

Complications of Endoscopic Surgery of Congenital Choanal

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Abstract:

Background: Choanal atresia (CA) is a life-threatening, but relatively uncommon, anomaly involving the congenital obliteration of the posterior nasal choana, due to the blocked oronasal membrane in children. This study aimed to evaluate and analyze the effectiveness and safety of endoscopic technique for the C.A treatment, the complications of endoscopic techniques and the steps and tricks to avoid this complications. **Materials and Methods:** This retrospective study was conducted to evaluate the outcome of transnasal endoscopic repair for choanal atresia regarding the patency of the repair and the complications of surgery. The medical records of twenty five patients with CCA, underwent primary endonasal surgical repair in the past 5 years were reviewed. All patients were treated by endoscopic transnasal approach at ENT department Zagazig university hospital. **Results:** The endoscopic surgical technique iii, starting with vomer resection showed low rate of early and late complications compared to other endoscopic techniques. Restenosis was common complication reported in current study which showed statistically significant relation between restenosis post endoscopy surgery of CCA and age at time of surgery $p=0.038$, site of CA $p=0.008$, except with techniques iii, vii. **Conclusions:** The endoscopic transnasal approach is an effective, safe and minimal invasive surgery to treat unilateral or bilateral CCA. Starting endoscopic repair of choanal atresia with vomer resection (technique iii), give good result regarding patency of neochoana, with low complications rate compared to other endoscopic techniques, no age or site limit for the procedure.

Keywords: Choanal atresia, Complications, Bilateral choanal atresia, Congenital choanal atresia

INTRODUCTION

Choanal atresia, initially reported by Roederer in 1755, is a congenital deformity defined by blockage of the posterior nasal choana. 70 percent of patients have mixed bony-membranous blockage. Pure bone blockage occurs in 30% of patients and is caused by enlarged vomer and/or medialized pterygoid plates⁽¹⁾. CA affects approximately 20% to 50% of patients with concomitant congenital defects, most often CHARGE syndrome; the incidence of CA is one in every 5000 live births Jones et al.⁽²⁾ and it can be unilateral or bilateral. Surprisingly, CA characteristics follow the 2-1 rule, namely the ratio of unilateral to bilateral CA, female to male, and right sided to left sided⁽³⁾. The newborn with bilateral CA usually presents as an acute emergency with respiratory distress and cyanosis that improves when the child cries (cyclic cyanosis), as well as the inability to feed

and breathe at the same time. This patient requires an urgent establishment of an oral airway and securing it to save his life while also allowing time to evaluate the patient and plan for surgery. Unilateral CA, on the other hand, is characterized by nasal obstruction and/or discharge. Nasal endoscopy and computed tomography (CT) constitute the gold standard for accurate diagnosis⁽⁴⁾.

The only option for CA treatment is surgery, and there are numerous surgical approaches for correcting CA. Trans palatal, trans septal, trans nasal puncture, and endoscopic trans nasal approaches are the most often employed procedures nowadays. Age of the patients, associated medical conditions, type of atretic plate, laterality of atresia, primary or revision surgery, use of adjunct therapy, and surgeon preference are all factors that influence surgical approach selection. There are numerous studies in the literature that use tools to improve the outcomes of surgical intervention, beginning with alternative surgical methods and progressing to the use of adjunct tools or drugs. Restenosis of the posterior choana is a typical problem following CA repair⁽⁵⁾.

Although surgery is the ultimate treatment for CA, there is still debate about a uniform surgical strategy and the best procedure for preventing restenosis⁽⁶⁾. The ideal CA repair procedure should be safe, involving brief surgery and hospitalization, avoiding damage to any growing structures, and restoring nasal patency with minimal complications⁽⁷⁾.

The problems of CA repair vary depending on the surgical method, the patient's age, the type of atresia, its laterality, concomitant malformations, the patient's age at the time of surgery, and the surgeon's experience⁽⁸⁾. The complications that may arise during CA surgical repair and are documented in the literature are classified as early complications (intra-operative and early post-operative) and late complications that are recorded during patient follow-up.

