



Effect of Middle Turbinate Intervention on Outcomes of Middle Meatal Endoscopic Surgery

Khaled Mohamed Bofares

otorhinolaryngology, Omar Almoukhtar University, Elbyda, Libya

Email address:

bofaresstat2012@yahoo.com

To cite this article:

Khaled Mohamed Bofares. Effect of Middle Turbinate Intervention on Outcomes of Middle Meatal Endoscopic Surgery. *International Journal of Otorhinolaryngology*. Vol. 1, No. 2, 2015, pp. 13-19. doi: 10.11648/j.ijjo.20150102.11

Abstract: *Back ground and objectives:* 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 ostiomeatal complex and as one of major aims of middle meatal endoscopic surgery is providing the sufficient drainage and ventilation at the level of this complex thus the middle turbinate should be assessed properly before the surgery regarding its position, size, and shape which may predispose for sinusitis via the obliteration of ostiomeatal complex. In addition among the normal middle turbinate which may lateralize post-operatively and subsequently result in the re-obstruction 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. For this reason the serial analytic coherent clinical study was planned prospectively to postulate for which technique is the best among previously mentioned three techniques and compared furtherly with non-interfered middle turbinate cases. *Patients and methods:* Sixty patients aged 14-63 years of chronic sinusitis, presented with clinical as well as radiological evidences of maxillo-ethmoidal sinusitis with or without frontal and sphenoidal involvement at ENT OPD –Al-tarahom private center Elbyda city- Libya at period in between July 2013 to March 2015 who operated by FESS, and the patients divided into four groups; group-A (n=16), group-B (n=18), group-C (n=6), and group-D (n=20), which include those patients who proceeded after middle meatal endoscopic surgery by the different techniques. The four groups were compared in relation to post-operative patency persistence of ipsilateral middle meatus and correlated to the incidence of sinusitis recurrence after the surgery. *Results and Conclusion:* 49% of the patients who underwent just medialization of ipsilateral middle turbinate without any further fixations developed recurrence of sinusitis due to re-obliteration of middle meatus either by synaechia between middle turbinate and lateral wall or by extreme lateralization of the middle turbinate as compared to the other groups among which all patients got complete improvement without any evidences of recurrence of sinusitis after one year of follow up apart of 12% of patients at group-B who presented with evidences of sinusitis recurrence after 3-6 months postoperatively. Broadly speaking, the intervention with the normal middle turbinate can be considered as one of 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 Intervention, Middle Turbinate Medialization, Middle Turbinate Partial Turbnectomy, Middle Turbinate Stitching, Middle Turbinate Fixation

1. Introduction

The functional endoscopic sinus surgery (FESS) is considered as one of widely performed procedures in rhinology. Although since 1985 up to now there are continuous trials to advance and improve this significant task of rhinology but basically speaking this procedure still depending mainly up on the intervention with middle meatus as the cornerstone for the drainage of most of para-nasal

sinuses which could be affected by variable forms of sinusitis. This is based universally on providing of sufficient ethmoidal infundibulectomy via performance of complete uncinectomy. Although in spite of adequate uncinectomy, still there is risk of re-obliteration of ethmoidal infundibulum by lateralized ipsilateral middle turbinate^(1-10, and 16). As it is very well-known that the ethmoidal infundibulum is considered as main draining space at ostio-meatal complex it is three-dimensional space that bounded posteriorly by bulla

ethmoidalis, antero-medially by middle turbinate, and antero-laterally by unciniate 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 antero-medial aspect⁽¹⁻¹⁷⁾.

Hence the middle turbinate surround the ethmoidal infundibulum at the antero-medial side with the engulfing of the bulla ethmoidalis and the unciniate process thus the pathological middle turbinate 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 ostio-meatal complex by abnormal middle turbinate which need to be interfered surgically by their resection⁽⁸⁾. In accordance the normal middle turbinate may play a significant role regarding the determination of recurrence incidence rate of sinusitis after middle meatal endoscopic surgery⁽¹⁻²⁵⁾. It was found that the in-fracturing of middle turbinate to get access for middle meatus during endoscopic surgery is associated with high risk of post-operative middle turbinate lateralization and re-obstruction of drainage at the middle meatus. On the other hand, it was confirmed that even the gentle medialization of middle turbinate without its in-fracturing may provide the insufficient patency of middle meatus after the surgery either due to the middle turbinate bulk itself, or the development of synechia between the middle turbinate and 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 middle meatus^(1, and 3-26).

