

Effect of middle turbinate intervention on outcomes of middle meatal endoscopic surgery

Khaled M. Bofares*

Department of Otorhinolaryngology, Omar
Almoukhtar University, Elbyda, Libya

*Correspondence to Khaled M. Bofares MD,
Department of Otorhinolaryngology, Omar
Almoukhtar University, Elbyda, Libya
Tel: +218 917455466; +218 945419813
e-mail : bofaresstat2012@yahoo.com

Received 21 July 2015

Accepted 18 August 2015

Pan Arab Journal of Rhinology

2016, 06:27–32

Background and objective

Middle turbinate position, bulk, and shape play a significant role in the determination of drainage and ventilation at the middle meatus. The middle turbinate constitutes the corner stone for the performance of drainage as well as ventilation functions at the area of the ostiomeatal complex. As one of the major aims of middle meatal endoscopic surgery is providing sufficient drainage and ventilation at the level of this complex, the middle turbinate should be assessed properly before the surgery with regard to its position, size, and shape, which may predispose for sinusitis through the obliteration of the ostiomeatal complex as in cases of paradoxical middle turbinate, concha bullosa of the middle turbinate, hypertrophy of the middle turbinate, and double middle turbinate. These varieties of abnormal middle turbinate need to be interfered accordingly to reduce the risk for recurrence of sinusitis after the surgery. In addition, the normal middle turbinate may lateralize postoperatively and subsequently result in the reobstruction of the drainage and ventilation at the middle meatal area. Therefore, for the purpose of maintenance of sufficient drainage and ventilation after middle meatal endoscopic surgery, it is suggested to interfere with the normal middle turbinate either by means of its partial resection at its lower part, its medialization and further fixation of it to the nasal septum with a stitch, or by creating a synechia with the mucoperiosteal flap over the nasal septum. For this reason the serial analytic coherent clinical study was planned prospectively to postulate as to which technique is the best among the previously mentioned three techniques and compared further with noninterfered middle turbinate cases.

Patients and methods

Sixty patients between 14 and 63 years of age with chronic sinusitis presented with clinical as well as radiological evidence of maxilloethmoidal sinusitis with or without frontal and sphenoidal involvement at ENT OPD, Al-Tarahom Private Center (Elbyda, Libya), during the period between July 2013 and March 2015 and underwent functional endoscopic sinus surgery. The patients were divided into four groups, group A ($n = 16$), group B ($n = 18$), group C ($n = 6$), and group D ($n = 20$), which included those patients who proceeded after middle meatal endoscopic surgery with the medialization of the ipsilateral middle turbinate and creation of a synechia between it and the nasal septum, partial resection of the ipsilateral middle turbinate at its lower third, medialization and further fixation of the ipsilateral middle turbinate to corresponding nasal septal flap using a vicryl stitch material, or just medialization of the ipsilateral middle turbinate without any further fixations, respectively. The four groups were compared in relation to postoperative patency persistence of the ipsilateral middle meatus and correlated with the incidence of sinusitis recurrence after the surgery.

Results and conclusion

An overall 49% of the patients who underwent just medialization of the ipsilateral middle turbinate without any further fixations developed recurrence of sinusitis due to reobliteration of the middle meatus either by means of a synechia between the middle turbinate and the lateral wall or by means of extreme lateralization of the middle turbinate compared with the other groups. All patients in other groups achieved complete improvement without any evidence of recurrence of sinusitis after 1 year of follow-up, apart from 12% of patients in group B who presented with evidence of sinusitis recurrence after 3–6 months postoperatively. Broadly speaking, the intervention with the normal middle turbinate can be considered as one of the important steps during the middle meatal endoscopic surgery that may help significantly toward the improvement of outcomes of this commonly performed procedure.

