

Isolated Sphenoid Sinus Disease

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ABSTRACT:

BACKGROUND:

Isolated sphenoid sinus disease represents a difficult to diagnose disease, generally presents with unclear symptoms. With potential serious complications, early diagnosis requires a high index of clinical suspicion and appropriate radiological imaging.

OBJECTIVE:

The study aims to evaluate clinical presentation, pathological features, radiological appearance and different surgical approaches of isolated sphenoidal sinus disease.

PATIENTS AND METHODS:

A cross-sectional study was performed at Baghdad medical city (Ghazi Hariri Hospital for Specialized Surgery/ otorhinolaryngology and Private Nursing Home Hospital) from December 2018 to December 2019, involved 23 patients with isolated sphenoid disease all patients were assessed by history, examination and investigations diagnosis made by CT scan evidence, demographic data, clinical presentation, pathological feature, radiological appearance and surgical approaches were evaluated.

RESULTS:

23 patients with isolated sphenoid sinus disease, their gender distribution was 10 male and 13 female, their mean age was 33.26 years, headache was the most common clinical presentation in 15 (65.21%) patients, CSF leak in 2(8.69%) patients, epistaxis in 1(4.34%) patient, left side facial pain in 1(4.34%) patient, bilateral nasal obstruction in 1(4.34%) patient, recurrent attack of sore throat in 1(4.34%) patient, loss of vision in 1(4.34%) patient and blurred vision in 1(4.34%) patient. Most common etiology of isolated sphenoid sinus disease was inflammation in 17(73.91%) patients, Neoplasm account in 3(13%) patients. Others account in 3(13%) patients. All patients underwent C.T imaging and M.R.I done to some of them, its finding was recorded. Two surgical approaches used in sphenoid sinus disease, most cases operated by direct endoscopic trans-nasal approach 86.95% in (20) patients and trans-ethmoid used in three patients 13%.

CONCLUSION:

Headache mainly retroorbital is the most common clinical presentation, inflammatory lesion mostly mucocoele is the most pathological feature, isodense homogenous soft tissue opacity without bone erosion is the most common radiological appearance, transnasal approach is the most surgical approach of isolated sphenoid sinus disease.

KEYWORDS: Isolated sphenoid sinus disease, CT scan, headache, Transnasal approach

INTRODUCTION:

Sphenoid bone and sinus anatomy:

The anterior aspect of the lateral skull base is made up from the body, posterior border of the lesser wings, and the greater wings of the sphenoid superiorly, with the medial and lateral pterygoid plates inferiorly. The central part of the sphenoid is the body, between the clinoid processes, its sloping inferior surface forming the roof of the postnasal space and containing the sphenoid sinus. Its superior surface is hollowed as the pituitary fossa, sellae. or Sella turcica ('Turkish saddle'), itself roofed by a sheet of fibrous dura mater, the diaphragm.

Three pneumatization patterns have been described with reference to the sella turcica. The sellar type is most common and describes sphenoid pneumatization posterior to the sella turcica. The presellar type describes sphenoid pneumatization up to the anterior sella and the conchal type describes a shallow bowl with minimal sphenoid pneumatization and trabecular bone between the sinus and Sella. The sphenoid sinuses can also pneumatize laterally into the pterygoid root resulting in the presence of a lateral sphenoid recess.⁽¹⁾ This pneumatization pattern results in exposure of the neurovascular structures surrounding the sphenoid sinus.

