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A Systematic and Critical Review on the Anatomy of the Ethmoidal Foramina

Miriam Durante, PH.D., Denise Bonente, M. B.SC.*†, Niccolò Fagni, M.D.‡, Marco Mandalà, M.D.‡, Virginia Barone, PH.D.*, Claudio Nicoletti, PH.D.*, and Eugenio Bertelli, M.D., PH.D.**

**Department of Molecular and Developmental Medicine; †Department of Life Science; and ‡Department of Medicine, Surgery and Neuroscience, University of Siena, Siena, Italy*

Purpose: The osteologic anatomy of the orbit is still a field of intense research, particularly as far as vascular channels are concerned. Among them, ethmoidal foraminas (EFs) are certainly those that have more clinical importance and indeed have been deeply investigated. Unfortunately, the vast production of articles, far from clarifying their anatomy, generated a certain degree of confusion.

Methods: A search on Pubmed and Scopus databases updated up to December 31, 2023, has been carried out with the keyword "ethmoidal foramen" yielding a list of 357 items. With a careful screening process, 31 articles were enlisted to be included in the present review.

Results: A critical review process confirmed that many results published over the years appear inconsistent, particularly as far as EFs topography is concerned. The possible reasons for this lack of consistency can be traced back to inter-ethnical differences, uncertainty on the anterior bony landmarks employed in the investigations, and lack of a general consensus over EFs classification. A novel approach, based on the normalization of the distance of the anterior landmarks relative to the length of the orbit (relative depth index), should overcome some of the major problems encountered so far.

Conclusions: Novel and clear guidelines to classify EFs and to locate them on the medial wall are required. Determining the relative depth index of EFs may be an interesting approach to solve the matter. Other methods can be also devised. However, direct measurements from bony landmarks, without any further analysis seem inadequate and possibly misleading

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Quite unexpectedly, the last 10 years have witnessed an intense revival of interest for orbit osteology. Indeed, at first sight, it seems hard to believe that a region so easily accessible to inspection may still conceal anatomical details that have escaped the attention of anatomists and clinicians. For instance, an item that received the first detailed anatomical description only recently has been the spina musculi recti lateralis.[1] Most of the articles dealing with orbital osteology mainly focused on the variations of the vascular channels, including orbitomeningeal foramen, minor canals associated with the optic strut, and zygomaticoorbital and ethmoidal foramina.[2–4] For their clinical relevance, however, ethmoidal foraminas (EFs) are certainly the most prominent of all these anatomical items and, indeed, they received much attention. Unfortunately, far from clarifying their anatomy, the long list of studies that have been published over the years seems to have generated some degree of confusion and uncertainty. This systemic review is aimed, not only to give an overview of what has been published so far but also to exert some degree of critic to investigate the reasons underlying the inconsistent results that have been produced so far.

MATERIALS AND METHODS

A search on Pubmed (U.S. National Library of Medicine, NIH, Bethesda, Maryland) and on Scopus (Elsevier B.V.) updated up to December 31, 2023, has been carried out with the keyword ethmoidal foramen (EF). Pubmed and Scopus yielded 190 and 167 research items, respectively. A flowchart of the inclusion/exclusion criteria followed to compile this review is shown in Figure 1. In brief, results from the search on the 2 databases were confronted, and item duplicates were removed. From the resulting combined list, articles that were not written in English or dealing with animal species other than humans, as well as reviews, were also excluded. Abstracts of the articles surviving from this first survey were checked, and all reports that were clearly off-topic were removed. The remaining articles were all looked for, downloaded, and subjected to a second round of screening for the final assessment of their inclusion eligibility in the review. Articles that were off-topic, whose results were not relevant to the review, or were not clear (e.g., poor English editing; results not clearly presented or meaningless) were excluded. The reference lists of all included articles were screened and additional relevant articles that did not come out from the databases were also included. Other references have been added to place the anatomy of EFs in a clinical context but they were not necessarily extracted with the above-mentioned screening process as many of them were clinically oriented articles. The identification process from databases and the initial screening based on the abstracts of the articles was carried out independently by 2 researchers (M.D. and D.B.). Studies potentially to be included in the review were downloaded and critically read

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Miriam Durante and Denise Bonente contributed equally to this work.
Address correspondence and reprint requests to Eugenio Bertelli, M.D., Ph.D., Department of Molecular and Developmental Medicine, University of Siena, Via Aldo Moro 2, Siena, Italy. E-mail: eugenio.bertelli@unisi.it

