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A Systematic Literature Study of the Sinus Septi Nasi, Crista Galli and Other Minor Pneumatizations

Estudio Bibliográfico Sistemático del Seno Septi Nasi, Crista Galli y Otras Neumatizaciones Menores

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SUMMARY: Variations in the paranasal sinuses and pneumatizations originating from these structures are clinically important for surgical procedures to be performed in the nose and nasal cavity regions. No systematic review examining the sinus septi nasi, crista galli and other minor pneumatizations was found in the literature review. This study aimed to review the papers in the literature including the sinus septi nasi, crista galli and other minor pneumatizations and standardize the mean incidence, distribution by sex, age and origin of these structures. Furthermore, it was aimed to examine the height, length, and width values of sinus septi nasi and crista galli pneumatizations, determine the measurement intervals and measurement values, and standardize them. The studies involving these pneumatizations were reviewed from various databases. After being evaluated according to the inclusion and exclusion criteria, 35 articles between the years 1991-2021 were reviewed. Based on the data obtained from these articles, we examined the incidence of sinus septi nasi, crista galli, and other minor pneumatizations. Middle nasal turbinate pneumatization had the highest incidence among all these pneumatizations. Uncinate process pneumatization had the lowest incidence. Considering the distribution by sex, no difference was found. Upon examining the age range, there were people aged between 1-95 years, and the mean age range was 33.05-41.48. The length, width and height values of crista galli and sinus septi nasi could not be standardized due to the insufficient number of studies and variable data in the literature. We believe that our study will contribute to similar future studies in larger populations with the clinical procedures to be performed in and around the nasal cavity.

KEY WORDS: Sinus septi nasi; Crista galli; Pneumatization; Nasal cavity; Systematic review.

INTRODUCTION

The paranasal sinuses are the structures found in the cranium around the nasal cavity and where the nasal cavity is opened. The paranasal sinuses in and around the nasal cavity are among the structures with the most frequent anatomical variations (Mures¸an *et al*., 2021). While the paranasal sinuses may show variations outside of their normal anatomy, pneumatizations may occur in addition to these variations (Mures¸an *et al*., 2021).

Sinus pneumatizations may be caused by changes in the sinus walls. These pneumatizations may occur depending on different ethnic origins, different age groups, sex, and environmental factors (Papadopoulou *et al*., 2021). The variations of sinus pneumatizations may originate from different sinuses in different age groups. While variations of frontal, maxillary, and ethmoidal origins are more common, variations of the sphenoid sinus origin are more common in adults. The volume of pneumatization increases with age, and there is no difference between males and females (Mladina *et al*., 2017a).

Pneumatizations may originate from sinus structures, and pneumatizations of unknown origin may also occur. In the studies, pneumatizations were observed in the sinus septi nasi, crista galli and anterior clinoid process of unknown origin, nasal turbinates supreme/superior/middle, and uncinate process structures (Dutra & Marchiori, 2002; Leunig *et al*., 2008). Pneumatizations in these structures are important for surgical procedures to be performed in the nasal cavity (Papadopoulou *et al*., 2021). In the literature review, 154 studies conducted between 1991-2021 were reviewed, and pneumatizations in these structures were observed in 35 studies. CT (computed tomography), MDCT (multidetector computed tomography), and CBCT (cone-beam computed tomography) methods were used in these pneumatizations (Som *et al*., 2009; Al-Qudah, 2010; Hajiioannou *et al*., 2010; Papadopoulou *et al*., 2021).

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The studies investigated pneumatization variations, the incidence and origin of variations, incidence in males and females, and age range (Papadopoulou *et al*., 2021).

This research aimed to present the studies in the literature including the sinus septi nasi, crista galli and other pneumatizations as a review, compare the incidence of pneumatizations in these studies, and investigate the effect of age and sex on the incidence. Furthermore, it was aimed to determine the measurement intervals in sinus septi nasi and crista galli pneumatizations and the mean values of these measurements and standardize the measurements in all structures.