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The lateral recess pneumatization pathway occurs between the second trigeminal division and the vidian nerve.⁽²⁾ The internal carotid artery is a prominence in the lateral sphenoid sinus wall in 65% of individuals. Approximately 25% of bony capsules separating the internal carotid artery from the sphenoid sinus are partially dehiscent. An optic nerve prominence is present in 40% of individuals with dehiscence in 6%.⁽³⁾ Isolated sphenoid sinus disease, which accounts for 1–2.7% of cases with the diagnosis of paranasal sinus diseases. The common isolated pathologies of the sphenoid sinus are infectious, inflammatory and neoplastic in nature. Bacterial and fungal infections are the two commonest culprits causing infectious diseases in the sphenoid sinus. Mucocèles and polyps are the commonest inflammatory lesions involving the sphenoid sinus. Neoplastic lesion in the sphenoid sinus is more often an invasion from the surrounding structures rather than a primary lesion in the sphenoid sinus. The common benign and malignant tumours encountered in the sphenoid sinus consist of osteoma, clival chordoma, pituitary tumours, inverted papilloma, petrous apex chordosarcoma, and metastatic lesions from prostate, renal, and lung cancers. Other lesions, such as meningoencephalocele, cerebrospinal fluid leaks, and fibrous dysplasia are often seen in sphenoid sinus too.⁽⁴⁾

Management:

Clinical evaluation: As sphenoid sinuses are deep-seated paranasal sinuses, symptoms of sphenoid sinus diseases may be vague.⁽⁵⁾ Retro-orbital headache, nasal obstruction, nasal discharge, and postnasal drip are common clinical presentations. Abnormal vision and adjacent cranial nerves deficits may be the presenting symptoms when the lesions involve or extend to the surrounding structures. Sphenoid sinus disease usually is not present in early childhood and typically is not seen until the patient is at least 3 years old.⁽⁶⁾ Patients are usually not referred to an otorhinolaryngologist, which contributes to further delay in diagnosis and proper management.⁽⁷⁾

Treatment: The treatment of sphenoid sinus disease depends on the underlying disease. Surgical intervention is the primary treatment modality for most of the isolated sphenoid sinus diseases. Suspected bacterial sphenoiditis can be managed medically. However, if medical treatment fails, surgical intervention will be necessary. Fungal infection, inflammatory and neoplastic lesions are treated with surgical intervention.

Management of sphenoid sinus neoplasms is individualized for each tumour and it depends on histopathology, site of the origin, and extent of the tumours.⁽⁸⁾ Currently, with the evolution of techniques in endoscopic surgery, endoscopic endonasal approach to the sphenoid sinus is the technique of choice. This is because of superior illumination and visualization made possible by the different angles of the endoscopes and better understanding of endoscopic surgical anatomy in relation to sphenoid sinus. Furthermore, the use of intra-operative image-guided system in navigating the complex anatomy of the skull base will reduce the risk of damage to vital surrounding structures, especially been obliterated by tumor or previous surgery.⁽⁹⁾ There are four endoscopic approaches to the sphenoid sinus, namely: transnasal approach, transtethmoid approach, transseptal approach, and transpterygoid approach. Several factors are considered before selecting the most appropriate approach. These include preoperative diagnosis, anatomical location of the disease process, the extent of the sphenoid sinus pneumatization especially lateral recess, available surgical equipment, extent of the surgery, and the level of experience in endoscopic sinus surgery.^(10,11)

PATIENTS AND METHODS:

In Baghdad Medical City (Ghazi Hariri Hospital for Specialized Surgery/ otorhinolaryngology and Private Nursing Home Hospital), the study was done from December 2018 to December 2019, all patients' consents regard the surgery and study and ethical committee approval were taken. The design of the study is cross-sectional descriptive study that involves (23) patients. The patients were collected from the outpatient clinic of our hospital, and referred cases from other centers of E.N.T.

History was taken from patients included: Nasal symptoms, with associated symptom, History involve chief complain and duration, history of presenting illness, systemic review, past medical history, past surgical history, social history, family history and drug history. Examination was done started by general examination, then local include: Examination of face, External nose regarding deviation, gross deformity, and any previous scar. Nasal Patency assessed by cotton piece, Internal nasal examination done by anterior Rhinoscopy using nasal speculum and head light looking for lateral nasal wall, septum (deviation and spur), mucosa, discharge (amount, consistency, Odour and color).

