Effect of Nasal Packing on Middle Ear Pressure

Chander Mohan, Abhinav Srivasta, Puneet Shukla

ABSTRACT

Introduction: Eustachian tube connects nasopharynx with the tympanic cavity. The normal middle ear has an inherent tendency to lose gas to maintain the middle ear pressure by diffusion into the surrounding tissues and circulation.

Materials and methods: This cross-sectional study was conducted in 2012 to 2014. A total of 100 ears of 50 consecutive cases undergoing nasal surgery followed by bilateral nasal packing were included in the study and the middle ear pressure and hearing threshold were determined in all the subjects in presurgery, and then after 48 hours of surgery with nasal packing in situ and then at 7 and 30 days of nasal pack removal.

Conclusion: There is an increase in middle ear pressure transiently for few days while the nasal pack is in situ, which returns to normal in a month after pack removal; but, in chronic nasal obstruction cases, such as nasal polyps, there is persistent negative middle ear pressure, probably due to irreversible changes in the Eustachian tube function.

Keywords: Eustachian tube, Middle ear pressure, Nasal pack.

INTRODUCTION

Eustachian tube connects nasopharynx with the tympanic cavity. The normal middle ear has an inherent tendency to lose gas to maintain the middle ear pressure by diffusion into the surrounding tissues and circulation. The loss is compensated by the Eustachian tube, which admits just enough gas to maintain the middle ear pressure. When this system fails to function properly, a negative middle ear pressure develops in the middle ear.

The lymphatics of the middle ear and Eustachian tube course along the posterioinferior aspect of the Eustachian tube, getting afferent from nasal cavity, paranasal sinus, nasopharynx, and adenoids. Efferent from plexus terminates in the retropharyngeal lymph nodes. Inflammation and edema in these areas cause obstruction to the flow, resulting in retrograde obstruction of tympanic and tubal lymphatics producing tubal dysfunction and middle ear effusion, which may be reversible or irreversible.

Nasal packing causes complete nasal obstruction and induces edema of the nose, nasopharynx, and paranasal sinuses that may overload the regional lymphatics at the level of peritubal plexus and retropharyngeal nodes. Thus, if the Eustachian tube is affected by nasal obstruction or lymphatic stasis, patients subjected to nasal packing will demonstrate abnormalities in tubal function.

Nasal packing is a procedure used routinely in ENT department and has multiple complications ranging from nasal mucosal damage during placement of packs to hypoxia or sinonasal infections and eustachian tube dysfunction, which ranges from 25 to 75%.

The middle ear, serving as an impedance matcher between air and the inner ear fluid, is critical in effective transmission of sounds from the outside world into the inner ear. However, certain pathologies in the ear may compromise the function of the middle ear. Tympanometry, a noninvasive methodology, is used to evaluate the function of the middle ear.

The present study is undertaken to evaluate the effect of nasal obstruction on middle ear pressure and hearing threshold.

MATERIALS AND METHODS

This cross-sectional study was undertaken in Department of Otorhinolaryngology and head and neck surgery, a tertiary care hospital in western Uttar Pradesh in 2012 to 2014. A total of 100 ears of 50 consecutive cases undergoing nasal surgery followed by bilateral nasal packing were included in the study and the middle ear pressure was evaluated by Impedance audiometer Interacoustics AT235 and hearing threshold by Pure Tone Audiometer ALPS AD 2000+ was determined in all the subjects before surgery, after 48 hours of surgery with nasal packing in situ, and then at 7 and 30 days after nasal pack removal. The information was recorded in a predesigned proforma and results were evaluated and statistically analyzed using paired t test and standard statistical methods.

Patients having allergic rhinitis or any known ear diseases or nasal packing done for epistaxis were excluded from the study.
OBSERVATIONS AND DISCUSSION

Fifty patients having nasal obstruction were included in the study, which included 30 males (60%) and 20 females (40%). The male: female ratio was 3:2. Bhuiyan MR et al\textsuperscript{1} have studied 30 patients composed of 20 male (66.66%) and 10 female (33.33%) patients (Table 1).

