Rhinology, 20, 27-31, 1982

Characteristics and origin of the human olfactory organ

Suenoske Ishii and Ryo Takahashi, Tokyo, Japan

SUMMARY

The peculiar and characteristic structure of the human ethmoid is probably the result of 1) encephalisation and 2) insufficient adaptation to rapid evolution. In simiae only one ethmoturbinate is found, in man four or five. Due to posterior displacement of the lamina lateralis the turbinates compress each other, with overlapping, fusion, deformation and displacement, in highly constricted interorbital spaces.

INTRODUCTION

Man is regarded as the pinnacle in the evolutionary process and the highest form of creation. The most remarkable event in the evolutionary process is the new encephalisation.

It does not necessarily follow, however, that every organ of man is evolutionally the most advanced of all mammals. On the contrary, many human organs exhibit marked degeneration or even deformation. Phylogenetically, the structure and function of each organ has not always improved with the process of evolution, so that teleological specification and even degeneration also represent expressions of evolution.

Olfactory sense and its associated organs are no exceptions. The structure of the human olfactory organ, particularly the ethmoid bone, is quite specific. The human ethmoid bone is actually a highly "complex" organ, also referred to as the ethmoid labyrinth. The characteristics of the human ethmoid are not limited to its complexity and labyrinthine structure. In fact, the etmoids in quadrupeds are much more complex. The architecture of the ethmoid complexes in quadrupeds is orderly and symmetrical in arrangement, an example of nature's elegant geometric design.

The human ethmoids, however, are different. Asymmetry, numerous variations and deformations, and a characteristic lack of uniformity even among the members of the same family support the impression that the human olfactory organ is a malformation.

Another characteristic of the human olfactory organ is that it represents an inter-

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Paper presented at the 8th Congress of the European Rhinologic Society and 2nd ISIAN, Bologna (Italy), October, 1980.

mediate pattern between the olfactory organs of quadrupeds and the degenerated olfactory organ of the simiae (a monkey between the prosimiae and anthropoid). Based on comparative anatomical studies of the olfactory organs of various mammals, the specificity of the human ethmoid and its origin will be discussed.

MATERIAL AND METHODS

Since the method utilized by the authors includes many parameters, detailed data on individual measurements are omitted (Ishii, 1955). Details of the materials used are similarly omitted. Characteristics are compared primarily among the following three groups: quadrupeds, simiae and man.

RESULTS AND DISCUSSION

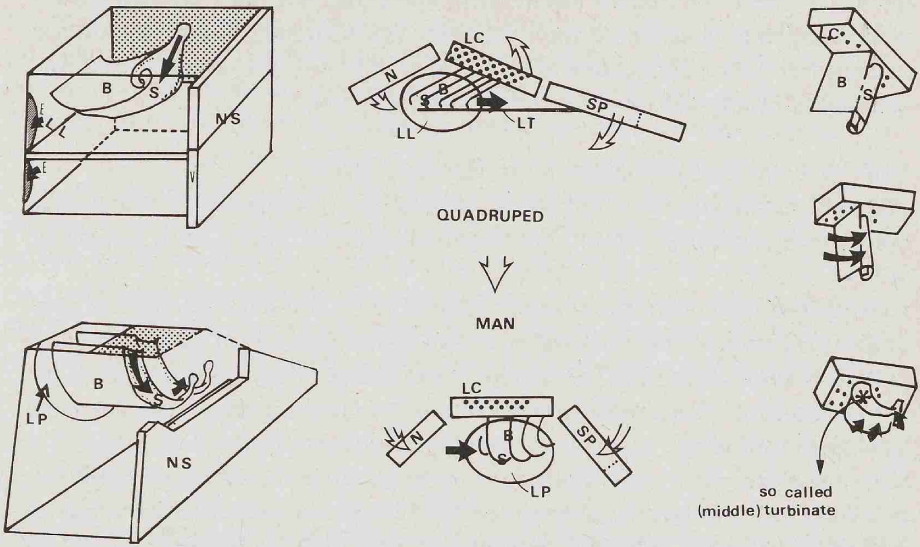
Characteristics of the skeletal components surrounding the ethmoid

The human ethmoid is confined to a very limited space with restrictions placed on its growth and development by surrounding structures. As is evident from a sagittal section of the cranium, the ethmoid is compressed by a large, cerebral mass, the result of encephalisation.

The anterior cranial fossa has gradually changed from a horizontal to an oblique posture during the course of evolution. The phenomenon of encephalisation has induced kyphotic changes in the cranial base, which resulted in a bending forward and narrowing of the space containing the ethmoid during the course of evolution. When the spheno-ethmoidal angle (the angle of the sella turcica) is measured during craniometry, an approximate value of 180° is obtained for quadrupeds, but a remarkably more acute angle of 133° is found in man. The lamina cribrosa is located at the floor of the horizontal anterior cranial fossa immediately superior to the human ethmoid, but assumes, however, a deep and wide basket-like shape in quadrupeds.

Thus, the surface area is extensive, and the numbers and size of holes allowing the passage of olfactory nerves are large. In the simiae, however, an extreme degeneration is evident. The lamina cribrosa does not appear to be laminar, but rather resembles a single funnel without a direct connection to the ethmoturbinate, which lies at a considerable distance. Paulli and his coworkers (1899) referred to this hole as "Riechnervenloch". In man, it appears as a palate with a slightly shallow concavity, resembling that of quadrupeds rather than that of the simiae.

