Dilemma of Inferior Turbinate Surgery

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Abstract

Back ground and objectives: Inferior turbinate surgery is considered as one of common surgical procedures which performed in rhinology. It is usually done for the purpose of reduction of the bulk of inferior turbinates. It can be conducted for different indication as to relieve the mechanical nasal obstruction due to hypertrophied inferior turbinates, or to achieve a sufficient nasal surgical access during endoscopic sinus surgery, or to remove the inferior turbinates as a part of wide and complete resection of rhino-sinus neoplastic lesions.The inferior turbinates have important role in the maintenance of nasal breathing function via providing the nasal valve mechanism that is necessary for regulation of air flow through the nose. Therefore in spite of availability of well-established variable techniques for this surgery but the main goal of this surgery still yet not completely achieved by preserving the balance in between the mechanical as well as the functional patency of the nose. This can be explained by the effect of different factors which usually difficult to be predicted and controlled.

Index terms— inferior turbinate surgery, inferior turbinectomy, sub-mucosal diathermy, turbinoplasty.

1 Dilemma of Inferior Turbinate Surgery

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The inferior turbinates have important role in the maintenance of nasal breathing function via providing the nasal valve mechanism that is necessary for regulation of air flow through the nose. Therefore in spite of availability of wellestablished variable techniques for this surgery but the main goal of this surgery still yet not completely achieved by preserving the balance in between the mechanical as well as the functional patency of the nose. This can be explained by the effect of different factors which usually difficult to be predicted and controlled.

Thus this pattern of surgery became one of big dilemmas in rhinology which need to be deeply evaluated and subsequently resolved. For this reason, this serial study was conducted prospectively as analytic trial to assess the different aspects of this dilemma and to give finally further suggested recommendation as possible solutions for the clarification of this issue.

Patients and methods: 1337 patients aged 3-65 years of hypertrophied inferior turbinates , presented with clinical pictures of mechanical nasal obstruction related presentations at ENT department -Althowra central hospital and Al-tarahom private center Elbyda city-Libya at period in between September 2005 to September 2014 who operated by variable techniques of inferior turbinate surgery, namely sub-mucosal diathermy (SMD) (n=864), partial inferior turbinectomy (PIT) (n=427), CO2 laser vaporization of inferior turbinate (n=21), and turbinoplasty (n=25) . The outcomes namely postoperative atrophic rhinitis, and persistence or recurrence of the mechanical nasal obstruction was studied in relation to different factors to postulate as much as possible the clear answers for many complex questions which form this dilemma.

2 Results and Conclusion:

The proper selection of patient for this pattern of surgery is considered as one of main aspects of this issue and one of significant steps toward the resolving of this dilemma it is very necessary to select the most suitable candidate for this surgery. On the other hand, the type of the technique for this surgery is needed to be selected probably; it was found that there are many factors, according to which the most proper technique will be selected. In addition the amount of the inferior turbinate which needed to be resected must be decided probably too. In accordance, it is necessary to confirm whether the accompanied septoplasty required to be performed in association with the inferior turbinate surgery, it was found that the septoplasty for even mild DNS (grade-I) may significantly reduce the risk of postoperative atrophic rhinitis as well as persistent functional nasal obstruction by minimizing as much as possible the resection action for inferior turbinates.

3 Introduction

he inferior turbinate surgery constitutes one of common patterns of surgical procedures which widely performed in rhinology. It represents that kind of surgery which aimed basically for reduction of inferior turbinate bulk. Hence this type of surgery is considered as very effective modality of surgery in relieving the mechanical nasal obstruction due to hypertrophied inferior turbinate therefore there were a lot of trials during last and presenting centuries to create new and more advanced manners of this important procedure. In deed all these trials were targeted for the purpose of the improvement of outcomes of this surgery. The cornerstone for improvement of outcomes of this surgery will be via the maintenance of optimum size for the inferior turbinates (1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14)(15)(16)(17)(18)(19)(20) . Anatomically as well as functionally speaking, the inferior turbinates are considered as very significant anatomical structures that acting through their size and position to preserve the one of primary and vital functions of the nose which is the sufficient nasal breathing this will be achieved by the committing the normal nasal valve mechanism at the most anterior part of nasal cavity that facilitate the eddy current flow of the air (1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14)(15)(16)(17)(18)(19)(20) . Therefore the difficulties for preservation of unique size of inferior turbinates can be recognized as a main reason on top of which the dilemma of this variety of surgery in rhinology was appeared (10)(11)(12)(13)(14)(15)(16)(17)(18)(19)(20)(21)(22)(23)(24)(25)(26)(27) .

Although the enough bulk of inferior turbinate is necessary for maintenance of normal nasal breathing function and in accordance the hypertrophied inferior turbinate that occupy more than one-third of nasal lumen may be manifested with significant nasal obstruction related symptomology thus the main goal of the inferior turbinate surgery is keeping the balance in between the over-resection and under-resection of inferior turbinate at optimum level that provide the preservation of sufficient breathing function through the nose and in the same time relieving the mechanical obstruction due to inferior turbinate hypertrophy **??**1-20 and 33-35) .

There are variable etiologies for inferior turbinate hypertrophy which could be allergic rhinitis, rhinitis medicamentosa, vasomotor rhinitis, chronic hypertrophic rhinitis, and chronic infective rhinitis as fungal rhinitis. As it is well established that all previously mentioned causes can be treated and controlled sufficiently by medical treatment before the decision of any surgical interventions. Hence the bulk as well as the contour of inferior turbinates is required for maintenance of normal nasal breathing function thus the medical therapy for inferior turbinate hypertrophy still is considered as the mainstay of treatment before the surgery .