MATERIAL AND METHOD

The article titled "Methods of Evidence-Based Anatomy: a guide to conducting systematic reviews and meta-analysis of anatomical studies," published in the Annals of Anatomy journal, was taken as a reference and used while determining the method of our study (Kim *et al*., 2012). After the literature review, it was decided that the subject of our study was to review pneumatizations originating from sinus structures or other sources. The aim of our study was to present the studies in the literature including the sinus septi nasi, crista galli, and other minor pneumatizations as a review and standardize the mean incidence, distribution by sex, age and origin of pneumatizations in these studies. Furthermore, it was also aimed to standardize the measurement intervals in sinus septi nasi and crista galli pneumatizations and the mean values of these measurements. To this end, the articles including the sinus septi nasi, crista galli and other minor pneumatizations and the studies showing the incidence of pneumatizations in individuals aged 1-95 years were included. Case reports, letters to the editor, conference proceedings, unpublished articles, and articles with incomplete results were excluded from our study. CT, MDCT, and CBCT were used for sinus and skull scans in the studies we reviewed. This is a retrospective trial that clearly describes the sinus septi nasi, crista galli and other minor pneumatizations. In the literature review, the Google Scholar, PubMed, and Scopus databases were used. In these databases, 154 articles were reached using keywords such as "sinus," "septi," "nasi," "crista galli," and "pneumatization," and 35 articles between the years 1991-2021 that met the inclusion criteria were used (Fig. 1).

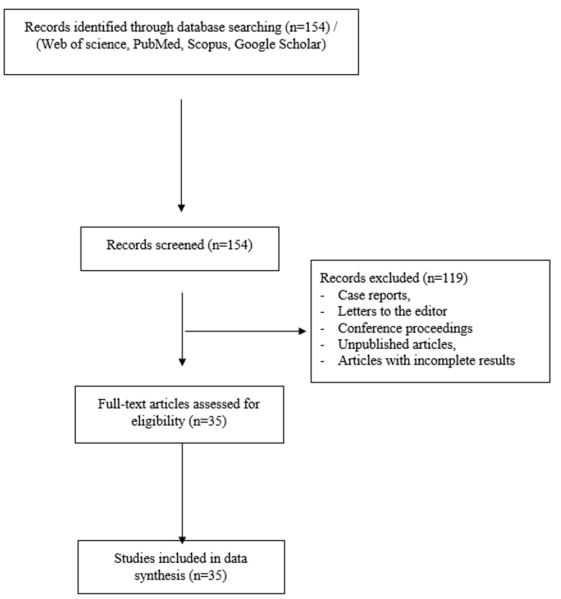

Fig. 1. Study Flow Diagram.

Pneumatizations in these articles were analyzed in terms of incidence, age, sex, origin, and the method used. Additionally, the height, length, and width values of sinus septi nasi and crista galli pneumatizations were reviewed, and their measurement intervals and measurement values were determined.

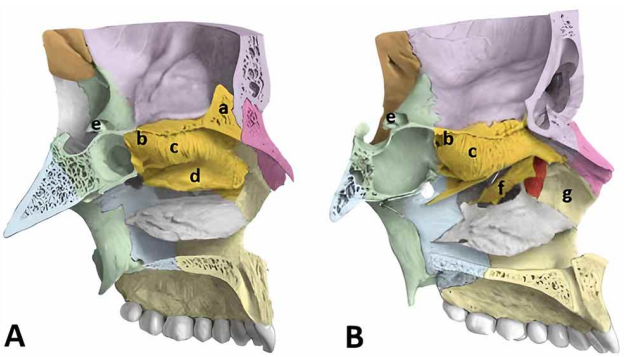

Fig. 2. A: Lateral nasal Wall. B: Lateral nasal wall (middle nasal turbinate removed) a: Crista galli; b: Supreme nasal turbinate; c: Superior nasal turbinate; d: Middle nasal turbinate; e: Anterior clinoid process; f: Uncinat process; g: Septum nasi (Susan, 2016).

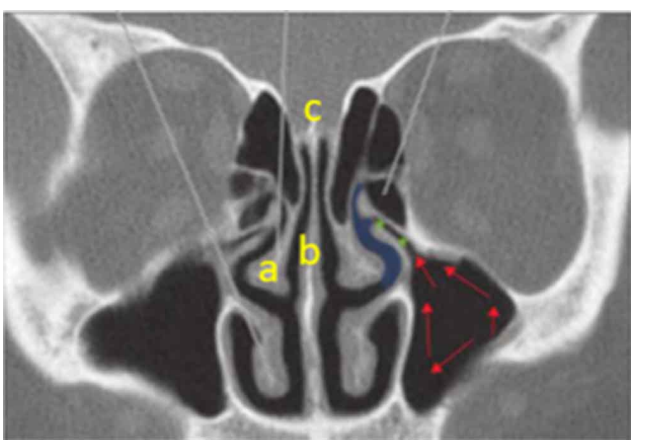

Fig. 3. A coronal CT scan nasal cavity a: Middle nasal turbinate; b: Septum nasi; c: Crista galli (Susan, 2016).

