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Computed Tomography Imaging in Orbital Complications of Acute Inflammatory Paranasal Sinuses Diseases

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ABSTRACT

Background: When it comes for identifying paranasal sinus disease (PSD) problems, CT scans are frequently the go-to imaging modality.

Objective: To diagnose orbital complications of acute inflammatory paranasal sinuses diseases by computed tomography.

Patients and methods: Thirty patients with orbital complications as pain, edema, and visual acuity disorders were referred from Ophthalmology Department to Radiology Unit at Zagazig University Hospitals. All patients were included in this comprehensive sample trial and were subjected to thorough history and clinical evaluation as well as multi detector CT examinations.

Results: 40% had opacity in maxillary ethmoid bone (erosion), 30% had opacity in Max sphenoid ethmoid, 20% had opacity in maxillary ethmoid and 10% had maxillary opacity. Majority were invasive fungal (40%), allergic fungal (30%), acute bacterial with 20% and mucocale (10%). Significant association and agreement between Opacity in Max, sphenoid ethmoid and allergic fungal also between opacity in maxillary with mucocele and between opacity in maxillary ethmoid and acute bacterial also between opacity in maxillary ethmoid bone erosion and invasive fungal.

Conclusion: CT has important role in diagnosis of orbital complications resulting from acute inflammatory paranasal sinuses diseases, as it can detect cause, site of lesion, erosion of bone, and it can give feedback about response to treatment or need for surgical interference and success rate of surgery. CT could be with contrast or without contrast for better evaluation of lesion extension and invasion to surrounding structures.

Keywords: Computed tomography, Paranasal sinuses disease.

INTRODUCTION

Anatomical connections explain the association between disorders of the paranasal sinuses and those of the orbit. Because of its proximity to the nose and paranasal sinuses, the orbit is particularly vulnerable to diseases that originate in the surrounding area. To the superior nasal floor, the medial wall of the ethmoid sinus, the inferior nasal roof, and to the posteromedial wall of the sphenoid sinus, the orbital wall was associated [(1)].

The walls of the paranasal sinuses make about 60 to 80% of the orbital wall. A mass or an inflammation process can easily penetrate these areas since the frontal sinus floor and the lateral wall of the ethmoid sinus walls are both thin [(2)]. Sinonasal and orbital cavities can be affected by a wide range of illnesses. Sinonasal disease is more likely to influence the orbit than the other way around [(3)].

The distinction between self-limiting infection and rhinosinusitis with ocular complications might be difficult. An orbital cross-sectional imaging study is required when clinical suspicion exists of an orbital problem [(4)].

Doppler and/or contrast-enhanced imaging should be performed. CT is frequently the imaging modality of choice for studying the bone sinus architecture because of this. As a result, CT is widely available as well as rapid and provides high-quality pictures with great spatial resolution. Sedation is rarely necessary because of the rapidity of the acquisition. The use of ionising radiation is a major drawback of CT. CeMRI may be preferable than ceCT in people who do not require sedation, especially if the CT scan shows no abnormalities but the patient continues to experience symptoms that suggest orbital problems [(5)].

The aim of the present work was to diagnose orbital complications of acute inflammatory paranasal sinuses diseases by computed tomography.

PATIENTS AND METHODS

Thirty patients with orbital complications (pain, edema, and visual acuity) were included in this comprehensive sample trial. They were referred from Ophthalmology Department, Zagazig University Hospital to Radiology Department. All cases with inclusion criteria were taken in the study. As number of cases did not exceed 5 cases per month, so in the study period, it will be 30 patients.

Inclusion Criteria: Patients with upper and lower orbital edema, orbital pain, ocular motility defect, opthalmoplegia, as well as visual acuity defects.

Exclusion Criteria: Patients with allergic reaction to contrast media, hyperthyroidism, renal insufficiency, and pregnant or lactating females.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee (ZU-IRB#6783). Every patient signed an informed written consent for acceptance of

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participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

All studied groups underwent the following:

1- **Complete history taking:** Personal history: name, age and sex, and present history (the present symptoms like pain oedema, ophthalmoplegia and exophthalmos).
2- **Full clinical examinations.**
3- **Imaging including:** CT and CT with contrast.