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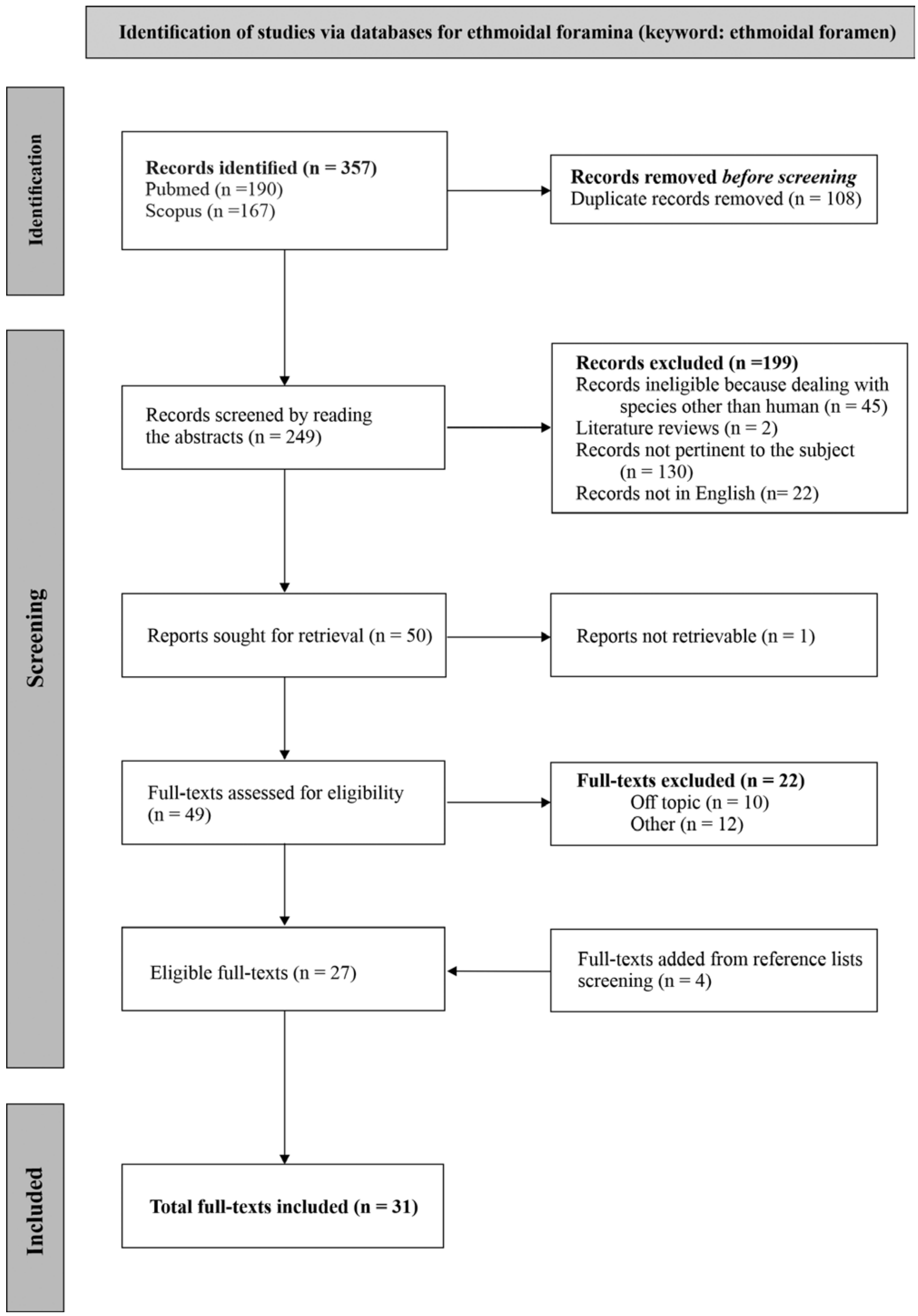

FIG. 1. Flowchart illustrating the identification of research items, the screening and the inclusion process into the review.

to extract the more relevant data. If disagreements arose over the opportunity to include/exclude an article, a third coauthor (E.B.) was consulted before reaching a final collegial decision. The present research adhered to the tenets of the Declaration of Helsinki as amended in 2008.

