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Evaluation of anatomical variations of uncinate process and its relationship with radiographic signs of maxillary sinusitis in Cone-Beam Computed Tomography (CBCT) images

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ABSTRACT

Introduction: Anatomical features of uncinate process are associated with many variations in different people. Since this process is the main landmark in functional sinus endoscopic surgery and the first structure to be removed during surgery, knowledge of anatomical variations of the process prior to surgery is essential to prevent damage to adjacent structures. *Materials & Methods:* This is a retrospective descriptive-analytical study using cone-beam computed tomography (CBCT) images of maxilla in coronal section of 109 patients (218 Uncinate processes) available in archives of the Department of Maxillofacial Radiology, Jundishapur School of Dentistry, Ahvaz during 2020. Images were examined for typing, type of flexing of uncinate process, and symptoms of maxillary sinusitis under supervision of a radiologist. Data were analyzed by SPSS software, Excel and GraphPad Prism (ver 8.0.2). *Results:* Among symptoms of maxillary sinusitis, increased mucosal thickness was the most common and air-fluid level was the rarest symptom. In this study, a significant relationship was observed between anatomical variation of Uncinate process and symptoms of maxillary sinusitis; so that, there was a significant relationship between increased thickness of sinus mucosa and Type II on the right and Type III on the left as well as increased thickness of sinus mucosa and both types of medial and lateral flexion on the left. *Conclusion:* Based on results of our study, Type II and Type III are associated with greater susceptibility to maxillary sinusitis. CBCT is also recommended to evaluate anatomy of uncinate process and symptoms of sinusitis before functional sinus endoscopic surgery.

Keywords: Uncinate process, Nasal cavity, Maxillary sinusitis, CBCT

1. INTRODUCTION

Uncinate process is part of the ethmoid bone, which is a sickle-shaped process located in middle meatus area on outer wall of the nasal cavity (Yoon et al., 2000). Structures of the Uncinate process, bullaethmoidalis and hiatus semilunaris, with ducts and entrances of sinuses that open to this area, together form a functional unit called ostiomeatal complex in middle meatus area of the nasal cavity (Bolger, 2003; Som & Curtin, 2011). Osteomeatal complex is a key area for drainage and ventilation of paranasal sinuses; thus, any tightness or blockage in this area due to inflammation or anatomical variations of its components, causes inflammation and infection of the sinuses due to defects in drainage and ventilation (Güngör et al., 2016). Uncinate process is the main component of the osteomeatal complex (Güngör et al., 2016) and acts as a barrier to prevent the direct entry of untreated air with allergens into the paranasal sinuses (Nayak et al., 2001); the importance of these variations is in the key role of the Uncinate process in the osteomeatal complex.Moreover, this process is the main landmark in functional sinus endoscopic surgery and the first structure to be removed during surgery; thus, knowledge of anatomical variations of the process prior to surgery is essential to prevent damage to adjacent structures (such as nasolacrimal duct, inner wall of eye cavity, sphenopalatine artery, etc.) (Bolger et al., 1990; Isobe et al., 1998); On the other hand, Uncinate process anomaly is the most common anomaly that is observed in nasal cavity of patients with chronic sinusitis (Tessema & Brown, 2012), which indicates the importance of investigating the relationship between variations of this process and sinusitis in etiology and treatment of this disease.

Sinusitis is a generalized inflammatory condition of the sinus mucosa that can be caused by allergens, bacteria, or viruses and can be acute (up to 4 weeks), subacute (4 to 12 weeks), and chronic (more than 12 weeks) depending on its duration (White & Pharoah, 2018). Mucosal thickening is the most common change due to inflammation in sinus structure, which is best seen on CT scan images (Yadav et al., 1999). In this regard, several studies have been conducted to investigate the anatomical variations of the uncinate process and the relationship between these variations and sinusitis, and very different results have been reported. General prevalence of Uncinate process variations (Mamatha et al., 2010; Tuli et al., 2013; Krzeski et al., 2001) and similarly the relationship between prevalence of these variants and sinusitis (Tuli et al., 2013; Krzeski et al., 2001; Erpek, 1998; Arun et al., 2017) has been different in various studies.Due to preference of CT scan images in observation of bone structures, radiological examination of anatomy of the nasal cavity and paranasal sinuses is mainly performed by Multi-Detector CT (MDCT) or Cone-Beam CT (CBCT) (da Lilly-Tariah, 2006; Khojastepour et al., 2015).

