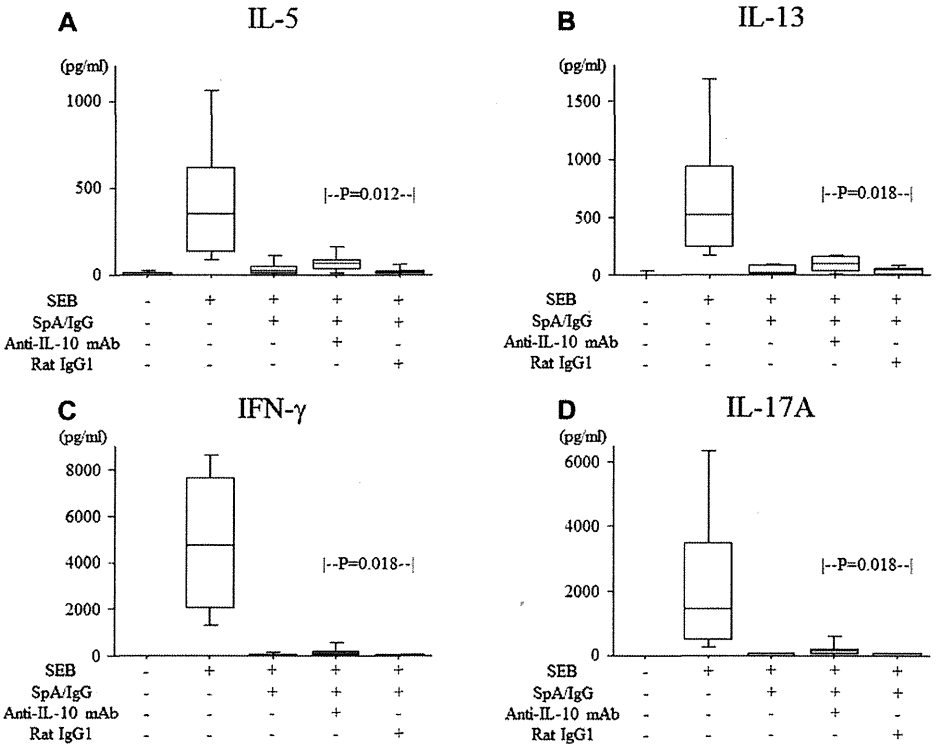

FIG E5. Effect of IL-10 neutralization on SpA-IgG IC–induced suppression against SEB-induced IL-5 **(A)**, IL-13 **(B)**, IFN-γ **(C)**, and IL-17A **(D)** production by nasal polyp cells. DNPCs were treated with or without the mixture of SpA (10 μg/mL) and IgG (100 μg/mL) and then stimulated with SEB (1 ng/mL) in the presence or absence of anti-human IgG mAb or control rat IgG_1 (20 μg/mL) for 72 hours. *P* values were determined by using the Wilcoxon signed-rank test.

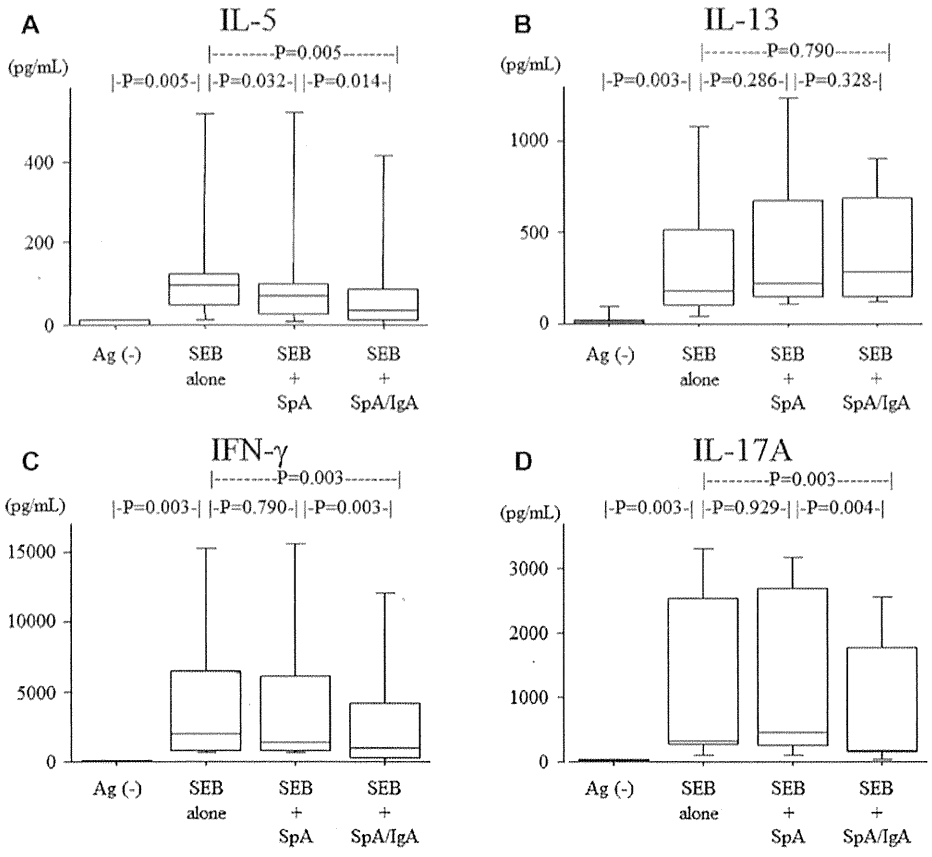

FIG E6. Effect of SpA-IgA ICs on SEB-induced IL-5 **(A)**, IL-13 **(B)**, IFN-γ **(C)**, and IL-17A **(D)** production by nasal polyp cells. DNPCs were treated with SpA (10 μg/mL) in the presence or absence of IgA (100 μg/mL) and then stimulated with SEB (1 ng/mL) for 72 hours. *P* values were determined by using the Wilcoxon signed-rank test.

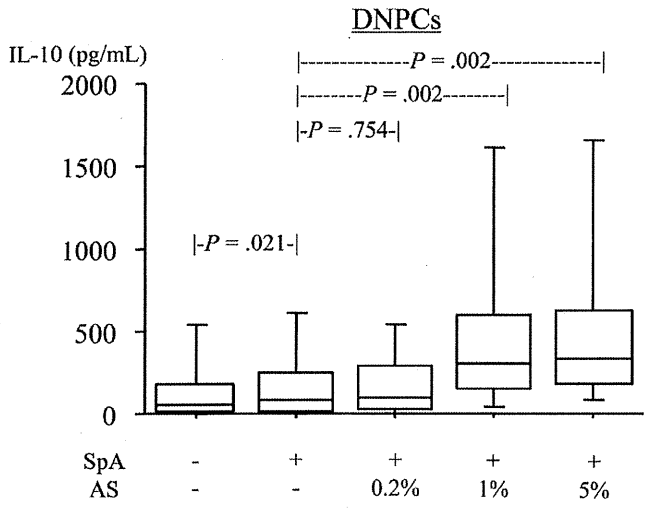

FIG E7. Enhanced IL-10 production by nasal polyp cells cultured with SpA plus autologous serum *(AS)*. DNPCs were stimulated with SpA (10 μg/mL) in the presence of 0%, 0.2%, 1%, or 5% autologous serum for 24 hours, and IL-10 levels in the supernatant were measured. *P* values were determined by using the Wilcoxon signed-rank test.