RESULTS

The search on PubMed with the keyword "ethmoidal foramen" updated to December 31, 2023, yielded 190 hits, whereas a similar search on Scopus achieved 167 results. Combined together, the 2 databases gave a list of 357 items. However, 108 of them were duplicate records and were discarded, so the screening process summarized in Figure 1 and described in *Materials and Methods* started from 249 titles. The final number of articles from which interesting anatomical data could be extrapolated was restricted to 31 titles that were included in the following discussion.

DISCUSSION

EFs are the orbital entrances of the homonymous canals which usually, though not always, contain ethmoidal arteries, veins, and nerves.[5–7] EFs have certainly been the focus of much interest as the management of ethmoidal arteries is encountered in several clinical contexts, from the transnasal approach to treat several skull base-related disorders practiced by endoscopists,[8] to the anterior ethmoidal artery (AEA) ligation that is sometimes required to control severe and refractory epistaxis.[9] Over the years, a vast production of articles has investigated the number of EFs, the distance occurring among them, the position relative to the frontoethmoidal suture, the anterior lacrimal crest (ALC), and the optic canal, and their right-left symmetry.

Numerosity

As far as the number of EFs is concerned, it is universally acknowledged that 2 EFs (Fig. 2A) are the most frequent pattern of neurovascular connection between the medial wall of the orbit and the anterior cranial fossa. Two EFs have been observed in more than half orbits (from 59% to 100%) in all the anatomical surveys published so far.[10–20] However, numerical variations of EFs are common.

EF absence is exceptional with only 2 cases observed so far.[18,21] Orbits with just one EF are mostly reported with low frequencies, from 0% to 6.8% of orbits (Fig 2B),[11,13–17,19,20] though occasional higher frequencies, from 15% to 18.1%, have been also recorded.[18,22] When a single foramen is present, it has been acknowledged as the anterior EF in 88.9% to 100% of cases.[14,15,18,23]

Orbits with 3 EFs (Fig. 2C) have been found in 13.9% to 39.9% of cases.[11–20,24,25] A pattern of 4 EFs (Fig. 2D) in the same orbit is rarer, ranging between 0.5% and 7.9% of orbits,[11–16,18,20] whereas 5 and 6 EFs have been detected, respectively, in 0.8% and 0.4% of orbits.[15] As far as the presence of supernumerary foramina is concerned, a dedicated study suggests that interethnic differences may exist, with Caucasians and Middle Eastern skulls showing a significantly lower number of accessory EFs than other ethnic groups (Asians, Africans, and Hispanics).[26] Even the presence of a horizontal deep groove between the anterior and the posterior EFs, overall observed in 19% of orbits, shows important interethnic variations.[27]

Topography

The anterior EF has been reported as located 9.40 ± 1.92 mm behind the medial canthal tendon.[28] However, the distances among EFs and major orbital osteological landmarks, as well as the interforamina gaps (distances among the EFs) have been recorded in several studies. They have major practical importance as their knowledge helps surgeons to navigate safely within the orbit. Unfortunately, these are also fields of confusion and uncertainty. For instance, the 3 measures between 1) the anteriormost bony landmark (usually the ALC) and the anterior EF, 2) the anterior and the posterior EFs, 3) and the posterior EF and the optic canal, have been employed to produce a 3-digit formula that should help to memorize EF topography. However, such a formula, built on average values, does not (and cannot) represent the remarkable inter-individual variability, as testified by the commonly observed high standard deviation. In addition, the 3-digit formula in itself is considerably different from survey to survey, as shown in Table 1. The reason for such divergent results is likely manifold. First, inter-ethnical differences probably play a major role. Second, there is a plethora of anterior reference points that have been used to take measures: the intersection between a vertical line passing through the medial rim of the anterior orbital opening and a line joining the anterior and the posterior EFs,[11,23] the midpoint of the ALC,[14,16,17,25,35] the highest point of the ALC,[19] the naso-maxillo-frontal point,[5] a point situated at the intersection between a horizontal plane passing through the nasion and the upper prolongation of the ALC.[29] Many investigators just mentioned the ALC without making any additional specification[12,13,15,18,27,33]

