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Effect of deviated nasal septum and hypertrophy of inferior turbinate on middle ear pressure

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Aim: The aim of this work is to analyze the frequency of changes in tympanometry in adults with deviated nasal septum (DNS) and hypertrophied inferior turbinate before and after surgery.

Material and method: This prospective study included 35 adult patients with DNS and hypertrophied inferior turbinate who were candidates for septoplasty and submucous diathermy of the inferior turbinate (SMD). The analysis concerned the morphology of DNS (division according to Mladina), and its effect on middle ear pressure (MEP) measured by tympanometry before and after operation.

Results: DNS type 2 and 3 with hypertrophy of inferior turbinate were the most common types each constituted 35.2% and were associated with type A tympanogram but DNS type 4 was less common 14.7% and was associated with type C tympanogram mean (-112.5 mm H2O). In the 1st postoperative day MEP become more negative (-71.02 ±33.34) in the right ear and (-65.75±24.6) in the left ear before removal of the nasal pack and become (-51.17±32.61) and (-48.82±23.90) respectively after pack removal. MEP dropped below the baseline tympanogram after the 1st and 2nd weeks postoperative.

Conclusions: different types of DNS associated with hypertrophy of the inferior turbinate affects MEP. Septoplasty with SMD causes significant improvement of the auditory tube function and hence the MEP (p < 0.05) after 1 week. Nasal packing causes significant worsening of the MEP so avoidance of the nasal packing or the use of nasal pack with integral pathway could minimize this problem.

Keywords: Nasal septum, inferior turbinate, tympanometry, septoplasty, SMD.

INTRODUCTION

The potential interaction between the middle ear mucosa, nasopharynx, Eustachian tube (ET) and nasal cavities have been studied by several authors. Most inflammatory disorders of the middle ear are thought to be due to inadequate ventilation through the ET. The tube is frequently involved by different pathological conditions of the nasal, paranasal and nasopharyngeal cavities. Therefore nasal obstruction can alter Eustachian tube function (ETF).\(^{(1,2)}\)

The consequent loss of equilibrium between air influx through ET and gas diffusion from middle ear cavity into systemic circulation lead to reduction of the middle ear pressure.\(^{(3)}\)

Deviation of the nasal septum which changes the airflow in this part of the respiratory tract can affect the state of the paranasal sinuses as well as the function of the auditory tube. It can also cause adenoids. Some authors reported that even minimal deviation of the nasal septum has a tubal dysfunction and consequent depression in the
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middle ear pressure and so surgical correction is justified.\(^\text{4-5}\) One should take into account that the type of deviation of the nasal septum and the location of the deviation can have a larger or smaller influence on the organs mentioned above. Nasal packing left in place after nasal surgery can cause tubal dysfunction.\(^\text{6,7}\) The incidence is high due to absence of nasal air flow and the release of inflammatory mediators.\(^\text{8}\)

The literature defines several divisions of types of DNS with respect to their location. Mladina’s\(^\text{9}\) classification is another more modern approach which includes the morphology of and the site of deviation. He divided it into 7 types which can be gathered into the following diagram (Fig. 1)

![Mladina's classification for deviated nasal septum](image)

**Fig 1. Mladina’s classification for deviated nasal septum.**

- **Type I** is described as a unilateral crest which does not disturb the function of the nasal valve. It is situated in the area of the valve.
- **In type II,** disturbance of the valve function is caused by the unilateral crest. Positive Cottle’s symptom can be observed after raise of the nostril, which gives a subjective and objective improvement in the nose patency.
- **Type III** – one unilateral crest at the level of the head of the middle nasal concha.
- **Type IV** defines two crests – one at the level of the head of the middle nasal concha, and the other on the opposite side in the valve area, disturbing the valve functions.
- **Type V** is a unilateral ridge on the base of the septum, while on the other side the septum is straight.
- **Type VI** shows a unilateral sulcus running through the caudal-ventral part of the septum, while on the other side there is a ridge and accompanying asymmetry of the nasal cavity.
- **Type VII** is a mix of types from I to VI.
An important clinical implication of poor tubal function and consequent middle ear hypoventilation is a drop of the success rate of the middle ear surgery and this event is particularly common in chronic nasal obstruction.(10,11)