Anesthetic problems (laryngospasm, bronchospasm, reintubation, difficult extubation, oxygen desaturation, and cardiac arrest), edema and airway obstruction, hemorrhage, iatrogenic damage, and chest infection are among the early complications. Iatrogenic injuries reported include septal, turbinate, and palatal injuries, damage to the torus tuberosus causing chronic Eustachian tube dysfunction and chronic otitis media, as well as damage to the skull base with CSF leak and meningitis, post-operative chest infection, and alar collapse following CA surgical repair⁽⁹⁾. Nasal infection, granulation tissue growth, crusting and fibrin clot, restenosis, and stent problems are examples of late consequences. The purpose of this study is to assess and analyze the effectiveness and safety of endoscopic techniques for C.A treatment, as well as the complications of endoscopic techniques and the measures and methods to avoid these difficulties.

MATERIALS AND METHODS

This a retrospective study included twenty five patients, with congenital CA underwent primary edonsnasal endoscopic repair. After obtained institutional review board (IRB) approval. The data collected from patients records at Zagazig University Hospital. 14 patients (56%) had bilateral choanal atresia and 11 patients (44%) had unilateral choanal atresia. 17 patients (68%) were females and 8 patients(32%) were males. The median age for the patients was 12 days, range from 3 days to 10 years. The main symptoms for bilateral choanal atresia cases was respiratory

distress, while unilateral cases usually present with nasal obstruction and or rhinorrhea. All patients were treated by endoscopic transnasal approach at ENT department Zagazig university hospital. All patients had full history, investigations recorded, also they had detailed systemic examination reviewed. Diagnosis was typically based on fibro optic nasal examination, and CT scan of the head. The data collected from patients records include: preoperative symptoms& investigations, age at time of surgery, laterality of the atresia, operative data regarding technique and steps, postoperative complications and outcome. The data collected classified into categories regarding technique, laterality and complications. Patient parameters such as age at time of surgery, laterality of atresia and CHARGE association were assessed in relation to the complications.

The complications was categorized as early complications (Intra operative & early postoperative) and late complications detected on follow up.

Surgical techniques reported aiming to improve surgical out-come :

- i. Stentless transnasal endoscopic repair⁽¹⁰⁾.
- ii. Transnasal endoscopic repair with stentless mucosal flap technique⁽¹¹⁾.
- iii. Stentless tansnasal endoscopic repair starting with vomer resection ending by no stent nor packing⁽¹²⁾.
- iv. Transnasal endoscopic repair with fenestrated endotracheal tube stent⁽¹⁰⁾.
- v. Endoscopic repair with topical intra-oprative mitomycine application⁽¹³⁾.
- vi. Endoscopic repair using post-oprative para-septal silicone sheet⁽¹³⁾.
- vii. Transnasal endoscopic repair with preservation of mucosa using fibrin glue technique⁽¹⁴⁾.
- viii. Endoscopic laser-assisted CA repair⁽¹⁵⁾.

Statistic analysis

SPSS 23.0 for Windows was used to gather, tabulate, and statistically analyze all data (SPSS Inc., Chicago, IL, USA). The mean, standard deviation, and median (range) were used to describe quantitative data, while absolute frequencies (number) and relative frequencies were used to express qualitative data (percentage). When appropriate, percentages of categorical variables were compared using the Chi-square test or the Fisher exact test. The Mann-Whitney U test was employed to compare the median of complications factors. All of the tests were two-sided. P-values less than 0.05 were considered statistically significant (S), whereas p-values more than 0.05 were considered statistically insignificant (I).

RESULTS:-

17 patients (68%) were females and 8 patients (32%) were males. The median age for the patients was 12 days, range from 3 days to 10 years. The main symptoms for bilateral choanal atresia cases was respiratory distress, in contrary nasal discharge and nasal obstruction was the main presenting symptoms in unilateral cases. Two patients had associated anomalies, one patient had cardiac anomalies and the other patient had CHARGE syndrome. The median age at time of surgery was 6 days for bilateral choanal atresia cases and 4 years for unilateral choanal atresia cases Table 1.

