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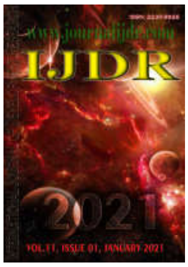

RESEARCH ARTICLE OPEN ACCESS

ANATOMIC VARIATIONS OF THE FRONTAL SINUS AND ITS IMPORTANCE ON MAXILLOFACIAL SURGERY

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ABSTRACT

The anatomy of the frontal sinus is a point of great interest for maxillofacial surgery, since surgical treatment of the region is often necessary. Through a study using CT scans, we seek to access the average volume, anteroposterior extension and width of the frontal sinuses in order to serve as a basis for surgical interventions in the upper third of the face resulting from trauma and other surgical techniques that address this region. The sample consisted of 199 patients of both sexes from the radiology clinic of the University Hospital Oswaldo Cruz at the Pernambuco University for diagnosis, during a period of four months. The images were taken in a 4-channels *multislice*/GE computerized tomographer (General Electric, New York, USA) and were visualized with Invesalius® (CTI, Brazil). The results impaired that the increase in the volume of pneumatized structures were not reflected among the studied age groups and that men have a significant difference between the measures when compared with women. With the variation of the sinuses it is concluded that a standardization for surgical reference of the frontal sinus is highly complex to obtain. Because of that, it poses a challenge for oral and maxillofacial surgeons.

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INTRODUCTION

The anatomy of the frontal sinus is a point of great interest for maxillofacial surgery since it is often necessary to have a surgical approach to the region to correct sequels resulting from trauma or even when used for other purposes, such as the vertical reference for orthognathic surgery that is taken as base that region through screw or wires inserted in the frontal sinus. However, the frontal sinus presents a considerable anatomical variety, and occupies a noble place on the face with aesthetic and functional repercussions associated with its structure (Han *et al*., 2017; Kim; Choi, 2016). The absence of the frontal sinus at birth is considered a defense mechanism of the body to prevent fractures due to the lack of balance in the early development of children, where they only begin their formation at around two years of age. The frontal sinus reaches its peak of which may vary according to sex, height and other individual aspects (Han *et al*., 2017; Strong; Shaye; Steele; Strong, 2017; Grayson *et al*., 2017). The frontal sinus in general has a pyramidal shape, responsible for the composition of the upper third of the face and glabella, with an external board ranging from 4 to 12mm thick and with pneumatized composition. This structure presents considerable resistance to trauma, requiring greater forces than necessary for a mandible or maxilla fracture[5]. High-energy fractures are the main causes of traumatic injuries to the frontal sinus, with the mandatory use of protective equipment in traffic there was a decrease in these types of trauma, but fractures of the frontal sinus still correspond to 5% of maxillofacial fractures. Another important surgical point related to the frontal sinus is its use as a stable point for external reference during Le Fort I osteotomies in orthognathic surgery, where its anatomy must be known for the installation of the device to be used (Arnold; Tatum

III, 2019; Torre *et al*., 2014). Through this extensive study in computed tomography we seek to evaluate the average volume, anteroposterior extension and width of the frontal sinuses in order to serve as a basis for surgical interventions in the upper third of the face resulting from trauma and other surgical techniques that address this region.