Considering the key importance of Uncinate process variations in etiology of sinusitis, its importance in functional endoscopic sinus endoscopic surgeries, as well as considering the differences and contradictions reported in literature in this field, this study tends to conduct a study on the prevalence of Uncinate process variations and the relationship between these variations and radiographic symptoms of maxillary sinusitis by studying CBCT images of patients referred to radiology department of Ahvaz Jundishapur School of Dentistry.

2. MATERIALS AND METHODS

Subjects and Design

The following descriptive-analytical study was performed retrospectively using cone-beam computed tomography (CBCT) images of maxilla in coronal section of 109 patients (218 uncinate processes) available in archives of the Maxillofacial Radiology Department of Ahvaz Jundishapur School of Dentistry (Ethical Code: IR.AJUMS.REC.1400.107). These images were taken with a tomographic device (NewTomVGi scanner, QRsrl; Verona, Italy) and stored with software (NNT viewer, QR, v9.1) and available in the archive. Images were taken with 110 KVP voltage and different exposure conditions, depending on the selected voxel size and FOV.Images were viewed in a semi-dark room on a monitor (LED flat screen, ASUS), 14 inches with a resolution of 1080 × 1920.

Sample Size

Taking into account 95% confidence level, reference number 0.4 and accuracy 0.07, total sample size was set at 94 patients (188 samples). Due to the fact that this number was close to total number of statistical population, all information in archives of the Maxillofacial Radiology Department of Ahvaz Jundishapur School of Dentistry was included for analysis and finally 109 patients (218 samples) were studied.

Evaluation of Variables

The evaluated variables included: anatomical variations of Uncinate process (anatomical difference in uncinate process based on upper extremity junction, overall curvature and prodding), side examined, radiographic signs of sinusitis (observed sinus mucosal thickening, air-fluid level and sclerosis of the walls), age and gender. Stammberger HR classification was used to examine

anatomical variations of the uncinate process (Stammberger & Kennedy, 1995; Stammberger & Posawetz, 1990). According to this classification, anatomical variations of the uncinate process can be divided into four categories and three types:

1. Upper junction of uncinate process:

Type I: upper extremity of the processflexes laterally and attaches to papyracea lamina.

Type II: upper extremity of the process extends to ethmoid ceiling (cranial base).

Type III: upper extremity of the processflexes towards the medial and attaches to the middle turbinate.

2. Uncinate process with general medial flexion

3. Uncinate process with general lateral flexion

4. Uncinate process aerated (Uncinate bulla)

The presence of maxillary sinusitis was also evaluated based on the observed sinus mucosal thickening, air-fluid level and wall sclerosis as the most common radiographic symptoms of sinusitis (da Lilly-Tariah, 2006).

Data Collection and Statistical Analysis

Data were collected by census of total maxillary CBCT images in the coronal section of 109 patients (218 Uncinate processes) available in the archives of Maxillofacial Radiology Department of Ahvaz Jundishapur School of Dentistry. T-test for independent samples and Chi-Square test were used to examine the relationship between means of quantitative variables and qualitative variables ($P<0.05$). Data analysis was performed using SPSS software (ver 22), Excel and Graph Pad Prism (ver 8.0.2).

3. RESULTS

Our statistical population was 109 people (218 cases), including 53 men and 56 women. Quantitative variables were reported as standard deviation ± mean and qualitative variables were reported as number and percentage. Out of 218 Uncinate process cases, 168 were Type I (most common), 27 were Type II and 24 were Type III (rarest). Out of 218 uncinate process cases, 182 cases had general lateral flexion and 36 cases had general medial flexion. Out of 151 casesof maxillary sinusitis symptoms, 143 cases of mucosal thickening (most common), 6 cases of sinus wall sclerosis and 2 cases of air-fluid level (rare) were observed.