Keywords:

middle turbinate fixation, middle turbinate intervention, middle turbinate medialization, middle turbinate partial turbinectomy, middle turbinate stitching

Pan Arab J Rhinol 06:27–32
© 2016 2090-7540

Introduction

The functional endoscopic sinus surgery (FESS) is considered as one of the widely performed procedures in rhinology. Although since 1985 up to now there are

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

continuous trials to advance and improve this significant task of rhinology, basically speaking, this procedure still depends mainly on the intervention with the middle meatus as the cornerstone for the drainage of most of the paranasal sinuses, which could be affected by variable forms of sinusitis. This is based universally on providing sufficient ethmoidal infundibulectomy through performance of complete uncinectomy. Despite adequate uncinectomy, there is a risk for reobliteration of ethmoidal infundibulum with lateralized ipsilateral middle turbinate [1–11]. It is very well known that the ethmoidal infundibulum is considered as a main draining space at the ostiomeatal complex. It is three-dimensional space that is bounded posteriorly by bulla ethmoidalis, anteromedially by the middle turbinate, and anterolaterally by an uncinated process. Therefore, in addition to the uncinectomy as well as the resection of bulla ethmoidalis, it is necessary to interfere with the middle turbinate to achieve enough ethmoidal infundibulectomy at the anteromedial aspect [1–17].

Hence, the middle turbinate surrounds the ethmoidal infundibulum at the anteromedial side with the engulfing of the bulla ethmoidalis and the uncinated process. Thus, the pathological middle turbinate such as hypertrophied middle turbinate, middle turbinate concha bullosa, paradoxical middle turbinate, floppy middle turbinate, and duplicated middle turbinate play a significant role in the pathogenesis of persistent as well as recurrent sinusitis due to permanent mechanical obliteration of the ostiomeatal complex by an abnormal middle turbinate, which needs to be interfered surgically by means of their resection [8].

Similarly, the normal middle turbinate may play a significant role with regard to the determination of recurrence incidence rate of sinusitis after middle meatal endoscopic surgery [1–25]. It was found that the infracturing of the middle turbinate to achieve access to the middle meatus during endoscopic surgery is associated with a high risk for postoperative middle turbinate lateralization and reobstruction of drainage at the middle meatus. In contrast, it was confirmed that even a gentle medialization of the middle turbinate without its infracturing may provide insufficient patency of the middle meatus after the surgery either due to the middle turbinate bulk itself or the development of a synechia between the middle turbinate and the lateral nasal wall. For this reason, as an important step in middle meatal endoscopic surgery it is required to interfere with the normal middle turbinate to maintain the patency of the middle meatus [1,3–26].

Therefore, the middle turbinate should be assessed properly by means of endoscopic as well as radiological evaluation before FESS. The abnormal middle turbinate

must be interfered accordingly by means of lateral resection of concha bullosa, partial turbinectomy of hypertrophied middle turbinate, or by means of resection of lower part for floppy middle turbinate. In addition, the paradoxical as well as duplicated middle turbinates can be proceeded with the resection of that part of the middle turbinate causing the obstruction [1–31].

From the other view, for the purpose of achieving the main goal of FESS, which is the maintenance of sufficient drainage and ventilation at the level of middle meatus, the normal middle turbinate can be managed using different recommended techniques:

- (1) The resection of the lower third of the middle turbinate corresponding to the ethmoidal infundibulum. This can be performed using a curved scissors or shaver [8].
- (2) Creation of a synechia between the middle turbinate and the nasal septum just by scratching the medial aspect of the middle turbinate and the opposite lateral aspect of the nasal septum [1–7,9–22,27–31].
- (3) Fixation of the middle turbinate to the nasal septum by stitching the mucosa of the middle turbinate to the mucoperiosteal flap of the nasal septum using a vicryl suture material with a small round needle. This technique is described as the conchopexy technique [1–26,32,33].

Although there are several studies that tried to evaluate the effect of these previously mentioned techniques, at this moment and on reviewing studies, we feel that there is a lack of enough data on the effect of these different techniques on the outcomes of middle meatal endoscopic surgery. Therefore, we planned this serial study to achieve the following aims:

- (1) To confirm the significance of middle turbinate intervention as one of the important steps for FESS.
- (2) To assess the outcomes of these variable middle turbinate intervention techniques after middle meatal endoscopic surgery.
- (3) To postulate a comparative elucidation between these different middle turbinate intervention techniques to conclude as to which technique has the best results after FESS.