Table (1): Demographic data of studied Patients (n=25).

	Number of patients	%
Sex		
Females	17	68.0
Males	8	32.0
Age per years Median (Range)	12 days (3days -10 years)	
Symptoms		
Respiratory distress	14	14
Nasal obstruction & Nasal discharge	11	11
Medical history		
No associated abnormalities	23	92.0
Congenital heart lesion	1	4.0
Charge syndrome	1	4.0
Frequency of side of congenital choanal atresia among studied children		
Site of lesion		
Bilateral	14	56.0
Unilateral	11	44.0

Table(2):Frequency and percentage distribution of early complications of endoscopic surgery for congenital choanal atresia among studied children (N. 25).

Early complications		Yes	No	Technique	Age	Surgical time	Laterality	stent	
								Sheet	tubule
Edema and airway obstruction	N	4	21	i,ii,iv	6D	L	4 B	-	+
	%	16.0%	84.0%						
Mucosa injury	Septal injury	N	4	i,ii,iv,v v,vi,vii,viii	6D	L	2 B	-	+
		%	16.0%		4Y	L	2 U		
	Turbinate injury	N	4		6D	L	2 B	-	
		%	16.0%		4Y	L	2 U		
Bleeding	N	3	22	Drilling on ant/ lat wall sphe / M inj	6D	L	2 B	-	-
	%	12.0%	88.0%		4Y	L	1 U		
Skull base injury	N	1	24	Superior drilling	4Y	L	1 U	-	-
	%	4.0%	96.0%						
Feeding difficulty	N	1	24	Stents	6D	L	1 B	-	+
	%	4.0%	96.0%						
Anterior nasal injury	N	4	21	i,ii,iv,v use powered instruments	6D	L	2 B	-	+
	%	16.0%	84.0%		4Y	L	2 B		
Palate injury	N	1	24	Inferior drilling	6D	S	1 B	-	-
	%	4.0%	96.0%						

L: long time > 2 hours, **S:** short time < 1 hour, **B:** bilateral, **U** unilateral, **ant:** anterior, **lat:** lateral, **sphe:** sphenoid sinus, **M:** mucosal, **inj:** injury

Table 2; Showed that early complications of endoscopic surgery for congenital choanal atresia among studied children, 16.0% had edema and airway obstruction, frequently with technique i,ii,iv. While 16.0% had Septal injury frequently with technique i,ii,iv,v and 16% had turbinate injury, frequently with technique v,vi,vii,viii also 16% developed anterior nasal injury, frequently with technique i,ii,iv,v, use of powered instruments, 12.0% were suffering from bleeding, frequently due to excessive drilling of anterior or lateral wall of sphenoid sinus and middle turbinate mucosal damage and 4.0% of the children were suffering from Skull base Injury due to superior drilling, or feeding difficulty due to stents use, or palate injury due to excessive inferior drilling.

Figure (1): Percentage of late complications of endoscopic surgery for congenital choanal atresia among studied children

