Chapter

Antrochoanal Polyp: Updated Clinical Approach, Histology Characteristics, Diagnosis and Treatment

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Abstract

Antrochoanal polyp (ACP) is a benign unilateral polyp, originating from the maxillary sinus and expanding through the accessory or natural ostia into the nasal cavity and choanae. It has a 2: 1 male predominance and is more common in children and young adults. The exact pathophysiology is unclear, and it is thought to have less of the inflammatory reactions as opposed to typical bilateral nasal polyps which are commonly seen in diffused chronic rhinosinusitis. The presenting symptoms of ACP are unilateral nasal obstruction and rhinitis. Epistaxis, pain, and foul-smelling secretions are not typically seen and point towards a different etiology. Diagnosis is mainly clinical via endoscopic examination and supported by Computed tomography (CT) imaging. In CT images the three components of the polyp can be identified; an intramaxillary portion, intranasal and choanal components. Treatment is surgical, where Endoscopic sinus surgery (ESS) is the main technique used with other assisting approaches to reach the more challenging anterior and inferior areas of the maxillary sinus. Successful resection depends on complete removal of the intramaxillary component of the polyp to avoid polyp regrowth. The typical histologic characteristics are cyst formation, fibrosis and squamous metaplasia that are significantly more common in ACP than diffused nasal polyps.

Keywords: histoloy, Immunohistochemistry, antrochoanal polyp, nasal polyps

1. Introduction

Antrochoanal polyp (ACP) is a benign, unilateral polyp originating from the maxillary sinus, extending through the natural or accessory ostia into the nasal cavity. This finding is more common in children and young adults [1] with 2:1 male to female ratio. Its etiology is vague and varies from neoplasia to inflammatory polyp or cystic degeneration of intramaxillary retention cyst. The exact anatomic origin of ACP inside the maxillary sinus is not agreed upon in the literature. The medial and posterior walls are the most common origin sites [2, 3], but the polyp may grow from virtually any site inside the maxillary sinus. ACP exits the maxillary sinus through the accessory ostium in at least 70% of cases [4], which may explain why the polyp grows inferiorly and posteriorly into the nasopharynx. Recent

publications show evidence that nearly all ACPs extend through the accessory ostium [2, 5]. The most common symptoms of ACP are nasal obstruction and anterior nasal discharge, while epistaxis and pain point towards a different etiology necessitating further workup. The treatment of choice for ACP is surgical resection [1]. While different surgical techniques were described in the past, endoscopic removal of both the intranasal and intramaxillary parts of the polyp is the common practice today. ACP is common in the pediatric population. While it represents only 4–6% of all nasal polyps in adults, up to 35% of nasal polyps in children will eventually be diagnosed as ACP [6]. The common symptoms are the same as with adults, however additional sinus pathologies are rarely seen in children. Oropharyngeal descent is more prevalent in children compared with adults [7]. In addition, children generally present with more advanced disease, probably as a result of delayed diagnosis. The recurrence rate of ACP after endoscopic surgical treatment is not significantly different between children and adults [8]. A meta-analysis conducted by Galluzzi demonstrated a 15% recurrence rate in children with significantly higher rates in patients who underwent endoscopic surgical treatment alone compared with combined approach (i.e. endoscopic and trans-canine sinusoscopy or mini-Caldwell-Luc) [9].

2. Pathophysiology

There are different theories regarding the pathogenesis of ACP; Early studies suggested that ACP grows from an antral mucous retention cyst, a quite common finding in the general population (8–10%) [10]. In their attempt to explain why ACP occurs in only a minority of patients with retention cysts, Frosini et al. hypothesized that increased intra-sinus pressure caused by partial occlusion of the natural ostium due to inflammatory changes and edema is leading an antral cyst to herniate through the accessory ostium [5]. Histologic features of ACP, which include a high rate of inflammatory cells, may support this theory.

