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An Essay of Computed Tomography (CT) to Study the Minimum Sinusal Retention

TC um Exercício da Tomografia Computorizada (TC) para Estudo da Diminuta Retenção Mucoide Nasossinusal

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Abstract

Introduction – The CT of paranasal sinuses in conjunction with the nasal endoscopy used to evaluate the retention and restitution of mucociliary drainage and normal permeability. This study is focused on the ethmoidal infundibulum and to the ostiomeatal complex that support FES (Functional Endoscopic Surgery).[1,2]
Objective – Study of individual morphology of the meatal complex to explain the sinus retention when confined; contribute to the corrective nasal endoscopy to be proposed by the clinic.
Material & Method – There are 110 cases with patency loss of the region of the medium conchae and surrounding sinuses. High resolution CT with three orthogonal scans in simultaneous display.
Results – The results are organized by incidence, retention level and stenosis of infundibulum and ostiomeatal complex drainage. Findings: High frequent variants are those between unciform and the bulla in the minimum retention (60%); The contact between the uncinate process and the orbit is more frequent than the contact between the uncinate process and the medium bulla – 17% vs 7%; The frontal retention is 12% in the stenosis of the hiatus with ethmoidal retention.
Discussion – Exercise the significance of CT for the pathophysiology of nasal retention with importance for the endoscopy.
Conclusion – Consider the duality of CT and endoscopy as a clinical matrix to share.

Keywords

Nasosinusal CT; CT and nasal endoscopy; Minimum retention CT.

Resumo

Introdução – A TC das cavidades paranasais acompanha a endoscopia para avaliar a retenção mucoide, tendo em vista a restituição da drenagem mucociliar e consequente arejamento. Este estudo orienta-se para o infundíbulo etmoidal e para os óstios meatais que suportam a FES (Functional Endoscopic Surgery).[1,2]
Objetivo – Conhecer a morfologia individual do complexo meatal anterior para explicar a retenção sinusal enquanto confinada; contribuir deste modo para a endoscopia nasal corretiva a ser proposta pelo clínico.
Material e método – São 110 TC com perda da permeabilidade do meato médio e células vizinhas. Alta resolução da TC sob três planos ortogonais com leitura simultânea.
Resultados – Repartidos pela prevalência, pelo teor da retenção e pelo grau de estenose meatal. Existe: predomínio das variantes da apófise unciforme e seu contacto com a bula etmoidal na retenção diminuta (60% dos casos); contacto da apófise unciforme-órbita que é mais frequente do que o contacto apófise unciforme-concha média, 17% vs 7%; retenção frontal em 12% da estenose hiatal com retenção etmoidal.
Discussão – Argumentada na relação da anatomia nasossinusal com a patofisiologia da retenção.
Conclusão – Considerada a dualidade da TC com a endoscopia segundo matriz de partilha clínica.

Palavras-chave

TC nasossinusal; TC e endoscopia nasal; TC da retenção nasossinusal diminuta.

Introduction

Combining CT with endoscopy has been a constant clinical motivation regarding nasosinusal retention, almost always yetadvanced, originating in the ethmoidal infundibulum and ostiomeatal complex. In this interdisciplinary context, it seems important to relate the retention, while limited to anterior sinus spaces – being certainly new – with the underlying anatomical variant. Hence our modest contribution to the study of small, minimal retention, whose incidence in chronic rhinosinusitis is quite pronounced and has high costs.[1,2]

Material and Method

There are 110 CT scans of the paranasal sinuses continuously performed between 2017 and 2019 on individuals with loss of nasal permeability compatible with mucoid retention. Retention is confined to the ethmoidal spaces, whose drainage is in the infundibulum, uncibular hiatus or semilunar hiatus, either isolated or combined. CT scans have been applied for the study of chronic nasal obstruction, without specifying its nature. Average age is 49 years (range 15-65 years). The CT scans have been requested by the Health Centres of Beja District. These have all been performed with the same image acquisition and reconstruction parameters. The examination has been