Therefore the middle turbinate should be assessed properly by endoscopic as well as radiological evaluation before FESS. The abnormal middle turbinate must be interfered accordingly by the lateral resection of concha bullosa and partial turbinectomy of hypertrophied middle turbinate or floppy middle turbinate by the resection of its lower part. In addition the paradoxical as well as duplicated middle turbinates can be proceeded by the resection of that part of middle turbinate which causing the obstruction^(1-26, and 32-36).

From the other view, for the purpose of achievement of 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 by different recommended techniques:

- a) The resection of lower third of middle turbinate that corresponding to ethmoidal infundibulum. This can be performed by use of cutting curved scissors, or shaver⁽⁸⁾.
- b) Creation of synechia between the middle turbinate and nasal septum just by scratching of medial aspect of middle turbinate and opposite lateral aspect of nasal septum^(1-7, 9-22, and 32-36).
- c) Fixation of middle turbinate to nasal septum by stitching of mucosa of middle turbinate to muco-

periosteal flap of nasal septum using vicryl suture material with small round needle. This technique is described as conchopexy technique⁽¹⁻²⁸⁾.

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

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

2. Patients and Methods

Sixty patients aged 14-63 years of chronic sinusitis, presented with clinical as well as radiological evidences of maxillo-ethmoidal sinusitis with or without frontal and sphenoidal involvement at ENT OPD –Al-tarahom private center Elbyda city- Libya at period in between July 2013 to March 2015 who operated by FESS, and the patients divided into four groups; group-A (n=16), group-B (n=18), group-C (n=6), and group-D (n=20), which include those patients who proceeded after middle meatal endoscopic surgery by the medialization of ipsilateral middle turbinate and creation of synechia between it and nasal septum, the partial resection of ipsilateral middle turbinate at its lower third, medialization and further fixation of ipsilateral middle turbinate to corresponding nasal septal flap by vicryl stitch material , or just medialization of ipsilateral middle turbinate without any further fixations consecutively. All patients were adequately assessed pre-operatively by complete history, local endoscopic evaluation, and coronal, axial as well as sagittal CT scan demonstrations. The patients who decided for surgery had been proved with failed medical treatment or recurrence after insufficient previous surgery. There were four adult patients who confirmed with high suggestion of eosinophilic nasal polyposis with co-morbid bronchial asthma. The internationally recommended steps of basic FESS were followed as: a) the medialization of ipsilateral middle turbinate just to get access to middle meatus, b) partial uncinectomy, c) anterior ethmoidectomy which was done by complete exentration of bulla ethmoidalis, d) posterior ethmoidectomy which was done by resection of vertical portion of basal lamella of middle turbinate and further exentration of posterior ethmoidal air cells, e) accordingly this may be associated with further non-cutting Draf-I frantostomy and\ or sphenoidotomy. The non-cutting Draf-I frantostomy was performed as preserved as well as non-preserved bullar techniques, and f) middle meatal

antroostomy was done subsequently. At beginning of surgery the contour of middle turbinate with most lateral part of uncinata process were preserved just to be used as significant anatomical landmarks for finishing of safe and proper further resection steps. Finally the intervention with middle turbinate had been done accordingly followed by the resection of residual part of uncinata process.

All patients followed-up postoperatively for six weeks to elucidate for any occurrence of post-operative middle meatal obliteration by synechia or lateralization of ipsilateral middle turbinate. The patients at four groups were compared with each other regarding the post-operative improvement in relation to patients' symptomatology, endoscopic findings, as well as radiological findings.

An informed consent was taken from the patients involved in the research prior to their participation.