Patients and methods

Sixty patients between 14 and 63 years of age with chronic sinusitis presented with clinical as well as radiological evidence of maxilloethmoidal sinusitis with or without frontal and sphenoidal involvement

at ENT OPD, Al-Tarahom Private Center (Elbyda, Libya), during the period between July 2013 and March 2015 and underwent FESS. The patients were divided into four groups, group A ($n = 16$), group B ($n = 18$), group C ($n = 6$), and group D ($n = 20$), which included those patients who proceeded after middle meatal endoscopic surgery with the medialization of the ipsilateral middle turbinate and creation of a synechia between it and the nasal septum, the partial resection of the ipsilateral middle turbinate at its lower third, medialization and further fixation of ipsilateral middle turbinate to corresponding nasal septal flap using a vicryl stitch material, or just medialization of the ipsilateral middle turbinate without any further fixations, respectively. All patients were adequately assessed preoperatively by means of complete history taking, local endoscopic evaluation, and coronal, axial as well as sagittal computed tomography scan demonstrations. The patients selected for surgery had undergone a failed medical treatment or were experiencing recurrence after insufficient previous surgery. There were four adult patients confirmed with a strong suggestion of eosinophilic nasal polyposis with comorbid bronchial asthma. The internationally recommended steps of basic FESS were as follows: (a) the medialization of the ipsilateral middle turbinate just to achieve access to the middle meatus; (b) partial uncinectomy; (c) anterior ethmoidectomy, which was performed by means of complete exenteration of bulla ethmoidalis; (d) posterior ethmoidectomy, which was performed by means of resection of the vertical portion of the basal lamella of the middle turbinate and further exenteration of posterior ethmoidal air cells; (e) noncutting Draf-I frantostomy and/or sphenoidotomy, which was performed using preserved as well as nonpreserved Bullar techniques; and (f) middle meatal antrostomy, which was performed subsequently. At beginning of the surgery, the contour of the middle turbinate with the most lateral part of the uncinate process was preserved just to be used as significant anatomical landmarks for finishing safe and proper further resection steps. Finally, the intervention with the middle turbinate was performed accordingly followed by the resection of the residual part of the uncinate process.

All patients were followed-up postoperatively for 6 weeks to elucidate for any occurrence of postoperative middle meatal obliteration with a synechia or lateralization of the ipsilateral middle turbinate. The patients in the four groups were compared with each other with regard to the postoperative improvement in relation to patients' symptomatology, endoscopic findings, and radiological findings.

Informed consent was obtained from the patients involved in the research before their participation.

Statistical analyses

Data were expressed using descriptive analysis as means \pm SEM and percentages. Test of significance was carried out using the χ^2 test and two-way analysis of variance. A P value of less than 0.05 was considered as significant, and the degree of significance was determined using level of SD test. Student's t -test was used for dependent sample, and contingency coefficient was calculated as measurement of association between nominal variables.

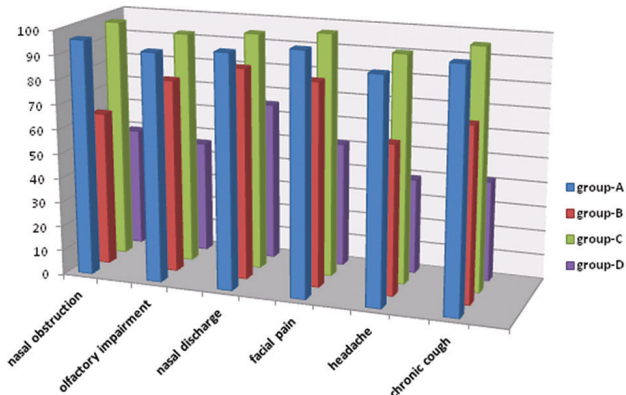
Results

As demonstrated in Fig. 1, the rate of postoperative improvement with regard to patients' symptomatology was significantly increased among groups A, B, and C compared with group D ($P < 0.05$). In contrast, as illustrated in Fig. 2, the incidence of postoperative obliteration of the middle meatus with synechia as well as lateralization of the middle turbinate was significantly higher in group D compared with groups A, B, and C ($P < 0.01$). There was a significant delay in postoperative local mucosal healing in group D compared with groups A, B, and C ($P < 0.01$) (Fig. 3). Furthermore, there was a significant increase in the incidence of postoperative radiological evidence of rhinosinusitis recurrence in groups B and D compared with groups A and C ($P < 0.01$) (Fig. 4).