Analytical Statistics. SPSS 25.0 package program was used to evaluate the data. Descriptive statistics are given as numbers and percentages for categorical variables and arithmetic mean, standard deviation, and minimum and maximum values for continuous variables. Whether the data conformed to a normal distribution was tested by the Kolmogorov–Smirnov and Shapiro–Wilk tests, Kurtosis-Skewness values, Q-Q/P-P plots, and histogram evaluation methods. The correlation analysis between the data was evaluated by Spearman's test.

RESULTS

Among the 154 studies obtained from the literature review, 35 studies that met our inclusion criteria were examined. These studies included 13,387 people between the ages of 1-95. The studies examined sinus septi nasi, crista galli, anterior clinoid process, nasal turbinate and uncinate process pneumatizations.

Table I. General descriptive data of crista galli pneumatization.

Studies	Age (years)	Number of people	Incidence of CG pneumatization (%)	Method	Origin
Basic *et al*., 1999	19-86 (42 Avg)	212 people (78 men 134 women)	2.4	CT _mage	Sinus Frontalis
Dutra & Marchiori, 2002	1-7	71 people (46 men 25 women)	2.8	CT _mage	-
Leunig *et al.,* 2008	49.9 Avg	641 people (305 men 336 women)	14	CT _mage	-
Som *et al*., 2009	21-74	200 people (73 men 127 women)	13	CT _mage	Sinus Frontalis
Al-Qudah, 2010	16-77 (34 Avg)	110 people (58 men 52 women)	28	CT _mage	-
Hajiioannou *et al*., 2010	9-95 (55.9 Avg)	99 people (58 men 41 women)	14.1	CT _mage	Sinus Frontalis
Kim *et al*., 2012	7-91 (44.51 Avg)	818 people	12.2	CT _mage	Sinus Frontalis
Robinson *et al*., 2010	-	-	7.1	CT _mage	-
Kaygusuz *et al*., 2013	13-70 (32,2 Avg)	99 people (74 men 25 women)	22.2	CT _mage	-
Cobzeanu *et al*., 2014	18-91 (45.67 Avg)	205 people (108 men 97 women)	22.92	CT _mage	-
Poje *et al*., 2014	19-72	527 people	37.5	CT _mage	Sinus Frontalis
Turna *et al*., 2014	19-85 (39.1 Avg)	5832 people (2852 men 2980 women)	9.4	MDCT	-
Rereddy *et al*., 2014	19-85 (52.5 Avg)	100 people (31 men 69 women)	9	CT _mage	
Shpilberg *et al*., 2015	10-82 (47,9 Avg)	192 people (106 men 86 women)	9.9	CT _mage	-
Dasar & Gokce, 2016	20-83 (40.26 Avg)	400 people (209 men 191 women)	3.3	CT _mage	-
Manea & Mladina, 2016	18-81 (39,6 Avg)	196 people	30.1	CT _mage	-
Mladina *et al*., 2017a,b	>20	102 people (76 men 26 women)	66.6	CBCT	-
Sommer *et al*., 2019	14-95 (48,7 Avg)	249 (129 men 120 women)	16.5	CT _mage	-
Akiyama & Kondo, 2020	15-89 (50 Avg)	300 people (146 men 154 women)	9.33	CT _mage	Sinus Frontalis
Acar *et al*., 2020	20-81 (41,45 Avg)	402 people (207 men 195 women)	16.1	CT _mage	Sinus Frontalis
Nautiyal *et al*., 2020	18-82	250 people (150 men 100 women)	7.18	CT _mage	Sinus Frontalis
Muresan *et al*.,2021	-	171 people (51 men 120 women)	7.01	CBCT	Sinus Frontalis