Data were expressed by using descriptive analysis as means \pm standard error of mean (s. e. m) and percentages, test of significance was carried out, using Chi-square test and two way analysis of variance. A probability less than 0.05 was considered as significant, the degree of significance was determined by using level of standard deviation test. Student -t- test was used for dependent sample, as well as contingency coefficient was calculated as measurement of association between nominal variables.

3. Results

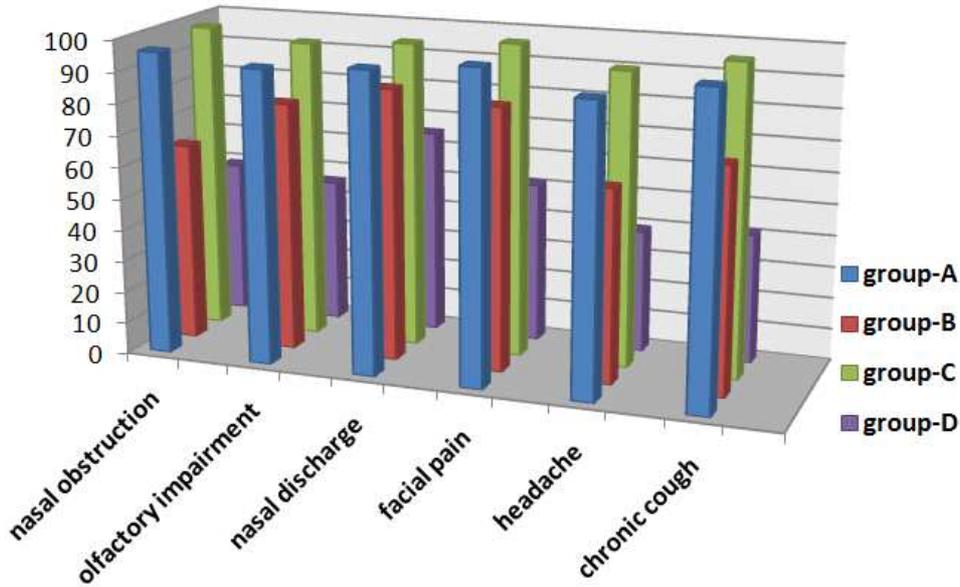


Figure I. The rate of post-operative improvement (%) regarding symptomatology among chronic rhino-sinusitis patients in relation to different middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.05$).

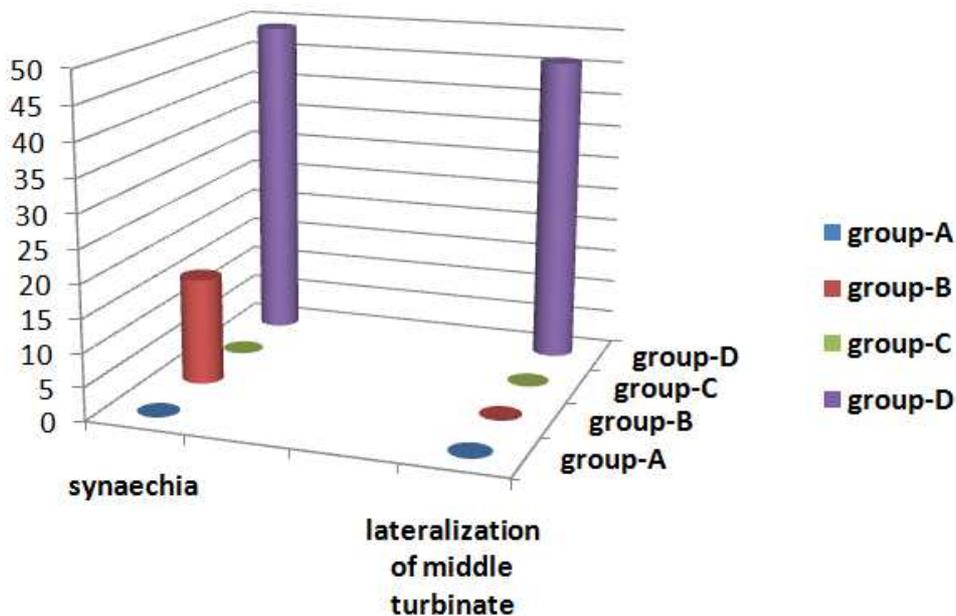


Figure II. The incidence of post-operative middle meatal obliteration (%) by synechia and middle turbinate lateralization in relation to different middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.01$).