4- Operational design:

(a) Type of the study: cross-sectional for study design

(b) Steps of performance: (1) Complete history taking. (2) Full clinical examination. (3) Revising imaging results. (4) Analysis of the result. (5) Preparing conclusion and recommendation.

CT technique: A Philips inventiveness 128 MDCT scanner was used for all of the scans, which had a detector row configuration of 128 x 1 mm; collimation was 1 mm; slice thickness was 1.25 mm; pitch was 1.375 mm and reconstruction intervals were 1 mm; 300 mAs; and 120 kVp.

Patients were scanned in a supine position with their heads facing the gantry without any gantry tilt to get direct axial images. Aside from maintaining a calm breathing pattern, no other patient preparation was necessary. When the frontal sinuses are cleaned, volumetric data gathering begins below the jaw. It is far more difficult to get direct coronal images in traumatic orbital fractures, even if they are more delicate than reformatted images. Afterward, the scans were rebuilt and checked for any errors. The machine software was used to create multiplanar reconstructions (MRP) in the coronal and sagittal planes.

Using the picture archiving and communication system (PACS), the thin axial slices are transported directly from the MDCT scanner to a workstation where they were used to create 3D images that are important for the evaluation of spatial relationships. In addition, 3D scans alone should not be used to identify or characterize fractures. A real 3D imaging modality for arbitrary cut planes and outstanding 3D presentations of the data volume had been created with Multidetector CT, which had converted CT from a trans axial cross-sectional approach. Scan times can be reduced by using multislice CT scanners and reducing section collimation or increasing significant amount of time.

Statistical analysis

The IBM SPSS software program version 20.0 was used. The range (minimum and maximum), mean, standard deviation, median, and interquartile range were used to characterise quantitative data (IQR). In order to determine the significance of the acquired results, a 5-percent threshold was used. Chi-square test was used for categorical variables, chi-square correction for more than 20% of cells with anticipated count less than 5 was required. Student t-test was used to calculate the quantities of data of normal distribution and to compare between two studied groups. P value ≤ 0.05 was considered significant.

RESULTS

Age was distributed as **42.40 ± 17.45** years with minimum 3 and maximum 62 years old, and majority were males (60.0%) as shown in table (1).

Table (1): Age and sex distribution among studied group (N=30)

		Age	
Mean ± SD		42.40 ± 17.45	
Median (Range)		46.5 (3-62)	
		N	%
Sex	**Female**	12	40.0
	Male	18	60.0
	Total	30	100.0

Technique CT was 60% and CT with contrast was 40% (Table 2).

Table (2): Technique distribution among studied group (N=30)

		N	**%**
Technique	**CT**	18	60.0
	CT with contrast	12	40.0
	Total	30	100.0

Regarding symptoms, the majority were headache orbital edema and headache orbital edema + vision affect (40% each) and headache proptosis was 20% (Table 3).

Table (3): Symptoms distribution among studied group (N=30)

		N	**%**
Symptoms	**Headache orbital edema**	12	40.0
	Headache orbital edema + vision affect	12	40.0
	Headache proptosis	6	20.0
	Total	30	100.0

Regarding side, the majority were at left side (50%), right side (30%) and finally bilateral with 20%. Regarding site the majority were maxillary ethmoid (40%), maxillary sphenoid ethmoid (30%), then Maxillary ethmoid sphenoid with 20% and finally Maxillary with 10% (Table 4).

Table (4): Side and site distribution among studied group (N=30)

		N	%
Side	**Left**	15	50.0
	Right	9	30.0
	Bilateral	6	20.0
	Total	30	100.0
Site	**Maxillary**	3	10.0
	Maxillary ethmoid	12	40.0
	Maxillary ethmoid sphenoid	6	20.0
	Maxillary sphenoid ethmoid	9	30.0
	Total	30	100.0

Opacity in maxillary ethmoid bone erosion (40%),
opacity in max sphenoid ethmoid (30%), opacity in maxillary ethmoid (20%) and maxillary opacity with 10% (Table 5).

