

The outline of naming process, anatomy and histopathology of infraorbital dark circles

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ABSTRACT

Infraorbital dark circle, previously known as allergic shiners. The pathogenesis, the swollen turbinate compressing the sphenopalatine vein plexus, causing venous congestion of eyelid vein and the canthus in eyes, is unattested. This article studies the anatomical structure under the orbital part. It is believed that the mechanism is more closely related to the backflow obstruction of infraorbital vein. Besides, it may also be the causes of infraorbital dark circle of local congestion of infraorbital space and inferior orbital lymph nodes backflow blocked. Finally, the histopathological findings of some aesthetic medicine are reviewed.

Keywords: *infraorbital dark circles; allergic shiners; anatomy; vein; histopathology*

1. Introduction

In recent years, more and more children suffer from bilateral undereye skin color deepening, which is generally symmetric around the canthus/nasal bridge. It has a boundary with normal skin. According to its external performance, it is called “infraorbital dark circle”. (See **Figure 1**) This phenomenon is commonly known as allergic shiners in abroad. It is considered to be the characteristic of allergic rhinitis. But some doctors say the phenomenon is not limited to allergic rhinitis, and other nasal disorders can also be caused. Besides, according to the Five Orbiculi of the Eye of Chinese medicine, eyelids belong to the spleen, and the subocular parts are closely related to the spleen and stomach. Color Burn is the expression of “spleen deficiency”. To further understand this phenomenon, this article reviews the naming process of this phenomenon, and the anatomy and histopathological literature of infraorbital parts were collected.

2. Text

2.1 Related description and terms

Academia is not unified on the naming of this phenomenon. Related descriptions and similar terms are arranged as follows on time order.

2.2 Infraorbital Fold

It was found that there were often two fine lines resembling the crow’s feet on the lower eyelids of patients with atopic rhinitis by Charles C. Dennie[.](See Figure 2) It was named as Infraorbital Fold, Dennie-Morgan fold or Dennie - Morgan line. And then a growing literature[2,3] showed that the sign was closely related to atopic rhinitis and atopic dermatitis. It was summarized by the article of Schram M E in 2011 that the characteristic to the sensitivity and specificity were reached to 78% and 76% in the diagnosis of atopic rhinitis.

2.3 Allergic shiners

This terminology was put forward by Marks MB[] in 1954. The clinical manifestation of bilateral orbital darker color has been widely accepted and used by doctors and allergic patients. The article published by Blanc S and Bourrier in 2015 was emphasized that the allergic shiners combined with the infraorbital fold are the manifestation of

family-specific constitution. However, there are few studies on the causes of allergic shiners. The first speculation was made by the article of Marks MB in 1966: The swollen turbinate compressing the sphenopalatine vein plexus, causing venous congestion of the eyelid vein and the canthus in eyes. But it was unattested. Since then, the above mechanisms have remained untested, dissected, or verified by other objective evidence.



Figure 1. Infraorbital dark circle



Figure 2. Infraorbital fold

2.4 Infraorbital dark circles

It was put forward by the article of Epstein JS in 1999 according to document indexing. This noun is limited to the objective description of the phenomenon without etiology and pathology. It is not easy to cause clinical controversy. More and more literatures have adopted this name in recent years.

2.5 Muxiahei

In order to clearly and accurately express the performance of only lower eyelid skin becoming darker, some Chinese medicine doctors name it Muxiahei. Highlight the refinement and vividness of Chinese.

2.6 Others

Such as dark circles under the eyes (Marks MB^[6], 1966), periorbital hyperpigmentation (Goodman RM^[1], 1969), infraorbital pigmented skin (Lowe NJ^[1], 1995), dark circles of the lower eyelid^[1] (2008), eye shadow and so on are not widely accepted and used.

3. Anatomical structure of infraorbital region

The area and depth of the suborbital region are small, but its anatomical structure is complex. There are obvious individual differences and even many unknowns. The anatomical structures of infraorbital region characterized from shallow to deep are skin, subcutaneous blood vessels, muscles (orbicularis, upper lip quadratus caput zygomaticum,

upper lip quadratus caput infraorbitale), infraorbital space, infraorbital arterio-vein, infraorbital nerve, infraorbital hole and upper maxillary bone. The causes of infraorbital dark circles are generally considered that the relatively thin eyelid skin, and various causes of blood circulation and venous blood deposition of the skin and muscle, resulting in eyes and orbits appearing black or livid through the skin^[12]. The blood circulation of different infraorbital anatomical

levels, especially the venous reflux, is complicated. To further explore the occurrence mechanism of infraorbital dark circles and the anatomical relationship of nasal cavity, the analysis is as follows.