On the other hand, broadly speaking the indications for inferior turbinate surgery can be classified as: a) for relieving of mechanical nasal obstruction due to confirmed persistent inferior turbinates hypertrophy, b) for providing a sufficient surgical access during certain internal nasal surgical procedures as functional endonasal endoscopic or microscopic sinus surgery, and c) as a part of wide resection for eradication of lateral nasal wall neoplastic lesions .

In fact, during the last century as well as the presenting century as one of developing aspects in the rhinology is the inferior turbinate surgery and in accordance there are many modalities of this surgery were performed namely; submucosal diathermy, partial inferior turbinectomy, CO2 laser vaporization, Argon laser vaporization, turbinoplasty, and lateral nasal wall lateralization. Each of these patterns has advantages and disadvantages which need to be correlated with each patient who had been decided as a candidate for inferior turbinate surgery to improve as much as possible the postoperative outcomes of this surgery. For some extent there will be certain difficulties which may interfere with the proper selection of most suitable modality for each particular patient and subsequently the achieved sequels of this surgery will not be as wished therefore this type of surgery was described as one of big dilemmas in rhinology .

Thus this serial study was aimed as prospective analytic study to resolve as much as possible this dilemma. We tried in this presenting study to put a frame-work for the solution of this dilemma via the finding of answers for these difficult questions: Q1-who is the patient that can be considered as most suitable patient for this surgery? Q2-which modality of this surgery will be selected as most unique technique for this particular patient? Q3-how much the bulk of inferior turbinate is recommended to be removed for the purpose of maintenance of sufficient size and contour of it? Q4-and as a trial to maintain the proper size and contour of inferior turbinate, is it advisable to perform concomitant septoplasty with inferior turbinate surgery or not? II.

Patients and Methods 1337 patients aged 3-65 years of persistent inferior turbinates hypertrophy due to different causes namely allergic rhinitis, rhinitis medica-mentosa, and vasomotor rhinitis, presented with

mechanical nasal obstruction that not responding to enough medical treatment at ENT department -Althowra central hospital and Altarahom private center -Elbyda city -Libya at period in between September 2005 to September 2014 who operated by different techniques of inferior turbinate surgery, namely sub-mucosal diathermy (SMD) (n=864), partial inferior turbinectomy (PIT) (n=427), CO2 laser vaporization of inferior turbinate (n=21), and turbinoplasty (n=25). The mechanical nasal obstruction was confirmed clinically by the gross appearance of inferior turbinates at pre-operative anterior rhinoscopic as well as endoscopic evaluation as enlarged turbinates that occupied more than one-third of nasal lumen, with non-shiny, thick and pale mucosa, in addition to postulation of positive Cottle's sign. According to intraoperative performed technique, SMD group was divided in relation to conducted cauterization points into three sub-groups (two points sub-group, three points subgroup, and four points sub-group), also PIT group was classified according to the amount of resected tissue into three sub-groups too (sub-group-A that include those patients who underwent for the resection of onethird of hypertrophied inferior turbinate, sub-group-B that include those patients who underwent for the resection of two-thirds of hypertrophied inferior turbinate, and sub-group-C that include those patients who underwent for the subtotal resection of hypertrophied inferior turbinate), in addition CO2 laser vaporization group was categorized in relation to the used laser power into four sub-groups (sub-goup1, sub-group2, sub-group3, and sub-group4) which include those patients who underwent CO2 laser vaporization with different powers in Watts (2, 3, 4, and 5 Watts consecutively). On the other hand, the part of patients who interfered with SMD and PIT were operated concomitantly with septoplasty (n= 355, n= 235 consecutively), and compared to those who operated by solitary SMD and PIT (n= 509, n= 192 consecutively) to assess the effect of concomitant septoplasty on outcomes of inferior turbinate surgery. The outcomes of the surgery were studied and compared between the groups and sub-groups in relation to different patients' demographic, environmental, habitual, socio-economic, pathological as well as technical factors. The patients postoperatively were evaluated throughout first week for any nasal bleeding and followed up for 3-36 months to be assessed for common late complications of the surgery which are mainly the persistence or recurrence of mechanical nasal obstruction, and post-operative atrophic rhinitis. The nasal obstruction was assessed post-operatively by elucidation of any olfactory In accordance and from economic point of view the expense of each technique was assessed in relation to drugs consumption (this was including anesthesia drugs, systemic antibiotics, analgesic drugs, intravenous fluids, post-operative local irrigation solutions, and sometimes anticoagulant drugs as tranxiemic acid which may be required to be administered for patients with uncontrolled postoperative epistaxis), any expense related to specific machine which is used in the inferior turbinate surgery technique as CO2 laser machine, used local nasal packs, expense related to patient's word admission, and finally expense related to patient post-operative followup. The total price for each technique was roughly calculated in Libyan dinars and equaled to American dollars.

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 + 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.