Table (5): CT in PNS disease finding distribution among studied group (N=30)

		N	%
CT findings	**Opacity in Max, sphenoid ethmoid**	9	30.0
	Opacity in maxillary	3	10.0
	Opacity in maxillary ethmoid	6	20.0
	Opacity in maxillary ethmoid bone erosion	12	40.0
	Total	30	100.0

Majority were invasive fungal (40%), allergic fungal (30%), acute bacterial (20%) and mucocale with 10% (Table 6).

Table (6): Aetiological distribution among studied group (N=30)

		N	%
Etiology	**Acute bacterial**	6	20.0
	Allergic fungal	9	30.0
	Invasive fungal	12	40.0
	Mucocale	3	10.0
	Total	30	100.0

Only 6 (20%) were with good prognosis (responders) and 24 (80%) were not responders (Table 7).

Table (7): Prognosis distribution among studied group (N=30)

		N	%
Prognosis	**Not**	24	80.0
	Respond	6	20.0
	Total	30	100.0

Responder cases significantly associated with younger age, female, headache proptosis (right side), maxillary ethmoid, opacity in maxillary ethmoid in CT and with acute bacterial (Table 8).

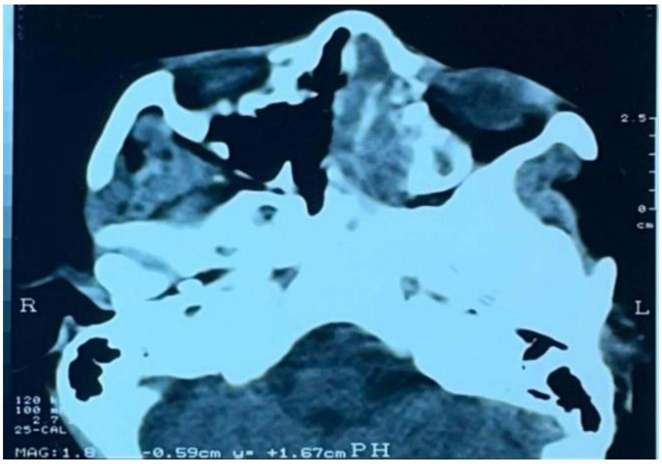
Table (8): Relation of prognosis with other items

			Not responded	Responder	Mann Whitney/ X^2	P
Age			48.25 ± 11.78	19.0 ± 12.63	3.87	0.008*
Sex	**Female**	**N**	6	6		
		%	25.0%	100.0%		
	Male	**N**	18	0	11.25	0.001**
		%	75.0%	0.0%		
Technique	**CT**	**N**	15	3		
		%	62.5%	50.0%		
	CT with contrast	**N**	9	3	0.31	0.57
		%	37.5%	50.0%		
Symptoms	**Headache orbital oedema**	**N**	9	3		
		%	37.5%	50.0%		
	Headache orbital oedema + vision affect	**N**	12	0	6.56	0.038*
		%	50.0%	0.0%		
	Headache proptosis	**N**	3	3		
		%	12.5%	50.0%		
Side	**Bilateral**	**N**	6	0		
		%	25.0%	0.0%		
	Left	**N**	15	0	17.50	0.00**
		%	62.5%	0.0%		
	Right	**N**	3	6		
		%	12.5%	100.0%		
Site	**Maxillary**	**N**	3	0		
		%	12.5%	0.0%		
	Maxillary ethmoid	**N**	6	6		
		%	25.0%	100.0%		
	Maxillary ethmoid sphenoid	**N**	6	0	11.25	0.010*
		%	25.0%	0.0%		
	Maxillary sphenoid ethmoid	**N**	9	0		
		%	37.5%	0.0%		
CT findings	**Opacity in Max, sphenoid ethmoid**	**N**	9	0		
		%	37.5%	0.0%		
	Opacity in maxillary	**N**	3	0		
		%	12.5%	0.0%		
	Opacity in maxillary ethmoid	**N**	0	6	30.0	0.00**
		%	0.0%	100.0%		
	Opacity in maxillary ethmoid bone erosion	**N**	12	0		
		%	50.0%	0.0%		
Diagnosis	**Acute bacterial**	**N**	0	6		
		%	0.0%	100.0%		
	Allergic fungal	**N**	9	0		
		%	37.5%	0.0%		
	Invasive fungal	**N**	12	0	30.0	0.00**
		%	50.0%	0.0%		
	Mucocele	**N**	3	0		
		%	12.5%	0.0%		
Total		**N**	24	6		
		%	100.0%	100.0%		

There were significant association and agreement between opacity in max, sphenoid ethmoid and allergic fungal, also between opacity in maxillary with mucocele, between opacity in maxillary ethmoid and acute bacterial and between opacity in maxillary ethmoid bone erosion and invasive fungal (Table 9).