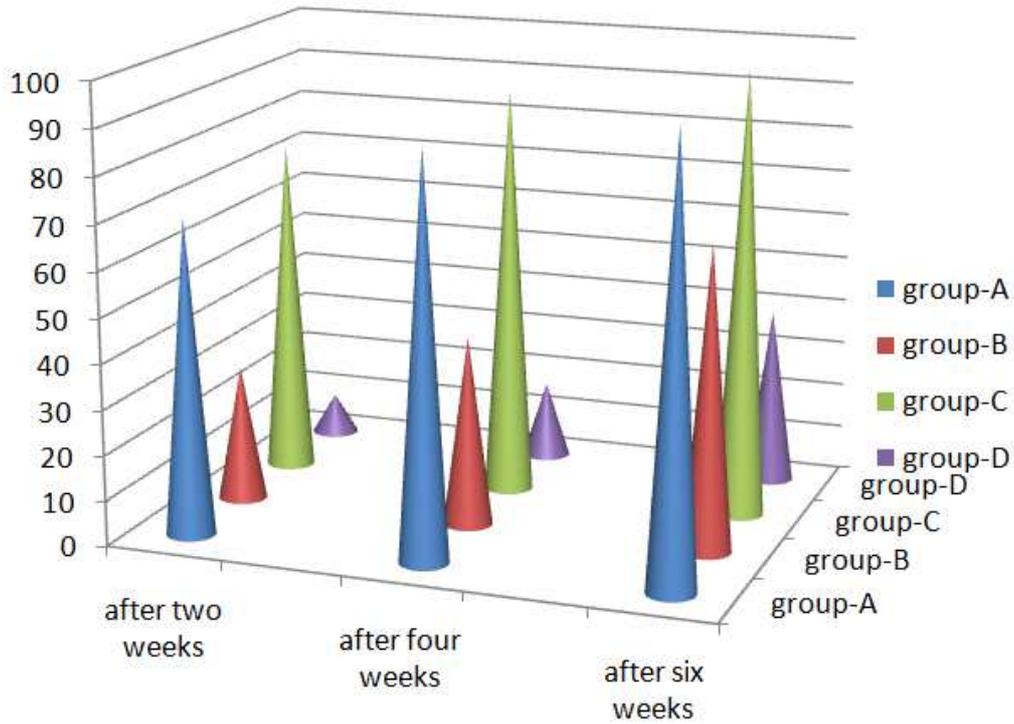


Figure III. The rate of post-operative local mucosal healing (%) in correlation with different middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.01$).