Discussion

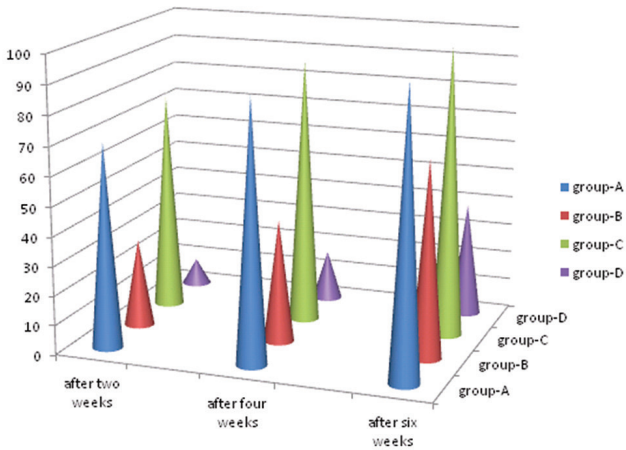
The main goals and key points of FESS are providing a sufficient drainage and ventilation for the interfered paranasal sinus group. The middle turbinate bulk and position directly affects the drainage of all groups of paranasal sinuses either through its relation with the ostiomeatal complex or sphenoethmoidal recess. Therefore, for reaching satisfied outcomes of FESS, it becomes very necessary to interfere with the middle turbinate accordingly. There are no controversies with regard to surgical management of pathological middle turbinate – namely, concha bullosa, paradoxical middle turbinate, double middle turbinate, floppy middle turbinate, and hypertrophied middle turbinate; however, there is a lot of debate with regard to the recommendations to proceed on normal middle turbinate for the purpose of maintaining enough patency of the middle meatus after middle meatal endoscopic surgery, which is important to achieve two main aims: (a) the maintenance of sufficient drainage and ventilation for all paranasal sinuses, and (b) providing wide access and gate to facilitate different endoscopic postoperative care activities such as proper examination as well as inspection of variable

Figure 1



The rate of postoperative improvement (%) with regard to symptomatology among chronic rhinosinusitis patients in relation to different middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.05$).

Figure 3

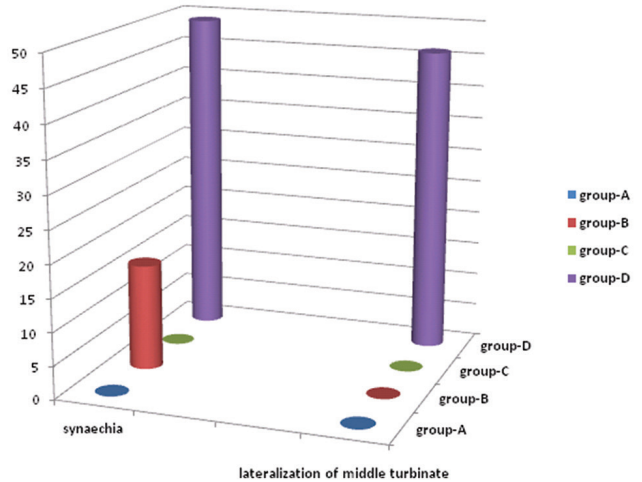


The rate of postoperative local mucosal healing (%) in correlation with different middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.01$).

interfered paranasal sinus groups to assess the gaining of healing process, recovery of normal mucosa, and any evidence of local scarring or granulations, in addition to the facilitation of further required invasive actions and instrumentations such as suction clearance of paranasal sinus cavities as well as eradication of any recognized local pathologies [1–36]. At this moment the question that would be raised is which technique can be considered as the most suitable procedure for the management of normal middle turbinate to improve outcomes of middle meatal endoscopic surgery?

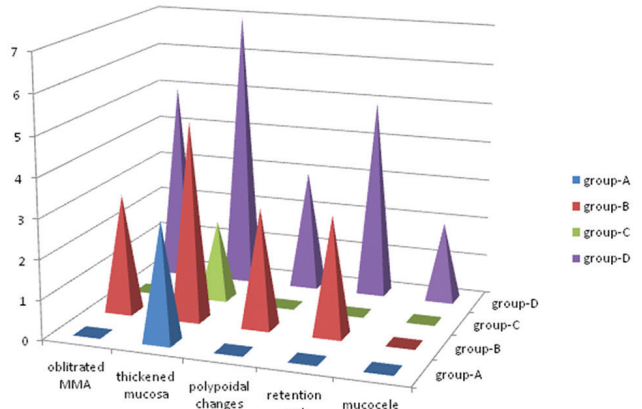
On reviewing many studies it was found that there are four recommended ways to proceed on normal middle turbinate during middle meatal endoscopic surgery: just its medialization without any further fixation;

Figure 2



The incidence of postoperative middle meatal obliteration (%) with synaechia and middle turbinate lateralization in relation to different middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.01$).