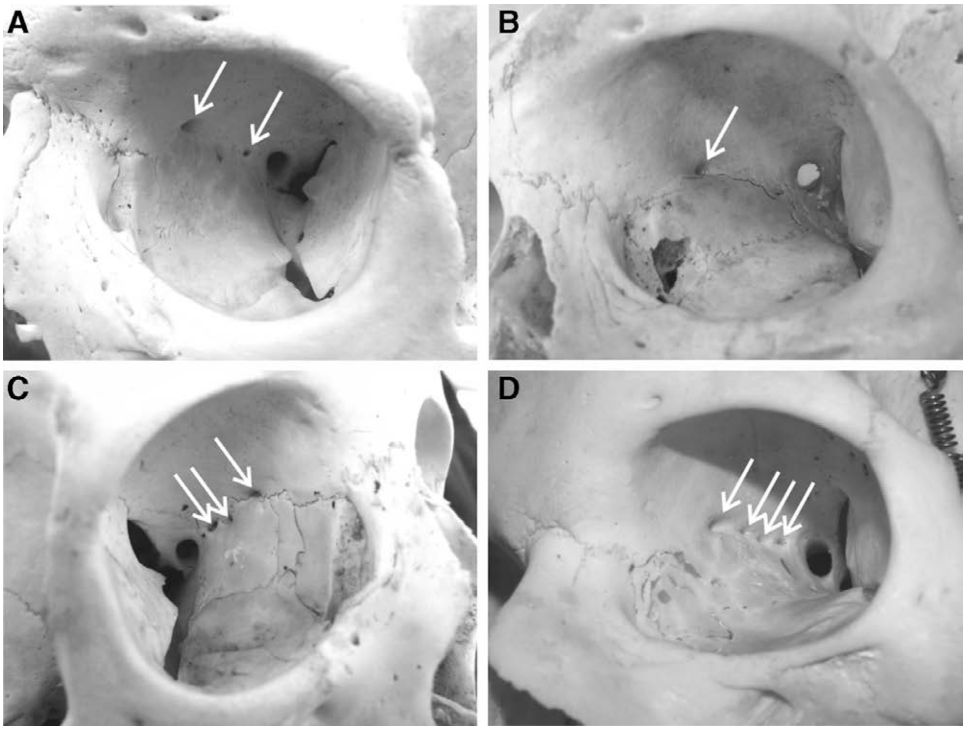

FIG. 2. Ethmoidal foramina (arrows). **A,** Left orbit with 2 (anterior and posterior) EFs. The fronto-ethmoidal suture is not visible. **B,** Left orbit with a single exsutural anterior EF. **C,** Right orbit with 3 sutural EFs. **D,** Left orbit with 4 EFs. The frontoethmoidal suture is not visible.

TABLE 1. Summary of the 3-digit formulas produced by different research groups

References	ABL-AEF	AEF-PEF	PEF-OC
Lang, 1983[5]	17*	13	5
Shin et al., 2016[29]	18†	15	8
Akdemir et al., 2004[30]	19*	13	5
Takahasi et al., 2011a[13]	20‡	14	8
Felding et al., 2018[19]	21§	14	6
McQueen et al., 1995[31]	22‡	12	9
Lethaus et al., 2013[23]	22¶	14	6
Ismail et al., 2022[22]	22‡	14	10
Piagkou et al., 2014[15]	23‡	10	4
Lang, 1983[5]	23‖	13	5
Huanmanop et al., 2007[32]	23‡	13	6
Yoon and Pather, 2016[33]	23‡	14	8
Karakas et al., 2003[34]	24‡	10	7
Hester et al., 2021[25]	24**	14	8
Cheng et al., 2008	25‡	11	6
Mehta and Perry, 2015[27]	25‡	14	6
Vadgaonkar et al., 2015[17]	27**	13	6
Celik et al., 2015[16]	28**	11	5

ABL-AEF: distance expressed in millimeters between the anterior bony landmark and the anterior ethmoidal foramen. The anterior bony landmark is specified for each study by the following superscripts:
*Dacryon.
†Intersection between a horizontal plane passing through the Nasion and the upper prolongation of the ALC.
‡ALC without further specification.
§Higher point of the ALC.
¶Medial orbital rim, defined as the anterior end of the medial orbital wall as seen on a CT paraxial plane aligned along a line joining the Nasion and the AEF.
‖Naso-maxillo-frontal point.
**Midpoint of the ALC.
AEF, anterior ethmoidal foramina; OC, optic canal; PEF, posterior ethmoidal foramina.
AEF-PEF: distance expressed in millimeters between the anterior and the posterior ethmoidal foramina. PEF-OC: distance expressed in millimeters between the posterior ethmoidal foramina and the optic canal.