performed in the supine position, volumetric acquisition, CARE 4D technology for automatic modulation of mAs (reference value of 32 mAs) and 130 kV. High resolution kernel reconstruction at 3mm, 3mm increments. The image reading window has been 2000/200UH. Measurements have been performed by one of the authors (CM); the densitometry measurement has been maintained by another author (MM), to avoid calculation variation. Measurements have been made using a cursor applied simultaneously in the 3 planes of space. The magnification used varies, depending on the detail to be highlighted. In the coronal plane, the permeability of the uncibular hiatus has been observed according to the "soft parts/air" interface. In the parasagittal plane, the outline and permeability of the semilunar hiatus have been recorded, in addition to the topographical relationship with the agger nasi and the frontoethmoidal recess. Deviation or subluxation of the nasal septum has not been considered.The three-dimensional image reformatting technique applied to CT of the paranasal cavities has been considered mandatory as it details the sinus structures in the parasagittal plane.[3]
While collecting data, retention with semiology of polyposis of dental origin, of mucocele, of pan-sinusitis, and of tumor has been removed. CT for which measurements were doubtful have not been considered.

Results

In the 110 CT, the retention is unilateral vs. bilateral in a 1:1 ratio.
Isolated retention in the maxillary antrum, when limited to 1/3 of the sinus, is evident in 75% of the cases; only in the anterior ethmoid (agger nasi cell and ethmoidal bulla) in another 16%; in both, still another 9% - Table I; the association of frontal sinus with anterior ethmoidal retention is 12%.

Table I – Distribution of nasosinusal retention CT (110 cases)

Only in the maxillary antrum (up to 1/3, inclusive)	75%
In the anterior ethmoid (*agger nasi*+bulla)	16%
Both	9%
In the anterior ethmoid + frontal recess	12%

In the maxillary antrum, retention represents 1/3 of the cases, i.e. 53%. In 32% of the cases, retention is ≤ 1/3. This antral retention is related with the contact of the uncinate process with the ethmoidal bulla in 49% of the cases. Contact with the middle conchae is 7%; with the orbit, 19%. Antrum retention ≤1/3 is associated with contact between the uncinate process and the ethmoidal bulla in 49% of the cases. The contact of the uncinate process, conjoint with the bulla and with the middle conchae is 7%. The association of contact between the ethmoidal bulla with the middle conchae and also with the orbit is 7%. Contact of the uncinate process with the orbit is more frequent than with the middle conchae: 19% vs 7% - Table II.

Table II – Maxillary antrum retention CT (110 cases)

Maxillary antrum retention	Total	Uncinate process - ethmoidal bulla contact	Uncinate process - middle conchae contact	Uncinate process-orbit contact	Ethmoidal bulla - middle conchae contact	Ethmoidal bulla - middle conchae – orbit contact
Inferior to 1/3	32%	23%	6%	5%	6%	3%
Equal to 1/3	53%	26%	1%	14%	1%	4%
Total		**49%**	**7%**	**19%**	**7%**	**7%**

Other characteristics of the uncinate process may be important for the endoscopy: contact with the middle conchae in 13%; contact with the orbital edge in 25%; combined contact with the ethmoidal bulla and the middle conchae in 13%; triple contact with bulla, conchae and orbit in 10%.
In maxillary antrum retention ≤1/3, the contact between the uncinate process and the ethmoidal bulla is predominant in 23%. In the retention of the antrum, which occupies already about 1/3 (prevalent in half of the cases studied), there is contact between the uncinate process and the ethmoidal bulla in 26%; in the most predominant retention, of ½ and 2/3, the distribution is almost the same, between 2% and 6%, between the contact of the uncinate process with the ethmoidal bulla, with the middle conchae and with the orbit, simple or combined. Therefore, the smallest retentions of the antrum, up to 1/3, can be related, namely, with the contact between the uncinate process and the ethmoidal bulla.
Table III shows that the variation in drainage depends on simple stenosis (32%), obstruction (52%) or obliteration (16%). Additionally, it also depends of the thickness of the uncinate process (47%), and of its lateral inclination (34%).