The association between ACP and allergy is controversial. While the exact pathogenesis of ACP is unknown, a relationship between ACP and allergic rhinitis or ipsilateral maxillary sinusitis has been shown in pediatric patients [7]. Moreover, increased recurrence rates of ACP after endoscopic surgery were noted in children who were exposed to cigarette smoke (aka 'passive smokers'); Mantilla described a series of 27 cases of recurrent ACP in children in which nearly half of the subjects were considered as passive smokers [11]. While this data may point to a causal correlation between smoking and the development of ACP, such a relationship is not documented elsewhere and more research is needed in this area.

3. Differential diagnosis

The diagnosis of ACP may be challenging, mainly in young children (5–8 years). In this age group, adenoid hypertrophy is a very common finding and the symptoms may resemble those of ACP, like nasal obstruction, chronic rhinorrhea and snoring. Even though the pre-operative management in these cases include nasal endoscopy and/or lateral plain films of the neck, sometimes the diagnosis of ACP may be overlooked. Another unilateral nasal pathology to be ruled out in children is foreign body but it usually manifests with unilateral foul-smelling rhinorrhea. Epistaxis is not a usual clinical feature of ACP. In these cases, vascular lesions (such as juvenile nasopharyngeal angiofibroma, hemangioma or hemangiopericytoma) and neoplasia (inverted papilloma or malignant tumors) should be excluded [12]. The key to

	Adenoiditis / Hypertrophy	**Antrochoanal polyp**	**Allergic rhinitis**	**Rhinosinusitis**
Age	Variable, 4–7 years	7 years <	7 years <	Any age (acute) 12 years < (chronic)
Etiology	Hypertrophy of adenoid tissue	Cystic enlargement of intramaxillary polyp	Inflammatory/ allergic	Infectious (acute) inflammatory (chronic)
Symptoms	Nasal obstruction snoring chronic rhinitis	Nasal obstruction (unilateral progressive to bilateral) rhinorrhea	Rhinorrhea sneezing itching nasal obstruction ocular symptoms	Nasal obstruction rhinorrhea facial pain complications
Signs	Endoscopy: obstructive adnoids X-ray (lateral neck): nasopharynx obstruction	Endoscopy: unilateral nasal polyp	Endoscopy: unilateral nasal polyp	Endoscopy: edema or pus drain from middle meatus
CT	Nasopharynx obstruction	Unilateral maxillary opacification choanal obstruction	Bilateral opacification of sinuses	Bilateral opacification of sinuses complication: (ring enhancement / extrasinus involvement)
Treatment	**Medical:** leukotriene receptor antagonist **Surgical**: adenoidectomy	**Surgical:** resection of antrochoanal polyp	**Medical:** nasal douche, nasal steroid spray, antihistamine, leukotriene receptor antagonist, systemic steroids	**Medical**: nasal douche, antibiotics, nasal steroid **Surgical:** adenoidectomy, endoscopic sinus surgery

Table 1.
Differential diagnosis of pediatric nasal obstruction [14].

differentiate between ACP and other pathologies is a thorough and detailed history along with meticulous physical examination. In cases of limited physical examination, imaging may contribute to the diagnosis. One should keep in mind that adenoid to nasopharynx ratio decreases with age (especially in children >8 years) due to a change in nasopharynx width [13]. Therefore, children older than 8 years must undergo complete nasal flexible endoscopy to rule out nasal polyp (**Table 1**).

4. Clinical manifestations

4.1 History

The most common presenting symptoms of ACP are nasal obstruction and anterior rhinorrhea. Nasal Obstruction may be unilateral or bilateral, depends on the evolution of growth of the polyp. When it emerges from the maxillary sinus ostium to the nasal cavity the patient will complain on unilateral nasal obstruction. However,

as the polyp further descends into the choana it may cause bilateral obstruction, as commonly seen in hypertrophic obstructive adenoid tissue. Rhinorrhea is usually unilateral and watery; purulence is rarely seen. Other symptoms may include mouth breathing, snoring and sleep disorders, although ACP does no lead to truly obstructive sleep apnea (OSA). The cystic component is very typical to ACP. Some patients report of a sudden watery or yellow drainage followed by a relief of the nasal obstruction implying to a spontaneous rapture of the cystic part in the ACP.