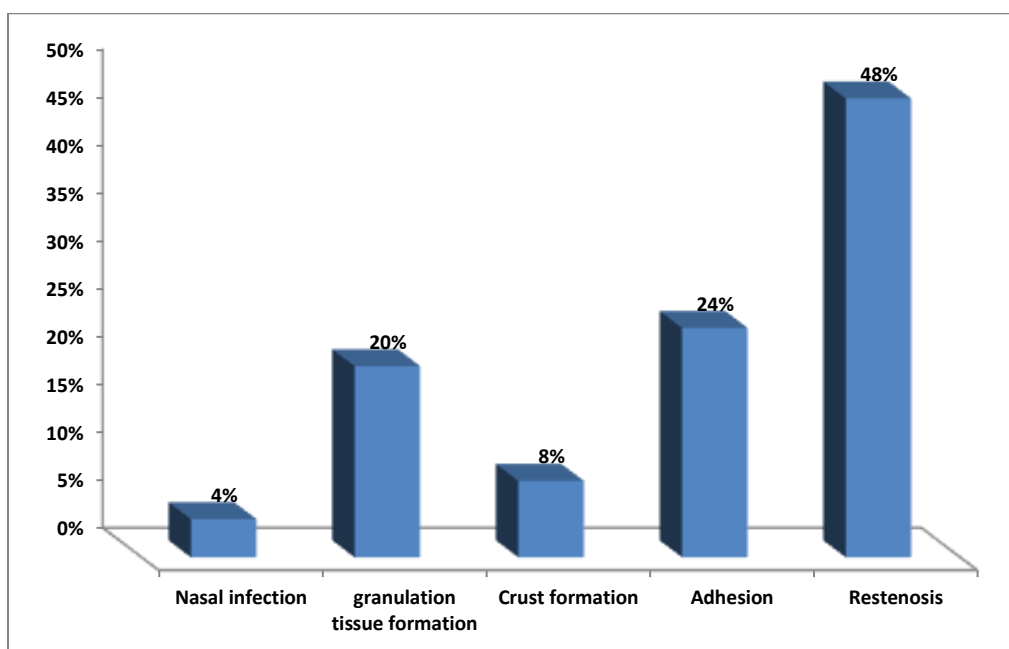


Figure (1): Showed that one patient (4.0%) with BCA had nasal infection due to use of stent, 5 patients (20.0%) had granulation tissue formation, 4 had bilateral CA and one unilateral CA, its due to use of stents and keeping bare bone exposed, also 2 patients (8.0%) had crust formation observed with stents use, one patient had bilateral CA formation, other one unilateral CA. In addition 6 patients (24.0%) had post endoscopic adhesion 3 of them had bilateral CA, others unilateral CA, commonly due to use of stents. Finally 48% of patients had post endoscopic restenosis two thirds of them had BCA while one third had UCA, restenosis commonly observed with techniques i, ii, iv, v, vi, viii. one patient had both granulation tissue formation and nasal infection included in both groups.

Table(3): Mean and standard deviation of duration per months lapse for restenosis (N. 12).

Duration lapse for restenosis per months	
Mean \pm SD	19.5 \pm 30.6
Median(range)	7.5(2-96)

Table 3; showed that median of duration per months lapse for restenosis was 7.5 months with range from two months to 5 years among studied patients.

Table 4: Relation between restenosis post endoscopic surgery of congenital choanal atresia and patients characteristics (N=25).

	Restenosis	N.	χ^2	p-value
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	Yes (N.12)		No (N.13)				
	No.	%	No.	%			
Age at operation							
Median (range)	6 days (3 days-9 yrs).		4years (3 days-10 years).			U=2.1	0.038(S)
Sex							
Females	10	58.8	7	41.2	17	f	0.202
Males	2	25.0	6	75.0	8		
Side of choanal atresia							
Bilateral	10	71.4	4	28.6	14	6.9	0.008(S)
Unilateral	2	18.2	9	81.8	11		
Associated congenital anomalies							
No	12	52.2	11	47.8	23	f	0.99
Yes	1	50.0	1	50.0	2		

χ^2 Chi square test f= fisher exact test u= Mann whitney u test
(S) significant p<0.05

Above table 4 showed statistically significant relation between restenosis post endoscopic surgery of congenital choanal atresia and age at operation p=0.038, site of choanal atresia p=0.008. It is noticeable that restenosis commonly occurred among young age exposed endoscopic surgery and who had bilateral stenosis. This developed with all surgical techniques but it's less in technique iii, vii.

DISCUSSION:

14 patients (56%) had bilateral choanal atresia and 11 patients (44%) had unilateral choanal atresia. 17 patients (68%) were females and 8 patients (32%) were males. The median age for the patients was 12 days, range from 3 days to 10 years. Two patients (8%) had associated anomalies, one patient had cardiac anomalies and the other patient had CHARGE syndrome. The median age at time of surgery for BCA was 6 days, while the median age at time of surgery for UCA was 4 years.

The obtained data were tabulated and the obtained results were compared with the results of other studies in literatures regarding postoperative complications. BCA cases commonly present with respiratory distress, cyclic cyanosis, feeding difficulty. Cases of UCA were presented by persistent unilateral rhinorrhea and or unilateral nasal obstruction.