Table III – Ethmoidal infundibulum and uncinate process CT (110 cases)

Ethmoidal infundibulum with simple stenosis	Ethmoidal infundibulum with obstruction	Ethmoidal infundibulum with obliteration
32%	52%	16%

Table IV shows that retention originated in the ethmoidal infundibulum, only drains the maxillary antrum in 55% of the cases; in the ostiomeatal complex, which simultaneously drains the antrum, the ethmoidal bulla and the agger nasi, in 15%; in the antrum and ethmoidal bulla (with normal agger nasi) in 10%; in the antrum and agger nasi cell in 9%; only in agger nasi, 1%; and additionally in the frontal sinus in 12%. Retention in the frontal sinus is related to obstruction of the semilunar hiatus that drains it (in 12%). Overall, anterior drainage is related to infundibular stenosis in 84%, only to obstruction in 52%. Häller's cell is present in 16% of retentions, whilst the middle turbinate with paradoxical curvature is present in 5%.

Table IV – Mucoide drainage and retention CT (110 cases)

Ethmoidal infundibulum (antrum drainage)	Uncibular hiatus (anterior ethmoidal drainage)	Semilunaris hiatus	Antrum + bulla (*agger nasi* normal)	Antrum + *agger nasi*	Frontal sinus associated
55%	15%	12%	10%	9%	12%

When in the CT scan, retention in the maxillary antrum is compared with the type/degree of stenosis of the infundibulum and ostiomeatal complex, it can be observed a smaller content (less than and equal to 1/3) in simple stenoses (contact of the uncinate process with the ethmoidal bulla or with the middle conchae). The greatest retentions overlap with the presence of complex contacts (middle conchae or bulla-medium conchae-orbit). The difference between the two is 70% (No. 1 and 2 – Table IV) vs 42% (No. 3 and 7 – Table IV).
Figs. 1-3 illustrate the key variants of the infundibulum-ostial complex and the pattern of minimum retention.

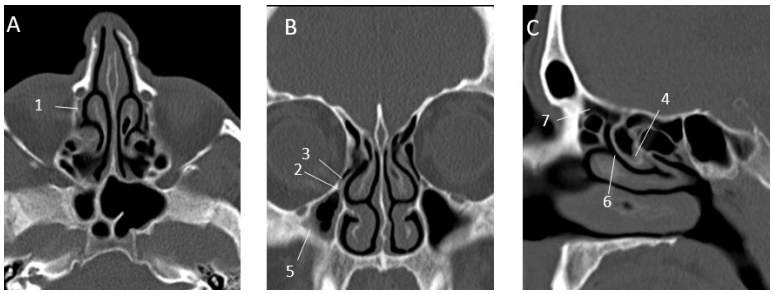


Figure 1 – Nasal CT. Axial, coronal and parasagittal planes (A, B, C). Infundibulum (1) and uncibular hiatus (2) stenosis. Contact between the uncinate process and the orbit (3). Retention confined to the ethmoidal bulla (4) and to the maxillary antrum (5). Normal permeability of the semilunar hiatus (6) and of the agger nasi cell (7).

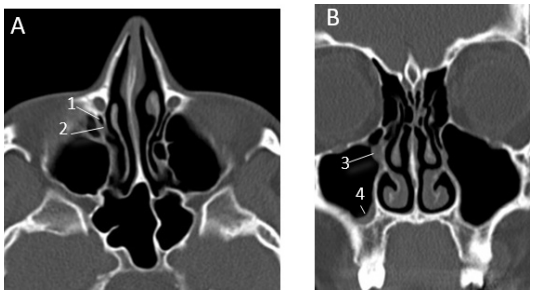


Figure 2 – Nasal CT. Axial and coronal plane (A, B). Ethmoid infundibulum stenosis (1). Contact between the uncinate process and the ethmoidal bulla (2). Uncibular stenosis. Contact retention in the uncibular hiatus (3). Retention confined to the lower recess of the antrum (4).

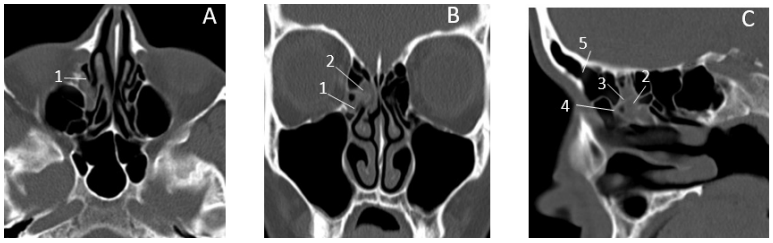


Figure 3 – Nasal CT. Axial, coronal and parasagittal planes (A, B, C). Contact of the uncinate process with the bulla (1A, 1B). Retention in the ethmoidal bulla (2A, 2B) and discreet in the antrum. Stenosis of the uncibular (3) and semilunar hiatus (4). Normal permeability of the frontal recess (5).