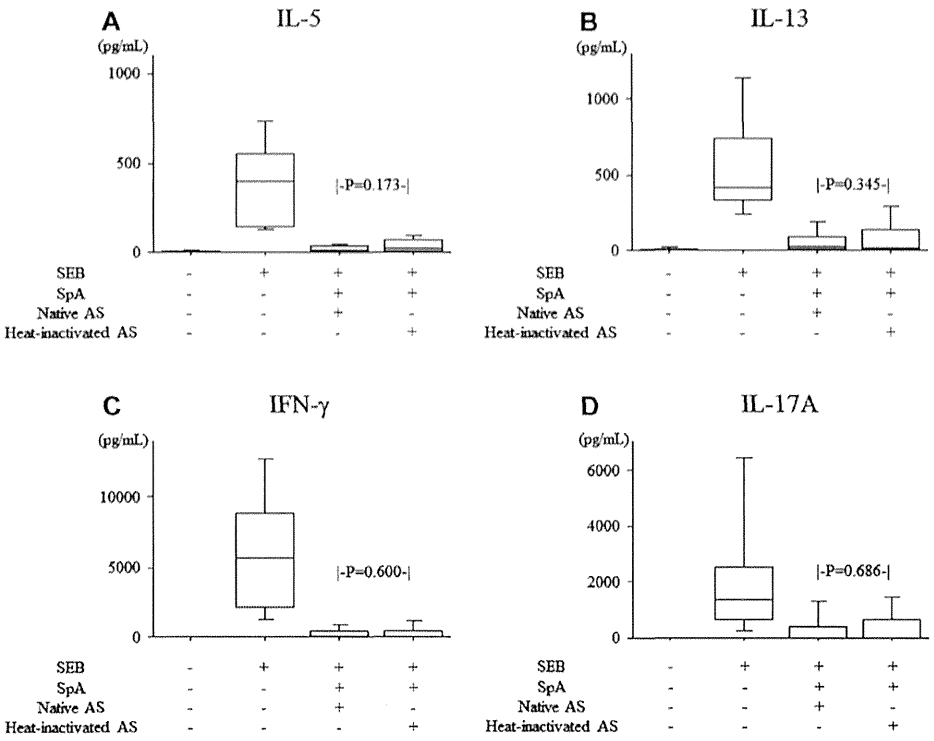

FIG E8. Effect of SpA plus native or heat-inactivated autologous serum *(AS)* on SEB-induced IL-5 **(A)**, IL-13 **(B)**, IFN-γ **(C)**, and IL-17A **(D)** production by nasal polyp cells. DNPCs were treated with SpA (10 μg/mL) in the presence or absence of 5% autologous serum with or without heat inactivation, and the cells were then stimulated with SEB (1 ng/mL) for 72 hours. *P* values were determined by using the Wilcoxon signed-rank test.

Ⅰ．好酸球性副鼻腔炎　総論

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近年，好酸球性副鼻腔炎と呼ばれる難治性の副鼻腔炎が増加している。気管支喘息などの下気道疾患を伴うことが多く，鼻副鼻腔粘膜に著明な好酸球浸潤を示し，従来通りにマクロライド療法や手術治療を行っても再発を繰り返すことが多い特徴をもつ。2001年にこの疾患概念が初めて提唱され，14年経過した現在でも病態の詳細な機序は解明されていない。治療については，経口ステロイドの有効性は示されているが，副作用の問題もあり，手術による副鼻腔の単洞化ののちに，鼻噴霧用ステロイドや洗浄などの局所治療で維持するのが望ましい。

好酸球浸潤／気管支喘息／ステロイド／内視鏡下鼻内副鼻腔手術

はじめに

近年，慢性副鼻腔炎の中で気管支喘息（特にアスピリン喘息）などの下気道疾患を伴い，鼻副鼻腔粘膜に好酸球優位な炎症性細胞浸潤を示し，マクロライド療法や手術的治療を行っても再発を繰り返す難治性の病態が指摘されており，好酸球性副鼻腔炎と呼ばれている。最近になりようやくEBMに基づいた診断基準案が示されてきているものの，病態の詳細な機序は未だ解明されていないため，治療に苦慮している状態である。この好酸球性副鼻腔炎についての各論は他稿に譲るが，本稿では疾患概念，病態，治療の総論について述べる。

Ⅰ．好酸球性副鼻腔炎の概念

副鼻腔炎のうち3カ月以上症状と炎症所見が続くものを慢性副鼻腔炎と定義する。慢性副鼻腔炎は，粘膿性鼻漏，鼻閉，嗅覚障害，頭重感などの生活に支障をきたす症状が長期にわたって持続し，かつ比較的罹患率の高い疾患である。その病態は，急性副鼻腔炎が契機となって生じた炎症が遷延化し，副鼻腔粘膜の不可逆的な変化を生じた状態である。このように従来の慢性副鼻腔炎の病態は，急性副鼻腔炎の反復や持続と慢性化による化膿性副鼻腔炎（蓄膿症）であった。すなわちウィルス感染に続く二次的な細菌感染により粘膜腫脹や分泌亢進が起こり，副鼻腔自然口が狭窄・閉塞し換気不全が生じ，洞内に慢性の炎症病態が形成されるような病態である。副鼻腔自然口の狭窄や

線毛機能障害により副鼻腔に催炎性の炎症産物が貯留し慢性化するため，急性増悪期を除いて細菌感染は主体ではない。そのため，軽度病変や鼻茸のない中等度病変例では，14員環マクロライド系抗菌薬の少量長期投与(マクロライド療法)が第一選択となる。その効果は抗菌作用ではなく抗炎症作用，免疫調節作用，粘液分泌抑制作用，バイオフィルム形成抑制作用などによるものであり，常用量の半量にして約3カ月間続ける。

高度病変や鼻茸合併例では内視鏡下鼻内副鼻腔手術(endoscopic sinus suregery：ESS)が適応となる。ESSとは，鼻内から内視鏡下に各副鼻腔を開放，副鼻腔自然口を拡大し分泌液の排泄を容易にし，副鼻腔粘膜をできるだけ保存した上で，副鼻腔の自然口を開大して通気と排泄の改善により病的粘膜を正常に導く手術法である。正常化した粘膜が再生し，副鼻腔本来の空洞は残され生理的な治癒が導かれる非侵襲的な手技であり，近年ではほとんどの例でこの手技が用いられている。ESSは副鼻腔を生理的形態に近い状態で治癒に導くため，吸気の加温，加湿，除塵などの下気道を保護する機能が回復する。慢性気管支炎や気管支拡張症などの下気道疾患を合併する慢性副鼻腔炎，すなわち副鼻腔気管支症候群（sino bronchial syndrome：SBS)の下気道症状に対しても効果がある。

ところが，従来の治療法では改善しない予後不良例が近年増加してきており，問題となっている[1]。このような治癒寛解が困難な病態をもつ慢性副鼻腔炎患者の多くには鼻腔ポリープが認められ(**図1**)，手術を行っても再発を繰り返すことが多い。このような難治症例の臨床的な背景を検討したところ，アスピリン喘息を含めた非アトピー性気管支喘息を合併している症例が多く，末梢血中の好酸球増多や鼻粘膜，鼻腔ポリープに著明な好酸球浸潤があることがわかってきた。そのような病態は，2001年に春名ら[2]により好酸球性副鼻腔炎として初めて提唱され，その診断基準は**表1**のように示されている。その後に，Sakumaら[3]により，**表2**のような診断基準も報告されている。これらの詳細については，次稿の「好酸球性副鼻腔炎の診断基準」に譲る。

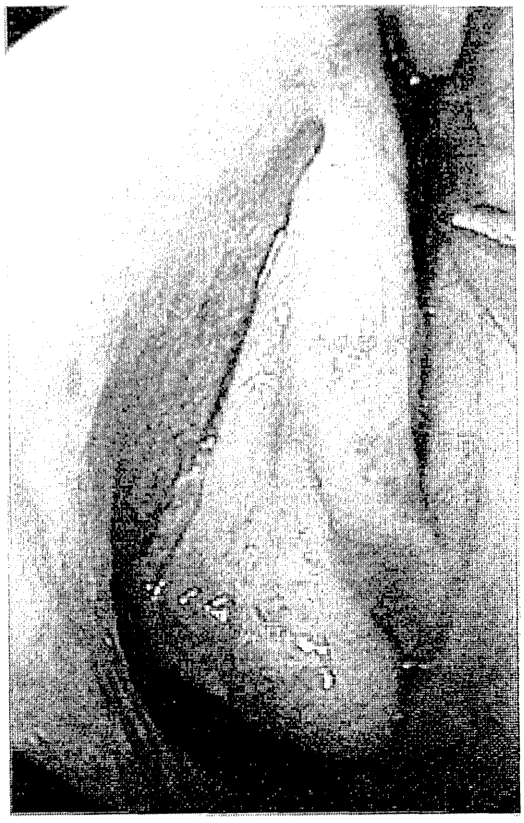

図1　好酸球性副鼻腔炎患者の右鼻腔の内視鏡所見
右中鼻道と嗅裂を占拠する鼻茸を認める．
（筆者提供）

ESS (endoscopic sinus suregery：内視鏡下鼻内副鼻腔手術)
SBS (sino bronchial syndrome：副鼻腔気管支症候群)