4 III.

5 Results

As shown in (Figure **??**I & II) the incidence of post-operative nasal bleeding and atrophic rhinitis was correlated to two significant factors which are the age of patient and the type of performed technique, it was found that the PIT increased significantly the risk of postoperative bleeding and atrophic rhinitis up to (20%) and (35%) consecutively among elderly patients as compared to SMD and CO2 laser vaporization ($P < 0.05$). On the other hand, as illustrated in (Figure **??**III) the incidence of post-operative recurrence of hypertrophied inferior turbinates was correlated to the patient related environmental as well as habitual factors, it was found that SMD and CO2 laser vaporization are associated with higher percentage of recurrence (30% and 80%) consecutively as compared to PIT among heavy smoking patients as well as those patients with history of frequent exposure to allergic rhinitis inducing allergens ($P < 0.05$). In accordance the (Table-I) postulated the effect of patients' local health status on outcomes of the inferior turbinate surgery, it was found that the patients with allergic rhinitis and vasomotor rhinitis who interfered by PIT as well as turbinoplasty showed a significant longstanding improvement may reach up to 93% as compared to those who interfered by SMD and CO2 laser vaporization ($P < 0.05$). As demonstrated in (Table -II) the effect of patients' general health status in relation to the type of performed technique outcomes, it was confirmed that the patients with uncontrolled systemic hypertension had a significant raising in the risk of post-operative epistaxis after PIT as compared to other techniques and also those patients with uncontrolled diabetes mellitus shown higher risk of recurrence of nasal obstruction after SMD as well as CO2 laser vaporization as compared to other techniques ($P < 0.05$). on the other hand, (Figure **??**IV) was elucidated the comparison between different techniques in relation to intraoperative time consumption, it was found that the duration of turbinoplasty was significantly longer as compared to PIT, CO2 laser vaporization, and SMD technique which was associated with the minimal duration ($P < 0.05$). Therefore from economic point of view, as illustrated at (Table-III) the CO2 laser vaporization can be considered significantly with higher expense as compared to other

techniques ($P < 0.05$). From the other aspect, technically speaking as can be noted from (Table -IV) the amount of direct or indirect reduction of inferior turbinate bulk had a significant effect on outcomes of the performed procedure, and as it is presented at the same table these results was correlated with number of cauterization points in SMD, the used power in CO2 laser vaporization, as well as the resected size of inferior turbinate among PIT, it was found that the three subgroups of SMD technique according to number of cauterization points (two points\three points\four points) did not show any significant difference in relation to post-operative outcomes namely local atrophic changes and persistent or recurrence of nasal obstruction ($P > 0.5$). In accordance the risk of postoperative atrophic rhinitis as well as persistence or recurrent nasal obstruction increased significantly among third sub-group of PIT as compared to other two sub-groups ($P < 0.05$). In addition it was observed that there is no direct proportional relation-ship between the used power of CO2 laser and postoperative outcomes ($P > 0.5$). On the other hand, as shown in (Table-V) there was significant improvement for outcomes of SMD as well as PIT if they are performed concomitantly with septoplasty procedure ($P < 0.05$).

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7 Discussion

The inferior turbinate surgery is considered as one of big issues in rhinology. Hence this pattern of surgery is frequently indicated and widely performed therefore it always needs to improve its outcomes. Although during last two centuries there are many conducted clinical studies which tried to present new techniques that may had been proved with better outcomes of this surgery but still as shown at other many clinical trials and observations that it may become very difficult to decide which technique is most suitable variety for certain particular patient. In accordance, it was found that there are many factors which may be responsible for creation of difficulties regarding the selection of most proper manner of inferior turbinate surgery . However most of the recent studies tried to resolve these difficult situations but from the clinical aspect it was noted that in spite of following of these studies recommendations, unpredicted post-operative outcomes still appearing. Thus this type of surgery can be classified as one of the dilemmas at rhinology and according to our experience the main points that in favor of this dilemma innovation are: a. Who is the patient that can be considered as most suitable candidate for inferior turbinate surgery? b. Which is the technique that can be selected as most proper technique for certain particular patient? c. How much uniquely is required to remove from the bulk of hypertrophied inferior turbinate? d. Is the solitary inferior turbinate surgery sufficient to relief the mechanical nasal obstruction or it needs to be performed with the septoplasty as concomitant procedure to improve outcomes of the surgery as much as possible?

In this serial study we tried to find out optimum answers for all these questions. In the same manner as it is noted from this presenting study the number of cases and the time of follow up of patients can be considered as very sufficient as well as very conclusive for any final recommendation which were given via this study.