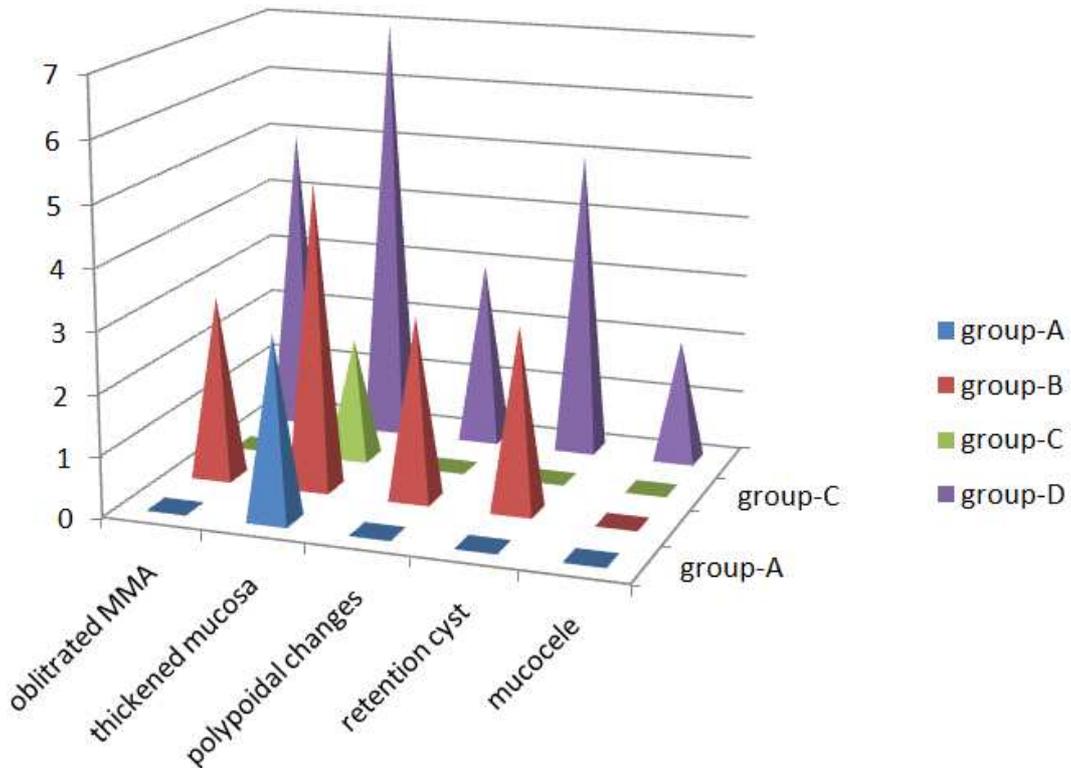


Figure IV. The incidence of different post-operative radiological evidences of rhino-sinusitis recurrence (%) in relation to variable middle turbinate intervention techniques during middle meatal endoscopic surgery ($P < 0.01$). [MMA = middle meatal antrostomy].

As demonstrated in (Figure – I) the rate of post-operative improvement regarding patients' symptomology is significantly increased among group-A, B, and C as compared to group-D ($P < 0.05$). On the other hand, as

illustrated in (Figure – II) the incidence of post-operative obliteration of middle meatus by synechia as well as lateralization of middle turbinate was significantly higher among group-D as compared to group-A, B and C ($P < 0.01$).

In accordance the (Figure-III) postulated the significant delay of post-operative local mucosal healing among group-D as compared to group-A, B, and C ($P < 0.01$). By further observations, (Figure-IV) elucidated the significant increase of incidence of post-operative radiological evidences of rhino-sinusitis recurrence among group-B and D as compared to group-A and C ($P < 0.01$).

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 is directly affecting the drainage of all groups of paranasal sinuses either through its relation with ostio-meatal complex or spheno-ethmoidal recess therefore for reaching satisfied outcomes of FESS it becomes very necessary to interfere with the middle turbinate accordingly. There are no any controversies regarding surgical management of pathological middle turbinate namely concha bullosa, paradoxical middle turbinate, double middle turbinate, floppy middle turbinate, and hypertrophied middle turbinate but there are a lot of discussing points raised regarding the recommendations to proceed on normal middle turbinate for purpose of maintaining the enough patency of 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) the providing of wide access and gate to facilitate different endoscopic post-operative care activities as proper examination as well as inspection of variable interfered paranasal sinus groups to assess the gaining of healing process, recovery of normal mucosa, and any evidences of local scarring or granulations, in addition to the facilitation of further required invasive actions and instrumentations as suction-clearance of paranasal sinus cavities as well as eradication of any recognized local pathologies⁽¹⁻³⁶⁾. At this moment the question which would be raised, which technique can be considered as most suitable procedure for management of normal middle turbinate to improve outcomes of middle meatal endoscopic surgery?

Although by reviewing of many literatures, it was found that there are four recommended ways to proceed on normal middle turbinate during middle meatal endoscopic surgery either by just its medialization without any further fixation, its medialization and its further fixation by creation of synechia between it and corresponding nasal septum, its medialization and its further fixation by suturing of it into corresponding septal flap, or the resection of its lower part but still we feel at this time there are no sufficient clear evidences in favor of which technique can be considered as most suitable technique with highest significance of satisfied post-operative outcomes therefore this serial study was conducted prospectively as comparative study to get more confirmations regarding which technique can be selected as most recommended variety.