Very large polyps may descend into the oropharynx and cause a foreign body sensation. As previously noted, the presentation of bilateral nasal obstruction is possible due to expansion of the polyp from one choanae to the other, however true bilateral ACP is extremely rare [15].

5. Imaging

Computed tomography (CT) imaging with nasal endoscopy represent the gold standard in the diagnosis of ACP [5]. All patients must have preoperative sinonasal CT scan, as it is a crucial part of the diagnosis and provides critical information of nasal and sinus bony landmarks prior to surgical intervention.

The classic appearance of ACP in CT is a hypo-attenuating unilateral soft tissue mass that completely occupies the maxillary sinus. It extends through the accessory maxillary ostium into the nasal cavity, medially to the inferior turbinate with progression towards the nasopharynx (**Figure 1**). Less commonly, the polyp

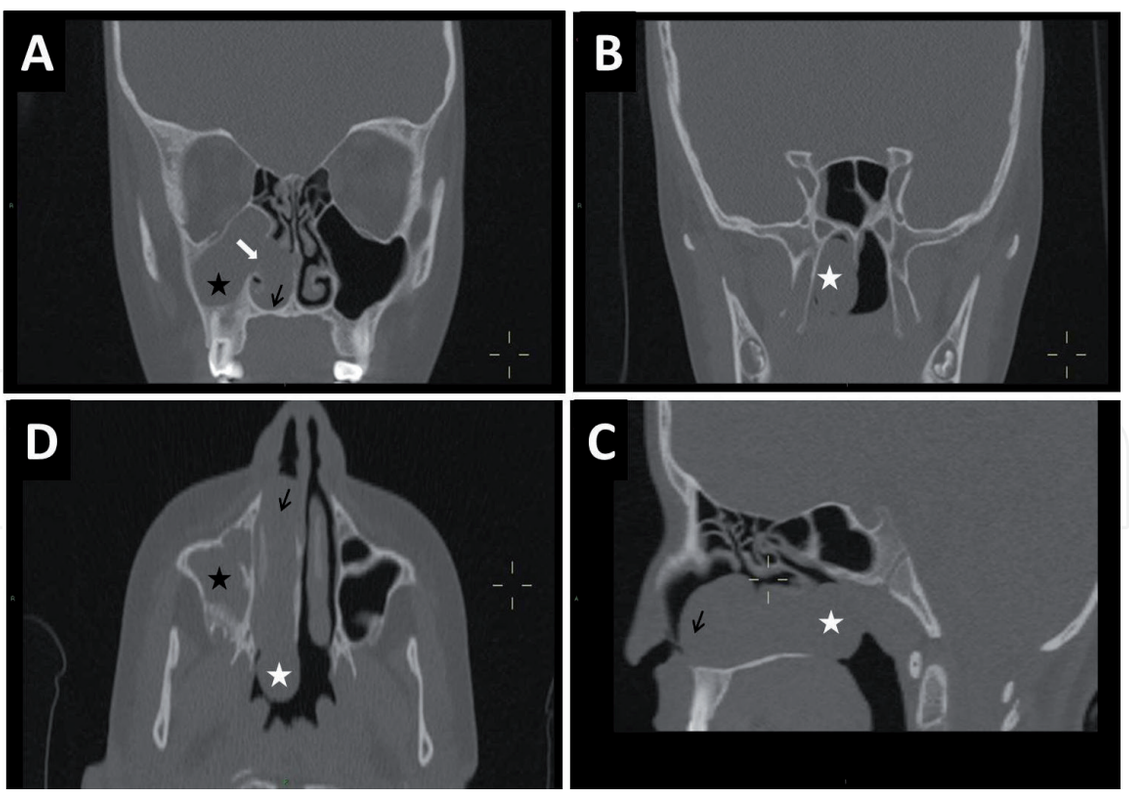

Figure 1.
Computed tomography (CT) imaging of right-sided antrochoanal polyp (ACP). (A) coronal image showing total opacification of the right maxillary sinus and nasal cavity. The antrochoanal polyp has both an intramaxillary component (black asterisk) and an intranasal component (black arrow) this view also demonstrates the enlarged accessory maxillary ostium (white arrow) through which the intramaxillary and intranasal portions are connected via a thin stalk. (B) Coronal view of choanal component of the polyp (white asterisk) obstructing the nasopharynx on the ipsilateral side. (C) and (D) axial and sagittal views demonstrating the different components of the antrochoanal polyp intra-maxillary (black asterisk), intranasal (black arrow) and choanal / nasopharyngeal (white asterisk) potions.