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- Endoscopic examination done by rigid 0degree Hopkin rod's 4mm in diameter after application topical decongestant and local anesthesia (xylometazoline drop 0.1% and xylocaine spray 10%) using three pass technique for visualization inferior turbinate and meatus, middle turbinate and meatus, superior turbinate and meatus, sphenoidal recess, septum and nasopharynx looking for any pathology (polyp, mass and so on). Investigations were done (hematological and radiological). Most radiological images were done in Ghazi Al-Hariri Hospital for Surgical Specialties, CT scan to nose and para nasal sinus (axial, coronal, sagittal views) .M.R.I (coronal, axial and sagittal planes) was done in some conditions and some with contrast using 1.5T MRI scanner.
- **Inclusion criteria:** Diseases limited to the sphenoid sinus were included as evidence by C.T scan.
- **Exclusion criteria:** Involvement of another paranasal sinus excluded.

Instruments and procedures:

Premedication: according to condition, we gave in patient with inflammatory lesion such as CRSsNP, polyp, fungal disease antibiotic (Augmentin tab (Amoxicillin /clavulanic acid) 625 mg*3 or azithromycin tab 500mg 1*1) and oral steroid 20mg/day to reduce inflammation for one week. We gave in patient with C.S.F leak antibiotic (ceftriaxone vial 1g 1*1) for three days. In neoplasm, no specific premedication was given. Patient with foreign body gave Antibiotic (Augmentin tab (Amoxicillin /clavulanic acid) 625 mg*3 for one week.

All the surgeries were done with general anesthesia through orotracheal tube.

Hypotensive technique and reverse Trendelenburg position and throat pack inserted, right sided head tilting of the patient; patients head fixed using a head ring. Endoscopic system consist of: 0,30,45 degree Hopkins rigid endoscope (4mm and 2.7mm) connected to a camera and display screen, then sterilization with povidone- iodine solution 10%, face, nasal vestibules, and draped.

The surgery started after preparation of the nose with 0.1% xylometazoline soaked packs left for 5 minute to decongest the mucosa. Most cases used transnasal approach to sphenoid sinus, in transnasal approach started with Lateralization of middle turbinate by using freer elevator placed onto the inferior aspect of the head of turbinate gently pressure, Pressure is sequentially applied posteriorly,

exposing the anterior pole of the Superior Turbinate, then, lateralization of superior turbinate, to create more space and identified of the sphenoidal recess. Some conditions need removed part of middle turbinate and superior turbinate for better visualization, Removing the inferior part of the middle turbinate at the time of surgery facilitates the direct trans-nasal approach to the sphenoid sinus during surgery, as well as postoperative inspection and cleaning of the sphenoid sinus by office nasal endoscopy. The sphenoid ostium was identified at the sphenoidal recess, about 1.5 cm above the nasal choanae lying medially to the superior turbinate. Blunt dissection to enter the sphenoid sinus Ostia, and widening it, Care should be taken when widening the sphenoid Ostia inferiorly as the posterior septal branch of the sphenopalatine artery runs under the sphenoid Ostia on the anterior face of the sphenoid sinus from lateral to medial. Three cases used transtethmoid approach to sphenoid sinus. In transtethmoid approach, started with uncinctomy by using back biter, microdebrider used in some condition removing lower two third , ethmoidal bulla is resected with a Blakesley remaining ethmoid cell, identify the basal lamella of the middle turbinate and lowered to visualization of the inferior aspect of the Superior Turbinate and posterior ethmoid cells removed, and sphenoid sinus is entered via an inferomedial direction by invade the basal lamella of the superior turbinate. Using Kerrison punch, to widening of the sphenoid sinus Ostia, Drill used in some conditions. Bipolar cautery was used for hemostasis in some cases. Two cases needed reconstruction of skull base by using fat, tensor fascia lata graft and then fat from thigh then gelfoam, one case used fibrin glue. Washing nasal cavity with normal saline at the end of procedure and nasal pack applied (merocel pack).