As can be elucidated from this serial study, the best post-

operative outcomes incidence was obtained after medialization and fixation of middle turbinate either by creation of synechia between it and nasal septum or its suturing into septal flap this was in agreement with other many previous studies that conclude to same results. This can be explained by: a) the maintenance of drainage and ventilation of paranasal sinuses by sustaining the maximum patency of middle meatus, b) the patent middle meatus providing the enough access during post-operative follow-up session for purpose of easier and conclusive endoscopic evaluation, suction-clearance, as well as proper instrumentations for any local pathologies as granulation, reoccurred polyps, and scar formations, and c) the preservation of the contour of middle turbinate is considered as very important additional factor in maintaining the paranasal sinuses ventilation and drainage by keeping the eddy current flow of air into paranasal sinuses cavities and facilitating the muco-ciliary clearing-drainage function from interfered paranasal sinuses^(1-10, 12-14, 17-19, 21, 25, and 29-36).

On other hand, the raising of post-operative recurrence incidence after the medialization of middle turbinate without any further conchopexy can be explained by the re-obliteration of middle meatus as the result of the re-lateralization of middle turbinate with further synechia formation between the ipsilateral middle turbinate and corresponding lateral nasal wall this was found frequently occurred due to instability of middle turbinate after the forceful medialization of it that may result in its in-fracturing^(13, and 32-36).

In accordance, this serial study was proved that the partial turbinectomy of middle turbinate at its lower part was associated with significant increase of the incidence of post-operative 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 middle turbinate this will predispose for persistent nasal dryness and crusts formation and subsequently lead to raising of risk of uncontrolled as well as difficult to be treated infective rhino-sinusitis, and b) the resection of lower part of middle turbinate will disturb the eddy current flow of air into middle meatus and in the same time will impair the drainage process from it therefore this functional obstruction of middle meatus in spite of its sufficient anatomical patency will cause more stagnation of secretions and increase the chance of variable micro-organisms growth which result in more impairment of muco-ciliary clearing mechanism from paranasal sinuses cavities and further stagnation of secretions thus the circumstance will become in form of virtuous cycle which difficult to be broken⁽¹⁻⁸⁾.

In agreement with all previously discussed points, Michael, et al on 2011 was describing the technique of medialization of middle turbinate with further conchopexy by vicryl suture into nasal septum as initial step during middle meatal endoscopic surgery and as he reported that this technique created a significant improvement regarding the intra-operative access facilitation into middle meatus in addition to significant improvement of post-operative outcomes these

results was in agreement with other conclusions of some authors as Marple and Jebeles, and in contrary with others as Bolger and Friedman^(13, and 32-36).

On the other hand, by reviewing of many literatures there were several studies that concluded to the negative effect of post-operative lateralization of middle turbinate on outcomes after middle meatal endoscopic surgery. From other view, there were varieties of clinical trials to improve the post-operative results of this surgery by prevention of this lateralization as the technique which was described by Jebeles and Hicks by application of small Merocel pack of size 1cm × 1cm between the bulla ethmoidalis and middle turbinate this pack is applied for 48 hours to give enough sustained medialization position of middle turbinate. In accordance Bolger et al described other modality of experience by creation of four shallow mucosal incisions on the medial aspect of 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 removed 24-48 hours later. The authors admit to variation in post-operative 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 reported a similar technique using micro-debrider to create the mucosal irritation on both nasal septum and 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 nasal septum by further pressing of the two surfaces together with temporary nasal packing for three minutes. This allowed the adhesive to fully polymerize and avoided the use of post-operative nasal packing. In addition Koppersmith and Atkins described another technique by using bio-resorbable implant (L-lactide-co-glycolide) which has three lateral barbs inserted to middle turbinate and one medial barb fasten to the nasal septum. The implant is kept for two weeks after the surgery this will help in the maintaining the middle turbinate sustained at medial position^(13, and 32-36).