The normal middle ear pressure is controversial as different researchers give different ranges. Jerger(12) postulated that negative middle ear pressure more than 100 mm H2O only should be accepted as pathological. Negative middle ear pressure is attributed to faulty ETF.(13) Recently the international accepted range of middle ear pressure is ±100 mmH2O.(12,14)

High negative middle ear pressure indicates obstruction of the ET but the finding of normal resting middle ear pressure doesn’t necessarily indicate normal ETF and so the finding of negative middle ear pressure is presumptive evidence of ET dysfunction.(15)

Tympanometry is a non-invasive and objective tool to detect middle ear pressure, patency of the ET and compliance of the tympanic membrane. When the tympanic membrane is intact, the tubal function can be assessed during tympanometry by measuring MEP at maximum compliance. If MEP is within the normal range then the normal tubal function can be assumed.(16)

The aim of this study is to investigate the effect of surgical correction of the nasal septal deviation and hypertrophy of the inferior turbinate on the middle ear pressure and whether the type and morphology of DNS has an impact on the MEP.

PATIENTS AND METHODS

This prospective study was carried out on 35 patients (29 male and 6 female) who presented to otorhinolaryngology department in a private hospital in Jeddah, Saudi Arabia between December 2010 to March 2012. The age of the patients ranged from 18-50 years with the mean age 31.5. All the patients presented to the outpatient clinic with chronic nasal obstruction not responding to medical treatment. They all had DNS and hypertrophy of the inferior turbinate.

The following Patients were excluded from the study:

1) Previous nasal septal or inferior turbinate surgery.

2) Patients with nasal polypi, tumors, recent rhinitis or sinusitis.

3) Patients with chronic hearing disorder like chronic otitis media, otosclerosis, tympanosclerosis or recent middle ear infection.

4) Patients with any bleeding disorder.

5) Residence outside the city, incomplete address or patient unable to come for follow up.

Informed consent was taken from the patients after explaining the procedure and the possible complications in details. All patients were assessed by the following:


2. Clinical assessment of hearing by tuning fork test.

3. Middle ear pressure assessment by tympanometry. The middle ear pressure is expressed in mm of H2O or deka Pascal unit (dapa) unit.

4. Rigid nasal endoscopy and CT scan paranasal sinuses to detect the type of DNS and accurately localize the site and shape of deviation. Mladina’s classification was used to categorize the type of DNS.

Anaesthesia was standardized for all the patients and no premedication was given. Septoplasty and (SMD) were done for all the patients followed by anterior nasal packing with derma-tulle dressing 2 in each side which were left in place for 24 hours postoperative.

Tympanometric assessment was done before the operation as a base line and on 1st post-operative day (before and after pack removal), after 1 week and 2 weeks post-operative. We use (GSI 38 version 2 Auto Tymp, USA) tympanometer.

Tympanogram was classified in the standard manner similar to that described by Jerger.(12) A tympanogram with MEP peak between +50dapa and -100 dapa was considered type A. At -100 dapa or more it was considered as type C.

A tympanogram with flattened peak ≤ 0.3 ml admittance was considered type B.

Statistical analysis was done using SPSS program software version 8. Descriptive analysis was done by using mean ± standard deviation (SD). Pre-operative and postoperative values were done using paired sample t-test. A P value < 0.05 was considered statistically significant.

RESULTS

35 patients were included in this study but only one patient did not complete the follow up so he was excluded from the results so the total number became 34 (28 male and 6 female). Their age ranged from 18-50 years with the mean 31.5. The different types of DNS are shown in Table 1.
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Table 1. Different types of septal deviation and MEP.

<table>
<thead>
<tr>
<th>Type of DNS</th>
<th>Numbers (%)</th>
<th>Mean MEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4 (11.76%)</td>
<td>-11.25 dapa</td>
</tr>
<tr>
<td>2</td>
<td>12 (35.29%)</td>
<td>-30.41 dapa</td>
</tr>
<tr>
<td>3</td>
<td>12 (35.29 %)</td>
<td>-67.91 dapa</td>
</tr>
<tr>
<td>4</td>
<td>5 (14.7 %)</td>
<td>-112.5 dapa</td>
</tr>
<tr>
<td>5</td>
<td>1 (2.94%)</td>
<td>-10 dapa</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

Type 2 and 3 were the most common in this study both were 24/34 (70.58%). The table shows that type c tympanogram (< -100 dapa) was found in only 5 patients (14.71%) and all were type 4. The rest of the patients 29 (85.29%) had MEP within the normal range as shown in Table 2.