3.1 Inferior palpebral vein (IPV)

The inferior palpebral vein and its branches below the orbits are the superficial vein(See **Figure 3**). IPV, together with the tributary of the lower eyelid of orbicularis oculi muscle and angular vein(AV), merges into angular vein(AV). Besides, ramus communicans and lacrimal venous plexus are communicated with IPV in inner canthus.Ramus communicans is communicated with infraorbital vein to the deep under the orbit. It was found that there were large anatomical differences on IPV by dissecting the samples of fifteen Korean and nineteen Thai. There were four distribution patterns, such as tilting, vertical, multiple and missing(See **Figure 4**).

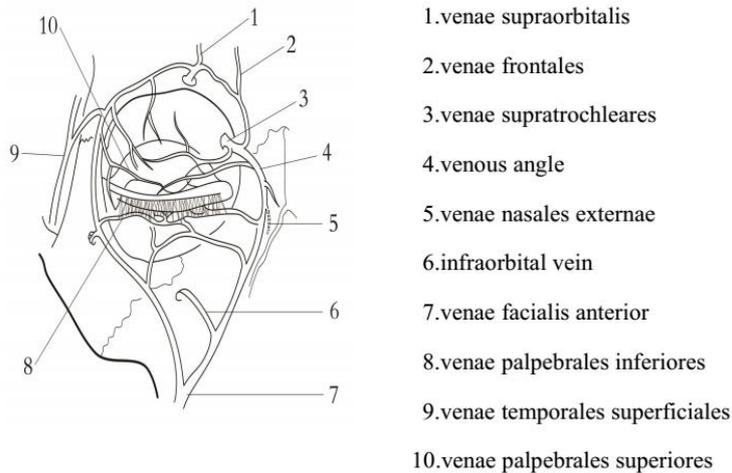


Figure 3. The sketch map of palpebral peripheral vein

The anatomical distribution of venae palpebrales inferiores makes it the most probable diseased region. But the direction of the reflux and the blood vessels are far away from the nasal cavity. It does not explain the close relation of infraorbital dark circles and nose disease.

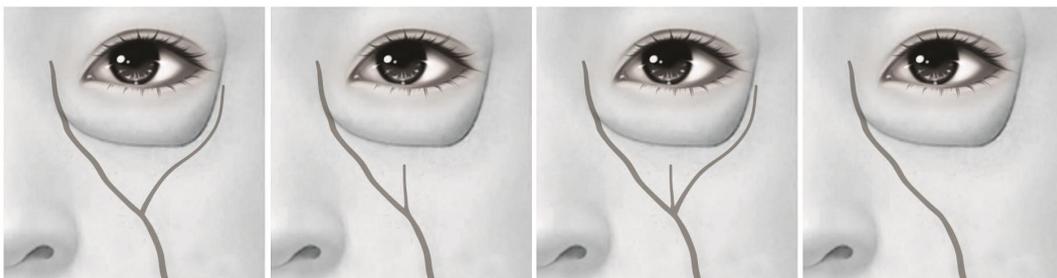


Figure 4. Individual differences in the distribution of venae palpebrales inferiores

3.2 Infraorbital vein(IV)

The deep vein below the orbit is mainly the infraorbital vein. Venous blood is collected from the infraorbital vein through infraorbital foramen, suborbital canal, inferior orbital fissure, infraorbital groove, postorbital foramen and pterygoid venous plexus. In theory, the blockages in these areas may resulting in suborbital congestion. It was found that there was a large difference in the population by Liu^[13], through reconstruction by autopsy and 64-row CT, observing the shape of the infraorbital tube. Some went out of their orbital bones, some were isolated in the maxillary sinus cavity and some were missing with infraorbital wall. There was only one layer of mucosa between the blood vessel and the maxillary sinus cavity.

There is no positive or negative evidence so far indicating that the maxillary sinusitis affects the infraorbital vein in

the cavity, resulting in backflow obstruction and infraorbital dark circles. The other part of deep infraorbital vein is gradually receding from the nasal cavity, sinus and nasopharynx (See **Figure 5**)^[15].

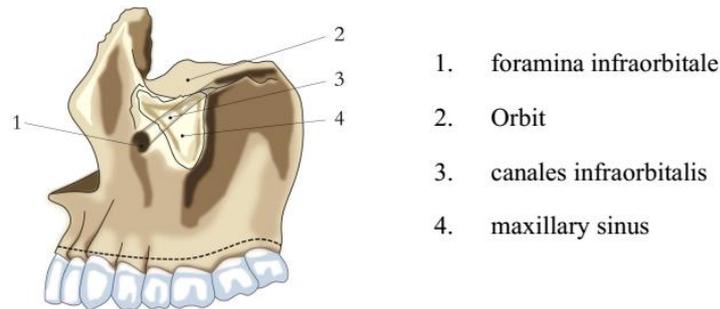


Figure 5. The sketch map of canales infraorbitalis

3.3 Venous plexus of lacrimal passages

Backflow of medial canthus vein and infraorbital vein on above. Injection of the nasal papillary vein plexus below. The pathogenesis of previous allergic shiners. The swollen turbinate compressing the sphenopalatine vein plexus resulting in congestion of palpebral veins and intraocular vein .Maybe it's a conjecture based on the communication structure of the lacrimal vein plexus. This mechanism has so far not been confirmed by anatomy or imaging. The following two objective facts are difficult to explain. One is that the infraorbital dark circles were significantly reduced in the canthus, the others is that there are few patients with infraorbital dark circles suffering from obstruction of lacrimal passage.