extends anteriorly to the middle turbinate and the anterior inferior turbinate region [16]. Bony changes (bone erosion, destruction or sclerosis) are not typically seen with ACP, although widening of the accessory maxillary ostium may occur, usually due to enlarging cystic portion of the polyp leading to the appearance of expansile maxillary mass (**Figure 1**) [8]. In cases of suspected bone destruction in CT, other pathologies such as malignancy should be considered. However, studies have shown that thinning of alveolar bone in the maxillary sinus may occur secondary to the progressive growing of ACP [2]. Lee classified 3 stages of ACP based on the radiological appearance of the lesion on CT [3, 17]: Stage I (antronasal polyp without extension to the nasopharynx), Stage II (full occlusion of the maxillary sinus ostium with extension to the nasopharynx) and Stage III (partially occlusion of the maxillary sinus ostium with polyp extension to the nasopharynx). In children, advanced CT stages (stage II, III) are more commonly seen due to delayed diagnosis in this population, as previously noted [7]. Magnetic resonance imaging (MRI) shows a hypointense T1 and enhanced T2 signals. With gadolinium administration, the cystic part of the polyp is peripherally enhanced. Although CT is the preferred imaging modality in the diagnosis of any nasal or sinus pathology including ACP, MRI may be considered in children (due to the lack of radiation exposure) and in cases of total unilateral nasal and sinus opacification in CT scans (in order to distinguish between sinus secretions and the mass itself). In nasal endoscopy, ACP appears as a gray-white colored mass with a smooth round surface. Unlike other allergic or inflammatory nasal polyps, ACP has a unique course from the maxillary sinus to the choana and has a bulging expansile behavior due to its cystic component.

6. Histology/histopathology

Macroscopically, ACP is composed of a cystic part filling the maxillary sinus and a solid part emerging through the maxillary ostia and filling the nasal cavity. It has a gross appearance of a "dumbbell" shape with a narrow stalk connecting between the cystic and solid components (**Figure 2**). Microscopically, the antral (or intramaxillary portion) part of ACP demonstrates a central cystic cavity surrounded by a homogeneous edematous stroma with few cells [5]. The intranasal portion of the polyp is covered with a respiratory epithelium similar to the normal mucosa of the sino-nasal tract and the choanal portion occasionally shows squamous metaplasia and reactive fibrosis (**Figure 3**). In comparison to allergic polyp, ACP is characterized by higher inflammatory cell infiltration and edema, lower eosinophilic infiltration and less submucosal glands [18]. These findings indicate that inflammatory changes are the main pathophysiological processes in the pathogenesis of ACP while allergy plays only a minor role. In addition, the paucity of submucosal glands suggests that ACP results from edematous hypertrophy of the respiratory epithelium rather than from distention of the glandular structure, which is the event responsible for the development of ordinary nasal polyps [18]. Angiogenesis is significantly less evident in ACP compared to nasal polyps resulting from chronic rhinosinusitis, with lower expression of angiogenic markers vasculo-endothelial growth factor (VEGF) and CD-34 [12]. These findings further support the idea that ACP is a result of a local inflammatory process and could also explain why ACP has less tendency to bleed compared with other types of polyps, both as a presenting symptom or during endoscopic surgery. ACP is characterized with a significantly high prevalence of intramural cysts [19, 20]. It is speculated that these cysts may have a role in the pathogenesis of ACP, and they contribute to the gross cystic appearance of both its intramaxillary and intranasal components. Moreover, the presence of intramural cysts supports