Postoperative care: patients in the ward were carefully assessed including consciousness level, vital sign, vision any nasal bleeding or discharge is inspected. Sleeping was with the head elevated (on at least 2 pillows) to decrease pain and swelling. Patients in the ward were followed until discharge from hospital. Patients stayed post-operatively for (1-5) days according to condition, Nasal packs were removed after 1- 10 days (1-2 days when no reconstruction to the skull base was done, and 10 days when reconstructed). Analgesia for pain was prescribed.

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IV Antibiotics for 3-7 days were prescribed (Mostly ceftriaxone vial 1 * 1 according to body weight) were prescribed then switched to oral (cefixime tab 1*1 according to body weight). Patients with inflammatory lesion after pack removed were given isotonic saline nasal wash and local steroid spray in different period according to condition.

RESULTS:

Age and gender:23 patients,10 male and 13 female (9-68) years, their mean age 33.26 ± 19.20 years as shown in figure 1

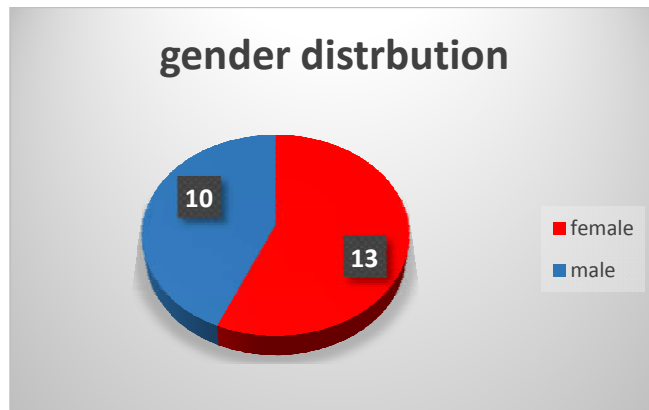


Figure 1: Demonstration of gender distribution.

Table.1: Demonstrated common presentation of patients.

Presentation	Number of patient	Percentage
Headache	15	65.21%
C.S.F leak	2	8.69%
Epistaxis	1	4.34%
Left side facial pain(on cheek)	1	4.34%
Bilateral nasal obstruction	1	4.34%
Recurrent attack of sore throat	1	4.34%
Loss of vision	1	4.34%
Blurred vision	1	4.34%
Total	23	

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Table 2: Radiological finding of each pathology.

Pathology	CT finding	MRI finding (if present)
Mucocele	isodense homogenous soft tissue opacity with widening of sinu	MRI T1 isointense and hyperintense homogenous intensity in T2
Meningocele	isodense homogenous soft tissue opacity with defect in the bony wall of sinus	
Chronic sinusitis without polyposis	showed heterogeneous opacity occupying sphenoid sinus without bony erosion	T1 isointense homogenous soft tissue intensity
Polyp	homogenous isodense soft tissue opacity without bony erosion	
Cholesterol granuloma	isodense homogenous soft tissue opacity with bone erosion	T1 and T2 heterogeneous (hyperintense and hypointense) soft tissue
Rhabdomyosarcoma	soft tissue homogenous isodense mass in sphenoid sinus with cortical breaches and bony erosion of medial and lateral pterygoid plate	T1 non contrast showed hypointense mass and with contrast showed hyperintense T2 showed isointense mass
Fungal sinusitis	showed homogenous soft tissue opacity without bony erosion often with associated hyperdense foci	M.R.I ,T2 showed heterogenous soft tissue density in sphenoid sinus
Foreign body (shell):	showed hyperdense object in right sphenoid sinus with absence part of floor of right sphenoid and fracture of intersinus septa	
Ewing sarcoma	showed isodense soft tissue opacity with cortical breaches in multiple sites bony erosion	M.R.I T1 and T2 views showed isointense homogenous mass
Chordoma	showed Insodense homogenous soft tissue mass occupying sphenoid sinus with bony erosion	T1 with contrast showed heterogenous soft tissue mass

Table 3: Etiology of isolated sphenoid sinus disease.