Regarding the selection of the patient who should be considered as most suitable candidate for inferior turbinate surgery, generally speaking the inferior turbinate surgery can be elective and non-elective i.e. when this pattern of surgery is decided to be performed for the management of persistent mechanical nasal obstruction at this case it will be classified as elective surgery (1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14)(15)(16)(17)(18)(19)(20) . On the other hand, the inferior turbinatectomy can be conducted non-electively as a part of wide resection of sino-nasal neoplastic lesions (36)(37)(38)(39)(40)(41)(42)(43)(44)(45)(46)(47)(48)(49)(50) . Our discussion is mainly highlight the elective category of this surgery. Basically there are five major criteria according to which the patient might be indicated for inferior turbinate surgery: Hence the patient was selected as indicated candidate for inferior turbinate surgery; the next step will be the selection of most suitable technique for that particular patient. Generally speaking there are five patterns of inferior turbinate surgical techniques namely; a) partial turbinectomy which can be done by lateral resection of maximum up to one-third of hypertrophied inferior turbinate either by using curved scissors, or shaver, or radio-frequency ablation, or co-ablation **??**1-20 and 37-71) . b) submucosal diathermy, this technique is considered as old fashion for inferior turbinate surgery. It is performed by creation of electrical cauterization at multiple points (2-5 points) through sub-mucosal layer of hypertrophied inferior turbinate. This technique acts mainly by cauterization of sub-mucosal venous sinusoids among hypertrophied inferior turbinate with active sensitization inflammatory process due to allergic rhinitis, vasomotor rhinitis, or rhinitis medica-mentosa. Thus the sub-mucosal fibrosis will be induced subsequently as a reaction to venous sinusoids cauterization and this will result in the shrinkage of inferior turbinate bulk. However the submucosal diathermy technique was proved to be very effective and simple technique but still it is of no benefits among those patients with hypertrophied inferior turbinate due to increase in bulk of concha bone rather than soft tissue (1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14)(15)(16)(17)(18)(19)(20) . c) CO2 laser vaporization of hypertrophied inferior turbinate, this technique was confirmed to be very effective with minimal post-operative local atrophic changes as compared to other previously mentioned two techniques. It acts by same mechanism of submucosal diathermy through its penetration effect into sub-mucosal layer of hypertrophied inferior turbinate and as compared to submucosal diathermy technique it has less destructive effect on the mucosal glandular acini as well as venous sinusoids therefore the incidence of post-operative atrophic rhinitis after CO2 laser vaporization is limited but in the same time its action to relief the mechanical nasal obstruction due to hypertrophied inferior turbinate will be lesser as compared to other techniques

(20)(21)(22)(23)(24)(25)(26)(27)(28)(29)(30)(31)(32)(33)(34)(35) . d) turbinoplasty, simply this technique can be described as that inferior turbinate surgical modality which is conducted via the reduction of bone bulk of inferior concha. In accordance this technique is aimed to maintain the mucosal cover of inferior turbinate therefore the eddy current mechanism of air flow by inferior turbinate mucosal lining will be preserved in addition to the maintenance of moisture consistency of inspired air by mucosal glandular acinic secretions thus the turbinoplasty is the technique which associated with minimal post-operative nasal atrophic changes.

Although the turbinoplasty is the recommended technique for hypertrophied inferior turbinate due thickened concha bone but for some extent it can be performed even for reduction of inferior turbinate soft tissue . e) lateral nasal wall lateralization, which was first described by Daniel simmen on 2013 and this technique is simply performed by submucosal resection of lateral nasal wall bone just in front to lacrimal sac and this can give sufficient access for more lateralization of ipsilateral inferior turbinate (72) .

In fact we observed throughout our long practical experience that the following of the recommendations which frequently come out from several old as well as recent studies regarding inferior turbinate surgeries did not sufficiently give the predicted results as those studies concluded. For this reason we tried through this planned serial study to suggest certain possible factors that may had been thought to be effective factors on the outcomes of this pattern of surgery and the further conclusions from this study can be roughly considered as a first step toward the resolving of this big dilemma in rhinology. Accordingly in this serial study these suggested factors were mainly correlated to the answer of the second question of this dilemma (Which is the technique that can be selected as most proper technique for certain particular patient?). Moreover these studied factors can be discussed as: a) Patient's age, generally speaking, the elderly patients showed higher incidence of post-operative epistaxis as well as the atrophic rhinitis among four performed procedures namely PIT, SMD, CO2 laser vaporization, and turbinoplasty as compared to the young ages. On the other hand, specifically speaking, the incidence of post-operative epistaxis as well as atrophic rhinitis significantly increased by interfering with PIT as compared to other inferior turbinate surgical techniques i.e. the risk of post-operative epistaxis and atrophic rhinitis is direct proportionally to increasing of patient's age. This can be explained by a scientific and basicphysiological fact that vascular related aging process among elderly patients contributes the main predisposing factor for the impairment of local homeostasis control after the surgery as well as the delay of proper healing process at the site of surgery, in addition to the significant decrease in the number of venous sinusoids and mucosal glandular acini at submucosal layer of the turbinate among elderly patient due to local physiological aging changes too **??**1-20 and 37-71) . Thus PIT might not be considered as most suitable technique for inferior turbinate surgery among old ages because technically speaking PIT can be described as highly invasive procedure that associated with cutting action and wide resection of the turbinate's soft tissue that may increase significantly the risk of intra-operative as well as post-operative bleeding in addition to the increasing of risk of post-operative local atrophic changes particularly among elderly patients (15)(16)(17)(18)(19)(20) . b) Patient related habitual and environmental factors, the results of this study postulated that the incidence of post-operative recurrence of inferior turbinate hypertrophy increased significantly by smoking and chronic exposure to certain allergens as pollens, animal epithelials, house dust mites, and chemical irritants as compared to the non-smokers as well as those patients who are not frequently exposed to environmental irritants. In accordance the incidence of recurrence of inferior turbinate hypertrophy by smoking and persistent allergens exposure was significantly higher after CO2 laser vaporization as compared to other techniques this can be explained by the insufficient reduction of submucosal venous sinusoids as the histological changes on the inferior turbinate mucosa after CO2 laser vaporization this will increase the incidence of the inferior turbinate re-congestion and subsequent hypertrophy as the result of IgE -hypersensitivity reaction activation due to the persistent smoking and exposure to the allergens. On the other hand, the SMD, PIT, and turbinoplasty are associated with significant lowering of the incidence of inferior turbinate hypertrophy after the surgery this is because of obvious reduction of the number of sub-mucosal venous sinusoids due to sub-mucosal cauterization by SMD and enough tissue bulk resection by PIT as well as turbinoplasty techniques. Therefore CO2 laser vaporization might not be selected as most suitable technique for inferior turbinate surgery among smokers and those patients who live or work at contaminated environment **??**18-20 and 23-27) . c) Patient's local health status, this serial study confirmed that the local nasal pathological status of the patient may affect significantly the decision regarding the selection of most proper technique of inferior turbinate surgery i.e. those patients who presented as cases of allergic rhinitis and vasomotor rhinitis got significant long standing improvement regarding the patency of nose after PIT and turbinoplasty as compared to SMD and CO2 laser vaporization. This can be discussed in relation to the sufficient amount of tissue which resected either by PIT or turbinoplasty. On the other hand, the basic idea behind the performance of SMD as well as CO2 laser vaporization is the reduction of number of venous sinusoids and enhancement of diffuse fibrosis at the level of sub-mucosal layer of inferior turbinate either by cauterization effect of SMD or penetration effect of CO2 laser vaporization; these effects had been proved to be not sufficient to fulfill the adequate maintenance of optimum size of inferior turbinate because still there is risk of proliferation of the venous sinusoids and subsequent recurrence of congestion as well as hypertrophy of inferior turbinate due to the allergic or autonomic nervous system disturbance phenomena predisposition. Thus the most suitable techniques for inferior turbinate surgery among patients with allergic rhinitis or vasomotor rhinitis are PIT or turbinoplasty . d) Patient's systemic health status, this presenting study demonstrated that the risk of epistaxis is increased after PIT among hypertensive patients as well as diabetic patients; this can be explained by extensive local tissue injury due to PIT as compared