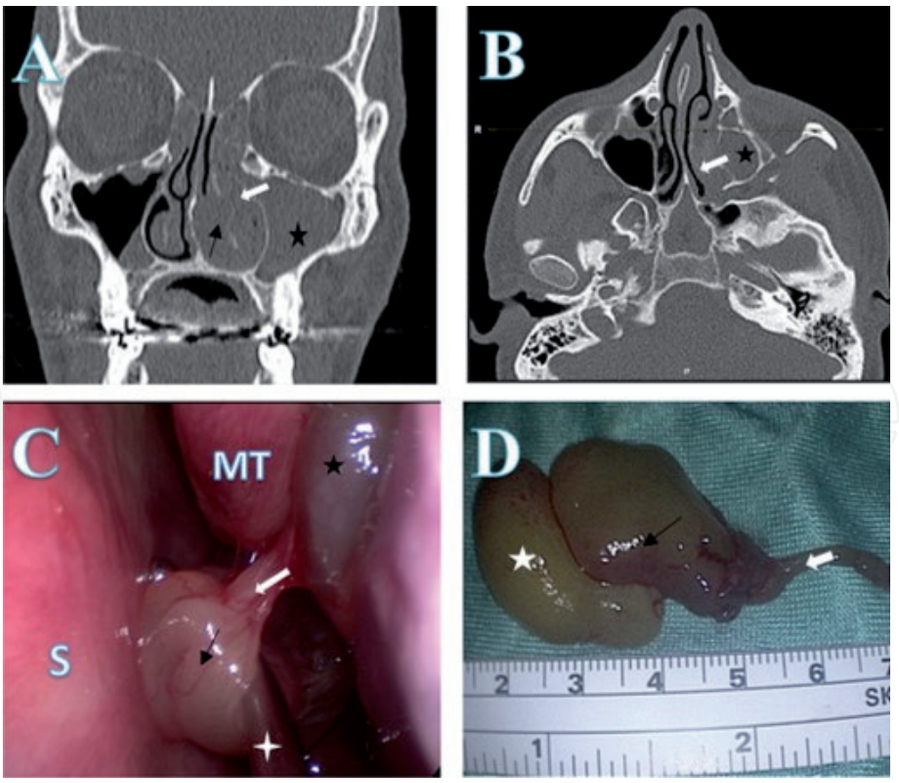

Figure 2.
Combined radiologic and intraoperative views of a left-sided Antrochoanal polyp. (A) & (B). Coronal and axial images showing total opacification of the left maxillary sinus and nasal cavity. The intra-maxillary portion (black asterisk) and the intranasal portion (black arrow) are connected through the enlarged accessory maxillary ostium (white arrow). (C). Endoscopic view of the same patient: The intranasal component of the polyp (black arrow) is medialized with a sinus-seeker (white cross) exposing the stalk (white arrow) that connects it to the intramaxillary component (black asterisk). (D). Gross appearance of the antrochoanal polyp after resection. The intranasal (black arrow) and the choanal (white asterisk) portions are seen clearly, the stalk preserved (white arrow) is seen after separating it from the intra-maxillary portion. MT = middle turbinate. S = nasal septum.