MATERIALS AND METHODS

This work consisted of a cross-sectional study since the data concerning the variables of interest were collected simultaneously. Prospective since the data were obtained from patients in the imaging service. Observational, since the objective of the study is to describe the distribution of certain anatomical parameters with a view to greater knowledge for frontal sinus surgical approaches. The sample consisted of 199 patients of both sexes from the radiology clinic of the University Hospital Oswaldo Cruz at the Pernambuco University for diagnosis, during a period of four months, referred by neurology, oral and maxillofacial surgery, and otolaryngology. Therefore, the patients were not submitted to radiation for the sole purpose of this study. Patients with signs of trauma, younger than twenty years old, congenital pathologies involving the region of interest, previous surgery or that presented artifacts in the tomography were excluded from the sample. All participants who agreed to participate in the study signed the informed consent. The University of Pernambuco Research Ethics Committee approved this research under the process number 31173514.9.0000.5207. The sex and age for each individual were recorded at the same time as the tomographic exam. The individuals were divided according to the age range as 20 to 39 years old, 40 to 59 years old, and above 60 years old. The images were taken in a 4-channels *multislice*/GE computerized tomographer (General Electric, New York, USA), with slice thickness of 1.25mm and 1-mm increment. This exam produced sliced images over three planes and along the three dimensions of an object. The images were visualized with Invesalius® (CTI, Brazil), which allowed the adjustment of position and orientation of the head plans and the analysis of skull and frontal sinuses. The measurements were taken directly from the screen, using the tomography console cursor with 0.01 mm precision. An independent trained evaluator took all measures, who was not involved in height, weight and gender data collection. Horizontal and vertical lines were defined on CT sagittal plane for the measurements. The base of the skull was defined as the horizontal reference plan and referred to as the H line. Perpendicular to it, the vertical reference line was defined and referred to as the V line. The forehead inclination was given as the angle (ANV) between line A and the vertical reference (V line). Line B represents the effective slope and was measured as the angle (BNV) between line B and the vertical reference (V line). Line C represents nose inclination and the nasofrontal angle (BNC) and is, therefore, defined as the angle between Lines B and C. On the sagittal view, the anterior and anteroposterior (AP) table of the frontal sinus thickness and depth of the sinus were measured at the most protruding level of the supraorbital edge. Width of the midline was measured at both sides to evaluate left and right variations. In the coronal plane, the frontal cavity height was measured at the midline and at 10mm, 20mm and 30mm from it at both sides. These measurements were also taken at the axial plane and at 10, 20 and 30mm from the midline at both sides. Finally, the width of the glabella, established as the midline of the area beyond the forehead's natural curvature, was also taken at the most protruding level of the supraorbital edge. In addition to these measurements, the frontal sinuses were evaluated which allows the assessment of the following features: presence or absence of the sinus, septum. The examiner evaluated the measurements using the software Invesalius® and the Evaluation Sheet. It is worth mentioning that at most ten images were evaluated per day to avoid visual fatigue and compromising the evaluation. The data were described with absolute and percentage distributions of the categorical variables and with the statistical measures: mean, median and standard deviation for the numerical variables. The following statistical tests were used: F (ANOVA) or Kruskal-Wallis analyzed numerical variables when comparing three categories; t-Student analyzed equal variances and when there were unequal variances Mann-Whitney. The association between the categorical variables was assessed with Pearson's chi-square test or Fisher's exact test when the conditions for the application of chi-square were not met. The degree of association between the numerical variables was given by Pearson correlation and by Spearman correlation when normality was not found. The tests F (ANOVA) or t-Student were chosen when normality was verified for each category and Kruskal-Wallis or Mann-Whitney otherwise. Shapiro-Wilk test verified normality and Levene's F test variance equality. All tests had a margin of error of 5.0%. The data were organized in an EXCEL sheet and the statistical calculations were done in SPSS (Statistical Package for the Social Sciences), version 21.

RESULTS

The age of the patients analyzed ranged from 20 to 105 years, had a mean of 41.41 years, a standard deviation of 17.47 years and a median of 38 years. More than half of the patients (53.3%) were 20 to 39 years old, followed by 30.2% who were 40 to 59 years old and the remaining 16.6% were 60 years or older. 122 (61.3%) were males and 77 (38.7%) were females. Table 1 presents the statistics of the numerical variables of the frontal isoforms. From this table it is pointed out that with the exception of the ANV variable, the variability expressed by the standard deviation in the others was not high since the measure was less than half the value of the average of the corresponding variable. Table 2 shows the statistics of the