Table 1 Relationship between types of upper junction, general medial flexion, general lateral flexion, uncinate bulla and types of maxillary sinusitis symptoms with gender in two different directions (right and left)

		Right			Left		
		Gender		P-Value	Gender		P-Value
		Male	Female		Male	Female	
Type I	Negative	12	16	0.479	9	13	0.418
	Positive	41	40		44	43	
Type II	Negative	43	50	0.229	45	53	0.092
	Positive	10	6		8	3	
Type III	Negative	51	46	0.019*	52	46	0.008*
	Positive	2	10		1	10	
General medial flexion	Negative	48	41	0.019*	48	45	0.132
	Positive	5	15		5	11	
General lateral flexion	Negative	5	15	0.019*	5	11	0.132
	Positive	48	41		48	45	
Uncinate bulla	Negative	49	44	0.041*	51	45	0.011*
	Positive	4	12		2	11	
Mucosal thickening	Negative	12	16	0.479	26	21	0.223
	Positive	41	40		27	35	
Air-fluid level	Negative	52	56	0.486	52	56	0.486
	Positive	1	0		1	0	
Sinus wall sclerosis	Negative	52	53	0.619	52	55	>0.999
	Positive	1	3		1	1	

* Statistically Significant is P-Value<0.05.

According to Table 1, there was no significant difference between Type I and gender on both sides (P-Value = 0.479 on the right and P-Value = 0.418 on the left).There was no significant difference between Type II and gender on both sides (P-Value = 0.229 on the right and P-Value = 0.092 on the left). There was a significant difference between Type III and gender in both right and left (P-Value = 0.019 on the right and P-Value = 0.008 on the left) and it was higher in women. There was also a significant difference between general medial and lateral flexions and gender on the right (P-Value = 0.019) and general medial flexion on the right side was higher in women and general lateral flexion on the right side was higher in men, but this difference was not significant on the left (P-Value = 0.132). There was also a significant difference between Uncinate bulla and gender on the right (P-Value = 0.041) and left (P-Value = 0.011), and it was higher in women. There was no significant relationship between symptoms of maxillary sinusitis on both sides and gender (P-Value>0.05). According to Table 2, no significant difference was found between symptoms of maxillary sinusitis and age of patients (P-value>0.05).

Table 2 Relationship between symptoms of maxillary sinusitis and age of patients in two different directions (right and left)

		Right		Left	
		Age (Mean ± S.D)	P-Value	Age (Mean ± S.D)	P-Value
Mucosal thickening	Negative	32.6 ± 10.7	0.564	32.4 ± 11.2	0.485
	Positive	31.2 ± 10.4		31.0 ± 9.9	
Air-fluid level	Negative	31.5 ± 10.4	0.278	31.6 ± 10.5	0.469
	Positive	43.0 ± 0.0		24.0 ± 0.0	
Sinus wall sclerosis	Negative	31.7 ± 10.6	0.456	31.6 ± 10.5	0.674
	Positive	27.7 ± 5.1		28.5 ± 7.7	

*Statistically Significant is P-Value<0.05.

Table 3 Relationship between Type I and Type II upper junctions in different directions (right and left) with general medial flexion, general lateral flexion, uncinate bulla and various symptoms of maxillary sinusitis in two different directions (right and left)

		Type I (Right)			Type I (Left)		
		Negative	Positive	P-Value	Negative	Positive	P-Value
General medial flexion (right)	Negative	9	80	<0.001*			
	Positive	19	1				
General medial flexion (left)	Negative				10	83	<0.001*
	Positive				12	4	
General lateral flexion (Right)	Negative	19	1	<0.001*			
	Positive	9	80				
General lateral flexion (Left)	Negative				12	4	<0.001*
	Positive				10	83	
Uncinate bulla (right)	Negative	23	70	0.581			
	Positive	5	11				
Uncinate bulla (left)	Negative				18	78	0.311
	Positive				4	9	
Mucosal thickening (Right)	Negative	11	17	0.056			
	Positive	17	64				
Mucosal thickening (Left)	Negative				8	39	0.474
	Positive				14	48	
Air-fluid level (Right)	Negative	28	80	>0.999			
	Positive	0	1				
Air-fluid level (Left)	Negative				22	86	>0.999
	Positive				0	1	
Sinus wall sclerosis (Right)	Negative	28	77	0.571			
	Positive	0	4				