Regarding early postoperative complications, the following was recorded:

4 patients (16%) developed edema and airways obstruction necessitating prolonged intubation and ICU monitoring, it may be due to associated airway anomalies, mucosal injury and

excessive drilling during surgery. To avoid this complication, the presence of synchronous airway anomalies as well as the risks associated with intubation and ventilation difficulties need to be considered to reduce risk of anesthetic related complications as laryngospasm, bronchospasm, oxygen desaturation, reintubation, difficult extubation and cardiac arrest⁽⁹⁾. Patient with bilateral CA especially if surgical procedure has been lengthy, airway edema is present or patient is hemodynamic unstable, should remain intubated in NICU under monitor until the issue have been resolved and the patient is stabilized⁽¹⁶⁾. Powered instrumentation with soft tissue shavers and small drills are believed to be less traumatic to nasal mucosa and allow better healing of the mucosa which decrease risk of mucosal edema⁽¹⁷⁾.

Regarding bleeding, 3 patients (12%) developed bleeding which may be caused by excessive mucosal damage, excessive drilling to anterior wall of sphenoid sinus during surgery and injury to sphenopalatine artery and its septal branch or vidian artery, its usually controlled by backing or cauterization. This hemorrhagic complication can be avoided by backing the nasopharynx to protect adjacent structures, keeping the surgical field clean of blood and debris by continuous suction, prevention of excessive damage to mucosa, and avoid excessive drilling to anterior wall of sphenoid sinus in order to prevent injury to sphenopalatine artery and its septal branches. **Khafagy**⁽¹⁸⁾ reported one case died from profuse IO bleeding, presumed hemorrhagic disease of newborn while **Nour et al.**⁽¹⁹⁾ reported one case of bleeding that require endoscopic control. Technique iii help this more than other by creating a wide surgical field and working through both nasal cavity. The resection of atretic plate usually started at junction between vomer and hard palate at the inferomedial direction of atretic plate which represent the safest portion of blocking membrane in order to avoid hemorrhagic complications (Sphenopalatine & Vidian artery injury), the use of soft tissue shaver and small drill is less traumatic to nasal mucosa which decrease risk of bleeding.⁽²⁰⁾

Regarding mucosal injury 4 patients (16%) developed septal injury; 4 patients (16%) developed turbinate injury. This iatrogenic injuries may due to small nasal anatomy in neonates that restrict the size of instrumentations used during surgery, unclear surgical field, excessive drilling, and associated anatomic anomalies. This complications can be avoided by careful preoperative assessment of nasal anatomy, using nasal decongestant to diminish volume of nasal turbinate, endoscopic nasal examination before starting surgery, keeping surgical field clean by continuous suction and avoid excessive drilling. Anatomic landmark have to be respected and basic surgical guideline should be followed **Teisser et al.**⁽²¹⁾. The 3rd technique starting with resection of the vomer and use 2 nostril for instruments simultaneously will help to avoid this complication.

As regard skull base injury one patient (4%) developed skull base injury which may caused by misdirection of perforation of atretic plate, failure to back the nasopharynx, working in unclear surgical field and excessive drilling. This injury can be avoided by backing the nasopharynx to protect adjacent structures, directing the puncture of atretic plate inferiomedially to avoid skull base and keeping the surgical field clean by continuous suction. Technique iii help vision by using two

nasal sides simultaneously which provide clear anatomic orientation that help keeping inferior away from skull base.

Regarding nasal skin injury 4 patient (16%) developed nostril injury that my caused by thermal damage as result of excessive use of power instruments and drilling. This injury is usually avoided by careful use of power instrument, keeping it away from nasal skin and nasal saline irrigation. **Mohamed et al.**⁽¹⁰⁾ reported one case of palatal fistula, one case of alar cartilage injury and a case of septal thermal injury during intranasal drilling of atretic plate that suffered alar collapse later, as an intraoperative complications following trans nasal endoscopic CA repair. The use of 3rd technique help avoiding aggressive use of power instruments.