Table 1. Statistics of the studied variables according to BMI classification

		Classification of BMI		
Variable	Overall	Normal Mean ± SD (Median)	Overweighted/ Obese Mean ± SD (Median)	P value
● Sinus thickness				
Right	7.34 ± 2.48 (7.55)	6.89 ± 2.09 (7.68)	7.60 ± 2.71 (7.55)	$p^{(1)} = 0.725$
Left	6.98 ± 2.96 (6.39)	6.52 ± 2.56 (5.46)	7.32 ± 3.27 (6.86)	$p^{(1)} = 0.610$
Total	7.67 ± 2.72 (6.66)	7.04 ± 2.14 (6.41)	8.15 ± 3.07 (8.01)	$p^{(2)} = 0.275$
● Sinus total width	47.48 ± 15.97 (49.61)	44.25 ± 17.71 (49.27)	49.95 ± 14.56 (49.61)	$p^{(1)} = 0.325$
● Sinus height				
Right	13.10 ± 5.18 (13.13)	12.38 ± 4.07 (13.03)	13.53 ± 5.82 (13.13)	$p^{(2)} = 0.588$
Left	13.40 ± 5.99 (12.76)	12.16 ± 5.62 (11.13)	14.33 ± 6.27 (13.61)	$p^{(2)} = 0.352$
Total	16.35 ± 7.30 (13.61)	13.99 ± 5.74 (13.28)	18.15 ± 8.00 (15.81)	$p^{(2)} = 0.125$
● Cortical anterior	3.23 ± 1.00 (2.96)	3.35 ± 1.01 (3.29)	3.13 ± 1.01 (2.91)	$p^{(2)} = 0.553$
● Cortical posterior	3.88 ± 1.75 (3.11)	4.03 ± 1.87 (3.35)	3.77 ± 1.71 (2.90)	$p^{(1)} = 0.738$
● Anteroposterior distance	8.79 ± 3.31 (8.41)	7.89 ± 3.21 (8.11)	9.48 ± 3.30 (8.57)	$p^{(2)} = 0.197$
● Angle				
ANV	10.07 ± 6.08 (11.52)	11.12 ± 6.17 (13.24)	9.27 ± 6.08 (9.09)	$p^{(1)} = 0.544$
BNV	24.05 ± 9.99 (24.16)	25.08 ± 11.47 (24.36)	23.27 ± 8.98 (23.96)	$p^{(2)} = 0.632$
BNC	125.88 ± 11.15 (126.75)	125.65 ± 12.40 (125.49)	126.05 ± 10.49 (128.52)	$p^{(2)} = 0.924$

(1): Using Mann-Whitney's test. 2): Using t-Student's test with equal variances measures between age groups and in this table, there were no significant differences between the age groups for any of the variables analyzed (p> 0.05) for the fixed margin of error (5%). that the largest percentage differences between the age groups occurred with one or more right-sided scans in the 20-39 and 60-year old or higher bands in the 20-29 age range (38.3% vs. 21.2 %) and

Table 2. Statistics of the studied variables according to gender

Variable	Gender: Male average ± DP (Median)	Female average ± DP (Median)	Value of p
● Sinus thickness			
Right	8.39 ± 2.63 (8.10)	6.20 ± 1.77 (6.27)	$p^{(1)} = 0.017$*
Left	8.20 ± 2.59 (8.19)	5.57 ± 2.80 (4.61)	$p^{(1)} = 0.001$*
Total	9.18 ± 2.66 (8.77)	6.17 ± 1.85 (5.46)	$p^{(1)} < 0.001$*
● Sinus total width	51.19 ± 13.89 (50.50)	43.77 ± 17.49 (48.76)	$p^{(2)} = 0.208$
● Sinus height			
Right	15.50 ± 5.07 (14.77)	10.51 ± 4.05 (10.40)	$p^{(2)} = 0.009$*
Left	15.18 ± 6.39 (15.91)	11.34 ± 4.96 (11.19)	$p^{(2)} = 0.091$
Total	18.90 ± 7.54 (18.97)	13.80 ± 6.30 (13.31)	$p^{(1)} = 0.049$*
● Cortical anterior	3.40 ± 1.04 (3.00)	3.05 ± 0.96 (2.91)	$p^{(2)} = 0.346$
● Cortical posterior	3.83 ± 1.74 (2.81)	3.93 ± 1.83 (3.35)	$p^{(1)} = 0.943$
● Anteroposterior distance	10.21 ± 3.79 (10.68)	7.37 ± 1.99 (7.45)	$p^{(2)} = 0.016$*
● Angle			
ANV	8.39 ± 5.68 (10.66)	11.74 ± 6.19 (13.43)	$p^{(1)} = 0.038$*
BNV	27.78 ± 11.58 (30.44)	20.32 ± 6.53 (22.86)	$p^{(3)} = 0.003$*
BNC	119.99 ± 12.34 (117.64)	131.76 ± 5.58 (132.48)	$p^{(2)} = 0.137$

(*): Significant difference (p < 0,05).
(1): Using Mann-Whitney's test.
(2): Using t-Student's with equal variances.
(3): Using t-Student with unequal variances.