Figure 4



The incidence of different postoperative radiological evidences of rhinosinusitis recurrence (%) in relation to variable middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.01$). MMA, middle meatal antrostomy.

its medialization and its further fixation by creating a synaechia between it and the corresponding nasal septum; its medialization and its further fixation by suturing it into the corresponding septal flap; or the resection of its lower part. However, still we feel at this time that there are no sufficient clear pieces of evidence in favor of which the technique can be considered as most suitable technique with a highest significance of satisfied postoperative outcomes. Therefore, this serial study was conducted prospectively as a comparative study to get more confirmations on which technique can be selected as the most recommended one.

As can be elucidated from this serial study, the best postoperative outcome incidence was obtained after

medialization and fixation of the middle turbinate either by creating a synechia between it and the nasal septum or its suturing into the septal flap. This is in agreement with many other previous studies that concluded the same. This can be explained as follows: (a) the maintenance of drainage and ventilation of paranasal sinuses by sustaining maximum patency of the middle meatus; (b) the patent middle meatus providing enough access during postoperative follow-up session for the purpose of easier and conclusive endoscopic evaluation, suction clearance, as well as proper instrumentations for any local pathologies such as granulation, reoccurred polyps, and scar formations; and (c) the preservation of the contour of the middle turbinate, which is considered as a very important additional factor in maintaining the paranasal sinus ventilation and drainage by keeping the eddy current flow of air into paranasal sinus cavities and facilitating the mucociliary clearing-drainage function from interfered paranasal sinuses [1–10,13–15,17–19,21,25,27–31,34–36].

In contrast, the increased incidence of postoperative recurrence after the medialization of the middle turbinate without any further conchopexy can be attributed to the reobliteration of the middle meatus as a result of the re-lateralization of the middle turbinate with further synechia formation between the ipsilateral middle turbinate and the corresponding lateral nasal wall. This was found to frequently occur due to instability of the middle turbinate after the forceful medialization of it that may result in its fracturing [14,27–31].

In accordance, this serial study proved that the partial turbinectomy of the middle turbinate at its lower part was associated with a significant increase in the incidence of postoperative recurrence of sinusitis after middle meatal endoscopic surgery. This can be interpreted by two factors: (a) local atrophic changes due to the reduction of normal bulk of the middle turbinate, which will predispose for persistent nasal dryness and crust formation and subsequently lead to increased risk for uncontrolled as well as difficult-to-treat infective rhinosinusitis, and (b) the resection of lower part of the middle turbinate, which will disturb the eddy current flow of air into the middle meatus and at the same time impair the drainage process from it. Therefore, this functional obstruction of the middle meatus despite its sufficient anatomical patency will cause more stagnation of secretions and increase the chance of variable microorganism growth, which result in more impairment of mucociliary-clearing mechanism from paranasal sinus cavities and further stagnation of secretions; thus, the circumstance

will become a virtuous cycle that is difficult to be broken [1–8].

On reviewing many studies, there were several studies that concluded that postoperative lateralization of the middle turbinate had a negative effect on the outcomes after middle meatal endoscopic surgery. However, many clinical trials were conducted to improve the postoperative results of this surgery by preventing lateralization – for example, the technique described by Jebeles and Hicks [28], in which a small MeroCel pack of size 1 cm × 1 cm was applied between the bulla ethmoidalis and the middle turbinate. This pack is applied for 48 h to provide enough sustained medialization position of the middle turbinate. Similarly, Bolger *et al.* [29] described other modalities of experience by creating four shallow mucosal incisions on the medial aspect of the middle turbinate using a sickle knife and also on the nasal septum, just opposite to the turbinate; additional incisions were made to violate the mucosa. Packing was then placed in the middle meatus, forcing the middle turbinate to abut the nasal septum. These nasal packs were removed 24–48 h later. The authors admit to variation in postoperative care and that occasionally gel-film would be placed after packing removal to further prevent scarring. They cited technical difficulty and invariable results related to concerns with suture conchopexy. Friedman and Schalch [27] reported a similar technique using microdebrider to create the mucosal irritation on both the nasal septum and the middle turbinate. Following the denuding of the mucosa, bovine serum albumin tissue adhesive (bio-glue) was applied to the region just to fix the middle turbinate to the nasal septum by further pressing the two surfaces together with temporary nasal packing for 3 min. This allowed the adhesive to fully polymerize and avoided the use of postoperative nasal packing. In addition, Koppersmith and Atkins [30] described another technique using bioresorbable implant (l-lactide-co-glycolide), which has three lateral barbs inserted into the middle turbinate and one medial barb fastened to the nasal septum. The implant is kept for 2 weeks after the surgery. This will help in maintaining the middle turbinate sustained at medial position [14,27–31].