to other less invasive techniques. Moreover the SMD creates higher risk of recurrence of nasal obstruction among diabetic patients as compared to other techniques; this can be reasoned to that the patients with diabetes mellitus are more prone for local atrophic changes and diffuse fibrosis as compared to non-diabetic patients due to high incidence of local diabetic angiopathic changes this can result in functional nasal obstruction rather than mechanical nasal obstruction, in addition to the higher incidence of vasomotor rhinitis among diabetic patients as compared to non-diabetic patients this will increase the risk of post-operative recurrence of mechanical nasal obstruction due to inferior turbinate hypertrophy. Accordingly we can judge that the PIT is not the advised technique for hypertensive as well as diabetic patients and SMD is not the curable procedure for patient with diabetes mellitus (1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14)(15)(16)(17)(18)(19) .

In accordance there is another important factor which may has significant interaction for rooting of this dilemma namely the socio-economic factor. As it was elucidated at this serial study and via the rough evaluation of different economic aspects for each performed technique including the expense of used drugs, nasal packing, patient word stay, specific machine expense, and post-operative patient follow-up it was found that PIT and turbinoplasty had higher prices as compared to SMD as well as CO2 laser vaporization. Although the machine expense for CO2 laser vaporization is very significantly higher but still the total price is obviously lower as compared to other procedures. This can be discussed in relation to the

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 other aspects rather than the machine expense i.e. PIT and turbinoplasty are considered as more invasive techniques which consume longer intra-operative duration therefore there will be more utilization of intraoperative anesthesia drugs in addition to certain specific drugs which might be needed to be administrated as tranxiemic acid for purpose of epistaxis control which of higher incidence among these two procedures (20-45). On the other hand, patients after PIT as well as turbinoplasty need to be observed and cared more as compared to other techniques this will result in the prolongation of patient's post-operative stay at word. Also the patients after PIT and turbinoplasty need frequent follow-up sessions after their discharge this is because of high tendency for recurrent local dryness and crusts formation during first 4-6 weeks postoperatively which may predispose to infective rhinitis that result in subsequent healing by scaring and synaechia creation, for this reason the repetitive sessions of local irrigation and suction-clearance after PIT as well as turbinoplasty are recommended to reduce all previously mentioned risks. However the PIT and turbinoplasty are considered as very effective technique for the surgical management of persistent mechanical nasal obstruction due to inferior turbinate hypertrophy but at the same time they are considered as expensive procedures as compared to SMD and CO2 laser vaporization .

In the same manner, we thought that the used power during CO2 laser vaporization constitutes one of important issues which may play a role in building-up of this big dilemma thus we tried via this clinical study to assess which is the most suitable power for CO2 laser vaporization. As it was illustrated at the results of this serial study the power of 3-4 watts were associated with lower incidence of post-operative atrophic rhinitis as well as persistence or recurrence of nasal obstruction as compared to lower powers which had been proved with significantly high incidence of post-operative persistent or recurrent nasal obstruction and higher powers which showed significant raising in the incidence of both postoperative atrophic rhinitis as well as persistence or recurrence of nasal obstruction.

These observations can be explained by inability of low powers to destroy sufficient number of sub-mucosal venous sinusoids that may increase the risk of persistence and recurrence of mechanical nasal obstruction due to the inferior turbinate congestion and hyperemia and on the other hand the high powers are more destructive powers that lead to extensive venous sinusoids and glandular acini loss this will result in higher incidence of local atrophic changes after the surgery which can be considered as main cause for persistence or recurrence of functional nasal obstruction (19)(20)(21)(22)(23)(24)(25)(26)(27)(28)(29)(30)(31)(32)(33) .