Table 3. Presence of right, left and central sinuses, and presence of right and left intersinus septa according to gender

Variable	Classification BMI: Normal n	%	Overweight/ Obese n	%	Total group n	%	P value	Gender: Male n	%	Female n	%	Total group N	%	P value
TOTAL	13	100	17	100	30	100		15	100	15	100	30	100	
● Presence of right sinus														
Yes	11	84.6	17	100	28	93.3	$p^{(1)} = 0.179$	14	93.3	14	93.3	28	93.3	$p^{(1)} = 1.000$
No	2	15.4	-	-	2	6.7		1	6.7	1	6.7	2	6.7	
● Presence of left sinus														
Yes	12	92.3	16	94.1	28	93.3	$p^{(1)} = 1.000$	15	100	13	86.7	28	93.3	$p^{(1)} = 0.483$
No	1	7.7	1	5.9	2	6.7		-	-	2	13.3	2	6.7	
● Presence of central sinus														
Yes	12	92.3	16	94.1	28	93.3	$p^{(1)} = 1.000$	14	93.3	14	93.3	28	93.3	$p^{(1)} = 1.000$
No	1	7.7	1	5.9	2	6.7		1	6.7	1	6.7	2	6.7	
● Presence of right intersinus septa														
Yes	10	76.9	12	70.6	22	73.3	$p^{(1)} = 1.000$	12	80	10	66.7	22	73.3	$p^{(1)} = 0.682$
No	3	23.1	5	29.4	8	26.7		3	20	5	33.3	8	26.7	
● Presence of left intersinus septa														
Yes	7	53.8	11	64.7	18	60.0	$p^{(2)} = 0.547$	9	60	9	60.0	18	60.0	$p^{(1)} = 1.000$
No	6	46.2	6	35.3	12	40.0		6	40	6	40.0	12	40.0	
· No of right scaloppings														
No	3	23.1	5	29.4	8	26.7	$p^{(1)} = 0.179$	3	20.0	5	33.3	8	26.7	$p^{(1)} = 0.380$
One	-	-	4	23.5	4	13.3		1	6.7	3	20.0	4	8	
Two or more	10	76.9	8	47.1	18	60.0		11	73.3	7	46.7	18	60.0	
· N° of left scallopings														
No	5	38.5	6	35.3	11	36.7	$p^{(1)} = 0.552$	6	40.0	5	33.3	11	36.7	$p^{(1)} = 0.489$
One	1	7.7	4	23.5	5	16.7		1	6.7	4	26.7	5	16.7	
Two or more	7	53.8	7	41.2	14	46.7		8	53.3	6	40.0	14	46.7	

Table 3 shows that: with the exception of the variables "posterior cortical", "BNV" and "BNC" that presented correspondingly higher averages in the female sex than in the other variables, the mean values were higher in the male sex; with the exception of the variables: "Mean height of the left sinus", "Anterior cortical", "posterior cortical" and "ANV" for the other variables, a significant difference between the sexes was verified (p <0.05). Table 4 shows the association between the presence or absence of right, left and central sinus, right and left inter septum, and right and left scapula with the age range variable. Table 5 shows that: in the total group, the majority of patients had right sinus (94.0%), central sinus (94.0%), left sinus (92.0%), left sinus septum 60.8%), septum inter seio right (60.3%) and had one or more scapulations on each side, with the scoring percentages ranging from 28.7% and 30.2% and with two or more scapulaations ranged from 30.7% to 31.7%; it is possible to calculate two or more scans in the bands 20 to 29 years and 60 years or more, (42.4% vs. 29.2%), but there was no significant association between the age group and the variables analyzed (p> 0.05).