Twenty-two studies included crista galli pneumatization. The studies examined 11176 people aged between 1-95 years. The mean age of the people examined was 41.48 ± 12.57, and 51.55% and 48.45% were male and female, respectively. The incidence of crista galli was between 2.40-66.60%, and the mean value was 16.39 ± 14.49%. CT image (90.9%), MDCT (4.5%), and CBCT (4.5%) methods were employed in the studies. Upon examining the origin of pneumatizations, no origin was indicated in 13 (59.1%) studies. However, 9 (40.9%) studies revealed that it originated from the frontal sinus (Table I). The length, width, and height of the crista galli were measured in the studies. According to the data obtained, the length values of the crista galli were between 2.8-20.8 mm, and the mean value was 10.30 ± 4.52 mm. The height value was between 3.6-26.0 mm, and the mean value was 14.66 ± 4.08 mm. The width value was between 0.9-9.9 mm, and the mean value was 4.77 ± 1.30 mm (Table VI).

Nine studies included anterior clinoid process pneumatization. The studies examined 8455 people between the ages of 10-86. The mean age of the people examined was 39.79 ± 7.46, and 51.08% and 48.91% were male and female, respectively. The incidence of the anterior clinoid process was between 0.50-29.20%, and the mean value was 17.48 ± 8.74%. CT Image (88.9%) and MDCT (11.1%) methods were used in the studies. The origin of pneumatization was not indicated in the studies (Table II).

Seventeen studies included uncinate process pneumatization. The studies examined 9256 people between the ages of 2-91. The mean age of the people examined was 38.17 ± 9.88, and 50.76% and 49.23% were male and female, respectively. The incidence of the uncinate process was between 1.40-13.80%, and the mean value was 5.98 ± 3.71%. CT Image (88.2%), CBCT (5.9%), and MDCT (5.9%) methods were used in the studies. The origin of pneumatization was not specified in the studies (Table III).

Nine studies included sinus septi nasi pneumatization. The studies examined 7592 people aged between 2-85 years. The mean age of the people examined was 33.05 ± 11.56, and 51.24% and 48.76% were male and female, respectively. The incidence of sinus septi nasi pneumatization was between 2.00-40.00%, and the mean value was 21.86 ± 13.86%. CT Image (66.7%), CBCT (22.2%), and MDCT (11.1%) methods were used in the studies. Upon examining the origin of pneumatizations, no origin was indicated in 7 (77.8%) studies, while 2 (22.2%) studies showed that it originated from the sphenoid sinus (Table IV). The length, width, and height of the sinus septi nasi were measured in the studies. The length values were between 3.5-18.8 mm, and the mean value was 17.43 ± 11.22 mm. The height value was between 3.8-17.7 mm, and the mean value was 11.09 ± 3.52 mm. The width value was between 0.5-5.75 mm, and the mean value was 4.02 ± 2.43 mm (Table VII).

Nine studies included nasal turbinate pneumatizations. Pneumatizations found in the supreme turbinate, superior turbinate, and middle turbinate were demonstrated in these studies. The studies examined 7088 people between the ages of 2-91. The mean age of the people examined was 36.69 ± 13.38, and 50.07% and 49.93% were male and female, respectively. The incidence of supreme turbinate

Table II. General descriptive data of anterior clinoid process pneumatization.

Studies	Age (years)	Number of people	Incidence of Anterior Clinoid Process pneumatization (%)	Method
Basic *et al*., 1999	19-86 (42 Avg)	212 people (78 men 134 women)	0.5	CT Image
Leunig *et al*., 2008	49.90 Avg	641 people (305 men 336 women)	16.5	CT Image
Nouraei et al., 2009	20-56 (33 Avg)	278 people (172 men 106 women)	17.6	CT Image
Kaplanoglu *et al*., 2013	18-81 (39,41 Avg)	500 people (239 men 261 women)	23	CT Image
Turna *et al*., 2014	19-85 (39,10 Avg)	5832 people (2852 men 2980 women)	20	MDCT
Shpilberg *et al.,* 2015	10-82 (47,90 Avg)	192 people (106 men 86 women)	16.7	CT Image
Dasar *et al*., 2016	20-83 (40,26 Avg)	400 people (209 men 191 women)	25.5	CT Image
Yazici, 2019	16-56 26,76 Avg	150 people (74 men 76 women)	29.2	CT Image
Nautiyal *et al*., 2020	18-82	250 people (150 men 100 women)	8.36	CT Image

Table III. General descriptive data of uncinate process.