From the other aspect, we tried at our serial clinical trial to evaluate whether the concomitant septoplasty has any role regarding improvement of outcomes of inferior turbinate surgery, in accordance we found that the performance of septoplasty even for mild deviated nasal septum as bothersome procedure with inferior turbinate surgery may improve significantly the outcomes of this surgery and this can be explained simply by the reduction of points of cauterization among SMD cases and limitation of the tissue resection among PIT cases therefore the risk of post-operative atrophic rhinitis and subsequent functional nasal obstruction is significantly decreased in addition that the patient get important relieve regarding the mechanical nasal obstruction because of the interfering with both deviated septum as well as hypertrophied inferior turbinate (53) .

Finally we can conclude to that really the inferior turbinate surgery is considered as one of big dilemmas at rhinology and because it is widely conducted surgery thus always it needs frequent research to resolve all possible associated problems and issues. The cornerstone of this dilemma is how to avoid the adverse outcomes of inferior turbinate surgery mainly postoperative epistaxis as early complication and atrophic rhinitis as well persistent or recurrent nasal obstruction as late complications. As it can be noted from the results of this serial study which tried to evaluate different patterns of inferior turbinate surgery and correlated with variable groups of factors the proper selection of most suitable candidate for this surgery is very necessary and we mean by suitable candidate that the patient who is strongly indicated for this surgery, in addition the proper selection of the most suitable technique is another significant key point toward the resolving of this dilemma. In accordance and as suggested recommendation the selection of proper technique needs to be based up on certain patient's related

factors namely age, local as well as general health status, surrounding environment, habitus, and socio-economic status.

Although this study was well-controlled, longstanding, and of adequate number of cases but it may be considered as non-formative study regarding CO2 laser vaporization, and turbinoplasty because the number of operated cases among these two procedures is not sufficient as compared to other two procedures thus the comparative elucidations of CO2 laser vaporization as well as turbinoplasty with SMD and PIT will be non-conclusive therefore as other suggested recommendation the further clinical studies are advised to be committed to confirm these concepts which obtained from this presenting study and in the same time the new aims may be suggested to be postulated toward the resolving of this dilemma. [1]

Figure 1:

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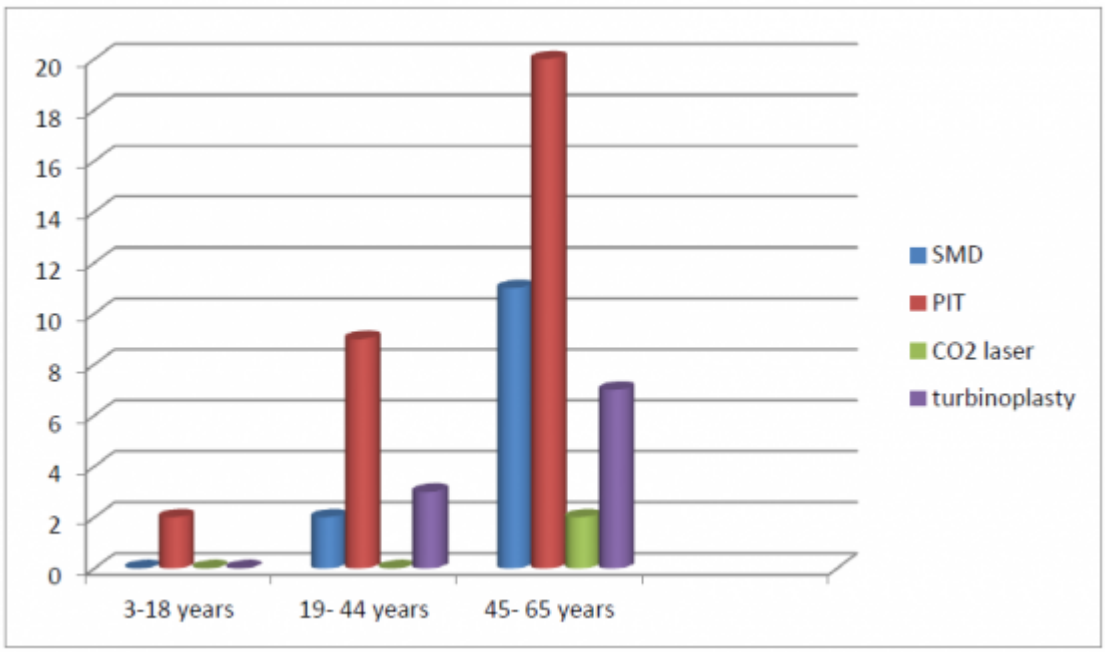
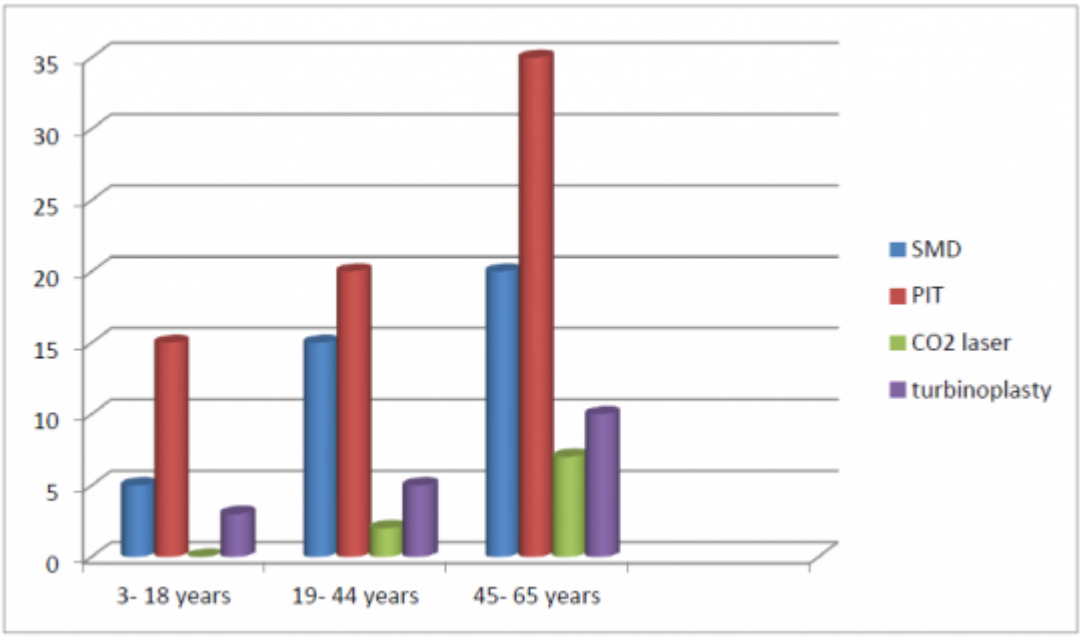