Thus, from our serial study we can conclude that, among all described techniques, the most suitable procedures for the management of the middle turbinate during middle meatal endoscopic sinus surgery are the conchopexy with fixation of the middle turbinate to the nasal septum using a 4-0 vicryl suture material on a P3 needle, and enhancement of adhesion between the middle turbinate and the corresponding

nasal septum by violating the mucosa using a sickle knife, shaver, or scratching the mucosal surfaces on the middle turbinate as well as the nasal septum with sharp instruments such as antral curate. However, the medialization of the middle turbinate followed by application of middle meatal nasal packs is not preferred because of two main reasons:

- (1) The high incidence of the middle turbinate lateralization and subsequent reobliteration of the middle meatus after the surgery.
- (2) The problems that are usually associated with nasal packing are severe pain, severe headache, nasal obstruction with breathing difficulties, persistent rhinorrhea, and recurrent bleeding. This was confirmed before by Weitzel and Wormald [14,31].

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- 1 Hewitt KM, Orlandi RR. Suture medialization of the middle turbinates during endoscopic sinus surgery. *Ear Nose Throat J* 2008; 87:E11.
- 2 Shrimme MG, Tabaei A, Hsu AK, Rickert S, Close LG. Synechia formation after endoscopic sinus surgery and middle turbinate medialization with and without FloSeal. *Am J Rhinol* 2007; 21:174–179.
- 3 Chen W, Wang Y, Bi Y, Chen W. Turbinate-septal suture for middle turbinate medialization: a prospective randomized trial. *Laryngoscope* 2015; 125:33–35.
- 4 Dutton JM, Hinton MJ. Middle turbinate suture conchopexy during endoscopic sinus surgery does not impair olfaction. *Am J Rhinol Allergy* 2011; 25:125–127.
- 5 Baguley CJ, Stow NW, Weitzel EK, Douglas RG. Silastic splints reduce middle meatal adhesions after endoscopic sinus surgery. *Am J Rhinol Allergy* 2012; 26:414–417.
- 6 Thornton RS. Middle turbinate stabilization technique in endoscopic sinus surgery. *Arch Otolaryngol Head Neck Surg* 1996; 122:869–872.
- 7 Friedman M, Landsberg R, Tanyeri H. Middle turbinate medialization and preservation in endoscopic sinus surgery. *Otolaryngol Head Neck Surg* 2000; 123:76–80.
- 8 Banfield GK, McCombe A. Partial resection of the middle turbinate at functional endoscopic sinus surgery. *J R Army Med Corps* 1999; 145:18–19.
- 9 Moukarzel N, Nehmé A, Mansour S, Yammine FG, Moukheiber A. Middle turbinate medialization technique in functional endoscopic sinus surgery. *J Otolaryngol* 2000; 29:144–147.
- 10 Lindemann J, Keck T, Rettinger G. Septal-turbinate-suture in endonasal sinus surgery. *Rhinology* 2002; 40:92–94.
- 11 Higgins TS, Lane AP. Chapter 12: Surgery for sinonasal disease. *Am J Rhinol Allergy* 2013; 27:S42–S44.
- 12 Fortune DS, Duncavage JA. Incidence of frontal sinusitis following partial middle turbinectomy. *Ann Otol Rhinol Laryngol* 1998; 107:447–453.
- 13 Hu KH, Lin KN, Li WT, Huang HM. Effects of Meropack in the middle meatus after functional endoscopic sinus surgery in children with chronic sinusitis. *Int J Pediatr Otorhinolaryngol* 2008; 72:1535–1540.
- 14 Lee MR, Marple BF. Middle turbinate medialization for improved access during endoscopic sinus surgery. *Int Forum Allergy Rhinol* 2011; 1:187–190.
- 15 Rettinger G, Lindemann K, Ashoor M, Scheithauer M, Sommer F, Lindemann J. Long term results of transseptal suture of the middle turbinate during sinus surgery. *Laryngorhinootologie* 2011; 90:471–475.