DISCUSSION

The research sought to demonstrate the anatomical and volumetric patterns of the frontal sinus in order to facilitate the surgical reconstruction of this structure through the correlation with sex, age group using an examination method that offers high-level images of anatomical structures and three-dimensional volumes. Defects resulting from trauma to the frontal sinus leave severe aesthetic sequelae when not properly treated, these sequels lead surgeons to complex surgical approaches with the purpose of returning the standard of normality (Carter; Poetker; Rhee, 2010; Yakirevitch *et al*., 2013). With increasing age, the pneumatized anatomical structures of the body increase their volume, expanding to adjacent regions that were previously filled with bone. However, this increase was not reflected in a significant difference between the age groups studied, with no variable with major changes, which can be explained by the greater number of fractures in this region being associated with young adults victims of high-energy trauma and not the elderly (Carter; POETKER; RHEE, 2010;ARNOLD; TATUM III, 2019; CHEGINI *et al*., 2016). Men continue to present themselves as the sex most affected by facial trauma, and especially in high energy ones, as is the case of fractures that affect the frontal sinus. It was possible to observe in the study that with the exception of three measurements (total frontal sinus width, average height of the right sinus and anterior cortical), all other measurements had a significant difference in relation to men when compared to women, demonstrating that the size of the frontal sinuses they are greater in this sex, which can be associated with the greater number of fractures (CHEGINI *et al*., 2016). We often observe large extensions of fractures of the upper third of the face, which may affect the entire forehead region from one supra-orbital arch to another, requiring extensive synthesis materials or in significant quantities. This is justified by the extension of the frontal sinus widths that presented averages above 50mm for men and close to that for women, but without significant difference between the sexes, but with an increase in the course of age, showing that the elderly have a greater extension of the sinuses front (BULLER *et al*., 2018; NIKOLOVA; TONEVA; GEORGIEV; LAZAROV, 2017; ASLIER *et al*., 2016). Fractures of the frontal sinuses, even when resulting from major traumas, are restricted to the anterior wall and, on a few occasions, intervention on the posterior wall is necessary to correct bone defects. We can observe a greater thickness of the posterior wall in relation to the anterior in both sexes, which can demonstrate, in addition to their anatomical positions, greater resistance due to its width for the trauma of the posterior wall of the maxillary sinus, corroborating with the literature that shows that the need for a surgical approach for posterior wall fractures is rare (BEAINI; DUAILIBI-NETO; CHILVARQUER; MELANI, 2015; BELLAMY *et al*., 2013). Routinely in orthognathic surgery, considerable size Kischner screws or wires are used to obtain a vertical reference for the position of the maxilla after the Le Fort I osteotomy, a method advocated due to its bone anchorage and non-movement. Some care must be taken so that an iatrogenic lesion of the posterior sinus wall is not caused by these maneuvers, since they are performed empirically until anchoring, as was seen in the study, an average of 11.48 ± 3.62mm for men and 8.65 ± 3.70mm for women, demonstrating that the introduction limits for these materials are restricted to a few millimeters, as the monocortical routinely (CARTER; POETKER; RHEE, 2010; ROSENBERGER; KRIET; HUMPHREY, 2013; PAWAR; RHEE, 2014). The frontal sinuses do not always have a uniform morphology, with cases of aplasia or even hypoplasia being present, which leads to a greater number of fractures of the frontal region without the involvement of the sinus. We observed a non-significant absence rate of the right, left and central sinuses in the study, which is in accordance with the literature that suggests a rate of 5% for frontal sinus agenesis (BULLER *et al*., 2018). Computed tomography scans are valuable tests for the evaluation and planning of facial traumas, allowing a three-dimensional assessment of the affected region and with little distortion of the bone artifacts involved. However, the importance of a high anatomical knowledge, with established standards, is highlighted in order to have good results in surgical procedures in challenging regions such as the frontal sinuses. With the variation of the sinuses found between the sides of the same individual and the significant difference between the sexes, it is concluded that a standardization for surgical reference of the frontal sinus is highly complex to obtain. Because of that, it poses a challenge for oral and maxillofacial surgeons at the time of surgical reconstruction of the frontal sinuses.

Table 4. Correlation coefficients between height and each variable relative to the frontal sinus

Variáble	Correlation	Regression
Mean sinus thickness		
Right	0.21 (0.028) (1)	
Left		
Total	0.24 (0.012*) (1)	$Heigh_{estimated} = 1.628 + 0.007.\ R^2 = 0.044$
Total frontal sinus width		
Mean sinus height		
Right		
Left		
Total		
Anterior cortical		
Posterior cortical		
Anteroposterior distance	0.24 (0.009*) (2)	$Heigh_{estimated} = 1.628 + 0.005; R^2 = 0.058$
Angle		
ANV		
BNV	0.29 (0.001*) (2)	$Heigh_{estimated} = 1.618 + 0.003; R^2 = 0.084$
BNC	- 0.36 (<0.001*) (1)	$Heigh_{estimated} = 1.963 - 0.002; R^2 = 0,118$

Table 5. Analysis of areas under the ROC curve plotted by sex for sinus measurements