Thus from our serial study we can conclude to that among all described techniques most proper procedures for the management of middle turbinate during middle meatal endoscopic sinus surgery are the conchopexy by fixation of middle turbinate to nasal septum using 4-0 vicryl- suture material on a P3 needle, and enhancement of adhesion between the middle turbinate and corresponding nasal septum by violating the mucosa using sickle knife, shaver, or scratching the mucosal surfaces on the middle turbinate as well as nasal septum by sharp instruments as antral curate, this comes in agreement with Michael and Marple, as well as Bolger, Friedman and Schalch consecutively. On the other hand the medialization of middle turbinate followed by application of middle meatal nasal packs is not preferred because of two main reasons:

I) The high incidence of the middle turbinate lateralization

and subsequent re-obliteration of middle meatus after the surgery.

II) The problems which are usually associated with nasal packing as severe pain, severe headache, nasal obstruction with breathing difficulties, persistent rhinorrhea, and recurrent bleeding. This occasionally confirmed before by Weitzel and Wormald^(13, and 36).

References

- [1] Hewitt KM, Orlandi RR. Suture medialization of the middle turbinates during endoscopic sinus surgery. *Ear Nose Throat J.* 2008 Dec; 87(12):E11.
- [2] Shrime MG, Tabae 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 Mar-Apr; 21(2):174-9.
- [3] Chen W, Wang Y, Bi Y, Chen W. Turbinate-septal suture for middle turbinate medialization: a prospective randomized trial. *Laryngoscope.* 2015 Jan; 125(1):33-5. doi: 10.1002/lary.24820. Epub 2014 Jul 7.
- [4] Dutton JM, Hinton MJ. Middle turbinate suture conchopexy during endoscopic sinus surgery does not impair olfaction. *Am J Rhinol Allergy.* 2011 Mar-Apr; 25(2):125-7. doi: 10.2500/ajra.2011.25.3560.
- [5] Baguley CJ, Stow NW, Weitzel EK, Douglas RG. Silastic splints reduce middle meatal adhesions after endoscopic sinus surgery. *Am J Rhinol Allergy.* 2012 Sep-Oct; 26(5):414-7. doi: 10.2500/ajra.2012.26.3810.
- [6] Thornton RS. Middle turbinate stabilization technique in endoscopic sinus surgery. *Arch Otolaryngol Head Neck Surg.* 1996 Aug; 122(8):869-72.
- [7] Friedman M, Landsberg R, Tanyeri H. Middle turbinate medialization and preservation in endoscopic sinus surgery. *Otolaryngol Head Neck Surg.* 2000 Jul; 123(1 Pt 1):76-80.
- [8] Banfield GK, McCombe A. Partial resection of the middle turbinate at functional endoscopic sinus surgery. *J R Army Med Corps.* 1999 Feb; 145(1):18-9.
- [9] Moukarzel N, Nehmé A, Mansour S, Yammine FG, Moukheiber A. Middle turbinate medialization technique in functional endoscopic sinus surgery. *J Otolaryngol.* 2000 Jun; 29(3):144-7.
- [10] Lindemann J, Keck T, Rettinger G. Septal-turbinate suture in endonasal sinus surgery. *Rhinology* 2002 Jun; 40(2):92-4.
- [11] Fortune DS, Duncavage JA. Incidence of frontal sinusitis following partial middle turbinectomy. *Ann Otol Rhinol Laryngol.* 1998 Jun; 107(6):447-53.
- [12] 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 Oct; 72(10):1535-40. doi: 10.1016/j.ijporl.2008.07.006. Epub 2008 Aug 26.
- [13] Lee MR, Marple BF. Middle turbinate medialization for improved access during endoscopic sinus surgery. *Int Forum Allergy Rhinol.* 2011 May-Jun; 1(3):187-90. doi: 10.1002/alr.20013. Epub 2011 Feb 8.