Table 2. Show No. of patients in each MEP range.

<table>
<thead>
<tr>
<th>Middle ear pressure</th>
<th>Rt. ear</th>
<th>left ear</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -100</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>-50 to -100</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>&lt; -50</td>
<td>18</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 3 shows the change of mean MEP from the base line to day 15. On day 1 before removal of the nasal pack there was worsening (increase in negativity) of the MEP for all the patients (-71.02 ±33.34) on the right ear and (-65.75±24.6) on the left ear and this change was significant (P<0.05). 6 patients (17.6%) developed type c tympanogram (4 on the right ear and 2 on the left ear).

Table 3. Details of MEP in both ear in the form of means and standard deviation.

<table>
<thead>
<tr>
<th>Time of tympanometry</th>
<th>Mean MEP ± SD (Rt.)</th>
<th>Mean ±SD (lt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative</td>
<td>-50.15 ±33.11</td>
<td>-47.9±24.09</td>
</tr>
<tr>
<td>1st day postoperative ( before removal of the nasal pack)</td>
<td>-71.02 ±33.34</td>
<td>-65.75±24.6</td>
</tr>
<tr>
<td>1st day (after pack removal)</td>
<td>-51.17±32.61</td>
<td>-48.82±23.90</td>
</tr>
<tr>
<td>7th day postoperative</td>
<td>-40.4±31.29</td>
<td>-36.47±24.63</td>
</tr>
<tr>
<td>2 weeks postoperative</td>
<td>-39.85 ±30.23</td>
<td>-34.85±24.87</td>
</tr>
</tbody>
</table>

After removal of the pack MEP dropped and decreased in negativity to (-51.17±32.61) on the right ear and to (-48.82±23.90) on the left ear but this drop was still higher than the base line. The change of MEP before and after pack removal was significant (P< 0.05). On day 7 MEP was (-40.4±31.29) on the right ear and was (-36.47±24.63) on the left ear. On day 14 MEP was (-39.85 ±30.23) on the right ear and was (-34.85±24.87) on the left ear. MEP dropped below the base line on both 7th and 14th day but the change from day 7 to day 14 was not significant P value was 0.624 on the right ear and 0.102 on the left ear as shown by Table 4. Non-significant difference was found between both ears before the operation or after it as shown in Table 5.
Table 4. Significance of change of MEP before and after operation in both ears.

<table>
<thead>
<tr>
<th>Comparison between MEP</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative &amp; before pack removal (Rt)</td>
<td>20.88</td>
<td>14.11</td>
<td>*0.00</td>
</tr>
<tr>
<td>Pre pack and post pack(Rt)</td>
<td>-19.85</td>
<td>13.788</td>
<td>*0.001</td>
</tr>
<tr>
<td>Preop and post pack(Rt)</td>
<td>-1.029</td>
<td>2.95</td>
<td>0.059</td>
</tr>
<tr>
<td>Pre op. and after 1 week(Rt)</td>
<td>-10.00</td>
<td>5.90</td>
<td>*0.001</td>
</tr>
<tr>
<td>After 1 and 2 weeks(Rt)</td>
<td>-0.294</td>
<td>3.46</td>
<td>0.624</td>
</tr>
<tr>
<td>Pre op.and before pack removal (left)</td>
<td>17.79</td>
<td>3.73</td>
<td>*0.00</td>
</tr>
<tr>
<td>Pre pack and post pack(lt)</td>
<td>-16.911</td>
<td>3.89</td>
<td>*0.00</td>
</tr>
<tr>
<td>Pre op. and post pack removal (left)</td>
<td>0.88</td>
<td>4.34</td>
<td>0.245</td>
</tr>
<tr>
<td>Preop. And after 1 week( left)</td>
<td>-11.47</td>
<td>4.85</td>
<td>*0.00</td>
</tr>
<tr>
<td>After 1 and 2 weeks( left)</td>
<td>-1.61</td>
<td>5.60</td>
<td>0.102</td>
</tr>
</tbody>
</table>

* MEAN STATISTICALLY SIGNIFICANT P<0.05.

Table 5. Shows non-significant difference between MEP in the right and left ear before and after operation.