			IC 95%	
Variable	**Area below the curve**	**p value**	**Lower limit**	**Upper limit**
Mean sinus thickness				
Right	0.694	0.001*	0.592	0.797
Left	0.661	0.005*	0.551	0.771
Total	0.693	0.001*	0.588	0.798
Mean sinus height				
Left	0.616	0.043*	0.506	0.727
Total	0.624	0.030*	0.514	0.733
Anteroposterior distance	0.737	<0.001*	0.642	0.831
Angle				
BNV	0.663	0.003*	0.563	0.762

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REFERENCES

ARNOLD MA, TATUM III SA. 2019. Frontal Sinus Fractures: Evolving Clinical Considerations and Surgical Approaches. Craniomaxillofacial Trauma & Reconstruction; 12: 2, pp. 85-94.

ASLIER NGY. *et al*. 2016. The classification of frontal sinus pneumatization patterns by CT-based volumetry. Surg Radiol Anat; 38 (8), pp. 923-930,

BEAINI TL, DUAILIBI-NETO EF, CHILVARQUER I, MELANI RF. 2015. Human identification through frontal sinus 3D superimposition: Pilot study with Cone Beam Computer Tomography. J Forensic Leg Med; 63, pp. 63-69.

BELLAMY JL. *et al*. 2013. Facial fractures of the upper craniofacial skeleton predict mortality and occult intracranial injury after blunt trauma: an analysis. J Craniofac Surg; 24 (6), 1922 - 1926.

BULLER J *et al*.. 2018. Frontal Sinus Morphology: A Reliable Factor for Classification of Frontal Bone Fractures?. J Oral Maxillofac Surg; 76(10), pp. 2168.e12168.e7. DOI:10.1016/ j.joms. 2018.06.020.

CARTER KB Jr, POETKER DM, RHEE JS. 2010. Sinus preservation management for frontal sinus fractures in the endoscopic sinus surgery era: a systematic review. Craniomaxillofac Trauma Reconstruction; 3(3): pp. 141-149.

CHEGINI S. *et al*. 2016. Outcomes of treatment of fractures of the frontal sinus: review from a tertiary multispecialty craniofacial trauma service. Br J Oral Maxillofac Surg; 54 (7), pp. 801– 805.

DEHDJA RD, MORISADA VM, TOLLEFSON TT, STROG EB. 2019. Contemporary Management of Frontal Sinus Fractures. Curr Opin Otolaryngol Head Neck Surg; 27(4), pp. 253-260. DOI: 10.1097/MOO.0000000000000546.

GRAYSON JW. *et al*. (2017) Changing the surgical dogma in frontal sinus trauma: transnasal endoscopic repair. Int Forum Allergy Rhinol; 7, pp. 441–449.

HAHN HM. *et al*. 2017. Reduction of closed frontal sinus fractures through suprabrow approach. Arch Craniofac Surg; 18, pp. 230–237.

KIM J, CHOI H. 2016. A review of subbrow approach in the management of noncomplicated anterior table frontal sinus fracture. Arch Craniofac Surg; 17, pp. 186–189.

NIKOLOVA S, TONEVA D, GEORGIEV I, LAZAROV N. (2017) Digital radiomorphometric analysis of the frontal sinus and assessment of the relation between persistent etopic suture and frontal sinus development. Am J Phys Anthropol; 165 (3), pp. 492 - 506.

PAWAR SS, RHEE JS. 2014. Frontal Sinus and Naso-orbital-Ethmoid Fractures. JAMA Facial Plastic Surgery; 16(4), pp. 284 - 289, DOI:10.1001/jamafacial.2014.14.

ROSENBERGER E, KRIET JD, HUMPHREY C. (2013) Management of nasoethmoidal fractures. Curr Opin Otolaryngol Head Neck Surg; 21(4), pp. 410-416.

STRONG EB, SHAYE DA, STEELE TO, STRONG EB. (2017) Frontal sinus fractures: a surgical management paradigm. Otorinolaringologia; 67, pp. 10–25.

TORRE DD. *et al*. (2014) Management of frontal sinus fractures—treatment decision based on metric dislocation extent. J Craniomaxillofac Surg; 42, pp. 1515– 1519.

YAKIREVITCH. A *et al*. (2013) Relation between preoperative computed tomographic criteria of injury to the nasofrontal outflow tract and operative findings in fractures of the frontal sinus. Br J Oral Maxillofac Surg; 51: pp. 799– 802.

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