As regard to palate injury. One patient (4%) developed soft palate injury that healed conservatively, this consistent to studies of **El Ahl et al.**,⁽¹²⁾, **De Freitas et al.**⁽¹⁵⁾ and **Ibrahim et al.**⁽²²⁾. Keeping surgical field clean and avoiding excessive inferior drilling will help to reduce risk of palate injury

One patient (4%) developed feeding difficulties that may related to mucosal edema, use of stents and inadequate vomer resection, this complication can avoided by careful use of power instruments, use of soft tissue shaver and small drill which is less traumatic to nasal mucosa that allowing better mucosal healing with early resumption of oral feeding, and creating wide cavity posteriorly which provide a large nasal airway so the child can feed and breathe without any difficulty. Techniques iii , vii avoid these.

Most of the patients resume oral feeding on the evenings of operation day and discharged on next day, this is in contrast to trans palatal approach where convalescence is prolonged due to palatal incisions and associated edema that will delay resumption of oral feeding and discharge from hospital.

The late complications reported in the current study were nasal infection , granulation tissue formation , intranasal crust , Synechia and restenosis

The common late complications reported in current study was restenosis (48%) .BCA repair is associated with an increased risk of restenosis as reported by **Teissier et al.**⁽²¹⁾ (2008), **Chia et al.**, (23) and **Mohamed et al.**, (10), this tendency was significantly reported in the current study. The relatively high recurrence rate in the current study could be attributed to the high proportion of bilateral case, that need surgery in early neonatal period. **Friedman et al.**, (24) reported that children with low weight at time of surgery, restenosis is more frequent than in higher weight children and **Tiessier et al.**, (21) have shown that age younger than 10 days at time of surgery is associated with increased risk of relapse which significantly reported in the current study except cases done by 3rd technique, beginning with removal of posterior portion of vomer first that give wider surgical field, allowed early using both nasal passages for instrumentation simultaneously, so both atretic plate can be removed easily, it obviate the difficulty to operate through one nasal cavity in BCA cases, with no age limit for the procedure and good result regarding patency in BCA cases. **El-Ahl et al.**, (12) .

prevention of restenosis is an important challenge in surgery for CA, the use of choanal stenting, topical mitomycin C, and resurfacing of the surgical defect with mucosal flaps in order to prevent restenosis, are the most controversial issues in management of CA (25).

Restenosis can be avoided by creation a widely patent posterior nasal choana sufficient for normal bilateral nasal breathing, removal of adequate portion of posterior part of the vomer which is essential step to get good result as failure commonly attributed to inadequate vomer resection, minimizing mucosal injury is also important step to avoid endonasal scar tissue formation. Efficient postoperative nasal saline irrigation is extremely beneficial for surgical outcome, and teaching patients or their parents how to do it properly at home is highly recommended to avoid secretion accumulation, crusting, fibrotic scar and restenosis, moreover periodic postoperative endoscopic surveillance or second look procedure to clean the neochoana of secretions, clots, crust, will help to avoid inflammatory process, infection, granulation tissue formation and restenosis **Kwong. (26), Karligkiotics et al. (25) and Saraniti et al (27)**. The sequence of steps of endoscopic technique that begin with vomer resection is an important element to prevent restenosis and improve the outcome (12,28). (El-Ahl et al., 2012.) (El- Anwar et al., 2016)

Regarding granulation tissue formation and crusting . 5 patients had granulation tissue formation and 2 patients had crust formation, frequently due to use of stents and keeping bare bone exposed. **Saafan et al., (29)** reported in their study that 5 patients represent 50% of studied group using stents suffered postoperative granulation tissue formation as compared to 2 case 20% of non stent group, while **Joseph et al., (30)** reported one case who developed granulation tissue formation a week after stent removal. Granulation tissue formation and crust can be avoided by prevention of excessive damage or removal of mucosa, use of mucosal flap to cover the raw areas, avoid excessive drilling of the bone and use of stents as possible, frequent nasal saline irrigations and periodic endoscopic surveillance.