表1　春名らによる好酸球性副鼻腔炎の診断基準

絶対条件

- 成人発症
- 両側性副鼻腔病変
- CT所見で上顎洞より篩骨洞の陰影が優位
- 主訴のなかに嗅覚障害がある
- 内視鏡鼻内所見で上・中鼻道，中鼻甲介にポリープを認める
- 血中好酸球数6%（300個/μL）以上あるいは副鼻腔組織中好酸球数100個以上で好酸球優位

付帯条件

- ステロイド薬，特に経口ステロイド薬が臨床所見の改善に有効
- 気管支喘息，アスピリン喘息を合併する
- 内視鏡下鼻内副鼻腔手術後に経過不良を呈する
- マクロライド療法の効果は不明
- 粘稠性分泌物が認められる

春名らは，発症年齢，症状，病変部位，血中および組織中好酸球数，合併症に着目し診断基準を作成した．この診断基準では，絶対条件の6項目がそろっている場合に好酸球性副鼻腔炎と診断できる．

（文献2より引用）

表2　Sakumaらによる好酸球性副鼻腔炎の診断基準

- 血中好酸球6%以上
- CT所見（嗅裂陰影スコア1以上，後部篩骨洞陰影スコア1以上）
- 気管支喘息の合併の有無

血中好酸球，CTでの後部篩骨洞および嗅裂所見が有意に好酸球浸潤程度と相関するので，Sakumaらの診断基準では，これら3項目を用いると高い特異度で好酸球性副鼻腔炎が診断できるとしている．

（文献3より引用）

Ⅱ．好酸球性副鼻腔炎の病態

欧米において，局所に著明な好酸球浸潤を認める鼻副鼻腔炎としては，allergic fungal rhinosinusitis（**AFRS**）[4]や，eosinophilic mucin rhinosinusitis（**EMRS**）[5]が報告されているが，厳密には本邦の好酸球性副鼻腔炎とは必ずしも病態は一致しない。また，欧米における chronic rhinosinusitis with nasal poyp（**CRSwNP**）に病態が類似するとも言われている。欧米では，CRSwNPは慢性副鼻腔炎の20%ほど存在し，術後再発率が69%と高率である[6]。しかし，アジアでは欧米と比較して鼻茸中の好酸球浸潤が少ない症例が多いとの報告もあるため[7,8]，鼻茸の有無だけで分類すると，従来の好中球性炎症によって形成された鼻茸を有する症例も多くふくまれてしまう可能性

AFRS（allergic fungal rhinosinusitis）
CRSwNP（chronic rhinosinusitis with nasal poyp）
EMRS（eosinophilic mucin rhinosinusitis）

表3　CRSwNPに対する治療のエビデンスレベルと推奨度

治療	エビデンスレベル (Level)	推奨度 (Grade)	関連性 (Relevance)
ステロイド（局所）	Ia	A	yes
ステロイド（経口）	Ia	A	yes
抗菌薬（経口）＜4週	Ib and Ib（−）	C	yes, small effect
抗菌薬（経口）≧12週	Ⅲ	C	yes, especially if IgE is not elevated, small effect
カプサイシン	Ⅱ	C	no
プロトンポンプインヒビター	Ⅱ	C	no
アスピリン減感作	Ⅱ	C	unclear
フロセミド	Ⅲ	D	no
免疫抑制剤	Ⅳ	D	no
生食による洗浄	Ib, no data in single use	D	yes for symptomatic relief
抗菌薬（局所）	no data	D	no
抗IL-5抗体	no data	D	unclear
植物療法	no data	D	no
血管収縮剤（局所，経口）	no data in single use	D	no
粘液溶解薬	no data	D	no
抗ヒスタミン薬（経口）	no data	D	no
抗真菌薬（局所投与）	Ia（−）	A（−）	no
抗真菌薬（全身投与）	Ib（−）	A（−）	no
抗ロイコトリエン薬	Ib（−）	A（−）	no
抗IgE抗体	Ib（−）	A（−）	no

European position paper on rhinosinusitis and nasal polyps 2012（EPOS 2012）によると，CRSwNPの治療としては，ステロイド（局所）とステロイド（経口）がエビデンスレベル，推奨度ともに高い治療となっている．

（文献12より引用）

が高い。実際，2007年から2008年にかけて東京慈恵会医科大学付属病院で手術を受けた慢性副鼻腔炎患者についてのprospective cohort studyにおいて，鼻茸の有無よりも組織中の好酸球浸潤の方が術後再発との有意な相関がみられ，400倍顕微鏡下1視野あたり70個以上の好酸球浸潤が有意に予後を増悪させる因子であった[9), 10)]。なお，その後に行われた全国的な大規模調査である厚生労働科学研究費補助金：難治性疾患等克服研究事業（難治性疾患克服研究事業）「重症好酸球性副鼻腔炎の診断基準作成と治療法確立に関する研究」（研究代表者：藤枝重治）において，組織中の好酸球浸潤と予後との相関におけるカットオフ値は，400倍顕微鏡下1視野あたり70個であった

CAM（クラリスロマイシン）　　RXM（ロキシスロマイシン）

ことが研究報告書[11]に示されている。

慢性副鼻腔炎において上気道と下気道の関連性については古くから重要性が認識されており，両者の相関を端的に示している疾患として副鼻腔気管支症候群（SBS）がある。好酸球性副鼻腔炎では，下気道疾患として高率に気管支喘息を合併していることが知られており，気管支喘息の合併が慢性副鼻腔炎の予後に関連している。好酸球性副鼻腔炎は鼻内に鼻茸が多くみられることが特徴だが，このような鼻茸と気管支喘息との関連性についても既に数多く報告されている。例えば，鼻茸中の好酸球浸潤が強いほど喘息や下気道過敏性を合併しやすく，鼻茸の手術をするだけで下気道過敏性が改善するという報告もあるので，耳鼻咽喉科と呼吸器内科の連携が好酸球性副鼻腔炎の病態の管理において非常に重要である。

Ⅲ．好酸球性副鼻腔炎の治療

慢性副鼻腔炎では，前述したようにマクロライド療法が有効である場合が多くみられる。実際にはクラリスロマイシン（CAM）やロキシスロマイシン（RXM）を通常量の半量で投与し有効性を判定する。効果がなければ投与を中止し，有効であれば約３カ月間投与する。この治療の有効性は細菌に対する抗菌作用ではなく，抗炎症作用，免疫調節作用，粘液分泌抑制作用，バイオフィルム形成抑制作用などによると考えられている。

しかし，好酸球性副鼻腔炎ではこのような治療だけでは改善しない難治性の病態が存在する。前述したように，欧米のCRSwNPに似た病態を示すことから，欧米のガイドラインにおけるCRSwNPに対する治療が参考となる。エビデンスレベルと推奨グレードが高い治療としては，経口および局所投与のステロイドが挙げられる（表３）[12]。好酸球性副鼻腔炎に対する局所ステロイドの効果については賛否両論あるものの，経口ステロイドに対する反応は良好であるため，その投与により一時的に病態は改善する。しかし，投薬の休止により再燃するため，経口ステロイドの依存症になる場合は，ESSのような手術療法を選択する。この手術のコンセプトは，一般的に各副鼻腔自然口を可及的に開大して換気と排泄機能を促し，副鼻腔内の病的粘膜を正常化させることにある。さらに，好酸球性副鼻腔炎において重要なポイントは，鼻副鼻腔を単洞化することにより術後の局所治療（鼻噴霧用ステロイド，洗浄）を容易にさせ，経口ステロイドの投与を最小限にとどめることである。残存蜂巣内には多量の好酸球由来の顆粒蛋白や炎症性サイトカインを含んだムチンが残存しており，これが早期の再発につながるため，隔壁を十分開放しないisthmus surgeryは避けるべきである。

おわりに

全体としては減少傾向にある慢性副鼻腔炎の中で，好酸球性副鼻腔炎は増加傾向にある。そのため，慢性副鼻腔炎に対する従来通りの治療で病態が改善しない場合は，必ず好酸球性副鼻腔炎を意識し漫然とした治療は避けるべきである。また，自宅での鼻洗浄など患者自身の治療への積極的な参加が求められる疾患でもあるため，十分な説明を行った上で疾患への認識を常に持たせることが求められる。

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Endoscopic modified medial maxillectomy for odontogenic cysts and tumours*

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Abstract

Background: Odontogenic maxillary cysts and tumours originate from the tooth root and have traditionally been treated through an intraoral approach. Here, we report the efficacy and utility of endoscopic modified medial maxillectomy (EMMM) for the treatment of odontogenic maxillary cysts and a tumour.