Etiology	Number of patients	(%)
Inflammatory:		
Mucocele	7	30.43
Fungal	5	21.73
Chronic sinusitis without polyposis	3	13
Polyp	1	4.34
Cholesterol granuloma	1	4.34
Total	17	73.91
Neoplasm:		
Rhabdomyosarcoma	1	4.34
Chordoma	1	4.34
Metastatic tumor (Ewing sarcoma)	1	4.34
Total	3	13
Other:		
Meningocele	2	8.69
Foreign body (shell)	1	4.34
Total	3	13

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Surgical approach:

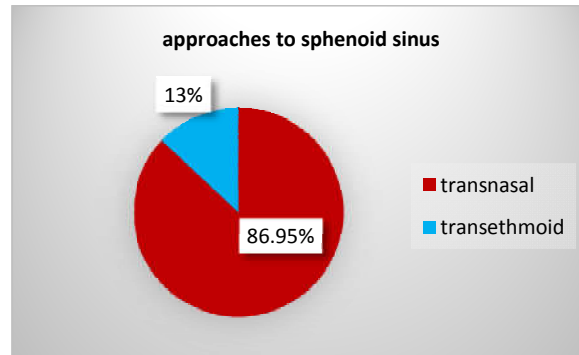


Figure 2: Percentage of transnasal and transtethmoid approaches to sphenoid sinus.

Table 4: Histopathology with age, gender, symptom correlation.

Histopathology	Number of patientS	range of age	Gender	Symptom	
Mucocele	7	13-52	3 female 4 male	5pt.Headache (1periorbital, 3retroorbital 1pt.frontal) 1pt.nasal obstruction 1pt.epistaxis	Chronic inflammation with one patient had previous pituitary surgery
Fungal infection	5	14-36	2 female 3 male	Headache (3pt.retroorbital, 2pt.diffuse)	4pt.allergic Fungal 1pt.fungal ball (aspergillus responsible Pathogen)
Chronic sinusitis without polyposis	3	10-45	2 female 1 male	Headache (2pt. on vertex, 1pt.frontal)	
Cholesterol granuloma	1	63	1 female	Headache (Retroorbital)	
Inflammatory polyp	1	35	1 female	Recurrent attack of sore throat	
Rhabdomyos- arcoma	1	9	1 female	Loss of vision in right eye	
Chordoma	1	25	1 female	Blurred vision in left eye	
Ewing sarcoma	1	21	1 female	Left side facial pain (on cheek)	Metastatic from bone
Meningocele	2	60-68	1 female 1 male	Right side C.S.F rhinorrhea	
Foreign body (shell)	1	68	1 male	Diffuse headache	

DISCUSSION:

Many Isolated sphenoid sinus patients experience a delay in diagnosis as a disease difficult to diagnose by routine examination especially when disease limited in sinus, patients presented with nonspecific symptom resemble benign situation as septal deviation, endoscopic examination give limited information in diagnosis sphenoidal disease, radiological image provides great information in diagnosis and information about the lesion, side (right or left), extension, density or intensity, bone erosion, onodi cell and proximity of optic nerve and carotid artery; therefore, avoid complication intraoperative. CT and MRI should be used in a complementary manner in the evaluation of sphenoid sinus diseases as CT scan is superior in defining the bony margins and MRI is superior in soft tissue resolution and mapping the lesion better and identifying intracranial and intra orbital extension.⁽¹²⁾

Headache was the most common symptom probably due to its sensory innervation of the sphenoid sinus. The fifth cranial nerve and afferent fibers from the sphenopalatine ganglion is innervated The sphenoid sinus, this agreed with all studies like Nour et al⁽¹³⁾ study headache (50%) most common presentation and Eravci et al⁽¹⁴⁾. as headache represents the most common presentation (76.6%) in his study.