Regarding post-operative adhesion (Synechia). 6 patients (24%) developed adhesion in current study **Mohamed et al., (10)** reported one case of mild nasal synechia with mild nasal obstruction and nasal discharge that improve after operative separation, while **Ibrahim et al., (22)** reported 3 infant developed postoperative nasal synechiae with no further treatment required. Postoperative synechiae can be avoided by preventing damage to nasal mucosa and excessive drilling, covering raw surface, keeping the new choana clean of secretion, debris and clot. **Karligkiotics (25)** use paraseptal silicone splints for about 20 days in order to separate the turbinate from nasal septum and prevent synechiae.

Regarding nasal infection one patient (4%) had nasal infection due to use of stent. One should avoid use of stents as possible and patient should receive prophylactic antibiotic to overcome this complication.

No growth disturbance of the palate, alveolar arch and mid face, nor occlusive abnormality were recorded, post transnasal endoscopy as compared to transpalatal approaches.

CONCLUSION:

The endoscopic transnasal approach is an effective, safe and minimal invasive surgery to treat unilateral or bilateral CCA, offering direct approach to the atretic plate, restore normal nasal passage, avoid damage to any growing structures, short surgical time, hospitalization stay with minimal morbidity and mortality. Starting repair with vomer resection give good result regarding patency of neochoana with low complications rate compared to other endoscopic techniques, there is no age or site limit for the procedure.

REFERENCES:

- 1- **Corrales CE, Koltai PJ.** Choanal atresia: current concepts and controversies. *Curr Opin Otolaryngol Head and Neck surg*, 2009; 17(6): 466-70.
- 2- **Jones DJ, Vanjelovic ND, Gonik NJ.** Novel use of a curved mastoid burr in the management of a difficult case of choanal atresia [in Press]. *Otolaryngology Case Reports*. 2019.
- 3- **Hengerer AS, Brichman TM, Jeyakumar A.** Choanal atresia: Embryologic analysis and evolution of treatment, a 30 year experience, *laryngoscope* (2008) 118 (5): 862 -6.
- 4- **Tan N, Jonas N.** Open access atlas otolaryngology, head& neck, operative surgery 2017.
- 5- **Saafan ME:** Endoscopic management congenital bilateral posterior choanal atresia: Value of using stents. *Eur Arch Otorhinolaryngol*. 2013;270 (1) : 129-34
- 6- **Asma A, Roslenda AR, Suroya A, Saraisa AB, Aini AA.** Management of congenital choanal atresia after multiple failures; a case report. *Med J Malaysia* (2013) 68 (1): 86-8.
- 7- **Cedin AC, Atallah AN, Andrriolo RB, Cruzol, Pignatari SN.** Surgery for congenital choanal atresia, *Cochrance Database sys Rev z*: CD008993, 2012(2)
- 8- **Mohamed MM, Kodah SM, Abdel-Gader M, El-Anwar MW, Ghanem AEM.** Transnasal choanoplasty with and without stent; comparative study, *AAMJ*, 2015; vol 13, no. 3.
- 9- **Yildirim ZB, Akdag M, Celik F, Baysal E .** Anesthesia management in patients with choanal atresia. *J Craniofac. Surg* .2016 ; 27:1991-1994.
- 10- **Mohamed MM, Kodah SM, Abdel-Gader M, El-Anwar MW, Ghanem AEM.** Transnasal choanoplasty with and without stent; comparative study, *AAMJ*, 2015; vol 13, no. 3.
- 11- **Tomoum M.O., Askar M.H., Mandour M.F., Amer M.A., Saafan M.E.** Stentless mirrored L-shaped septonasal flap versus stented flapless technique for endoscopic endonasal repair of bilateral congenital choanal atresia: A prospective randomised controlled study. *J. Laryngol. Otol*. 2018;132:329–335.
- 12- **El-Ahl MA, El- Anwar MW.** Stentless endoscopic transnasal repair of bilateral choanal atresia starting with vomer resection 2012; *Int J Pediatr Otorhinolaryngol* 76 (7): 1002 -6.