- [14] Rettinger G, Lindemann K, Ashoor M, Scheithauer M, Sommer F, Lindemann J. Long term results of trans-septal suture of the middle turbinate during sinus surgery. *Laryngorhinootologie*. 2011 Aug; 90(8):471-5. doi: 10.1055/s-0031-1280840. Epub 2011 Aug 1.
- [15] Lee KC, Lee SS, Lee JK, Lee SH. Medial fracturing of the inferior turbinate: effect on the ostiomeatal unit and the uncinat process. *Eur Arch Otorhinolaryngol*. 2009 Jun; 266(6):857-61. doi: 10.1007/s00405-008-0857-8. Epub 2008 Nov 8.
- [16] Higgins TS, Lane AP. Chapter 12: Surgery for sinonasal disease. *Am J Rhinol Allergy*. 2013 May-Jun; 27 Suppl 1:S42-4. doi: 10.2500/ajra.2013.27.3897.
- [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 Feb; 34(1):30-2.
- [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 Jan-Feb; 1(1):33-7. doi: 10.1002/alr.20001. Epub 2010 Nov 19.
- [19] Koch T. Medialization and stabilization of the middle turbinate in endoscopic sinus surgery. *Laryngorhinootologie*. 2008 Jan; 87(1):6-9. doi: 10.1055/s-2007-1022671.
- [20] Getz AE, Hwang PH. Basal lamella relaxing incision improves endoscopic middle meatal access. *Int Forum Allergy Rhinol*. 2013 Mar; 3(3):231-5. doi: 10.1002/alr.21086. Epub 2012 Oct 4.
- [21] Bassiouni A, Chen PG, Naidoo Y, Wormald PJ. Clinical significance of middle turbinate lateralization after endoscopic sinus surgery. *Laryngoscope*. 2015 Jan; 125(1):36-41. doi: 10.1002/lary.24858. Epub 2014 Sep 1.
- [22] French C, Goyal P. Submucosal resection of the middle turbinate. *Laryngoscope*. 2013 Aug; 123(8):1845-8. doi: 10.1002/lary.23989. Epub 2013 Mar 28.
- [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 Feb; 3(2):139-46. doi: 10.1002/alr.21079. Epub 2012 Nov 5.
- [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 May; 92(5):326-31. doi: 10.1055/s-0033-1334888. Epub 2013 Apr 2.
- [25] Soler ZM, Schlosser RJ. Post-FESS middle meatal dressings: avoiding the inevitable? *JAMA Otolaryngol Head Neck Surg*. 2013 Dec; 139(12):1351-4. doi: 10.1001/jamaoto.2013.5439.
- [26] Akbari E, Philpott CM, Ostry AJ, Clark A, Javer AR. A double-blind randomised controlled trial of gloved versus ungloved merocel middle meatal spacers for endoscopic sinus surgery. *Rhinology*. 2012 Sep; 50(3):306-10. doi: 10.4193/Rhino11.215.
- [27] Friedman M, Tanyeri H, Landsberg R, Caldarelli D. Effects of middle turbinate medialization on olfaction. *Laryngoscope*. 1999 Sep; 109(9):1442-5.
- [28] 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 Mar; 45(3):193-6.
- [29] Soler ZM, Hwang PH, Mace J, Smith TL. Outcomes after middle turbinate resection: revisiting a controversial topic. *Laryngoscope*. 2010 Apr; 120(4):832-7. doi: 10.1002/lary.20812.
- [30] 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 May; 269(5):1451-6. doi: 10.1007/s00405-011-1832-3. Epub 2011 Nov 16.
- [31] 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 Jan-Feb; 1(1):23-32. doi: 10.1002/alr.20020. Epub 2011 Feb 8.
- [32] Friedman M, Schalch PS. Middle turbinate medialization with bovine serum albumin tissue adhesive (Bio-Glue). *Laryngoscope*. 2008; 118:335-338.
- [33] Jebeles JA, Hicks JN. The use of Merocel for temporary medialization of the middle turbinate during functional endoscopic sinus surgery. *Ear Nose Throat J*. 1993; 72:145-146.
- [34] Bolger WE, Kuhn FA, Kennedy DW. Middle turbinate stabilization after functional endoscopic sinus surgery: the controlled synechia technique. *Laryngoscope*. 1999; 109:1852-1853.
- [35] Kuppersmith RB, Atkins JH. The use of bioresorbable implant to medialize the middle turbinate in sinus surgery. *Otolaryngol Head Neck Surg*. 2009; 141:781-782.
- [36] Weitzel EK, Wormald P. A scientific review of middle meatal packing\ stents. *Am J Rhinol*. 2008; 22: 302-307.