3.4 Infraorbital space

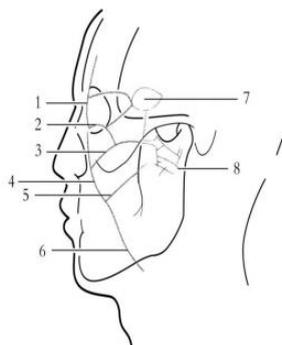
It is one of the gaps in the facial soft tissue, located between upper jaw bone antetheca below the orbit and facial expression muscle. Infraorbital margin is the upper boundary, alveolar process maxilla is the lower boundary,nasal margin is the inner boundary and cheekbone is the outside boundary. There are infraorbital veins, blood tubes and infraorbital lymph gland through infraorbital hole in infraorbital space. In addition, there are the medial canthus artery in the intermuscular region, the anterior venous vein and the traffic branches of the vena ophthalmica, the infraorbital vein and the venae faciei profunda vein. It is generally believed that the disease in infraorbital space is mostly secondary infection. Such as spreading of tooth source and adenogenous infection. Infraorbital space, an irregular inverted triangle, which is similar with the boundary of infraorbital dark circles. It is inferred from the anatomy that the blood stagnation in the infraorbital space may cause infraorbital dark circles. But the anatomical relation with nasal cavity and sinus is far away.

3.5 Inferior orbital lymph nodes

It is located near the infraorbital hole, main collection of the lymph of lpalpebra inferior and palpebral conjunctiva. The output tube is injected into the submandibular lymph nodes. The relationship with infraorbital dark circles is unknown.

3.6 Facial vein (See Figure 6)

The inner canthus is derived from the angular vein, accompanying with facial artery down. Facial vein collects the venous blood of facial soft tissue and communicates with angular vein, inferior ophthalmic vein and the cavernous sinus. Communicating with the pterygoid venous plexus through infraorbital vein and venae faciei profunda. Abouchement jugular vein through hyoid plane. There is usually no venous valve above the flat corner of the mouth. Firstly, the facial vein has a remote relationship with the nose anatomy. Secondly, there are many traffic branches, not easy to show blood stasis.



1. angular vein
2. Undereye and venae palpebrales inferiores
3. Infraorbital vein
4. facial vein
5. venae faciei profunda
6. facial vein
7. cavernous sinus
8. plexus pterygoideus

Figure 6. The reflux of the facial vein and the transport of the deep venous plexus

In conclusion, there is little possibility of the formation of infraorbital dark circles and the compression of the sphenopalatine venous plexus. Analysis from obstruction of venous reflux, there is more possibility of infraorbital vein. Besides, infraorbital space and inferior orbital lymph nodes may also cause local congestion or obstruction of lymph flow, resulting in infraorbital dark circles. But all of these are conjecture, lack of anatomical and imaging evidence. The results can be obtained through specific autopsy and high-resolution CT reconstruction.

3.7 Histopathology of dark circles

It is generally believed that the cause of infraorbital dark circles is poor local circulation and venous blood deposition previously. But in recent years, the results of the histopathological findings of several infraorbital dark circles of the cosmetic medical field have overturned this conclusion. The periorbital skin of twelve Japanese women with dark circles was examined by tissue biopsy by Freitag FM *et al*^[15]. All people in histology are found to have melanin deposits. The histopathological examination of forty-seven patients with dark eye circles revealed that melanocytes were the main histological factors in the formation of dark circles by Shifeng Jin and Shu Peng^[16]. The study of two hundred and eight cases of infraorbital tissue also revealed increased melanin and phagocytosis of dermal papilla layer by Graziosi AC^[17]. The moderate expansion of blood vessel in dermal papilla layer and reticular layer. There is no hemosiderin deposition in the dermis. These phenomena indicate that venous congestion is not the direct cause of the infraorbital dark circles or not the main reason. The source of these melanin deposits has not been studied and elaborated.

4. Conclusion

In conclusion, the pathogenesis of dark circles, especially the infraorbital dark circles, has not been clarified. There are many unknowns and contradictions in its theory and clinical practice, and further research and exploration is needed.

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