- 13-Cassano M. (2017).** Endoscopic repair of nasal septal perforation. *Acta Otorhinolaryngologica Italica*, 37(6), 486.
- 14- Cedin AC, Fujita R, Cruz OLM.** Endoscopic transeptal surgery for choanal atresia with a stentless folded – over flap technique . *Otolaryngol head Neck Surg.* 2006, 135: 693 -98
- 15- D' Eredita R, Lens BM.** Contact- Diode laser repair of bony choanal atresia: A preliminary report, *International Journal of Pediatric Otorhinolaryngology*, volume 72, Issue 5, May 2008, pages 625 – 628.
- 16-Landesman IR, Etsuro Motoyama. Smith Anesthesia for infants and children , 8 Edition, 2011.**
- 17- Rhombaux PH, Toeuf CD, Hamoir M, Eloy O, Bertrand B, Veykemans F.** Transnasal repair of unilateral choanal atresia,;*Rhinology* 2002, 41, 31-36.
- 18- Khafagy YW.** Endoscopic repair of bilateral congenital choanal atresia, *Laryngoscope* 2002 ; 112 :316 - 319
- 19-Nour YA, Foad H.** Swinging door flap technique for endoscopic transseptal repair of bilateral choanal atresia .*Eur Arch Otorhinolaryngol* 2008, 265 :1341-1347.
- 20- Budu V.A, Decuseara T, Costache AN, Bulescu I, Guliga A, Panfilou A, Tusliv M.** Choanal atresia- a permanent challenge in Rhinology ,*Pathology*. Doi: 10.1515/ SBEEF-2016-0001, E-mail:vladbudu@yahoo.com.
- 21-Teissier N, Kaguelidou F, Couloigner V, Francois M, Van Den Abbele T.** predictive factors for success after transnasal endoscopic treatment of choanal atresia. *Arch otolaryngol. Head Neck Surg / 2008; Vol 134,(No1) .*
- 22- Ibrahim A A, Magdy E A, Hassab M H.** endoscopic Choanoplasty without stenting for congenital choanal atresia repair, *Int. J Padiatr Otorhinolaryngol* 74: 144-150, 2010
- 23- Chia SH, Carvaiho DS, Jaffe DM, Pransky SM.** Unilateral choanal atresia in identical twins: A case report literature review. *Int J pediater Otorhinolaryngol* 2002; 62;249-252.
- 24- Friedman NR, Mitchell RB , Bailey CM. Albert DM, Leightron SE.** Mangemert and outcome of choanal atrsia correction. *Int J Padiatr. Otorhinolaryngol*, 52 (1); 2000; 45-51.
- 25-Karlrgkiotis A, Farneti P, Gallo S, Pusateri A, Zappoli_Thyrron F, Sciarretta V, Pagella F, Castelnuovo P, Pasquini E.** An Italian multicenter experience in endoscopic endonasal treatment of congenital choanal atresia; proposal for a nasal classification system of surgical outcome. *J of craneo-maxilo-facial surgery* 45 (2017) 108-10251.

- 26- Kwong K M .** current update on CA,Front pediater , 2015, 3, 52.
- 27- Saraniti C, Santangelo M, Salvago P.** Surgical treatment of choanal atresia with transnasal endoscopic approach with stent less single side- hinged flap technique: 5 year retrospective analysis, Braz J Otorhinology 2017, 83,(2): 183-189.
- 28- El- Anwar MW , Nofal AAF, EL-Ahl MAS.** Endoscopic repair of Bilateral choanal atresia: Start with vomer resection, AJ of rhinology & allergy 2016; 30 (3), e 95 – e 99.
- 29-Saafan ME:** Endoscopic management congenital bilateral posterior choanal atresia: Value of report, International Journal of Pediatric Otorhinolaryngology, volume 72, Issue 5, May 2008, pages 625 – 628.
- 30- Josephson GD, Vickery CL, Giles WC, Gross CW.** Transnasal endoscopic repair of congenital choanal atresia: long term results. Arch Otolaryngol, Head neck, Surg 1998; Vol. 124. using stents. Eur Arch Otorhinolaryngol. 2013,270 (1) : 129-34.