the face or jaw, and a number of medical and neurological problems are among the factors that contribute to sleep apnea. To enhance overall quality of life, these issues sometimes result in the necessity for an adenoidectomy or an adenotonsillectomy, which remains one of the most popular pediatric surgical operations globally [19, 20].

Pathology of adenoid:

Each person's level of adenoid vegetation varies, and it often shifts over time. Between the ages of three and seven, the adenoid reaches its maximum size before beginning to recede. Allergies and acute and repeated upper respiratory tract infections promote lymphoid follicle hyperplasia, which leads to adenoid vegetation [20].

A rise in lymphoid elements seems to be the cause of lymphoid hyperplasia. It has been demonstrated that the mean bacterial load is closely correlated with the size of the adenoid, and that sick tonsils had noticeably higher B and T cell counts [21]. It's interesting to note that among the several infections, Haemophilus influenzae has been connected to lymphoid hyperplasia in particular. Furthermore, lymphoid hyperplasia has been linked to Staphylococcus aureus. These researchers hypothesized that S. aureus and H. influenzae may be etiologic factors in the development of lymphoid hyperplasia [22].

CONCLUSION

Tonsillectomy and/or adenoids might be necessary for patient care if medical therapy fails. Even though tonsil and/or adenoidectomy are common operations, it is important to fully comprehend the architecture of these lymphoepithelial organs in order to reduce the possibility of uncommon but potentially dangerous consequences.

Conflict of interest: None.
Fund: None.

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