and others employed the dacryon (fronto-maxillo-lacrimal point) as anterior landmark[5,30] which is located, by definition, behind the ALC. One way or another, most studies employed the ALC as a reference point. However, the trickiness of tracing a site along the ALC that can be easily spotted to take measures may affect the final results. To make things even more complicated, the ALC has been employed and apparently defined in a very subjective way. For instance, taking measures from the midpoint of the ALC requires a well-established way to identify the extremities of the ALC which are not so obvious. Whereas the upper extremity, though vanishing upward, can be roughly identified, the lower extremity, continuing with the infraorbital margin of the anterior side of the maxillary body cannot be defined with certainty. In addition, some investigators extended the ALC inferiorly including into it the infraorbital margin of the maxillary bone, as if the crest was made by a vertical part (the true lacrimal crest) and a horizontal part (the infraorbital margin).[25] Be as it may, it is evident that the uncertainty to define a reliable anterior landmark is a critical issue. Third, and in our opinion more important, the reason for such diverse results is possibly even more basic and can be traced back to the lack of a general consensus over the definition of anterior and posterior EFs. In principle, this is not a problem when EFs are 2 as, forcedly, one is the anterior one and the other is the posterior one. Things are less obvious and can affect results when the number of EFs is not just 2. For instance, in case of a single EF, which criteria can be employed to assign it to the anterior one rather than to the posterior one?[6,15,23,25] Similarly, in case 3, 4 or even 5 EFs are present, which guideline can be followed to decide which of them is the anterior one and which is the posterior one? Some researchers referred to the anteriormost of the EFs as the "anterior EF" and all the other foramina, regardless of their position and number, were considered as posterior EFs.[14] On the other hand, with a very pragmatic approach, most investigators solved the matter by assigning the name "anterior EF" to the anteriormost one and the name "posterior EF" to the posteriormost one. In this case, a third EF has been referred to as middle or intermediate EF.[12,15–17,24–27,35,36] As far as the position of the middle EF on the medial wall of the orbit is concerned, reports are contrasting. Whereas for some investigators most of the middle EFs are located within the posteriormost quarter of a line joining the anterior and the posterior EFs, and never ahead of the midpoint,[37] for others it is located just around the midpoint as it is reported almost equidistant (11.77 ± 2.09 mm from the anterior EF and 11.40 ± 2.34 mm from the posterior EF) from the 2 main EFs.[24] However, these values should be taken cautiously as the sum of the 2 distances (23 mm), which should correspond to the distance between the anterior and the posterior EFs, is far greater than the measures resulting from all the other investigations (Table 1, third column). Supernumerary EFs have been also called "accessory anterior EF," "accessory posterior EF," "accessory middle EF,"[15] or simply "accessory EFs."[13,22] However, assigning to the EFs the value of main (either anterior or posterior or middle) rather than accessory remains a very subjective matter. In summary, some gray zones exist and should be openly faced to avoid muddling results.

Indeed, an attempt to address these issues has been carried out with a quite simple and innovative approach that does not rely only on direct measurements from usual bony landmarks.[18] As direct measurements suffer from inter-individual differences in orbit size and length, Regoli et al.[18] propose to adopt an index, the relative depth index (RDI), as the ratio between the distance of the EF from the ALC along a horizontal line and the length of the medial orbital wall (i.e., the distance between the ALC and the anterior rim of the optic canal). This ratio normalizes EF position relative to the orbit length, which is an individual feature. RDIs have been calculated for the anterior and the posterior EFs in orbits with 2 EFs (i.e., by far, the most common pattern), resulting in 0.53 ± 0.04 and 0.84 ± 0.06, respectively. By the very low standard deviations of these indexes, we can infer that the position of both EFs on the medial wall of the orbit is remarkably constant, regardless of individual differences in orbit length. The position for the anterior EF corresponds to a point a bit farther than the midpoint of a line joining the ALC to the optic canal whereas the posterior EF is placed a little farther than the junction between the anterior 4/5 and the posterior 1/5 along the same line (Fig. 3). The quite constant position of the EFs also allows to calculate a "watershed index" (0.685, the average between 0.53 and 0.84), an RDI value under which an EF falls into the domain of the anterior EF, and above which it falls into the domain of the posterior EF. Following these criteria, Regoli et al.[18] have determined that most orbits with a single EF are indeed provided with the anterior EF (255 out of 261), whereas only a few orbits (6 out of 261) have the posterior EF. Interestingly, this is in accordance with angiological data that report the posterior ethmoidal artery (PEA) as missing more frequently than the AEA.[10,38–40]