Methodology: We undertook EMMM under general anaesthesia in six patients: four had radicular cysts, one had a dentigerous cyst, and one had a keratocystic odontogenic tumour.

Results: The cysts and tumours were completely excised and the inferior turbinate and nasolacrimal duct were preserved in all patients. There were no peri- or postoperative complications, and no incidences of recurrence.

Conclusion: Endoscopic modified medial maxillectomy appears to be an effective and safe technique for treating odontogenic cysts and tumours.

Key words: endoscopic sinus surgery, keratocystic odontogenic tumour, radicular cyst, dentigerous cyst, maxillary sinus

Introduction

Odontogenic maxillary cysts and tumours arise in the maxilla and originate from the root of the tooth. In 2005, the World Health Organization classified keratocystic odontogenic tumour as a benign cystic neoplasm. Incomplete removal of the cystic lining may reflect technical difficulties encountered during excision, but risks recurrence [1]. Dentigerous cysts should also be completely resected [2], while marsupialisation is considered to be acceptable for radicular cysts [3]. Nevertheless, it is sometimes difficult to discriminate between keratocystic odontogenic tumours and radicular cysts before surgery [4]; consequently our clinical practice is to completely excise the lesion in all such cases.

Traditionally, odontogenic maxillary cysts have been treated by marsupialisation, enucleation, or enucleation and bone grafting by means of an intraoral approach by dentists and oral and maxillofacial surgeons [3]. As the indications for endoscopic sinus surgery have expanded, there have now been several reports of odontogenic cysts and tumours being treated endoscopically [2,5,6]. However, it is not always possible to completely enucleate the lesion in every case using this technique alone.

Endoscopic medial maxillectomy (EMM) is a safe and effective procedure for the treatment of inverted papillomas originating from the anteromedial and anterior walls of the maxillary sinus [7,8]. Extensive turbinate resection, however, may result in abnormal nasal aerodynamics [9]. Some patients who have undergone EMM complain of empty nose syndrome [10]. Once the empty nose syndrome arises, it is very difficult to treat [11].

We previously reported the use of endoscopic modified medial maxillectomy (EMMM) for the treatment of inverted papillomas and mucocoeles [12]. This technique completely preserves the inferior turbinate mucosa and nasolacrimal duct, and preserves as large a portion of the inferior turbinate as possible, while facilita-

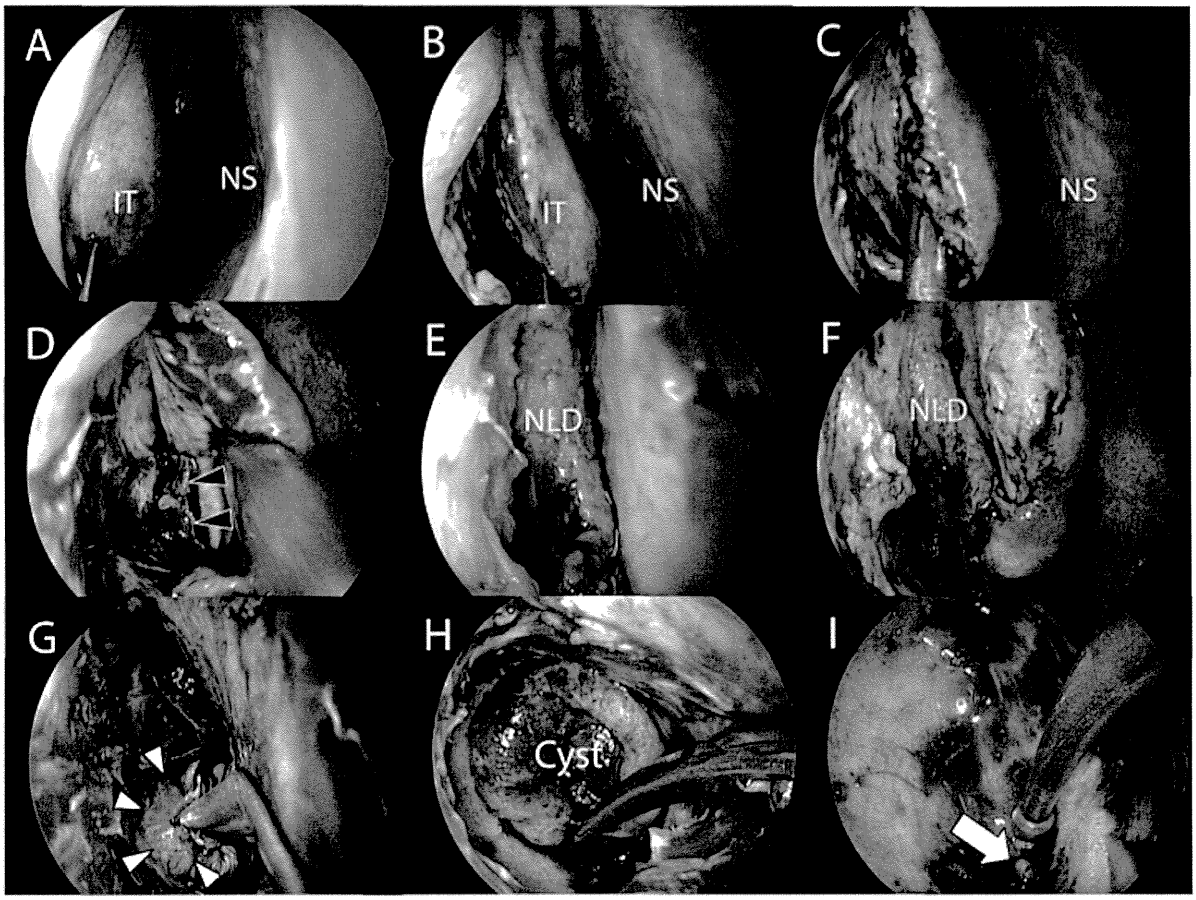

Figure 1. Intraoperative endoscopic photographs of endoscopic modified medial maxillectomy in a patient with a radicular cyst.
(A) Incision of the lateral wall parallel to the mucocutaneous junction directly behind the pyriform aperture. (B) Elevation of the nasal mucosa. (C) The bone of the inferior turbinate (IT) was adequately exposed. (D) A cut was made between the conchal crest and the inferior turbinate. The IT is visible (Black arrowheads). (E) After resection of the lateral nasal wall, the nasolacrimal duct (NLD) was widely exposed. (F) The nasal mucosa and NLD could be displaced medially. (G) Exposure of the radicular cyst (white arrowheads). (H) Endoscopic view (70°) inside the cyst. The cyst was clearly visible. (I) After cyst resection, the root of the affected tooth was visible (white arrow).

ting equally good access to the maxillary sinus as conventional EMM. We undertook a prospective study to establish the safety and efficacy of EMMM for the treatment of odontogenic cysts and tumours that occupy most of the maxillary sinus.

Materials and methods

Study design and patient population

We report a prospective case series of six patients who underwent EMMM between April 2011 and May 2012 at Jikei University Hospital, Tokyo, Japan, and Dokkyo Medical University Hospital, Tochigi, Japan. The ethics committees of both institutions approved the conduct of the study. Four patients had radicular cysts, one patient had a dentigerous cyst, and one patient had a keratocystic odontogenic tumour. One of the patients with radicular cysts had bilateral disease. In all patients, the lesion occupied most of the maxillary sinus.