- 16 Lee KC, Lee SS, Lee JK, Lee SH. Medial fracturing of the inferior turbinate: effect on the ostiomeatal unit and the uncinate process. *Eur Arch Otorhinolaryngol* 2009; 266:857–861.
- 17 Zhang G, Liu X, Xu G. Possibility and clinical significance of reservation middle turbinate in endoscopic sinus surgery. *Zhonghua Er Bi Yan Hou Ke Za Zhi* 1999; 34:30–32.
- 18 Grisel JJ, Atkins JH, Fleming DJ, Kuppersmith RB. Clinical evaluation of a bioresorbable implant for medialization of the middle turbinate in sinus surgery. *Int Forum Allergy Rhinol* 2011; 1:33–37.
- 19 Koch T. Medialization and stabilization of the middle turbinate in endoscopic sinus surgery. *Laryngorhinootologie*. 2008;87:6–9.
- 20 Getz AE, Hwang PH. Basal lamella relaxing incision improves endoscopic middle meatal access. *Int Forum Allergy Rhinol* 2013; 3:231–235.
- 21 Bassiouni A, Chen PG, Naidoo Y, Wormald PJ. Clinical significance of middle turbinate lateralization after endoscopic sinus surgery. *Laryngoscope* 2015; 125:36–41.
- 22 French C, Goyal P. Submucosal resection of the middle turbinate. *Laryngoscope* 2013; 123:1845–1848.
- 23 Gore MR, Ebert CS Jr, Zanation AM, Senior BA. Beyond the 'central sinus': radiographic findings in patients undergoing revision functional endoscopic sinus surgery. *Int Forum Allergy Rhinol* 2013; 3:139–146.
- 24 Koch T, Iwers L, Lenarz T, Stolle S. Ability of smell after medialization of the middle nasal turbinate in endoscopic sinus surgery. *Laryngorhinootologie* 2013; 92:326–331.
- 25 Soler ZM, Schlosser RJ. Post-FESS middle meatal dressings: avoiding the inevitable? *JAMA Otolaryngol Head Neck Surg* 2013; 139:1351–1354.
- 26 Akbari E, Philpott CM, Ostry AJ, Clark A, Javer AR. A double-blind randomised controlled trial of gloved versus ungloved Meroceal middle meatal spacers for endoscopic sinus surgery. *Rhinology* 2012; 50:306–310.
- 27 Friedman M, Schalch P. Middle turbinate medialization with bovine serum albumin tissue adhesive (BioGlue). *Laryngoscope* 2008; 118:335–338.
- 28 Jeebles JA, Hicks JN. The use of Meroceal for temporary medialization of the middle turbinate during functional endoscopic sinus surgery. *Ear Nose Throat J* 1993; 72:145–146.
- 29 Bolger WE, Kuhn FA, Kennedy DW. Middle turbinate stabilization after functional endoscopic sinus surgery: the controlled synechia technique. *Laryngoscope* 1999; 109:1852–1853.
- 30 Kuppersmith RB, Atkins JH. The use of a bioresorbable implant to medialize the middle turbinate in sinus surgery. *Otolaryngol Head Neck Surg* 2009; 141:781–782.
- 31 Weitzel EK, Wormald P. A scientific review of middle meatal packing/stents. *Am J Rhinol* 2008; 22:302–307.
- 32 Friedman M, Tanyeri H, Landsberg R, Caldarelli D. Effects of middle turbinate medialization on olfaction. *Laryngoscope* 1999; 109:1442–1445.
- 33 Zhou JB, Xiao XP, Wang JH, Zhang QH. Significance of conservation of the horizontal bony strut of the basal lamellae in endoscopic sinus surgery. *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi* 2010; 45:193–196.
- 34 Soler ZM, Hwang PH, Mace J, Smith TL. Outcomes after middle turbinate resection: revisiting a controversial topic. *Laryngoscope* 2010; 120:832–837.
- 35 Eweiss AZ, Ibrahim AA, Khalil HS. The safe gate to the posterior paranasal sinuses: reassessing the role of the superior turbinate. *Eur Arch Otorhinolaryngol* 2012; 269:1451–1456.
- 36 Murr AH, Smith TL, Hwang PH, Bhattacharyya N, Lanier BJ, Stambaugh JW, Mugglin AS. Safety and efficacy of a novel bioabsorbable, steroid-eluting sinus stent. *Int Forum Allergy Rhinol* 2011; 1:23–32.