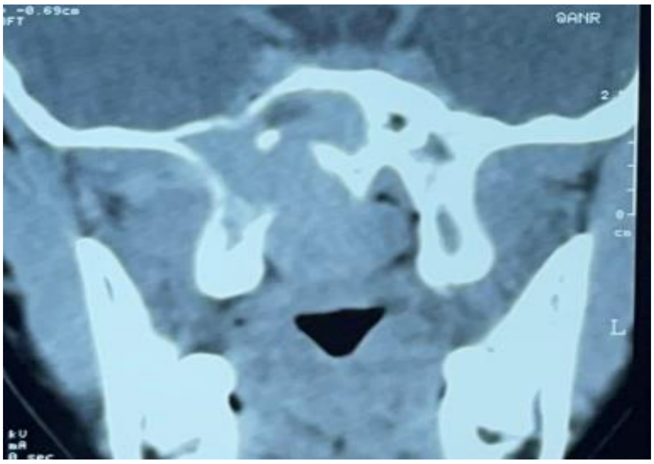
Table (9): Relation between CT finding and diagnosis

			Diagnosis				X²	P
			Acute bacterial	Allergic fungal	Invasive fungal	Mucocale		
CT findings	**Opacity in Max, sphenoid ethmoid**	**N**	0	9	0	0		
		%	0.0%	100.0%	0.0%	0.0%		
	Opacity in maxillary	**N**	0	0	0	3		
		%	0.0%	0.0%	0.0%	100.0%		
	Opacity in maxillary ethmoid	**N**	6	0	0	0	90.0	0.00**
		%	100.0%	0.0%	0.0%	0.0%		
	Opacity in maxillary ethmoid bone erosion	**N**	0	0	12	0		
		%	0.0%	0.0%	100.0%	0.0%		
Total		**N**	6	9	12	3		
		%	100.0%	100.0%	100.0%	100.0%		



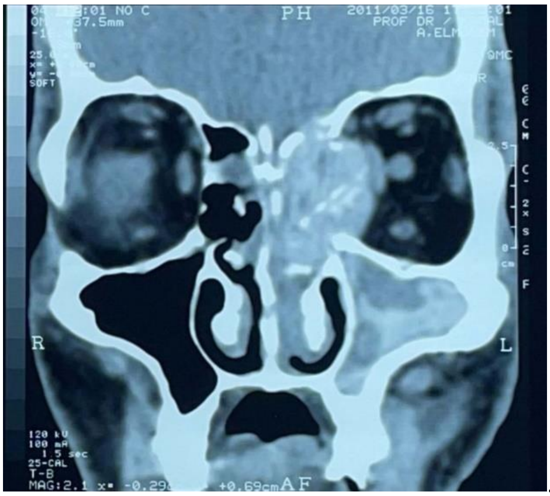
CT PNS and orbital axial view.

Figure (1): Patient presented with headache, left nasal obstruction and post-nasal discharge. Large ill-defined soft tissue lesion was seen in the left maxillary sinus as well as the left nasal fossa. It was displacing the medial orbital wall lateral with no evidence of bone resorption or invasion.



CT with contrast PNS axial view.

Figure (2): Patient complained of right posterior nasal obstruction with post-nasal discharge and right eye proptosis. Evidence of soft tissue mass was seen totally occupying the sphenoidal sinus extending to the posterior aspect of the right nasal fossa and nasopharynx associated with minimal encroachment upon the base of the right optic canal causing mild right eye proptosis



CT PNS and orbital coronal view.