		Type II (Right)			Type II (Left)		
		Negative	Positive	P-Value	Negative	Positive	P-Value
General medial flexion (right)	Negative	82	7	<0.001*			
	Positive	11	9				
General medial flexion (left)	Negative				85	8	0.203
	Positive				13	3	
General lateral flexion (Right)	Negative	11	9	<0.001*			
	Positive	82	7				
General lateral flexion (Left)	Negative				13	3	0.203
	Positive				85	8	
Uncinate bulla (right)	Negative	78	15	0.458			
	Positive	15	1				
Uncinate bulla (left)	Negative				86	10	>0.999
	Positive				12	1	
Mucosal thickening (Right)	Negative	20	8	0.016*			
	Positive	73	8				
Mucosal thickening (Left)	Negative				40	7	0.202
	Positive				58	4	
Air-fluid level (Right)	Negative	92	16	>0.999			
	Positive	1	0				
Air-fluid level (Left)	Negative				97	11	>0.999
	Positive				1	0	
Sinus wall sclerosis (Right)	Negative	89	16	>0.999			
	Positive	4	0				
Sinus wall sclerosis (Left)	Negative				96	11	>0.999
	Positive				2	0	
Sinus wall sclerosis (Left)	Negative				22	85	>0.999
	Positive				0	2	

*Statistically Significant is P-Value<0.05.

According to Table 3, there was a significant difference between Type I upper junction on both the right and left side with both general medial and lateral flexions (P-Value<0.001). The majority of Type I cases had lateral flexion on both sides (80 of 81 cases on the right and 83 of 87 cases on the left). There was no significant relationship between Type I upper junction on both right and left and Uncinate bulla (P-Value = 0.581 on the right and P-Value = 0.311 on the left). There was also no significant relationship between type I upper junction on both the right and left side and symptoms of maxillary sinusitis (P-Value>0.05). According to Table 3, there was a significant difference between type II upper junction and general medial and lateral flexions on the right side (P-Value<0.001). Of 16 cases of Type II on the right, 9 had medial flexion and 7 had a lateral flexion. There was no significant difference between type II upper junction and general medial and lateral flexions on the left side (P-Value = 0.203). There was no significant relationship between type II upper junction on both right and left and Uncinate bulla (P-Value = 0.458 on the right and P-Value >0.999 on the left). There was a significant difference between type II upper junction on the right and sinus mucosal thickening on the same side (P-Value = 0. 016), but this difference was not significant on the left (P-Value = 0.202). No significant difference was observed between type II upper junction and other symptoms of maxillary sinusitis on the left and right side (P-Value>0.999).

According to Table 4, there was a significant difference between type III upper junction on both the right and left side and both general medial and lateral flexions (P-Value<0.001). The majority of Type III cases had medial flexion on both sides (10 of 12 cases on the right and 9 cases of 11 cases on the left). There was no significant relationship between Type III upper junction on both right and left and Uncinate bulla (P-Value = 0.075 on the right and P-Value = 0.124 on the left). On the left, there was a significant difference between type III upper junction and sinus mucosa thickening on that side (P-Value = 0.022), but this difference was not significant on the right (P-Value>0.999). There was no significant difference between type III upper junction and other symptoms of maxillary sinusitis on the left and right (P-Value>0.999) (Figure 1).

Table 4 Relationship between TypeIII upper junction in different directions (right and left) with general medial flexion, general lateral flexion, uncinate bulla and various symptoms of maxillary sinusitis in two different directions (right and left)

		Type III (Right)			Type III (Left)		
		Negative	Positive	P-Value	Negative	Positive	P-Value
General medial flexion (right)	Negative	87	2	<0.001*			
	Positive	10	10				
General medial flexion (left)	Negative				91	2	<0.001*
	Positive				7	9	
General lateral flexion (Right)	Negative	10	10	<0.001*			
	Positive	87	2				
General lateral flexion (Left)	Negative				7	9	<0.001*
	Positive				91	2	
uncinate bulla (right)	Negative	85	8	0.075			
	Positive	12	4				
uncinate bulla (left)	Negative				88	8	0.124
	Positive				10	3	
Mucosal thickening (Right)	Negative	25	3	>0.999			
	Positive	72	9				
Mucosal thickening (Left)	Negative				46	1	0.022*
	Positive				52	10	
Air-fluid level (Right)	Negative	96	12	>0.999			
	Positive	1	0				
Air-fluid level (Left)	Negative				97	11	>0.999
	Positive				1	0	
Sinus wall sclerosis (Right)	Negative	93	12	>0.999			
	Positive	4	0				
Sinus wall sclerosis (Left)	Negative				96	11	>0.999
	Positive				2	0	

*Statistically Significant is P-Value<0.05.