The same criteria are applicable when 3 or even more EFs are found in the same orbit and, in doing so, there is no need to define the middle EF. All EFs with an RDI lower than the watershed index (0.685) should be considered anterior EFs and all foramina with an RDI higher than 0.685 should be considered posterior EFs. Based on the low variability of the RDIs belonging to the main EFs, the presence of a double or triple anterior EF can also be easily handled by assigning the value of "anterior EF" to the foramen with the RDI closest to 0.53 and referring to the remaining ones as "accessory anterior EFs." Similar reasoning (but with reference to the appropriate RDI) can be applied to double or triple posterior EFs. On the ground of these criteria, according to Regoli et al.,[18] when orbits show 3 EFs, the anteriormost one is always the anterior EF, whereas the posteriormost one is not always the posterior EF, being an accessory posterior EF in 8.9% of cases. The "so-called middle EF" is indeed an accessory anterior EF in 20.8% of cases, an accessory posterior EF in 70.3% of cases, or the posterior EF in 8.9% of cases.

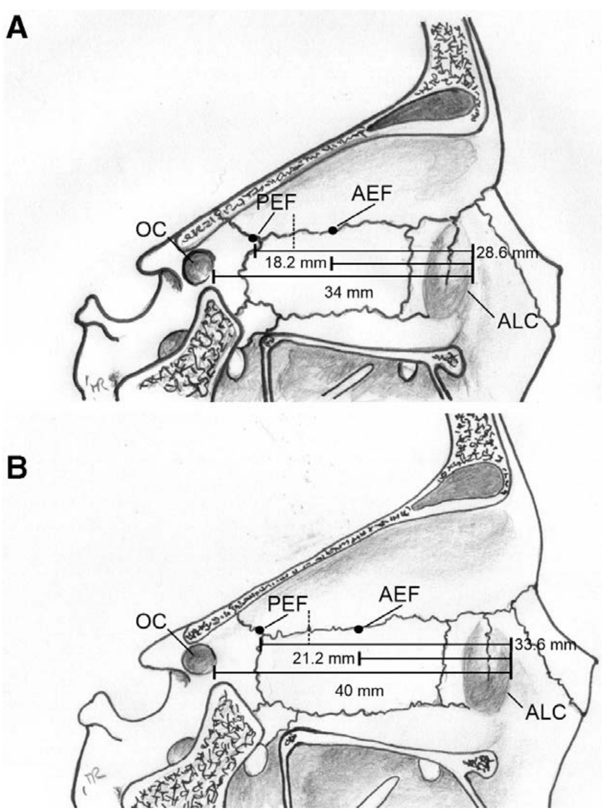

FIG. 3. Relative depth index (RDI). The sketch illustrates 2 examples of how the RDI applies to orbits of different length. **A,** Orbit with an anterior lacrimal crest (ALC)-optic canal (OC) distance of 34 mm. Distances between ALC and the anterior ethmoidal foramina (EF) (AEF) and between ALC and the posterior EF (PEF) are 18.2 mm and 28.56 mm respectively. AEF and PEFs have RDIs, respectively, of 0.53 and 0.84. Vertical dotted line shows the site of the "watershed" RDI. **B,** Orbit with an ALC-OC distance of 40 mm. Distances between ALC and AEF and between ALC and PEF are, respectively, 21.2 and 33.6. AEF and PEFs have exactly the same RDIs as in orbit A. Vertical dotted line shows the site of the "watershed" RDI. In conclusion, though distances for the AEF and the PEF from the ALC measured in orbit A and orbit B are quite different, their respective RDIs are the same in both orbits. The watershed index represents a border behind which foramina should be considered PEFs and in front of which should be considered AEFs.

This approach has the merit of producing objective guidelines for EF classification, which otherwise require a certain dose of arbitrariness and subjectivity.[18] In addition, by normalizing the distance from the ALC relative to the length of the orbit, this method reduces the relevance of inter-individual differences in orbit geometry, and just knowing the orbital length allows to predict with a very good approximation the distance between the ALC and the EFs (Fig. 3). Admittedly, the real RDIs can be slightly different from those calculated by Regoli et al.[18] as they conducted their investigation with graduated scales and calipers. A study carried out on digital imaging (i.e., CTs) should provide more precise measurements and calculations. However, we believe that the RDI could be a valuable tool to investigate EFs topography.