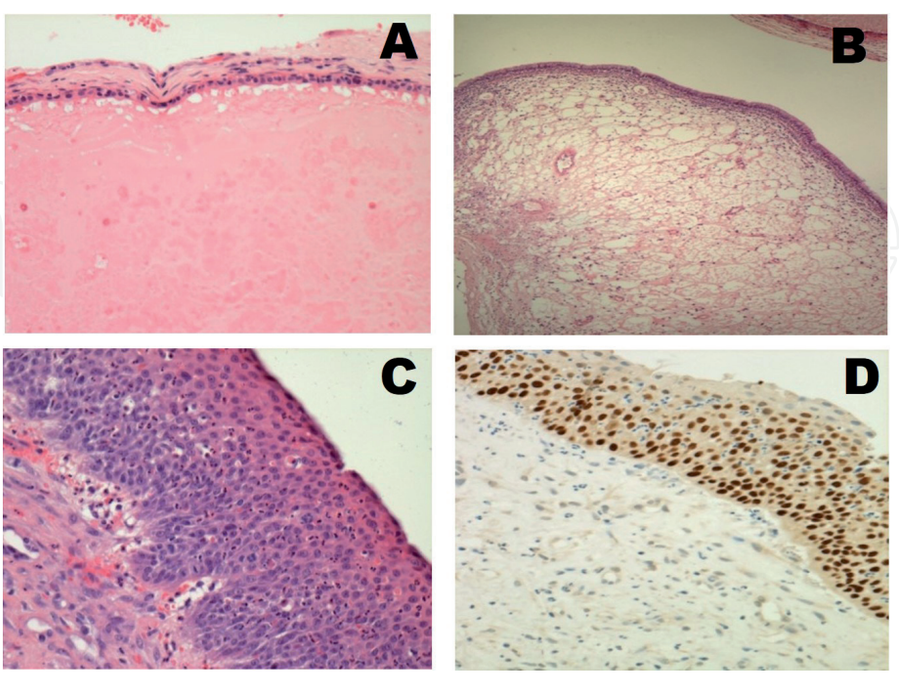

Figure 3.
Typical histologic characteristics of ACP. Image (A) shows a cystic portion of ACP with cuboidal epithelium (H&E original magnification X200). Image (B) demonstrate the intranasal portion of the ACP, edema is seen (H&E X100). Images (C) & (D) demonstrate squamous metaplasia of choanal portion of the ACP (C- H&E X200, (D)- monoclonal P63 antibody stain x200).

Berg's theory [10, 20] that the cystic part of the polyp develops from obstruction in the acinar glands or lymphatic ducts secondary to persistent inflammation. The pressure generated in the process of the polyp's growth through the accessory sinus ostium may be the cause for the substantial edema that is seen.

An explanation of why ACP presents with more cystic changes than diffuse chronic rhinosinusitis with nasal polyps (d-CRS) may be related to their different origins. ACPs develop from the maxillary sinus, characterized by typical respiratory epithelium with thin lamina propria, cyst formation and fewer submucosal glands. On the contrary, nasal polyps in d-CRS typically originate from the ethmoid sinus, which has a thick submucosal layer [21].

When comparing ACP with d-CRS preparations, Warman et al. found that ACP exhibits typical histologic features like cyst formation and edema. ACP demonstrated significantly increased edema when compared to the d-CRS (82.5% vs. 44.4% respectively, $p < 0.001$), and higher cyst formation (40% vs. 6.2% $P = 0.02$). More over ACP preparations demonstrate lower degrees of inflammatory markers than d-CRS [22]. The lack of an inflammatory drive in the pathogenesis of ACP may explain why anti-inflammatory treatment is futile in this population, leading to the common notion that ACP is a rather surgical issue than a medical one.

7. Treatment

Surgery is the standard of care in the treatment for ACP. Since its first description by Killian in 1906, many surgical techniques have been proposed for exposing the maxillary region [4]. Successful ACP resection depends on complete removal of the intramaxillary component of the polyp. The ideal procedure should facilitate excellent approach to all maxillary sinus walls and yet be minimally invasive as possible, especially in children. Currently, various surgical approaches are available: endoscopic sinus surgery (ESS) with polyp removal via either inferior meatus or middle meatus, or a combined inferior and middle meatal naso-antral window. Other options such as ESS with adjuvant canine fossa puncture, or ESS with "mini Caldwel-Luc" procedure aim to facilitate visualization of the anterior and inferior walls of the maxillary sinus [4, 23, 24].

8. Endoscopic inferior meatal antrostomy (EIMA)

Described by Mikulicz in 1887, inferior meatal antrostomy (known as intranasal antrostomy) was a common surgical procedure in the management of maxillary sinus disease. However, the popularity of this technique has declined with the increased use of middle meatal antrostomy due to the growing recognition that an opening in the inferior meatus does not improve sinus drainage, and might even harm the maxillary sinus mucociliary clearance mechanism. Nevertheless, endoscopic approach via inferior meatal antrostomy has the advantage of inferior meatal naso-antral window that avoids violation of the ostiomeatal complex (OMC) and provides better access to anterior-inferior maxillary sinus lesions. Arguments against inferior meatal antrostomy include: persistent sinus disease following surgery, low patency rates, possible injury to the nasolacrimal duct or to developing canine teeth, and technical difficulties associated with the procedure [24, 25]. While these arguments were substantial using anterior rhinoscopy approach, they are not valid with endoscopic approach in EIMA. As the inferior turbinate is carefully medialized, the opening of the nasolacrimal duct (Hasner's valve) is clearly seen and preserved. Then, the maxillary wall is penetrated posterior to that point, and an antrostomy of 8–10 mm is created. Once a