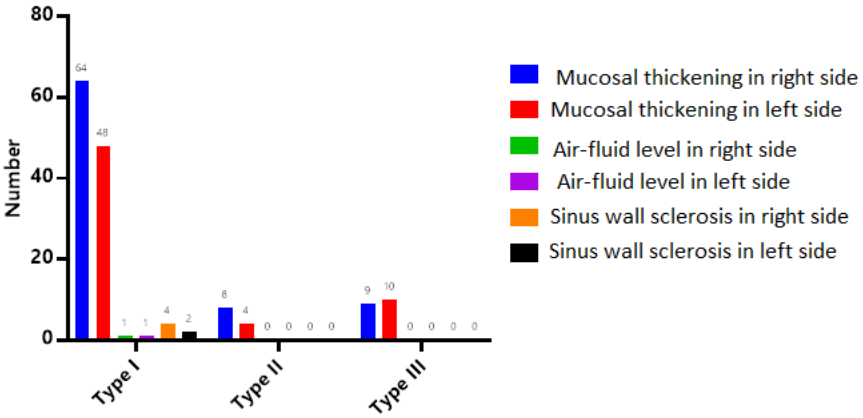

Figure 1 Relation between Uncinate process types and sinus pathologies

Table 5 Relationship between general medial and lateral flexion in different directions (right and left) with various symptoms of maxillary sinusitis in two different directions (right and left)

		General medial flexion (Right)			General medial flexion (Left)		
		Negative	Positive	P-Value	Negative	Positive	P-Value
Mucosal thickening (right)	Negative	20	8	0.105			
	Positive	69	12				
Mucosal thickening (left)	Negative				44	3	0.033*
	Positive				49	13	
Air-fluid level (right)	Negative	88	20	>0.999			
	Positive	1	0				
Air-fluid level (left)	Negative				92	16	>0.999
	Positive				1	0	
Sinus wall sclerosis (Right)	Negative	85	20	>0.999			
	Positive	4	0				
		General lateral flexion (Right)			General lateral flexion (Left)		
		Negative	Positive	P-Value	Negative	Positive	P-Value
Mucosal thickening (right)	Negative	8	20	0.105			
	Positive	12	69				
Mucosal thickening (left)	Negative				3	44	0.033*
	Positive				13	49	
Air-fluid level (right)	Negative	20	88	>0.999			
	Positive	0	1				
Air-fluid level (left)	Negative				16	92	>0.999
	Positive				0	1	
Sinus wall sclerosis (Right)	Negative	20	85	>0.999			
	Positive	0	4				
Sinus wall sclerosis (Left)	Negative				16	91	>0.999
	Positive				0	2	
Sinus wall sclerosis (Left)	Negative				91	16	>0.999
	Positive				2	0	

* Statistically Significant is P-Value<0.05.

According to Table 5, there was a significant difference between general medial flexion on the left and sinus mucosa thickening on that side (P-Value = 0. 033), but this difference was not significant on the right (P-Value = 0.105). There was also no significant difference between general medial flexion and other symptoms of maxillary sinusitis on the left and right (P-Value > 0.999). According to Table 5, there was a significant difference between general lateral flexion on the left and sinus mucosal thickening on that side (P-Value = 0. 033), but this difference was not significant on the right (P-Value = 0.105). There was also no significant difference between general lateral flexion and other symptoms of left and right maxillary sinusitis (P-Value >0.999).

Table 6 Relationship between uncinate bulla in different directions (right and left) and different symptoms of maxillary sinusitis in two different directions (right and left)

		Uncinate Bulla (Right)			Uncinate Bulla (Left)		
		Negative	Positive	P-Value	Negative	Positive	P-Value
Mucosal thickening (right)	Negative	24	4	0.946			
	Positive	69	12				
Mucosal thickening	Negative				45	2	0.031*

(left)	Positive				51	11	
Air-fluid level (right)	Negative	92	16	>0.999			
	Positive	1	0				
Air-fluid level (left)	Negative				95	13	>0.999
	Positive				1	0	
Sinus wall sclerosis (Right)	Negative	89	16	>0.999			
	Positive	4	0				
Sinus wall sclerosis (left)	Negative				95	12	0.225
	Positive				1	1	

*Statistically Significant is P-Value<0.05.