Surgery

We performed EMMM under general anaesthesia as previously described [12]. First, we created a mucosal incision just behind the pyriform aperture (Figure 1A) and elevated the nasal mucosa from the lateral nasal wall (Figure 1B). Next, we adequately exteriorised the inferior turbinate (Figure 1C) and cut between the conchal crest and inferior turbinate with a chisel (Figure 1D). The lacrimal process of the inferior turbinate, frontal process of the maxilla, and inferior portion of the lacrimal bone were resected using a diamond burr. The nasolacrimal duct was then widely exposed (Figure 1E). We elevated the mucosa of the inferior meatus from the lateral nasal wall so that the nasal mucosa and nasolacrimal duct could be displaced medially (Figure 1F). The

Table 1. Patient characteristics and outcomes of endoscopic modified medial maxillectomy.

No.	Age (yrs)	Gender	Side	Disease	Follow-up (mo)	Current status
1	33	M	Right	Keratocystic odontogenic tumour	32	Disease free
2	66	M	Right	Dentigerous cyst	24	Disease free
3	35	M	Bilateral	Radicular cyst	15	Disease free
4	69	F	Left	Radicular cyst	10	Disease free
5	69	M	Right	Radicular cyst	17	Disease free
6	40	M	Right	Radicular cyst	6	Disease free

mucosa of the inferior turbinate was sutured to the nasal septum if it obstructed the surgical field. Next, we drilled away the medial wall of the maxillary sinus with a diamond burr and identified the cyst (Figure 1G). We mostly used a 0° endoscope, but a 70° endoscope was used in the anterior wall of the cyst and root of the affected tooth (Figure 1H, I). Finally, the transposed nasal mucosa and nasolacrimal duct were replaced, and the anterior portion of the transposed nasal mucosa was sewn to the lateral nasal wall.

Results

Table 1 summarises the patients' characteristics and outcomes after EMMM. The cyst walls and keratocystic odontogenic tumour were completely excised, and the inferior turbinate and nasolacrimal duct preserved, in all patients. There were no intraoperative or postoperative complications. The affected teeth were preserved in all four patients with radicular cysts. A dentist extracted the affected tooth prior to endoscopic surgery in the patient with a keratocystic odontogenic tumour, and the affected tooth of the patient with the dentigerous cyst was removed during the EMMM procedure (Figure 2). The mean follow-up period was 17.4 months (range, 6–32 months), and there has been no evidence of recurrence in any of the patients. Postoperative endoscopic views and computed tomography scans confirmed that the inferior turbinate had been preserved in every case (Figure 3). All patients reported that nasal breathing was satisfactory and none reported dryness.

Discussion

The three most common cystic lesions in the jaw are radicular

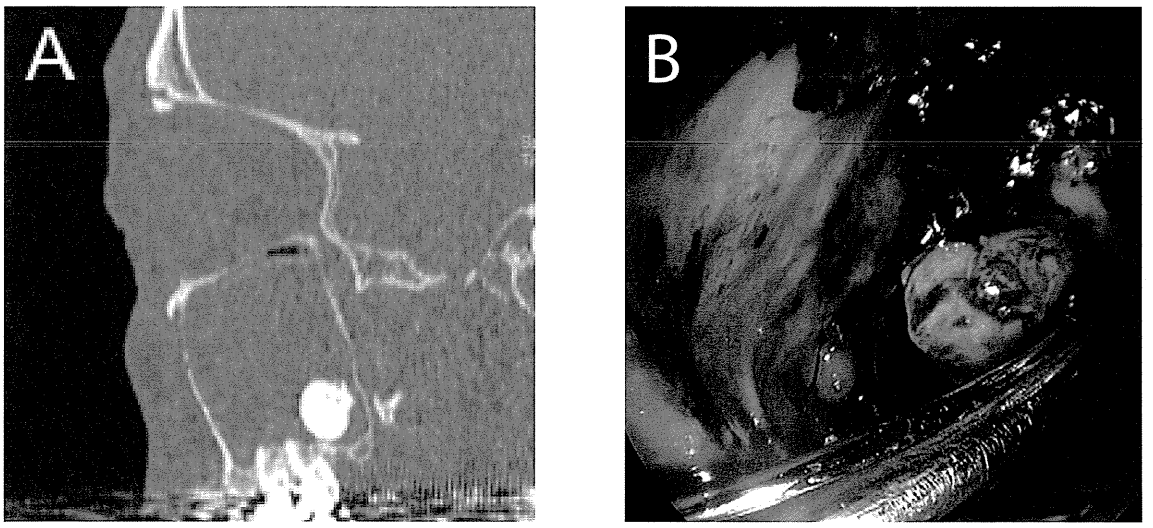

Figure 2. Images from Case 2. (A) Sagittal computed tomography scan showing cysts with the tooth occupying most of the maxillary sinus. (B) Endoscopic view (70°) inside the maxillary sinus showing the affected tooth.

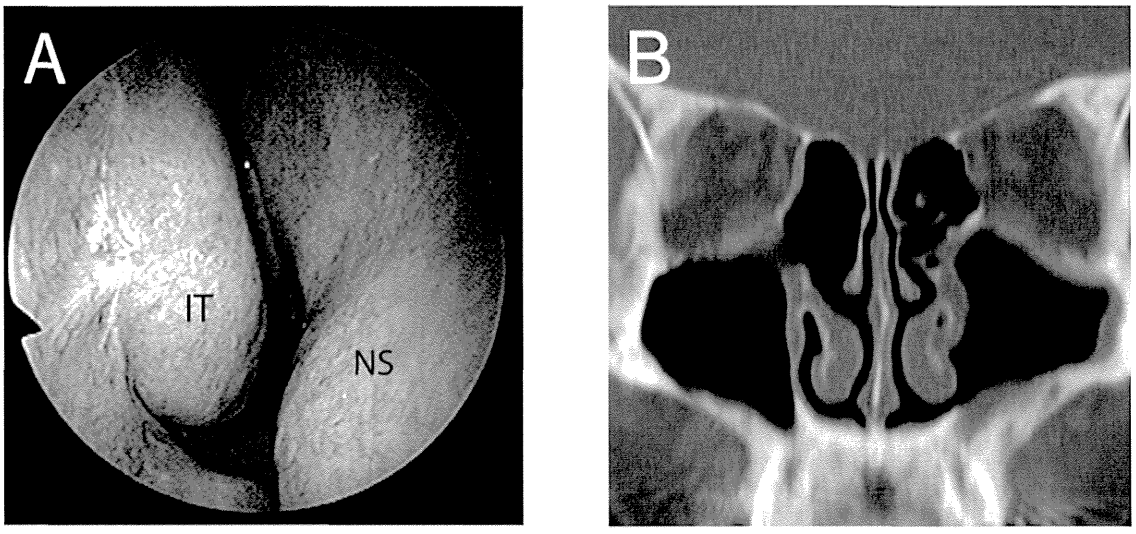

Figure 3. Images from Case 3. (A) Postoperative endoscopic view revealing preservation of the inferior turbinate 12 months after surgery. (B) Coronal computed tomography scan showing complete removal of bilateral radicular cysts and preservation of the inferior turbinate.

cysts, dentigerous cysts, and keratocystic odontogenic tumours [3]. When these diseases become severe, they may extend into the maxillary sinus. Incomplete removal of the cystic lining of a keratocystic odontogenic tumour may be a consequence of technical difficulties during surgery, but is a risk factor for recurrence [1]. Furthermore, it may be difficult to differentiate between keratocystic odontogenic tumours and radicular cysts before surgery. Even if the lesion is diagnosed preoperatively as a radicular cyst, we recommend complete removal – particularly because malignant transformation has been reported [5,13-15].

Odontogenic cysts and tumours have traditionally been treated via an intraoral approach by dentists and oral and maxillofacial surgeons. Otorhinolaryngologists have recently reported the successful endoscopic resection of odontogenic cysts and tumours when there is minimal extension into the maxillary sinus [2,5,6]. However, if the disease should occupy most of the maxillary sinus, enucleation is not possible. Staged operations have been reported for this type of extensive disease. First, a window in the cyst wall is created, and the cyst is decompressed. Complete resection is then carried out after the primary wound has closed [6,16], but this staged approach is particularly onerous for patients.