Discussion

Retention in the paranasal sinuses results from the change of the normal drag flow, originated from a morphological variant of the ethmoidal unit, which interferes with drainage. This is the basis sensu lato of the FES (Functional Endoscopic Surgery),[3-7] applied in about half of the cases of chronic rhinosinusitis in the USA between 2003 and 2008.[1] To summarize the terminology for academic purposes, the ORL Brazilian College[8] collects radiological opinions for the ostiomeatal pathways, followed in this essay.

Echo the main objective of the present work, study the nasosinusal retention only with an anterior location, thus designated as minimal or circumscribed. The partial or complete obstruction of the infundibulum ethmoidal, draining the maxillary antrum, of the uncibular hiatus that drains the anterior ethmoid, and of the semilunar hiatus draining the agger nasi cells, and additionally in some other cases the frontal recesses sinus, are considered responsible for the different models of retention.[9,10] Recognizing these models throughout CT, in their morphology and topography, is crucial to explain the complexity of the difficulties, with implications on the endoscopy.[3] However, there is no direct relation between the type and degree of meatal stenosis and the presence or absence of retention. Once the area of study has drainage around the uncinate process, the variants of the infundibulum and neighbouring hiatus explain, in isolation or in conjunction, the local thickening of the mucosa. It is the contact of the uncinate process with the ethmoidal bulla that, in approximately half of the cases, shows antral retention ≤ 1:3.

Likewise, it is possible to verify in our cases that simple obstruction of the infundibulum is approximately 5 times more frequent than obliteration. The thickness of the uncinate process, its relative position to the ethmoidal bulla and the middle conchae, alongside with its inclination, are other key parameters for the endoscopy,[11] where the maxillary antrum is constantly drained. The proximity of the infundibulum to the agger nasi cell and to the ethmoidal bulla, with unequal height of the uncibular and semilunar hiatus, depends on the number of cells retained in the meatal region. Hence, the anterior drainage (maxillary antrum and agger nasi cell, with or without the ethmoid bulla) is directly related to the ethmoidal infundibulum and uncibular hiatus in 70% of the cases. Another variant, potentially relevant for endoscopy, is based on the size of the ethmoid protrusions constituted by the agger nasi cells and the bulla, as the size and permeability of the hiatus between them, the usual place of drainage of the anterior ethmoid and in some cases of the frontal recesses. The latter in 12% of ethmoidal retentions. Thus, the ostiomeatal obstruction reaches the verge of extension when there is frontal retention associated with the ethmoid, that, if low (12%), can compromise the surgery.[12] The frequency of common drainage of the antrum and bulla (with permeable agger nasi cells) in 10%; still from the antrum and agger nasi cells in another 9%, it is not unremarkable in its recognition by the CT. The same happens with pneumatization and the paradoxical curvature of the middle conchae, the former being about 5 times more frequent.

Such results justify the importance of CT, in particular the morphometry prior to surgery,[13,14] never neglecting the previous role in the prediction of risky sites.[15] Therefore, CT and endoscopy should be integrated into a complementary matrix with mutual advantage.[16,17] The limitation of our work is due to the lack of correlation between the results of CT and endoscopy, as these result from siloed activities.

Conclusion

The diversity of sinus drainage pathways and their architecture favour the joint performance of CT and endoscopy, particularly when evaluating the indication for functional surgery. This combination, widely tested, is relevant for the outcome of models of mucoid retention and for accessing areas of potential endoscopic risk. It is also possible to predict the infundibular and ostial complexity of drainage, when retention in the maxillary antrum is moderate. CT infers about the type of contact of the uncinate process and the degree of permeability of the infundibulum, which are the predominant variants in minor retention, although there is not always a correlation between such retention and the obstruction of the drainage orifice.

Finally, the integration of imaging becomes mandatory to achieve clinical completeness.

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Protection of human and animal subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

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