satisfactory exposure is achieved, view of the posterior, lateral and anterior portions of the sinus walls is possible with 0- and 45-degree endoscope in respect. The lesion is then removed with straight and curved instruments. At the end of the procedure, the inferior turbinate is lateralized back to its original position [24, 25].

Landsberg and Warman reported 56 patients with multiple maxillary pathologies (45% of them with ACP) in which EIMA was the primary approach for revision surgery. In a follow-up period for at least a year, 93% of patients had no evident sinus disease recurrence. There were no cases of ACP recurrence, and recirculation was not observed during the follow-up period. In addition, no major complications such as nasolacrimal duct injury or bleeding were observed [24].

9. Endoscopic middle meatal antrostomy (EMMA)

Endoscopic sinus antrostomy via the middle meatus (EMMA) is currently considered the gold standard treatment for ACP resection. It is generally recommended that the antral portion should be completely removed together with its stalk to minimize polyp regrowth. As a result, the intranasal and choanal components of the polyp should be resected first (**Figure 2**). Occasionally when the choanal portion is too large, it is easier to push it back to the oropharynx and remove it trans-orally.

Next, the cystic part of the polyp is resected through maxillary antrostomy. The maxillary sinus natural ostium is identified and usually connected with the already enlarged accessory ostium. Resecting the intramaxillary portion includes −45°- 70°- endoscopes to better visualize and identify the origin of the polyp. Removal of this intramaxillary portion is extremely important as to minimize post-operative recurrence [4, 26, 27].

Recurrence rate after EMMA is low. Cook et al. observed no recurrence in 33 patients with ACP [28]. Sometimes the intramaxillary portion is tightly adherent to the anterior or antero-inferior walls of the sinus, which makes the dissection a challenging task. In these cases, usage of angled instrumentation is strongly recommended. Nevertheless, the recurrence rate in these cases may increase up to 20% [17, 24, 26, 27].

Ozer et al. reviewed 42 patients who underwent ESS for ACP removal. Transcanine sinoscopy and Caldwell Luc approach were used in addition in 14 and 13 patients respectively. They found recurrence in 3/15 patients after ESS alone (20%), yet there was no recurrence after combined ESS and transcanine sinoscopy or the Caldwell Luc approach [29]. They postulated that the relative high recurrence rate may be due to improper identification of the attachment site of the polyp inside the maxillary sinus (50% of all cases). As a result, they advised considering combined approaches in cases when the attachment site is not clearly recognized. Hong et al. recommended powered instrumentation (Hummer, Stryker Instruments, Kalamazoo, MI) during ESS as an effective technique for removing ACP, especially the antral portion. They found an improvement rate of 96.4% with no significant complications when powered instrumentation was used [29, 30]. Complications following ACP resection are rare.

10. Combining endoscopic middle meatal antrostomy and transcanine sinusocopy

Lee and Huang used the transnasal endoscopic approach for ACPs originated from the inferior and posterior walls of the maxillary sinus, saving the more invasive combined endoscopic and transcanine approach for polyps originated from the lateral wall or in revision surgery. They reported success rate of the transnasal

endoscopic approach and the combined endoscopic middle meatal and transcanine approach as 76.9% and 100%, respectively [31].

As mentioned earlier, Ozer et al. found no recurrence after combined ESS and transcanine sinoscopy approach [29].

Transcanine exposure has some complications such as facial swelling pain and rarely injury to the infraorbital nerve. Although rare these complications yet are against using transcanine procedure in ACP resection, especially if the polyp is approachable via EIMA.