Figure 2: Figure



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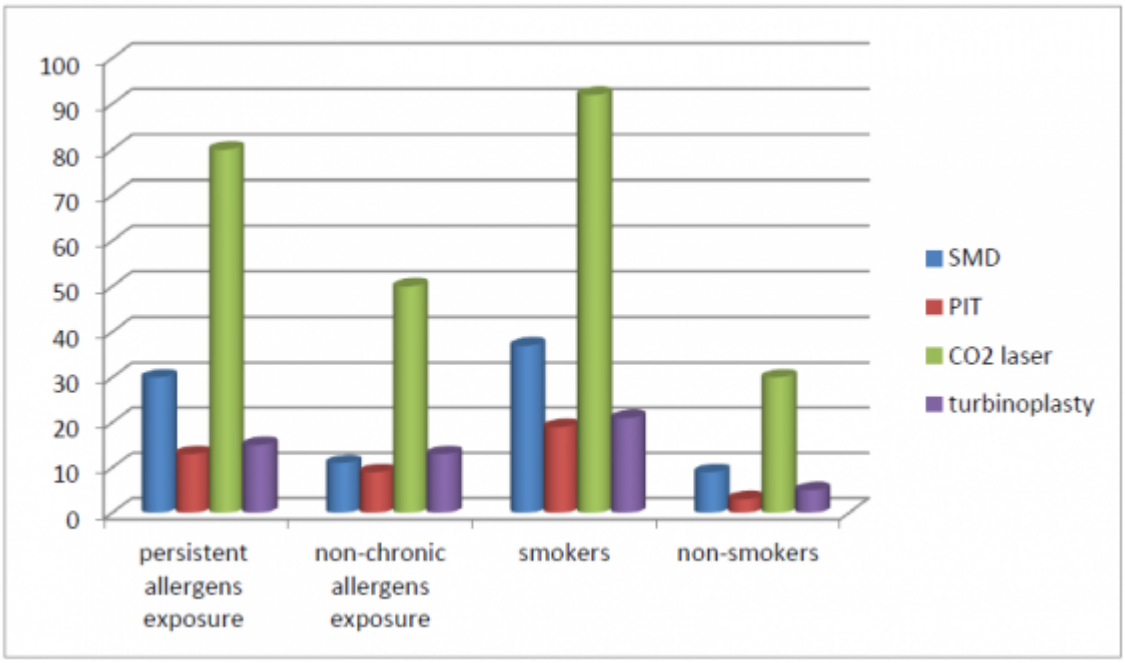

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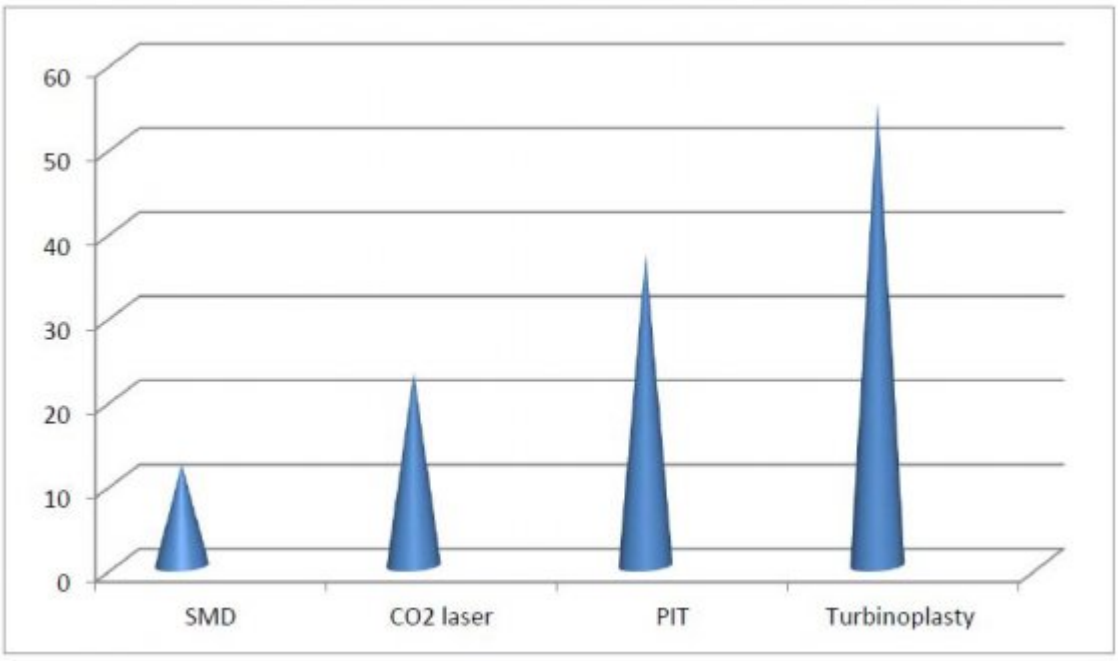