The principal behind EMMM is to achieve access to the maxillary sinus comparable to that of conventional EMM while preserving the inferior turbinate and nasolacrimal duct. The difficulty with endoscopic resection of odontogenic cysts and tumours lies in accessing the anteromedial, anterior and inferior walls of the maxillary sinus, but these portions of the maxillary sinus can be reached using EMMM. In our experience, odontogenic tumours and cysts were relatively easy to resect using this technique, as it was possible to peel them away from the maxillary wall, which contrasts with our experience of inverted papillomas [12]. The advantage of using EMMM for odontogenic tumours and cysts is that it allows for complete resection in one operation. The use of EMM to treat these diseases has not been previously reported, but we believe that EMMM is superior as it allows the morphology of the nasal cavity to be preserved.

Conclusion

We used EMMM to excise several odontogenic maxillary cysts and one tumour in this case series of six patients. Endoscopic modified medial maxillectomy is a technique that allows the morphology of the nasal cavity and nasolacrimal duct to be preserved. Patient outcomes after surgery were excellent, confirming the safety and efficacy of EMMM for odontogenic cysts and tumours.

Authorship contribution

TN: study design, data collection, manuscript preparation. NO: study design, data collection. DA, TO: data collection. SH: manuscript review.

Conflicts of Interest

None of the authors have any financial or other conflict of interest to declare.

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Endoscopic single-handed septoplasty with batten graft for caudal septum deviation

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ABSTRACT

Objective: Septoplasty is usually performed with a Killian incision in Japan. However, the major drawback of the Killian incision is the inability to correct deviations of the caudal part of the septum. For patients with mild deviation of the caudal part of the septum but with a straight caudal end, we performed a modified Killian incision and used a batten graft to correct the deviated cartilage under endoscopy. The aim of this study was to evaluate the usefulness of our surgical technique for these cases.
Methods: We prospectively collected data of 17 patients who underwent endoscopic septoplasty with a batten graft. Objective assessment by computed tomography and subjective assessment by questionnaire were performed before and 3 months after the surgery.
Results: On computed tomography, the ratio of the area of the convex side to that of the concave side in the anterior portion of the nasal cavity was significantly improved after surgery ($p < 0.001$). Subjective assessment revealed a significant improvement in nasal obstruction ($p = 0.002$). There were no complications in this study.
Conclusion: The herein-described septoplasty with a batten graft is technically easy and considered to be useful for deviation of the caudal part of the septum in selected cases.

1. Introduction

Septoplasty is one of the most commonly performed operations in otorhinolaryngology and is a well-established procedure for the treatment of nasal obstruction. Septoplasty has traditionally been performed under direct visualization with a headlight. However, endoscopic septoplasty was introduced in the 1990s [1] and has since become very popular. Endoscopy allows for better visualization and magnification and permits precise handling.

The Killian incision has been employed for septoplasty as a standard technique. This incision corresponds to the position 10–15 mm cephalic from the caudal end of the septum. The advantage of using this incision is that it prevents disruption of tip support and postoperative external nose deformation. We elevate the mucoperiosteal flap with great care because a successful operative outcome reportedly depends on whether the initial separation progressed smoothly [2]. The Killian incision allows for easy identification of the subperichondrial plane. The major drawback of the Killian incision, however, is the inability to correct deformities of the caudal part of the septum. In general, an open septorhinoplasty or hemitransfixion approach is used for this deformity [3–6]. These techniques involve the caudal border of the septal cartilage that is exposed by retraction of the nostril rim using hooks [7]. A drawback is that they require three or four hands with an assistant to retract or hold the tissue. In addition, we do not believe that the open septorhinoplasty and hemitransfixion approaches are necessary for patients with mild deviation of the caudal part of the septum but with a straight caudal end of the septum. We recently performed a technically easy, single-handed endoscopic septoplasty using a batten graft for these cases. In this study, we evaluated the outcome of this technique for deviation of the caudal part of the septum.

2. Methods

We prospectively collected data of 17 patients who underwent endoscopic single-handed septoplasty with a batten graft between January 2012 and April 2013 at Dokkyo Medical University Hospital. All procedures were performed under a 4-mm-diameter 0-degree endoscope (Karl Storz, Tuttlingen, Germany). All patients

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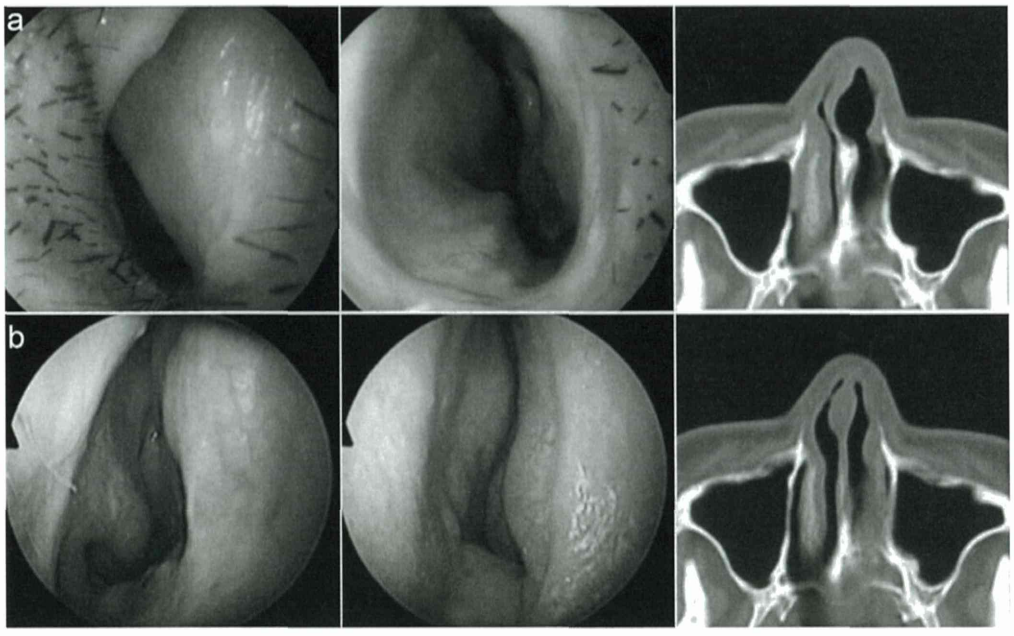

Fig. 1. Preoperative (a) and postoperative (b) endoscopic and computed tomography views.

had mild-to-moderate deviation of the caudal part of the septum, but the caudal end was straight without external nose deformities (Fig. 1a). The severity of nasal obstruction, rhinorrhea, postnasal drip, hyposmia, and sleep disturbance was evaluated according to the 7-point (score, 0–6) Likert scale before and 3 months after the surgery. Endoscopic evaluation was performed before and after the surgery using the 0-degree endoscope. This study was approved by the Ethics Committee of Dokkyo Medical University.

2.1. Surgical procedure (Figs. 2 and 3)

All procedures were performed under general anesthesia. First, we injected 1% lidocaine and 1:200,000 epinephrine into the septum. A modified Killian's incision (about 5 mm cephalic to the caudal end) was made on the concave side of the nasal septum, and the mucoperiosteal flap was elevated under endoscopy (Fig. 2a). We then incised the cartilage more than 1.5 cm from the anterior edge of the septal cartilage, and a mucoperiosteal flap was elevated on the convex side. After the cartilage had been released from the perpendicular plate of the ethmoid, vomer, and maxillary crest, the deviated bony septum was removed (Fig. 2b). The septal cartilage was harvested with preservation of the L-strut to prevent postoperative external nose deformation and was then used as a batten graft (Fig. 2c and d). The batten graft was trimmed appropriately to fit the length of the caudal end and inserted into the concave side. The batten graft and deviated caudal part of the