Inflammatory lesion was the most common pathology 73.91% in our study, this agreed with Nour et al⁽¹³⁾ (65%) inflammatory pathology and Friedman et al⁽¹⁵⁾ (72%) in their studies. From inflammatory pathology mucocele form the most common pathology (30.43%) as obstruction of sinus ostium with inflammatory process, one patient had history of previous pituitary surgery, this agreed with J.A . Socher et al.⁽¹⁶⁾ study who found mucocele (27.52%) in his study, unlike Moss et al. rhinosinusitis without nasal polyps (CRSSNP) (28.3%) most common pathologies and mucocles (20.3%) reported in his study⁽¹⁷⁾. Friedman et al showed in his study that Chronic sinusitis was the most common condition (34%), and mucocles (12%) unlike our study⁽¹⁵⁾, Eravci et al. showed (17.5%) fungal disease, and (15%) mucocele.⁽¹⁴⁾

C.T scan finding of mucocele homogenous sphenoid mass without surrounding bone erosion; this agreed with J.A. Socher et al. finding in his study⁽¹⁶⁾, and disagreed with Eravci et al. finding as mucocele in CT showed a lesion with minimal cortical erosions⁽¹⁴⁾

Polyp in CT showed soft tissue opacity in sphenoid sinus without bony erosion, this agreed with J.A. Socher et al⁽¹⁶⁾ and Eravci et al. as C.T

scan showed increased soft tissue⁽¹⁴⁾

Fungal ball in CT showed homogenous soft tissue density without bony erosion often with associated hyperdense foci, in M.R.I T2 showed heterogenous soft tissue density, this agreed with Eravci et al⁽¹⁴⁾ finding in his study.

In chronic sinusitis, C.T scan found homogeneous density occupying sphenoid sinus without bony erosion, this agreed with J.A. Socher et al. finding in his study⁽¹⁶⁾

Rhabdomyosarcoma and chordoma in our study showed a homogeneous mass, which occupied the sphenoid sinus eroding its bone walls, unlike J.A. Socher et al. showed the presence of a heterogeneous mass, which occupied the sphenoid sinus eroding its bone walls⁽¹⁶⁾.

In our study, endoscopic approach to sphenoid sinus mostly trans-nasal approach (86.95%) and trans-ethmoid (13%), as this approach suitable to lesion located medially, like in Eravci et al. trans-nasal approach was the main approach (80%) and trans-ethmoid approach (20%).⁽¹⁴⁾

unlike J.A . Socher et al. trans-ethmoid was main approach (51.3%) and trans-nasal (38.5%) in his study.⁽¹⁶⁾ Meningocele in C.T scan showed isodense homogenous opacity with defect in the bony wall of sinus in sphenoid sinus this agreed with CT finding of J.A. Socher et al.⁽¹⁶⁾ and Marcolini et al. Dehiscence of the bone wall with partial opacification of the sphenoid sinus⁽¹⁸⁾

CONCLUSIONS:

- Headache is common clinical presentation of isolated sphenoid sinus disease (mainly retroorbital headache).
- Inflammatory lesion is common pathological feature of isolated sphenoid sinus disease (mostly mucocele).
- Homogenous isodense soft tissue opacity without bone erosion is common radiological appearance of isolated sphenoid sinus disease
- Trans-nasal approach is a common surgical approach to sphenoid sinus

REFERENCES:

1. Huins C., Anatomy of the skull base and infratemporal fossa. IN: Watkinson JC, Clarke Rw(Eds). Scott-Brown's Otorhinolaryngology Head and Neck Surgery.8th ed. London: Taylor & Francis group;2018:1200
2. Dalgorf DM, Harvey RJ , Anatomy of the nose and paranasal sinuses. .IN: Watkinson JC, Clarke Rw(Eds). Scott-Brown's Otorhinolaryngology Head and Neck Surgery.8th ed. London: Taylor & Francis group;2018:963