The human lamina cribrosa closely resembles that of the antropoids. This is demonstrated by measuring the angle between the axe of the bilateral ophtalmic fossae and by the lacrimale/eurion ratio. The values derived from these measurements can be arranged in the order of quadrupeds > man > monkey. Specifically, the width of the septum interorbitale in man lies between that of the quadrupeds and monkeys. In both the catarrhine (old world monkey) and the platyrrhine



B: basal lamella
E: entrance to maxillary sinus
LC: cribriform plate
LL: lateral lamella
LP: papyraceous lamella
LT: transeverse lamella
N: nasal bone
NS: nasal septum
S: scroll of ethmoturbinate
SP: sphenoid bone
V: vomer

(new world monkey), the bilateral orbitas have become so closely approximated that the right and left lamina papyracea have become completely fused with the l. perpendicularis, forming a septum. This has been proven microscopically. In extreme instances, a large defect can be seen in the septum interorbitale, and the contents of the bilateral orbita are fused together any intervening nasal septum.
In quadrupeds, a plate or frame that appears as a fence or site for the attachment of many turbinates, and referred to as the lamina lateralis, may be divided into the following three parts:
l. dorsalis;
l. externa – l. papyracea;
l. ventralis – l. transversus.
The last part divides the nasal cavity vertically into the olfactory cul-de-sac (olfactory chamber) and the nasopharyngeal canal, each with its own separate function. Such a plate, however, is not found in mammals higher than the prosimiae. The l. externa is referred to as the l. papyracea in primates higher than the simiae. This forms the lateral wall of the ethmoid mass in quadrupeds and serves as the site for the attachment of ethmoturbinates in most instances.
This plate does not participate in the formation of the inner wall of the orbita, but represents the medial wall of the sinus maxillaris at the extreme anterior part of

the nasal cavity. As animals advanced in evolution, this plate has entered the orbita only in animals above the prosimiae. The bilateral orbitas have shifted, rotating from a lateral direction to a medio-anterior direction. The plate has thus penetrated deeply toward the interior of the cranium.

Changes in the human ethmoid within the nasal cavity

The most distinctive characteristic of the nasal cavity in man is the deviation of the septum. A description of its development is omitted (Ishii, 1955; Takahashi, 1971).

As described previously, the changes in the brain mass and the craniofacial components throughout the course of evolution have already been expressed in the monkey's nasal cavity with the change in the course of the basal lamella of the ethmoturbinate. This lamella originates from the lamina cribrosa, courses along the lateral wall of the nasal cavity, and finally attaches to the l. externa.

Since the l. externa is located anteriorly in the quadrupeds, the course of the turbinates of the basal lamella is rectilinear from the postero-superior to the antero-inferior direction in a radiating arrangement. In the monkey, however, the lamina cribrosa shifts superiorly and horizontally, and the l. externa (l. papyracea) enters the orbita located postero-superiorly, so that the course of the basal lamella curves as it follows and anterosuperior to a postero-inferior direction.

While only one turbinate with a simple structure is found in the monkey, four or five such turbinates are found in man. The turbinates in man are significantly more simple in structure than the scrolls of the quadrupeds. As was previously described, several turbinates are confined to a highly restricted space, however, and grow and develop under the influence of the cerebrum. Thus the turbinates compress each other, resulting in overlapping, fusion, deformation, and displacement. With the additional compression of the convex surface of the deviated nasal septum frequently found in man, and the effect of space filling from the concave surface, the human ethmoid bone is further deprived of unrestricted growth, until it assumes a specific configuration.

CONCLUSION

The specificity of human ethmoid bone and the ethmoid cells are probably the result of: 1) encephalisation, and 2) insufficient adaptation to rapid evolution. In the latter, the posterior shift of the human ethmoid and its surrounding structures, the development of multiple turbinates, and the coexistence of non-evolution and even degeneration in the bony structures are contributing factors to the final ethmoid configuration. These changes are probably due to several reasons. Man, descended from arboreal life to earth, evolved to an erect posture supported by the two lower extremities.

The rapidity in development following this evolutionary event was so abrupt that

the cerebrum increased in size without a subsequent degeneration of the olfactory organs. An imbalance, therefore, ensued among the olfactory organs, the organs off sight, and the surrounding cranio-facial skeleton, and the ethmoid, involved in this process, assumed a form that suggests insufficient adaptation.

As quadrupeds are referred to as olfactory animals, monkeys and humans may be referred to as visual and intelligent beings, respectively. As man rapidly developed intelligence, the abrupt change resulted in various malformations and deformations throughout his entire body, including the olfactory organs. With these various malformations has come a greater susceptibility to disease.

As a secondary phenomenon, the olfactory sense in man was decreased, or remained unchanged. The ethmoid bone, once the most important olfactory organ in man, lost its function, and thus reduced to its present deformed configuration.

RÉSUMÉ

La structure spéciale et caractéristique de l'ethmoïde humain est probablement le résultat 1) d'encéphalisation et 2) d'une adaptation insuffisante à l'évolution rapide. Chez le Singe il a été trouvé une seule conque nasale ethmoïde, chez l'homme, quatre ou cinq.

Par suite d'un déplacement postérieur des lames latérales, les conques turbinées se compriment l'une l'autre, elles se recouvrent partiellement, se fondent, se déforment et se déplacent dans les espaces interorbitaires extrêmement resserrés.

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S. Ishii, M.D.
Department of Otorhinolaryngology
The Jikei University School of Medicine
Tokyo, Japan