Figure 5:

Type of local pathology	Percentage (%) of persistence of nasal patency improvement for 36 months in relation to type of procedure				
	SMD (N=864) [ARn= 536 & VMRn =264]	PIT (N=427) [ARn= 269 & VMRn =133]	CO2 laser (N=21) [ARn= 13 & VMRn =8]	Turbinoplasty (N=25) [ARn= 20 & VMRn =5]	Total n &%
Allergic rhinitis (AR) (N= 838)	(n=306) 57%	(n= 250) 93%	(n= 8) 63%	(n= 16) 80%	(n= 580) 69%
Vasomotor rhinitis (VMR) (N= 410)	(n=129) 49%	(n= 118) 89%	(n= 3) 37%	(n=4) 83%	(n= 254) 62%
Total N= 1248	(n=435) 54%	(n= 368) 92%	(n=11) 53%	(n=20) 80%	(n= 834) 67%

Figure 6:

Type of general pathology	Percentage (%) of post-operative epistaxis (E) and recurrence of nasal obstruction (RNO) at each procedure in relation to patients' general health status							
	SMD (N=864) [HTNn= 47 & DMn =81]		PIT (N=427) [HTNn= 13& DMn =37]		CO2 laser (N=21) [HTNn= 3 & DMn =2]		Turbinoplasty (N=25) [HTNn= 4 & DMn =2]	
	E	RNO	E	RNO	E	RNO	E	RNO
Systemic hypertension (N= 67)	n= 13 27%	n= 18 39%	n= 12 91%	n= 2 13%	n= 0 0%	n= 1 34%	n= 2 50%	n= 0 0%
Diabetes mellitus (N= 122)	n= 15 19%	n= 70 87%	n= 27 73%	n= 6 17%	n= 0 0%	n= 0 0%	n= 0 0%	n= 0 0%

Figure 7:

The items	The expenses for different inferior turbine surgery techniques in Libyan dinars (mean± standard error of mean (s. e. m))			
	SMD	PIT	CO2 laser	turbinoplasty
Drugs	36±4.7	108±5.3	55±7.9	103±1.9
Nasal packing	15±11.5	33±0.2	0	31±0.5
Patients word stay	126±3.9	299±0.7	44±1.2	209±0.3
Specific machine expense	0	0	139±4.1	0
Post-operative patient follow-up	35±4.3	77±6.3	43±5.7	53±0.7
The total in Libyan dinars	212±5.7	517±7.1	281±4.9	396±0.3
The total in American dollars	106±2.9	258±3.7	140±2.5	198±0.16

Figure 8:

Outcomes of technique	The outcomes of CO2 laser vaporization of hypertrophied inferior turbinate (%) in relation to used power in Watts (N=21)			
	2 Watts (n=5)	3 Watts (n=6)	4 Watts (n=5)	5 Watts (n=5)
Local atrophic changes	40% (n=2)	17% (n=1)	20% (n=1)	60% (n=3)
Persistence or recurrence of mechanical nasal obstruction	60% (n=3)	34% (n=2)	60% (n=3)	80% (n=4)

Figure 9:

Outcomes	Percentage of outcomes with septoplasty N=590		Percentage of outcomes without septoplasty N=701	
	One point SMD n= 355	One-third PIT n= 235	Two point SMD n=509	Two -thirds PIT n=192
Atrophic changes	0	2% n=5	31% n=158	47% n=90
Persistent nasal obstruction	0	0	12% n=61	9% n=17

Figure 10:

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Figure 11: Table II :

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Figure 12: Table IV :

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Figure 13: Table V :

a) The patient has chronic nasal obstruction related presentations that mainly of five varieties, partial or complete inability to breathe through the nose, frequent or persistent opened mouth for mouth breathing, olfaction function impairment, sleep related breathing disorders, and recurrent sore throat, pharyngitis, as well as oral ulcers due to persistent mouth breathing.
b) The patient received sufficient medical therapy in form of local steroids, local nasal douching, systemic steroids, and systemic anti-histamines for enough time which is 3-6 months but the patient did not show any significant clinical improvement. c) The patient proved locally by anterior rhinoscopic as well as endoscopic evaluations that has significant hypertrophied inferior turbinate which occupies more than one-third of nasal cavity.
d) The hypertrophied inferior turbinate grossly appears as enlarged turbinate with thick, pale, grayish-white, and non-shiny covering mucosa.
e) The significant nasal obstruction due to hypertrophied inferior turbinate must be elucidated objectively by positive rhino-metric evaluation, and\or positive Cottle's sign, and\or positive impairment of olfactory function.

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Figure 14:

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