Studies	Age (years)	Number of people	Incidence of Uncinate Process pneumatization (%)	Method
Bolger *et al.* 1991	37.1 Avg	202 people (109 men 93 women)	2.5	CT Image
Sivasli *et al.*, 2002	2-16 (10.50 Avg)	47 people (22 men 25 women)	6	CT Image
Mazza *et al*., 2007	18-70 (46 Avg)	100 people (55 men 45 women)	5	CT Image
Leunig *et al*., 2008	49.90 Avg	641 people (305 men 336 women)	8.8	CT Image
Keast *et al*., 2008	13-77 (39.92 Avg)	180 people (99 men 81 women)	2	CT Image
Nouraei *et al*., 2009	20-56	278 people (172 men 106 women)	1.4	CT Image
Al-Qudah, 2010	16-77 (33 Avg)	110 people (58 men 52 women)	6	CT Image
Fadda *et al*., 2012	16-77 (45.5 Avg)	140 people (85 men 55 women)	2	CT Image
Adeel *et al*., 2013	(31 Avg)	77 people	5.2	CT Image
Kaplanoglu *et al*., 2013	18-81 (39.41 Avg)	500 people (239 men 261 women)	3.8	CT Image
Cobzeanu *et al*., 2014	18-91 (45.67 Avg)	205 people (108 men 97 women)	3.41	CT Image
Turna *et al*., 2014	19-85 (39.10 Avg)	5832 people (2852 men 2980 women)	7	MDCT
Rereddy *et al*., 2014	19-85 (52.50 Avg)	100 people (31 men 69 women)	11	CT Image
Roman *et al*., 2015	37.63 Avg	130 people (69 men 61 women)	5	CT Image
Dasar *et al*., 2016	20-83 (40.26 Avg)	400 people (209 men 191 women)	13.8	CT Image
Shokri *et al*., 2019	10-55	250 people (107 men 143 women)	12.8	CBCT
Mokhasanavisu *et al*., 2019	29.24 Avg	64 people (32 men 32 women)	6	CT Image

Table IV. General descriptive data of sinus septi nasi.

Studies	Age (years)	Number of people	Incidence of Sinus Septi Nasi pneumatization (%)	Method	Origin
Sivasli *et al*., 2002	2-16 (10.5 Avg)	47 people (22 men 25 women)	6	CT Image	
Nouraei *et al*., 2009	20-56 (33 Avg)	278 people (172 men 106 women)	9.4	CT Image	
Al-Qudah *et al.,* 2010	16-77 (34 Avg)	110 people (58 men 52 women)	27	CT Image	
Turna *et al.,* 2014	19-85 (39.10 Avg)	5832 people (2852 men 2980 women)	34.8	MDCT	
Dasar *et al.,* 2016	20-83 (40.26 Avg)	400 people (209 men 191 women)	2	CT Image	
Mladina *et al.,* 2017	>20	93 people (69 men 24 women)	34.4	CBCT	
Shokri *et al.,* 2019	10-55	250 people (107 men 143 women)	40	CBCT	
Acar *et al.,* 2020	20-81 (41.45 Avg)	402 people (207 men 195 women)	16.3	CT Image	Sinus of sphenoid bone
Muresan *et al.,* 2021	-	171 people (51 men 120 women)	26.91	CBCT	Sinus of sphenoid bone

pneumatization was 29.76%, the incidence of superior turbinate pneumatization was between 6.36% and 54.00%, and the mean value was 26.06 ± 15.80%. The incidence of middle turbinate pneumatization was between 30.73% and 58.00%, and the mean value was 47.37 ± 10.74%. CT Image (88.9%) and MDCT (11.1%) methods were employed in the studies. The origin of pneumatization was not specified in the studies (Table V).

Table V. General descriptive data of nasal turbinates pneumatization.