Figure (3): Patient complained of left nasal obstruction, left eye proptosis and redness. Large ill-defined soft tissue lesion was seen totally occupying left maxillary, left ethmoidal, left frontal and sphenoidal sinuses extending to the left nasal fossa showing central serpiginous hyperdensities. It was associated with destruction of the medial wall of the left orbit causing lateral displacement of the left maxillary sinus, smudging of the left orbital fat and mild left eye proptosis.

DISCUSSION

Even in adults, acute sinusitis might result in an orbital problem. There are many circumstances in which antibiotics can be used successfully to treat infections, but if they don't work or if the illness worsens too quickly, it can result in devastating consequences. Although medical treatment and imaging techniques have advanced, the disease's natural course can result in irreversible vision impairment and death as a result of treatment delay, partial treatments, or highly infectious organisms [(6)]**.** A further cause for bacterial orbital infection is transfer from the paranasal sinuses to the orbit via the valveless veins (ophthalmic veins) that have retrograde flow, resulting in an unobstructed progression of phlebitis and periphlebitis, which is usually ethmoid sinusitis. An infection in the cavernous sinus, which drains into the ophthalmic veins, can proceed to the brain [(7)]**.**

There are a variety of factors that can increase the risk of developing an orbital problem, including a patient's immune system, the organisms' virulence, and the architectural characteristics and variances of the sinonasal area that can lead to ostiomeatal unit occlusion [(8)]**.**

Regarding the sociodemographic distribution of the studied group, age was distributed as 42.40 ± 17.45 with minimum 3 and maximum 62 years old, and majority were males (60.0%). The study by **Bagul *et al.*** [(9)] showed that males had a higher prevalence of paranasal sinus diseases than females (62% & 33% respectively). The 11–30-year age group was the most commonly affected (45.5 %), while the least affected age group was less than 10 years (lower than 2%).

Regarding the utilized technique the current study showed that 60% of cases were diagnosed by CT and 40% with CT with contrast. Radiographs can be used to validate the clinical impression of sinusitis, although computed tomography (CT) has a higher level of accuracy. Context-enhanced CT is the first imaging modality of choice when there is a possibility of sinusitis-related orbital or intracranial problems [(10)]**.** There is some evidence that contrast-enhanced MRI can pick up on abnormalities missed by conventional CT scans in sinusitis complications, but no direct comparisons have been made [(11)]**.**

The present study showed that symptoms of sinusitis may include nasal congestion, purulent rhinorrhea, postnasal drainage, headache, cough, facial or dental pain, and fever. Regarding the symptom distribution of the studied cases, the majority were headache orbital edema and headache orbital edema + vision affect (40% each) and Headache proptosis (20%). While, the study by **Rao** [(12)] found that 60% of the patients had nasal blockage, followed by headaches (56%), and nasal discharge (40%). Swelling of the face was the least common complaint.

Regarding the side, our results showed that the majority were at left side (50%) followed by right (30%) and finally bilateral with 20%. Regarding site, the majority where maxillary sphenoid ethmoid (50%), maxillary ethmoid (40%), and finally maxillary with 10%. While, the study by **Rao** [(12)] showed that individuals with anterior ethmoid sinus involvement were found in 38 (76%) of the patients studied, followed by maxillary and posterior ethmoid sinuses in decreasing order of frequency.

Endoscopic/functional endoscopic sinus surgery findings were similar to CT findings in 44 (88%) patients and different from CT findings in 6 (12 %) patients. These different findings were related to either fungal disease or inspissate secretions [(12)]**.**

Regarding the CT finding distribution among studied group, we found that opacity in maxillary ethmoid was in 60%, opacity in max sphenoid ethmoid was in 30% and opacity in maxillary with 10%. Regarding the CT finding of orbit affection, we revealed that muscle affection was in 60% followed by intracranial fat inf, proptosis and bone erosion with 50.0% each, and then soft tissue thickness and abscess with 20.0% each. However, **LeBedis and Sakai** [13] reported that abscesses in patients with bacterial rhinosinusitis tend to be located outside the nasal cavity. Radiation-enhancing fluid can be detected on the rim of an orbital abscess on CT, which has severe angles to the orbital wall. In the study of **Chang *et al.*** [8]**,** stage I (preseptal cellulitis, n = 39), II (postseptal orbital cellulitis, n = 8), III (subperiosteal abscess, n = 16), IV (orbital abscess, n = 8), and V (intracranial involvement, n = 12) problems were found in 83 patients aged 9 days to 80 years. It is most common among those who are between the ages of 0 and 19 years. Having a chronic sinus infection or diabetes was not uncommon. Postseptal involvement was predicted by a decrease in extraocular movement and proptosis (stage II or above).