According to Table 6, there was a significant difference between Uncinate bulla on the left and sinus mucosal thickening on that side (P-Value = 0.031), but this difference was not significant on the right (P-Value = 0.946). There was also no significant difference between Uncinate bulla and other symptoms of left and right maxillary sinusitis (P-Value >0.999) (Figure 2).

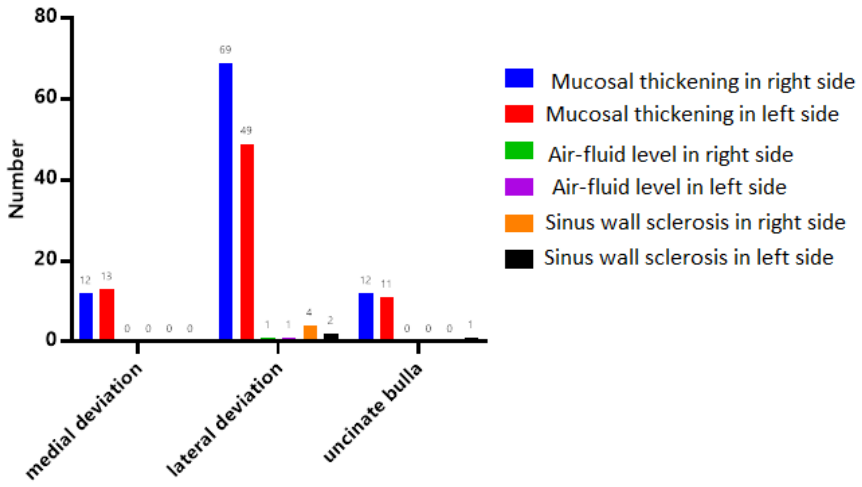

Figure 2 Relation between Uncinate process deviation and uncinate bulla and sinus pathologies

4. DISCUSSION

Uncinate process is part of the ethmoid bone, which is a sickle-shaped process located in the middle meatus area on outer wall of the nasal cavity (Yoon et al., 2000). Anatomical features of uncinate process are associated with many variations in different people (Stammberger & Kennedy, 1995; Stammberger & Posawetz, 1990). In this study, we used the Stammberger HR classification to examine the anatomical variations of the uncinate process (Stammberger & Kennedy, 1995; Stammberger & Posawetz, 1990). We also examined the presence of maxillary sinusitis based on the observed sinus mucosal thickening, air-fluid level, and wall sclerosis as the most common radiographic signs of sinusitis (da Lilly-Tariah, 2006). In the present study, out of 218 cases of Uncinate process, 77.06% were Type I (most common), 12.38% were Type II and 11% were Type III (rarest). Arun et al., (2017) examined anatomical variations of upper junction of uncinate process, along with positioned the frontal sinus canal in coronary and axial CT scan images of 100 patients over 10 years of age with no history of sinusitis, sinus surgery, trauma, or pathology. In this study, anatomical variations of upper junction ofuncinate process were divided into four categories. According to the results obtained from this study, Type I (67.5%), Type II (18.5%), Type III (9.5%) and Type IV (4.5%) had the highest prevalence.

Kulkarni et al., (2021) studied the anatomical variations of uncinate process and its relationship with age, gender, and sinonasal symptoms on CT scans of 50 patients. In this study, they used the Landsberg classification (Landsberg & Friedman, 2001), which classifies upper junction of uncinate process into 6 subgroups. Accordingly, the most common upper extremity junction of the process in both genders was type I (66%), followed by types II (22%) and III (12%), respectively. In our study, there was a significant difference between Type III and gender on both the right and left (P-Value = 0.019 on the right and P-Value = 0.008 on the left) and it was higher in women, but no significant difference was observed between other types with gender.