Studies	Age (years)	Number of people	Incidence of Supreme Turbinate pneumatization (%)	Incidence of Superior Turbinate pneumatization (%)	Incidence of Middle Turbinate pneumatization (%)	Method
Bolger *et al*. 1991	37.1 Avg	202 people (109 men 93 women)	-	-	53	CT Image
Sivasli *et al.*, 2002	2-16 (10.5 Avg)	47 people (22 men 25 women)	-	32	58	CT Image
Al-Qudah *et al*., 2010	16-77 (34 Avg)	110 (58 men 52 women)	-	25		CT Image
Turna *et al*., 2014	19-85 (39.10 Avg)	5832 people (2852 men 2980 women)	-		57.2	MDCT
Rereddy *et al*., 2014	19-85 (52.50 Avg)	100 people (31 men 69 women)	-	54	40	CT Image
Cobzeanu *et al*., 2014	18-91 (45.67 Avg)	205 people (108 men 97 women)	29.76	29.76	-	CT Image
Shpilberg *et al*., 2015	10-82 (47.90 Avg)	192 people (106 men 86 women)	-	26	-	CT Image
Yazici, 2019	16-56 (26.76 Avg)	150 people (74 men 76 women)	-	9.3	45.3	CT Image
Nautiyal *et al*., 2020	18-82	250 people (150 men 100 women)	-	6.36	30.73	CT Image

Table VI. Measurements of crista galli.

Studies	Width (mm)	Height (mm)	Lenght (mm)
Kim *et al*., 2012	-	(17.98 Avg)	-
Poje *et al*., 2014	Male: 3.3-7.1 (6.4 Avg)	-	Male: 5.4-12.4
	Female: 3.1-6.8 (5.5 Avg)		Female: 5.1-10.6
Manea & Mladina, 2016	Male: 3.3-6.8	Male: 5.1-12.7	Male: 5.3-13.8
	Female: 3.0-5.7	Female: 4.7-11.2	Female: 5.0-12.4
Mladina *et al*., 2017	0.9-6.6	3.6-17.1	2.8-12.9
	(3.0 Avg)	(10.1 Avg)	(7.1 Avg)
Akiyama *et al*., 2020	1.6-9.9	7.3-26.0	5.0-20.8
	(4.9 Avg)	(15.9 Avg)	(13.5 Avg)
Mure_an *et al*., 2021	2.7-5.25	-	-
	(4.08 Avg)		
Mean Value ± Std	4.77 ± 1.30	14.66 ± 4.08	10.30 ± 4.52

Table VII. Measurements of sinus septi nasi.

Studies	Width (mm)	Height (mm)	Lenght (mm)
Mladina *et al*., 2017	Male: 0.5-3.5 (1.96 Avg)	Male: 3.8-17.7 (8.5 Avg)	Male: 3.7-18.8 (9.1 Avg)
	Female: 1.0-4.2 (2.2 Avg)	Female: 4.1-15.1 (8.97 Avg)	Female: 3.5-16.2 (10.6 Avg)
	Total Avg: 2.3	Total Avg: 8.6	Total Avg: 9.5
Muresan *et al*., 2021	(5.75 Avg)	(13.58 Avg)	(25.37 Avg)
Mean Value ± Std	4.02 ± 2.43	11.09 ± 3.52	17.43 ± 11.22

DISCUSSION

Thirty-five studies were examined in the literature review. The studies examined the incidence, age range, origin, and distribution by sex of sinus septi nasi, crista galli, anterior clinoid process, nasal turbinates, and uncinate process pneumatizations and the measurement values of crista galli and sinus septi nasi pneumatizations. While standardizing the incidence, age range, origin, and distribution by sex of sinus septi nasi, crista galli and other minor pneumatizations, the measurement values of the crista galli and sinus septi nasi could not be standardized due to the insufficient number of studies and the inconsistency of the methods and the data obtained.

Upon reviewing the studies in terms of incidence, the incidence of crista galli pneumatization was between 2.40-66.60%, with a mean value of 16.39 ± 14.49% (Table I). The incidence of anterior clinoid process pneumatization was between 0.50-29.20%, and the mean value was 17.48 ± 8.74% (Table II). The incidence of uncinate process pneumatization was between 1.40-13.80%, and the mean value was 5.98 ± 3.71% (Table III). The incidence of sinus septi nasi pneumatization was between 2.00-40.00%, and the mean value was 21.86 ± 13.86% (Table IV). The incidence of supreme turbinate pneumatization was 29.76% [18], the incidence of superior turbinate pneumatization was between 6.36% and 54.00%, and the mean value was 26.06 ± 15.80%, The incidence of middle turbinate pneumatization was between 30.73% and 58.00%, and the mean value was 47.37 ± 10.74% (Table IV). Upon reviewing all these studies systematically, sinus septi nasi, crista galli and other pneumatizations had the highest incidence among the nasal turbinate structures, and middle turbinate pneumatization had the highest incidence among nasal turbinate structures. Uncinate process pneumatization was a pneumatization with the lowest incidence. The fact that middle turbinate pneumatization was the most common pneumatization is important in radiological and clinical procedures to be performed in and around the nasal turbinate.