<table>
<thead>
<tr>
<th>Rt. Vs. Lt.</th>
<th>Mean</th>
<th>SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative</td>
<td>-2.20</td>
<td>20.89</td>
<td>0.542</td>
</tr>
<tr>
<td>Pre pack</td>
<td>-5.29</td>
<td>24.92</td>
<td>0.224</td>
</tr>
<tr>
<td>Post pack</td>
<td>-2.35</td>
<td>20.56</td>
<td>0.509</td>
</tr>
<tr>
<td>After 1 weak</td>
<td>-3.67</td>
<td>19.93</td>
<td>0.290</td>
</tr>
<tr>
<td>After 2 weak</td>
<td>-5</td>
<td>18.74</td>
<td>0.129</td>
</tr>
</tbody>
</table>

DISCUSSION

The Eustachian tube is frequently involved in many pathological conditions of the nose, paranasal sinuses and nasopharynx.(3) In a report by Salvenelli et al.(9) they showed that chronic nasal obstruction is a frequent cause of ET dysfunction which can lead to middle ear hypoventilation. In a study by Lechoslow(17) he found that in the examined group of 104 children 57.62% of them with DNS had no hearing abnormality and they had type A tympanogram so he concluded that the configuration of nasal septum deviation has no influence on the development of auditory tube dysfunction. Bonding and Tos(3) reported that infectious mononucleosis, tonsillectomy and nasal packing can lead to Eustachian tube dysfunction and middle ear hypoventilation. They examined 15 patients with anterior nasal pack and they found 7 of them (46%) developed significant negative MEP that was resolved after removal of the nasal pack.

McCurd(18) demonstrated a negative MEP < -100 dapa in only 25% of 99 ears 3 days after applying bilateral anterior nasal pack but here in this study MEP was <100 in 6 patients (17.64%) after operation and before removal of
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the nasal pack and the change of MEP before and after nasal packing was significant \( p<0.05 \). The change of MEP after removal of the nasal pack was not significant from the base line \( p=0.059 \) on the RT ear and \( p=0.245 \) on the left ear.

There are varying explanations for the temporary ET dysfunction with nasal packing one of them is the mechanical obstruction caused by the nasal pack to the entrance of the ET. Other authors believed that this may be due to the inflammatory reaction and oedema caused by the pack to the nasopharyngeal mucosa. Thomson et al.\(^{(19)}\) in their study reported that type C tympanogram was recorded in at least 1 ear in 34/63 (54\%) after septal surgery. M Sinan et al.\(^{(20)}\) reported that type C tympanogram occurred in 73.9\% of their patients when merocel nasal pack was used and occurred in 21.4\% of the patients when silicon splint with integral pathway was used within 48 hours from septal surgery.

Here in this study the recording of MEP ranged between -15 to -120 mmH\(20 \) and MEP significantly improved from (-50.15±33.11) to (-40.4±31.29) on the Right ear and from (-47.9±24.09) to (-36.47±24.63) on the Left ear after 1 week from the operation \(( p<0.05 \) but the drop MEP after pack removal was not significant from the base line and this was probably due to oedema and secretions that occurred after the operation which were resolved after 1 week from operation and this indicates improvement of MEP of the patients after surgery and this matches with W.K Low et al.\(^{(2)}\) who found most of the reading of MEP in their patients with DNS between -0 and -100 mmH\(20 \) and the mean MEP significantly improved after septal surgery from (-25.7±28.2) to (-2.9±30.4) in the ipsilateral ear and from (-34.2±53.4) to (-1.1±45.2) in the contralateral ear and they concluded that type A tympanogram does not necessarily mean good ET function and marked negative MEP is due to continuous gas absorption in the closed air pocket and they believed that altered air current associated with DNS affect ET function but rarely completely obstruct E.T to form a closed gas pocket. In a study by McNicoll et al.\(^{(21)}\) they used xenon 133 scintigraphy to demonstrate the airflow pattern in 25 divers with DNS and they found marked postnasal air turbulence which improved after septal surgery.

The coexistence of hypertrophied inferior turbinate with DNS (which may affect the MEP) led to inability to detect the exact significance of different types of DNS on MEP.

**CONCLUSION**

Nasal septum deviation with hypertrophy of the inferior turbinate disturb the auditory tube function and hence the MEP. DNS type 2 and 3 were the commonest types and were associated with type A tympanogram. DNS type 4 was less common but had the most negative readings. Nasal packing worsen the MEP so avoidance of nasal packing, the use of nasal pack with integral pathway or septal suturing could minimize this problem.

**REFERENCES**