One investigation addressed the issue of EF location on the medial wall of the orbit in a pediatric population.[41] Using ancient dry skulls of known age, the study demonstrates that the anterior orbit grows at a greater rate compared with the posterior half. The distance of the anterior EF from the ALC doubles during the first 5 years of life to further increase, though at a slower rate, up to puberty. The posterior orbit has a much less marked growth. Interestingly, the distance between anterior and posterior EFs and the distance between the posterior EF and the optic canal on average are respectively 10 and 8 mm, regardless of postnatal age.[41] This is in accordance with the observation that both main EFs are located in the posterior half of the orbit (RDI >0.5)[18] which has a very limited growth rate.[41] However, the aging process seems to influence the distance among ALC, EFs, and optic canals. In general, observations on 2 age groups of an adult population (under or over 40 years old) show that the medial wall of the orbit increases in length with aging, and the distances among ALC, EFs, and optic canal grow accordingly.[35]

This discussion about the localization of the EFs on the medial orbital wall has focused so far on their position along the anteroposterior axis. However, EFs positioning along the vertical axis is also important. For this purpose, anatomists and clinicians mostly have used the frontoethmoidal suture as a bony landmark. This is an obvious choice as the superomedial and inferiomedial angles of the orbits are difficult sites to pinpoint with precision: whereas the superomedial angle of the orbit is a smoothly rounded corner, the medial wall of the orbits gradually merges with the orbital floor frequently without any real break of continuity.[42] However, it must be remarked that the fronto-ethmoidal suture is not always visible (Fig. 2A, D). This is a consequence of aging processes that may develop a synostosis between the frontal and the ethmoid bones, making their reciprocal border invisible. At any rate, when the frontoethmoidal suture is visible, EFs can be found along it (sutural foramina) (Fig. 2C), below it, or above it (exsutural foramina) (Fig. 2B). EFs are located along the suture line in most instances, between 61.3% and 84% of cases.[10,14,18,33]

On the other hand, they are exsutural from 15% to 38.7% of cases. To be more precise, they are mostly referred to as located above (19.7%–38.15% of cases) and never, or very rarely (from 0% to 0.54% of cases), below the suture.[10,18,33,36] However, for the sake of completeness, it should be noted that 1 investigation has reported the reverse, as to say that exsutural foramina have been observed mainly below the suture, in 13% of cases, and above the suture only in 2% of cases.[14]

Considering each EF, the anterior EF is a sutural foramen in 67% to 84% of cases, whereas the posterior EF is in 75.5% to 94.8% of cases.[10,22,33] When anterior EFs are exsutural (Fig. 2B), in 16% to 33% of cases,[10,12,22,23,36] their average distance from the suture is 1.55 ± 0.58 mm above it, ranging from 1.2 mm below to 4 mm above the suture.[10,12,22] Posterior EFs are more rarely exsutural, with a frequency ranging between 2.1% and 24.5% of cases, depending on the survey.[10,12,22,33,36] Still with small variations depending on the study, posterior EF has been found above the suture at an average distance of 1.5 ± 2 mm or 1.73 ± 0.86 mm,[22,33] though its position can range from 2.8 mm below[33] to 5.7 mm above the suture.[22] The so-called "middle EF" has been observed lying exsutural, above the frontoethmoidal suture, in 5.9% of cases.[36]

An alternative way to place the EFs along the vertical axis has been proposed employing as a reference line the one joining the optic canal with a point situated at the intersection between a horizontal plane passing through the nasion and the upper prolongation of the ALC. Both the anterior and the posterior EFs appear located almost exactly along this line, respectively 0.2 and 0.4 mm below this line.[29]

In accordance with the caliber of the arteries that travel through them, the anterior EF is usually larger than the posterior EF,[5] measuring 2.19 ± 0.80 mm vs. 1.55 ± 0.83 mm in diameter.[33] However, both foramina have an oval profile with an anteroposterior greater diameter and a vertical lesser diameter. They are also funnel-shaped as their diameter decreases progressively toward the middle of the canals.[5]