The mean age of the people examined in the studies on crista galli pneumatization was 41.48 ± 12.57, and they consisted of males by 51.55% and females by 48.45% (Table I). The mean age of the people examined in the studies on anterior clinoid process pneumatization was 39.79 ± 7.46 years, and they consisted of males by 51.08% and females by 48.9% (Table II). The mean age of the people examined in the studies on uncinate process pneumatization was 38.17 ± 9.88, and they consisted of males by 50.76% and females by 49.23% (Table III). The mean age of the people examined in the studies on sinus septi nasi pneumatization was 33.05 ± 11.56, and they consisted of males by 51.24% and females by 48.76% (Table IV). The mean age of the people examined in the studies on nasal turbinate pneumatization was 36.69 ± 13.38, and they consisted of males by 50.07% and females by 49.93% (Table V). The mean age range of the people examined in all these studies was found to be between 33-41. Considering the ratio of females to males in the studies, the ratio of males to females was higher. Since the incidences of males and females were not given separately while indicating the incidence of the sinus septi nasi, crista galli and other pneumatizations in the data obtained from the studies, no information could be obtained on how often they occurred in females and males. Concerning the correlation between the percentage of males and females included in the studies and the incidence, no correlation was found.

Upon reviewing the studies, there were differences in the methods of the studies. The MDCT method was employed in the study by Turna *et al*. (2014). The CBCT method was used in the studies by Mladina *et al*. (2017b), Mures¸an *et al*. (2021), and Shokri *et al*. (2019) The CT method was employed in all other studies. Tomography of the human skull was used in the study by Mladina *et al*. (2017a).

It was attempted to obtain information about the origins of pneumatizations by reviewing all studies. According to the information acquired, the frontal sinus and ethmoidal sinus were demonstrated as the origin of crista galli pneumatization. There were also studies indicating the frontal sinus as the origin of crista galli pneumatization (Leunig *et al*., 2008; Som *et al*., 2009; Kaplanoglu *et al*., 2013; Cobzeanu *et al*., 2014; Poje *et al*., 2014, Manea & Mladina, 2016). However, Akiyama & Kondo (2020) demonstrated in their study that both the frontal sinus and ethmoidal sinus were the origin of crista galli pneumatization. Upon reviewing the origin of sinus septi nasi pneumatizations, no origin was specified in many studies. However, the sphenoid sinus was indicated as the origin of sinus septi nasi pneumatization in the study by Acar *et al*. (2020). Mures¸an *et al*. (2021) also demonstrated the sphenoid sinus as the origin. The origins of the anterior clinoid process, uncinate process, and nasal turbinate pneumatizations were not specified.

When pneumatizations in the studies were examined, measurement values related to the anterior clinoid process, uncinate process, and nasal turbinate pneumatizations were not reported. The length, width, and height measurement values for the crista galli and sinus septi nasi were available. The study by Kim *et al*. (2012) found the mean height value in crista galli measurements as 17.98 mm. In the study by