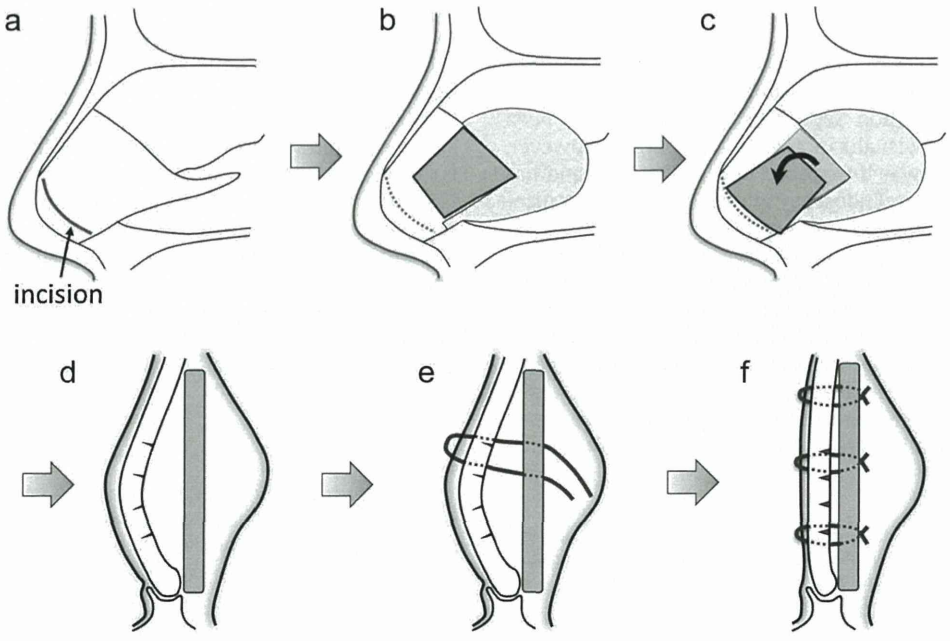

Fig. 2. Illustration of the surgical procedure. A modified Killian incision was performed on the concave side (a). Septal cartilage was taken (b) and used as a batten graft (c and d). A partial-thickness incision was made on the concave side in some cases. The septal cartilage and batten graft were sutured using 4-0 or 5-0 polydioxanone (e).

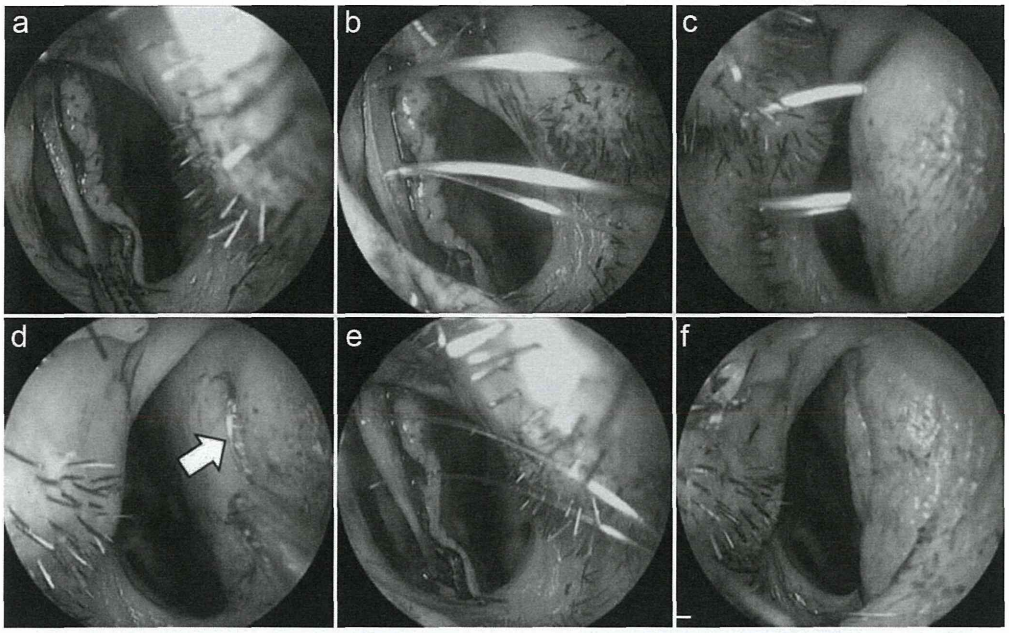

Fig. 3. Suturing technique. Harvested cartilage was replaced with the batten graft on the concave side (a). An empty needle (upper needle) and another needle with polydioxanone (PDS) were inserted through the septum, graft, and convex side of the mucosa (b and c). After PDS was passed through from the top of the empty needle, both needles were pulled out. The PDS could be seen on both the convex side (white arrow) (d) and concave side (e). The deviated caudal septum was straightened by suturing (f).

septal cartilage were sutured together with 4-0 or 5-0 polydioxanone (PDS; Ethicon Inc., Somerville, NJ, USA) (Fig. 2e and f). In some cases, a partial-thickness incision was made on the concave side of the deviated preserved caudal septum (Fig. 2d–f). The suture method is illustrated in Fig. 3. After the harvested cartilage had been replaced with the batten graft (Fig. 3a), we inserted a 22-gauge needle through the septum, graft, and convex side of the mucosa. Another needle with PDS was then inserted (Fig. 3b and c). The end of an unthreaded section of PDS was pulled out to the convex side and passed through the first needle (Fig. 3d). We removed the needles, leaving the PDS, which was used to suture and correct the deviated cartilage (Fig. 3e and f). These sutures were placed vertically and horizontally until we confirmed straightening of the deviated septum. We usually placed three sutures vertically and one horizontally. Finally, a 1-mm-thick silicone nasal splint was inserted into each nasal cavity and fixed by suturing it to the nasal septum [8]. These plates were removed 4 weeks after the surgery in the outpatient department.

2.2. Objective analysis

Objective assessment was performed by computed tomography (CT). Preoperative and 3-month postoperative CT was performed in all patients. We examined the cross-sectional areas of transverse CT sections. The CT images were acquired at 3-mm thickness in the axial plane. The areas were determined regions anterior to the anterior edge of the conchal crest of the maxilla. To measure these areas, images of the nasal cavity were extracted, and the pixels of five images from the anterior nasal spine were calculated by ImageJ software (National Institutes of Health, Bethesda, MD, USA) (Fig. 4). Finally, we calculated the ratio of the area of the convex side to that of the concave side.

2.3. Statistical analysis

Paired analysis was performed with the Wilcoxon signed-rank test to compare preoperative and postoperative subjective and objective parameters. A value of $p < 0.05$ was considered statistically significant. All analyses were performed by IBM SPSS Statistics version 21 (IBM Corporation, Armonk, NY, USA).

3. Results

All patients were male and aged 23–79 years (mean, 47.9 years). Septoplasty with resection of the mucosa of the inferior turbinate was performed in all patients. Endoscopic sinus surgery was simultaneously performed in 10 patients.

Postoperatively, the ratio of the area of the convex side to that of the concave side in the anterior portion of the nasal cavity was significantly improved on CT analysis ($p < 0.001$) (Fig. 5). However, neither this ratio nor the deviated septum improved on endoscopic examination in two patients. We confirmed the efficacy of the procedure using anterior rhinoscopy and endoscopy in the remaining patients for an average follow-up period of 8 months. Preoperative and postoperative subjective symptoms were completed in 12 patients. The mean value of nasal obstruction from pre- to postseptoplasty significantly decreased from 4.75 to 1.33 ($p = 0.002$). The other symptoms were also significantly decreased postoperatively (Table 1). No patients had any postoperative complications such as a saddle nose deformity, septal perforation, hematoma, infection, or nasal bleeding during the follow-up period. Fig. 1 presents the preoperative and postoperative endoscopic and CT findings of one patient.