11. Combination of ESS and "mini Caldwell-Luc" approach

Kelles et al. retrospectively reviewed 46 patients treated for ACP during a 7-year period. 20 patients underwent endoscopic endonasal surgery (ESS) with mini-Caldwell operation (performing a canine fossa window of 0.5–0.6 cm), while 26 patients underwent ESS alone. The only statistically significant difference between the groups was the recurrence rate, which was higher in the ESS group compared with ESS plus mini-Caldwell group ($P < 0.05$).

In the ESS group, bleeding, synechia, and ostium stenosis were more evident than in the ESS plus mini-Caldwell group, but these differences were not statistically significant. Therefore, Kelles theorized that adding the mini Caldewell-Luc approach allowed better visualization of the maxillary sinus walls and subsequently easier resection of the remnant polyp [23].

Atighechi et al. used a mini-Caldwell approach with ESS in their patients. They reported minimal recurrence and low complication rates, deciding that the technique is useful for the completely removal of ACP [32].

The traditional Caldwell-Luc approach offers good exposure and ensures complete removal of the polyp with the associated antral mucosa. Nevertheless, this approach has been largely abandoned in the treatment of maxillary sinus pathologies, because it does not address the natural ostium of the maxillary hence considered non-functional. Complications include: cheek anesthesia, sensory deficits, cheek swelling and risks for normal teeth development in children [4, 23, 29, 33, 34].

12. Special consideration in ACP resection; ESS in children

As previously noted, the incidence of ACP is higher in children and young adults. Although no difference in the pathophysiology or histology were seen between children and adults, children are at higher risk for recurrence. It is reasonable to believe that the anatomically narrow sinuses, the not-yet erupted teeth, and concern of maxillary growth may affect the surgeon's decision regarding the surgical approach, leading to higher failure rate [17, 31, 35].

In his review of 200 patients with ACP, Forsini described recurrence in 4 patients (2%) all of which were children <7 years of age, in whom only polypectomy was performed. Eventually, in all cases of recurrence ESS was performed without evidence of recurrence [4].

13. Recurrence and follow up

As evident by various published series, recurrence rates range from 0% reported by Tsukidate to 64% reported by Saito and collaborators. Recurrence rates vary

between different surgical approaches, patient's age and other factors such as accompanying sinus pathologies [36, 37]. This raises the question – how long should we follow patients ACP resection?

Lee and Huang determined that 65% of their pediatric patients with ACPs had associated chronic sinusitis. Similarly, some authors have also identified association of ACPs with allergic disease. The main hypothesis is the challenge of removing the entire sick mucosa with the origin of the polyp once there is chronic inflammation [31]. Natasha Choudhury reported 29 patients after EMMA surgery for ACP. They described no polyp recurrence, with a mean follow-up period of 14.7 months [8]. Galluzzi reviewed 13 studies and found that recurrence in children is higher than in adults, mostly because of reasons described earlier. The review showed that combined approach had the lowest recurrence rate, with a range of follow-up between 6 to 120 months. Most recurrences were noted between 5 months to 3 years after initial surgery [17]. Some authors claim that different anatomic variations in the nasal cavity such as septal deviation, conchal hypertrophy, and concha bullosa may increase the intramaxillary pressure, hence predisposing for the development of ACP. While these variations were documented in up to 80% of patients with ACP, none of them were linked to increased rates of recurrence [4, 17, 23, 24, 30]. In most relevant studies, the time of recurrence was 1.2 ± 0.6 years. Therefore, it is advised to monitor ACP patients for at least 2 years after surgery in order to detect 95% of recurrent cases [35].

14. Conclusion

ACP originates in the maxillary sinus of children and young adults. Its etiology is speculative, currently considered a benign cystic polyp with limited inflammatory characteristics. It has a consistent three component structure intramaxillary, intranasal and choanal portions. ACP has a typical imaging characteristic and the gold standard of treatment is complete surgical resection. Special attention should be given to identify and resect the intramaxillary portion to prevent recurrence. Long term follow-up is needed to rule out polyp regrowth.

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