Poje *et al*. (2014) the width values were found to be 3.3-7.1 mm (6.4 Avg) in males and 3.1-6.8 mm (5.5 Avg) in females, and the length values were found to be 5.4-12.4 mm in males and 5.1-10.6 mm in females. In the study conducted by Manea & Mladina (2016) the width value was found to be 3.3-6.8 mm in males and 3.0-5.7 mm in females, the height value was 5.1-12.7 mm in males and 4.7-11.2 mm in females, and the length value was found to be 5.3-13.8 mm in males and 5.0-12.4 mm in females. The study by Mladina *et al*. (2017a) determined the width value as 0.9-6.6 mm (3.0 Avg), the height value as 3.6-17.1 mm (10.1 Avg), and the length value as 2.8-12.9 mm (7.1 Avg). In the study by Akiyama & Kondo (2020) it was revealed that the width value was 1.6-9.9 mm (4.9 Avg), the height value was 7.3-26.0 mm (15.9 Avg), and the length value was 5.0-20.8 mm (13.5 Avg). In the study carried out by Mures¸an *et al*. (2021) the width value was found to be 2.7-5.25 mm (4.08 Avg). Upon reviewing all studies, the length values of the crista galli were between 2.8-20.8 mm, with a mean value of 10.30 ± 4.52 mm. The height value was between 3.6-26.0 mm, with a mean value of 14.66 ± 4.08 mm. The width value was between 0.9-9.9 mm, with a mean value of 4.77 ± 1.30 mm (Table VI). The length values of the sinus septi nasi were between 3.5-18.8 mm, with a mean value of 17.43 ± 11.22 mm. The height values were between 3.8-17.7 mm, with a mean value of 11.09 ± 3.52 mm. The width values were between 0.5-5.75 mm, with a mean value of 4.02 ± 2.43 mm (Table VII). According to these results, it was intended to standardize the measurement values of the crista galli and sinus septi nasi. However, they could not be standardized due to the differences in the data obtained from the studies and the insufficient number of studies.

CONCLUSION

This study compared the incidences of the sinus septi nasi, crista galli and other minor pneumatizations and found their mean incidence. Furthermore, these studies were reviewed, and the percentage distribution of males and females and the mean age values of the participants were calculated, and their correlation with the incidence was examined. According to the results obtained, the percentage of male participants was higher, and the correlation of age and sex with incidence could not be determined. The studies showed that crista galli pneumatizations originated from the frontal sinus and ethmoidal sinus, while sinus septi nasi pneumatizations originated from the sphenoid sinus. The origins of other minor pneumatizations were not indicated. In accordance with all these results, the incidence, distribution by sex, age and origin of the sinus septi nasi, crista galli and other minor pneumatizations were standardized. The measurement intervals of the crista galli and sinus septi nasi and their mean values and min-max value ranges were calculated, and the measurement values and intervals could not be standardized due to the small number of studies, the use of different methods, and the variability of the data. We believe that the data obtained will contribute to clinical procedures to be performed in and around the nasal cavity and future studies in this area with a larger population.

KABAN, Y. E.; COSKUN, Z. K. & AKAR, B. Un estudio bibliográfico sistemático del seno septi nasi, crista galli y otras neumatizaciones menores. *Int. J. Morphol., 41(3)*:944-952, 2023.

RESUMEN: Las variaciones en los senos paranasales y las neumatizaciones que se originan en estas estructuras son clínicamente importantes para los procedimientos quirúrgicos que se realizan en las regiones de la nariz y la cavidad nasal. En la revisión de la literatura no se encontró ninguna revisión sistemática que examinara el seno *septi nasi*, la crista galli y otras neumatizaciones menores. Este estudio tuvo como objetivo revisar los trabajos en la literatura que incluyen el seno *septi nasi*, la crista galli y otras neumatizaciones menores y estandarizar la incidencia media, la distribución por sexo, edad y origen de estas estructuras. Además, tuvo como objetivo examinar los valores de altura, longitud y ancho de las neumatizaciones del seno *septi nasi* y crista galli, determinar los intervalos de medición y los valores de medición, y estandarizarlos. Los estudios relacionados con estas neumatizaciones se revisaron a partir de varias bases de datos. Luego de ser evaluados según los criterios de inclusión y exclusión, se revisaron 35 artículos entre los años 1991-2021. Sobre la base de los datos obtenidos de estos artículos, examinamos la incidencia de *septi nasi* nasi, crista galli y otras neumatizaciones menores. La neumatización de la concha nasal media tuvo la mayor incidencia entre todas estas neumatizaciones. La neumatización del proceso uncinado tuvo la menor incidencia. Considerando la distribución por sexo, no se encontró diferencia. Al examinar el rango de edad, había personas con edades entre 1 y 95 años, y el rango de edad promedio fue de 33,05 a 41,48. Los valores de longitud, ancho y altura de crista galli y seno *septi nasi* no pudieron estandarizarse debido a la cantidad insuficiente de estudios y datos variables en la literatura. Creemos que nuestro estudio contribuirá a futuras investigaciones similares en poblaciones más grandes con los procedimientos clínicos que se realizarán en y alrededor de la cavidad nasal.

PALABRAS CLAVE: Seno septi nasi; Crista galli; Neumatización; Cavidad nasal; Revisión sistemática.

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