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3. Leung RM, Walsh WE, Kern RC, Sinonasal Anatomy and Physiology JOHNSON JT, ROSEN CA(eds).Bailey'sHead and neck surgery-otolaryngology. Fifth edition.in Philadelphia PA 19103. Wolters Kluwer I Lippincott Williams & Wilkins:2014:362
4. Ng YH, Sethi DS. Isolated sphenoid sinus disease: differential diagnosis and management. *Curr Opin Otolaryngol Head Neck Surg* 2011;19:16–20.
5. Marcolini TR, Safraidier MC, Socher JA, Lucena GO. Differential diagnosis and treatment of isolated pathologies of the sphenoid sinus: retrospective study of 46 cases. *Int Arch Otorhinolaryngol* 2015; 19:124–29
6. Wang P, Ge W, Ni X, et al. Endoscopic Treatment of Isolated Sphenoid Sinus Disease in Children. *Ear, Nose & Throat Journal*. 2019;98:425-30.
7. shak NL, Subha ST, Abu Bakar S. Isolated sphenoid sinusitis: A big headache. *Malays Fam Physician*. 2019;14:29-30.
8. Nour YA, Al-Madani A, El-Daly A, Gaafar A. Isolated sphenoid sinus pathology: spectrum of diagnostic and treatment modalities. *Auris Nasus Larynx* 2008; 35:500–8.
9. Alazzawi S, Shahrizal T, Prepageran N, Pailoor J. Isolated sphenoid sinus lesion: a diagnostic dilemma. *Qatar Med J* 2014; 2014:57– 60.
10. Elhamshary AS, Romeh HE, Abdel-Aziz MF, Ragab SM. Endoscopic approaches to benign sphenoid sinus lesions: development of an algorithm based on 13 years of experience. *J Laryngol Otol* 2014;128:791–96.
11. Hadad G, Bassagaisteguy L, Carrau RL, et al. A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. *Laryngoscope* 2006;116:1882–86.
12. Samia A. Fawaz, MD; Waleed F. Ezzat, MD; Manal I. Salman, MD Sensitivity and Specificity of Computed Tomography and Magnetic Resonance Imaging in the Diagnosis of Isolated Sphenoid Sinus Diseases. *The Laryngoscope*.2011, 121:1584–89.
13. Nour YA, Al-Madani A, El-Daly A, Gaafar A. Isolated sphenoid sinus pathology: spectrum of diagnostic and treatment modalities. *Auris Nasus Larynx*.2008;35:500–8.
14. ERAVCI FC, CEYLAN A, GÖCEK M , İLERI F, USLU SS, YILMAZ M, KIZIL Y. Isolated sphenoid sinus pathologies: a series of 40 cases. *Turkish Journal of Medical Sciences*. 2017;47:1560-67.
15. Friedman A, MD, S. Batra P, MD, Fakhri S, MD, J. Citardi M, MD, C. Lanza D, MD. Isolated Sphenoid Sinus Disease: Etiology and Management. *Otolaryngology–Head and Neck Surgery*. 2005;133:544-50: page number546
16. Socher JA, Cassano DM, Filheiro CA, Cassano P, Felippu A. Diagnosis and treatment of isolated sphenoid sinus disease: a review of 109 cases, *Acta Oto-Laryngologica*. 2008;128:1004-10
17. MossWJ, Finegersh A, Jafari A, et al. Isolated sphenoid sinus opacifications: a systematic review and meta-analysis. *International Forum of Allergy & Rhinology* .2017;1-6
18. Marcolini TR, Safraidier MC, Socher JA, Lucena GO. Differential Diagnosis and Treatment of Isolated Pathologies of the Sphenoid Sinus:Retrospective Study of 46 Cases. *International Arch Otorhinolaryngol*.2015;19:124–29.