4. Discussion

Septoplasty is usually performed with the Killian incision in Japan. The major drawback of the Killian incision is its inability to access the caudal septum and correct caudal septal deviation. Open septorhinoplasty and hemitransfixion approaches were thought to be required in such cases. In general, deformities of the external nose are less prominent in Japanese than in Caucasian patients, and relatively fewer Japanese patients require a transfixion approach [2]. In Japanese individuals, the external nose is broad with a flat dorsum and shallow, depressed origin, and the nostrils appear more rounded. In addition, Japanese patients tend to be less

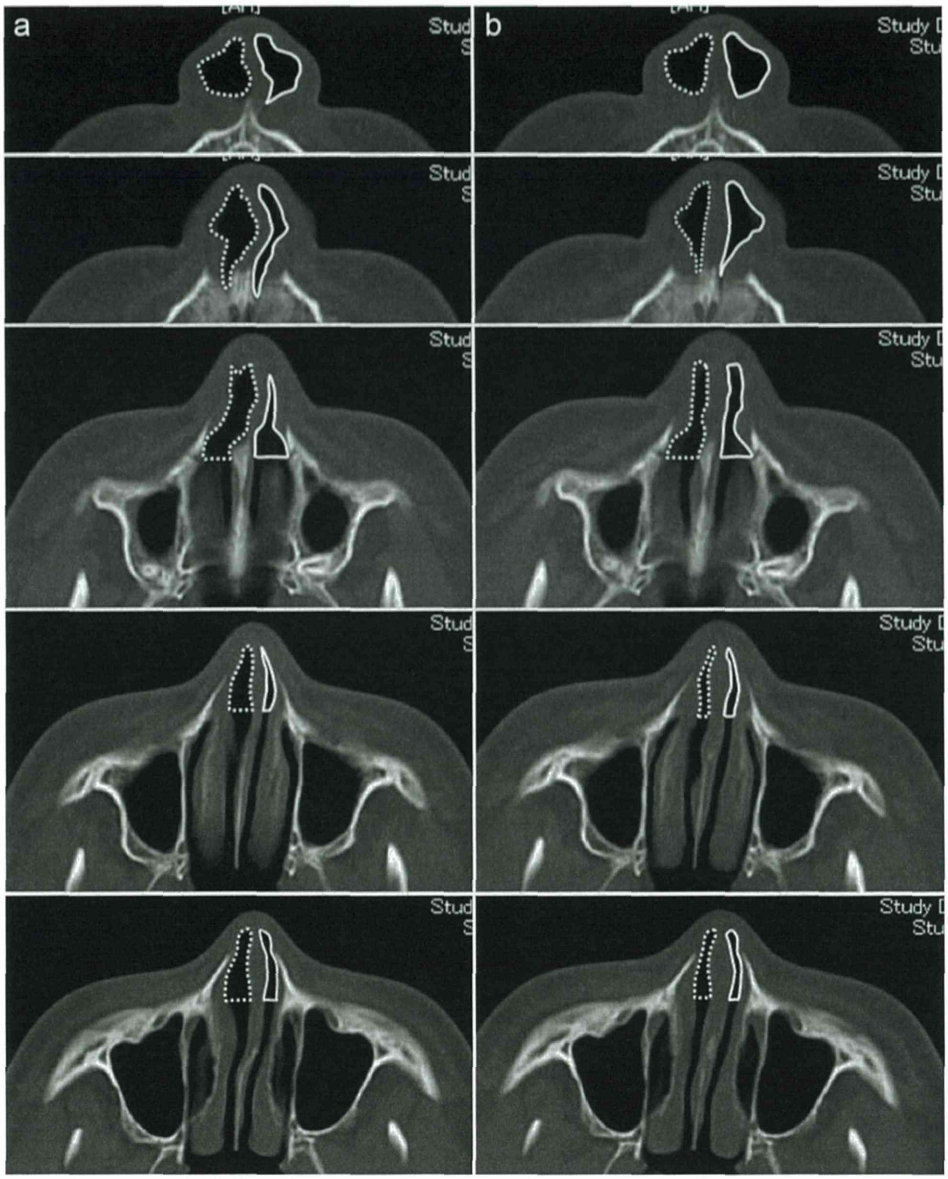

Fig. 4. Preoperative (a) and postoperative (b) areas anterior to the anterior edge of the conchal crest were measured by computed tomography. The dotted lines indicate the area of the concave side, and the solid lines indicate the area of the convex side.

concerned with slight deformities and generally do not wish to undergo an external incision. Consequently, open septorhinoplasty is not universally performed by Japanese rhinologists. Therefore, we devised endoscopic single-handed septoplasty with a batten graft because we are accustomed to the use of endoscopes.

Jang [9] classified deviation of the caudal septum into four types. When this classification applies to a patient with deviation of the caudal part of the septum but with a straight caudal end, a primary indication for this technique is a type 1 deviation, in which the posterior angle of the septum is located at the center of the anterior nasal spine. Most cases in which the caudal end is straight fall into this classification. Our technique is well suited to this type. The same research group reported endonasal septoplasty using a batten graft with a hemitransfixion approach [6]. They adapted this technique to patients with generalized C-shaped caudal septal deviation and with neither angulation nor dislocation of the caudal septum from the anterior nasal spine. This indication is the same as ours. We believe that hemitransfixion is required for patients with deviation of the caudal end. These cases frequently involve dislocation of the caudal septum from the anterior nasal spine and require suturing between the posterior septal angle and the spine.

Batten grafts have been used endonasally for caudal septal deviation [3,4,6]. In this study, the effectiveness of the caudal batten graft was confirmed in most cases. In addition, this surgical method is technically easier to perform than the other methods. This surgical technique has several other advantages. The first advantage is that it prevents the risk of a saddle nose deformity by preserving the L-strut. We maintained the relationship between the posterior septal angle and the spine. When cartilage bending was severe, a partial-thickness incision was made. We considered that the cartilage would weaken if cross-hatch and full-thickness incisions were performed. In fact, we had no cases of saddle deformities in this case series. Second, when the hemitransfixion incision is performed, initial identification of the subperichondrial plane can be difficult owing to the tight adherence of the perichondrium to the cartilage [10]. The modified Killian approach allows for easier identification of the subperichondrial plane and

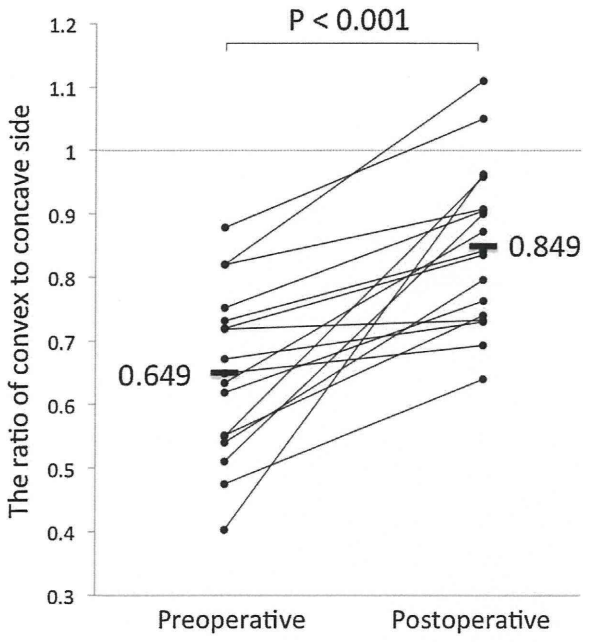

Fig. 5. Ratio of the area of the convex side to that of the concave side in the anterior portion of the nasal cavity before and after surgery. The ratio increased from 0.649 to 0.849 ($p < 0.001$).

creation of the mucoperiosteal flap under endoscopy. Finally, all procedures with the exception of suturing can be performed under endoscopy. However, deviation of the caudal part of the septum persisted despite our treatment in some cases. In two patients, the ratio of the area of the convex side to that of the concave side in the anterior portion of the nasal cavity did not change postoperatively. Failure of correction was thought to be causally related to insufficient suturing (knotting or tightening) between the deviated cartilage and batten graft.

This study and surgical technique have some limitations. One limitation of our study was that the number of patients was small and the follow-up time was very short. The cartilage memory for bending may result in future unfolding. A larger series of patients and a longer-term follow-up are needed before definitive conclusions can be drawn. In terms of complications, the development of infection may be associated with the presence of the PDS because we sutured the batten graft and the deviated cartilage together with the convex side of the mucosa. Fortunately, we did not encounter infections in this series. In addition, improvement was shown on subjective assessment, but we performed simultaneous endoscopic sinus surgery in 10 patients.

Table 1
Summary of subjective outcomes 3 months postoperatively.

	Preoperative	Postoperative	p value
Nasal obstruction	4.75	1.33	0.002
Rhinorrhea	2.92	0.83	0.005
Postnasal drip	2.92	0.92	0.007
Hyposmia	2.58	1.33	0.047
Sleep disturbance	2.75	0.67	0.012

Therefore, the endoscopic sinus surgery is suspected to have contributed to the improvement in symptoms in these patients.

5. Conclusion

We confirmed that this endoscopic single-handed septoplasty with a batten graft is minimally invasive and useful for correction of deviation of the caudal part of the septum. However, we must be careful in selecting the patients who may be benefit by this technique.

Conflict of interest

None.

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