Sinusitis caused by fungi is classified as either noninvasive or invasive with granulomatous acute fulminant, and chronic invasive types of the latter. Hematologic evidence of hyphal forms in mucosa, submucosa, blood vessels or bone is required for the diagnosis of invasion. The most frequent diseases mucormycosis and aspergillus, are prone to angioinvasion [10]**.**

It is common for acute bacterial rhinosinusitis to develop from a viral upper respiratory infection (URI). Acute bacterial rhinosinusitis affects 6 to 7% of all children who seek medical assistance for respiratory symptoms. Strep pneumonia, haemophilus influenza, and moxarella catarrhalis are the three most prevalent bacteria that cause this infection. Because the infection can spread to the orbits and the brain if infants with complications of acute bacterial rhinosinusitis are not promptly identified, early detection is critical. Ocular problems are the most common in clinical practice [7]**.**

Regarding diagnosis distribution among studied group, we found that the majority were invasive fungal with 40%, allergic fungal with 30%, then acute bacterial with 20% and mucocele with 10%. **Chang *et al.*** [8] reported that a CT scan was used to diagnose sinusitis and to determine the number of ocular problems in 85.5% of the patients they examined.

As regards the prognosis distribution, we found that only 6 (20%) were with good prognosis (respond) and 24 (80%) were not responder.

Responder cases were significantly associated with younger age. Female responder cases significantly associated with younger age, headache proptosis right side, maxillary ethmoid, opacity in maxillary ethmoid in CT with acute bacterial, headache proptosis right side, maxillary ethmoid, opacity in maxillary ethmoid in CT and with acute bacterial infection. significant association and agreement between opacity in max sphenoid ethmoid and allergic fungal, between opacity in maxillary with mucocele and between opacity in maxillary ethmoid and acute bacterial and invasive fungal. While, in the study of **Makihara *et al.*** [14] occlusions in the orbit were substantially more common in patients with ethmoid-frontal mucoceles (6/9) compared to individuals with other subtypes of mucoceles (frontal, zero; zero; zero nine; one sixty-six; three; zero two). This finding was significant (P0.01). One of the seven cases of mucocele compression resulted in a lamina papyracea (inferior orbital wall bone) deficiency. Orbital problems were substantially more common (7/28) in patients with a defect in the orbital wall's bone than in those who did not have the deficiency (0/64) (P0.01). A single with type I, three with type II, and three with type III were identified by Chandler's classification.

Presptal cellulitis and orbital cellulitis are thought to be drug-responsive, although surgical drainage is required for subperiosteal/orbital abscess or cerebral sequelae. Ethmoidal sinusitis-related subperiosteal abscess may be treated successfully by medication alone in certain children younger than 9 years old with intact vision. Good clinical judgement should always take precedence and immediate draining of an abscess in the subperiosteum to be necessary [15].

Orbital complications of sinusitis can lead to blindness and death [8]. Causes of vision-loss include optic neuritis resulting from a reaction to an adjacent or nearby infection [16] and ischemia resulting from thrombophlebitis along the valveless orbital veins [6].

CONCLUSION

CT has imported role in diagnosis of orbital complications resulting from acute inflammatory paranasal sinuses diseases, as it can detect cause, site of lesion and erosion of bone. Also, it can give feedback about response to treatment or need of surgical interference and success rate of surgery. CT with contrast or without contrast could be used for better evaluation of lesion extension and invasion to surrounding structures. Complications arising from Acute Inflammatory paranasal sinuses diseases can result in life-threatening illness. Knowing the anatomic relationship of the paranasal sinuses to the orbital and the mechanisms of infectious spread, is paramount for early diagnosis of these complication.

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Author contribution: Authors contributed equally in the study.

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