EFs are of great importance in clinical practice for the identification of the site from which one of the main sources of their blood supply reaches the nasal and paranasal cavities. However, when the surgical field is located on the other side of the lamina papyracea (i.e., in endoscopic ethmoidal surgery), other intranasal landmarks can be observed to find the AEA. For instance, the axilla of the middle turbinate and its basal lamella have been proposed to serve for this scope. In this respect, the distances between the AEA, from one side, and the "anterior face" of the axilla and the "center of the basal lamella" on the other side have been reported as 16.24 ± 2.75 mm and 8.97 ± 1.46 mm, respectively.[43] The intraethmoidal length of the AEA course is estimated between 5.82 ± 1.41 mm[44] and 8.4 ± 1.5 mm.[6] If not related to interethnic variations, the remarkable difference between these values is difficult to explain. Within the ethmoid, the AEA runs inside a canal directed laterally and slightly forward forming with the lamina papyracea at an angle of 60.5 ± 16.4 degrees.[6] When considering the vertical lamellae that divide the ethmoid sinus into smaller compartments, the first one is the lamella of the uncinated process, the second one is the lamella of the ethmoid bulla, the third one is the basal (or ground) lamella (also known as lamella of the middle turbinate, it spans from the nasal wall to the lamina papyracea and it makes a separation between the anterior and the posterior ethmoid cells), the fourth one corresponds to the superior turbinate, and the inconstant fifth one is the lamella of the supreme turbinate. According to most studies, the AEA mainly courses between the second and the third lamellae (nearly 80% of cases) or within the third lamella (12% of cases),[45] meaning that it shows a highly conserved position within the ethmoid. Incidentally, this observation confirms findings based on the RDI,[18] reporting that little variation occurs for the position of the anterior EF along the medial orbital wall through which the AEA passes. The position of the AEA at the skull base is also influenced by the presence of the supraorbital ethmoid cell (SOEC) and by the length of the lateral lamella of the cribriform plate (LLCP). In the presence of a well-pneumatized SOEC and/or a long LLCP, in fact, the AEA is more likely to be found running freely below the skull base, and extra caution should be exerted during endoscopic surgery.[45]

Symmetry

An interesting issue is the assessment of EFs right/left symmetry. However, results on this matter are confusing as some researchers claim that EFs are mostly symmetric structures[23,46] whereas others have an opposite view.[11,12,15] Indeed, in many reports, it is not easy to understand which kind of symmetry/asymmetry has been really assessed. Is symmetry referred to the position along the medial wall of the orbit or just to their number? More details, to our knowledge, have been supplied only once.[18] As far as their number is concerned, symmetric EFs have been found in 62% of skulls. To be more precise, a single EF can be found bilaterally in 7.6% of skulls, 2 EFs in 45.2% of cases, and 3 EFs in 9.1% of skulls. In contrast, 38% of orbits show different numbers of EFs on the 2 sides. The pattern of asymmetry is highly variable, as to say that the observed side-to-side ratio can be 1/2, 1/3, 2/3, 2/4, or 3/4. Interestingly, the orbit with the higher number of EFs is more frequently the left one, whichever is the considered pattern.[18] On the other hand, a score based on the distance from the ALC can be devised as far as a symmetric positioning along the medial wall is concerned.[18] An EF and its contralateral fellow have been considered symmetric if they show the same distance (with an approximation of ±1 mm) from the ALC. According to Regoli et al.,[18] if all EFs are symmetrical the degree of symmetry scores 100%. On the other hand, if the number of symmetric EFs is lower, the degree of symmetry is reduced accordingly. For instance, if the overall number of EFs on both sides is 5 (3 on one side and 2 on the other side) and only 2 of them (1 EF and its contralateral fellow) are symmetric, the degree of symmetry falls to 40%. In keeping with these guidelines, Regoli et al.[18] have shown that 40.2% of skulls have a 100% degree of symmetry, 14.6% of skulls a very high level of symmetry (between 80% and 99%, meaning 4 EF out of 5 are symmetrically placed), 38.1% of skulls a medium level of symmetry (between 40% and 79%), and only 5.8% have a low degree of symmetry (less than 39%). In summary, in most cases, EFs are placed in the same position when the 2 orbits are compared.

In conclusion, EFs have a remarkable clinical interest. A reliable knowledge of their anatomy is important to orbital surgeons and otolaryngologists. Unfortunately, a comparison of the results extrapolated from the studies that have been published so far shows a high degree of inconsistency which may leave the readers with a feeling of indeterminacy that is not reassuring. Novel and clear guidelines to classify EFs and to locate them on the medial wall are required. Determining the RDIs of EFs may be an interesting approach to solve the matter. Other methods, possibly more effective, can be also devised. However, direct measurements from bony landmarks, without any further analysis as has been done so far, seem inadequate and possibly misleading.

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