Sumaily et al., (2018) evaluated the effect of age and gender on anatomical variations of paranasal sinuses in CT scan images of 420 patients; as in our study, they found that the prevalence of type III was significantly higher in women, while in this study the prevalence of type II was higher in men. On the other hand, Kulkarni et al., (2021) studied anatomical variations of uncinate process and its relationship with age, gender and sinonasal symptoms in CT scan of 50 patients and did not observe any relationship between anatomical variations of Uncinate process and gender of patients. Differences in the number of samples as well as racial differences can be the reasons for this difference in results.In our study, out of 218 cases of uncinate process, 83.4% had general lateral flexion and 16.51% had general medial flexion. Few studies examined the flexing shape of the uncinate process (Arun et al., 2017; Kumar et al., 2015).

Mamatha et al., (2010) studied anatomical variations of osteomeral complex in CT scan images of coronal section of 40 patients with sinusitis, and divided the anatomical variation of uncinate process into three categories with medial deviation, straight and with lateral deviation. In the results, uncinate process deviation was observed in 65% of patients, including lateral deviation in 40% of cases and medial deviation in 25% of cases, which is consistent with the results of our study in terms of prevalence. In a similar study, Krzeski et al., (2001) examined CT scan images of coronal section of 157 patients with chronic sinusitis. In this study, anatomical variations of Uncinate process were divided into normal, long, aerated, hypoplastic, with medial and lateral deviation based on general shape of the process; direction of flexion was not investigated in long, aerated, hypoplastic, or straight upper cases. However, the results of this study showed lateral deviation with higher prevalence in 9.55% of cases and medial deviation with lower prevalence in 8.6% of cases.

In our study, 88 out of 109 patients (80.73%) had radiographic symptoms of maxillary sinusitis. In these 88 patients, the most common radiographic symptom of sinusitis was mucosal thickening, which was observed in all of them. This symptom was bilateral in 55 patients (62.5%) and unilateral in 33 patients (37.5%) (With a slightly higher prevalence on the right), followed by sinus wall sclerosis (symptom of chronic sinusitis) which was observed in 6 patients (6.81%) (Bilateral in 2 patients and unilateral in 2 patients).The rarest symptom was air-fluid level (acute sinusitis symptom) which was observed in only 2 patients (2.27%) and both cases were bilateral. Symptoms of maxillary sinusitis were observed in 151 out of 218 sides.

In our study, significant relationships were observed between anatomical variations of uncinate process and prevalence of maxillary sinusitis, although neither of them was significant in either direction. There was a significant relationship between sinus mucosal thickening and type II upper junction on the right and type III upper junction on the left. Moreover, sinus mucosal thickening was significantly associated with both medial and lateral flexion on the left side. In discussing the relationship between anatomical variations of uncinate process and prevalence of sinusitis, researchers have reported conflicting results. A number of studies have shown this relationship, including: Kaya et al., (2017) examined CT scan images of 350 patients to investigate the relationship between anatomical sinonasalvariations and prevalence of sinusitis.

In the results obtained from this study, there was a significant relationship between medial and lateral flexions of Uncinate process as well as the presence of Uncinate bulla and increased prevalence of sinusitis (prevalence of sinusitis in 76% of cases of medial flexion of Uncinate process, in 85% of cases of lateral flexion and in 76% of cases of aerated Uncinate process). In a case-control study, Roman et al., (2016) examined CBCT images of 130 patients to evaluate the prevalence of anatomical sinonasal variations in patients with sinusitis. In the reported results of this study, Uncinate process deviation was significantly associated with increased prevalence of sinusitis (Uncinate process deviation was observed in more than fifty percent of the Case group and in one third of the Control group). In this study, a significant relationship was observed between asymmetry of the ethmoid roof and concha bullosa and the prevalence of sinusitis. It is noteworthy that the above studies addressed the anatomical variations only in patients with sinusitis, while our study examined these variations in both patients and non-patients.

5. CONCLUSION

According to statistical data obtained from this study, Type I and lateral flexion were the most common anatomical variability of the uncinate process.In this study, a significant relationship was observed between anatomical variation of Uncinate process and symptoms of maxillary sinusitis; so that, there was a significant relationship between sinus mucosal thickening and Type II on the right and Type III on the left and between sinus mucosal thickening and both medial and lateral flexions on the left.

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Ethical approval

The study was approved by the Medical Ethics Committee of Jundishapur University of Medical Sciences, Ahvaz, Iran. (Ethical approval code: IR.AJUMS.REC.1400.107).

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Conflict of Interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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