We observed in our study that a maximum number of patients were in the age group 11 to 20 and 21 to 30 years, with 18 cases (36%) and 14 cases (28%) respectively. It is matching with the study done by H Virtanen et al\textsuperscript{4} in which the maximum number of patients were of the age group between 11 and 20 years and 14 patients of age group between 21 and 30 years (Table 2).

The patients included in our study were suffering from deviated nasal septum 34 (68%), antrochoanal polyp 14 (28%), and the rest 2 (4%) of the patients were suffering from inverted papilloma and rhinolith (Table 3).

In a similar study done by Bhuiyan et al\textsuperscript{1}, the different diseases considered were deviated nasal septum with turbinate hypertrophy (36.66%), deviated nasal septum (30%), ethmoidal polyp (16.66%), and antrochoanal polyp (10%).

The hearing thresholds were measured in all the 50 patients (100 ears), before the nasal pack, after 48 hours of nasal pack, 7 days after removal of nasal pack, and 30 days after removal of nasal pack. In this study, the normal hearing threshold was taken as less than 25 dB, and above this threshold was considered as hearing loss. The prepack pure tone audiometry was normal in 89 ears (89%) and hearing loss was seen in 11 (11%) ears. After 48 hours of nasal packing, 77 ears (77%) had normal hearing threshold, and 23 ears (23%) had conductive hearing loss. Seven days after removal of nasal pack, 83 ears (83%) were normal and 17 ears (17%) had hearing loss. Thirty days after pack removal there was original level, 89 ears (89%) had normal hearing threshold and 11 ears (11%) had hearing loss. All patients with hearing loss had mild-to-moderate hearing loss (Table 4 and Graph 1).

Huang et al\textsuperscript{5} measured hearing threshold in 55 patients who had chronic sinusitis and nasal obstruction. The hearing threshold was increased in 33.9% cases who had nasal obstruction. These results were similar to our study.

The middle ear pressure before the nasal pack was found to be normal in 82 ears and pressure less than \textasciitilde 100 was seen in 18 ears. After 48 hours of nasal packing, only 13 ears had normal middle ear pressure and in 87 ears there was negative middle ear pressure. The negative middle ear pressure came to normal range 7 days after nasal pack removal in 84 ears, and remained negative in 16 ears. After 30 days of nasal pack removal, negative pressure was found only in only 12 ears and 88 were in normal range of middle ear pressure (Table 5).

According to Bhuiyan et al\textsuperscript{1}, there was change in middle ear pressure following nasal packing, which was significant, and 5 days after removal of nasal pack, only 3 of 40 ears had negative middle ear pressure.

<table>
<thead>
<tr>
<th>Table 1: Sex ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Age group</th>
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<tbody>
<tr>
<td><strong>Age group (years)</strong></td>
</tr>
<tr>
<td>11–20</td>
</tr>
<tr>
<td>21–30</td>
</tr>
<tr>
<td>31–40</td>
</tr>
<tr>
<td>41–50</td>
</tr>
<tr>
<td>51–60</td>
</tr>
<tr>
<td>61–70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3: Percentage of disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnosis</strong></td>
</tr>
<tr>
<td>AC Polyp</td>
</tr>
<tr>
<td>DNS</td>
</tr>
<tr>
<td>Inverted papilloma</td>
</tr>
<tr>
<td>Rhinolith</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4: Pure tone audiometry in ears (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PTA (no. of ears)</strong></td>
</tr>
<tr>
<td>Normal</td>
</tr>
<tr>
<td>Hearing loss</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5: Middle ear pressure in ears (dapa)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEP (no. of ears)</strong></td>
</tr>
<tr>
<td>Normal</td>
</tr>
<tr>
<td>Abnormal (negative)</td>
</tr>
</tbody>
</table>
In our study, the results are similar; after 48 hours of nasal pack, there was significant change in middle ear pressure, which improved to normal range after 7 days of nasal pack removal.

In a similar study, Jasser et al. measured middle ear pressure in 40 ears before surgery, after 48 hours of nasal pack, and 7 days after removal of nasal pack. They found that, preoperatively, there was normal middle ear pressure in all the ears; none of ears had abnormal middle ear pressure. After 48 hours of nasal packing, 14 ears had got abnormal middle ear pressure, while 26 ears were normal. Seven days after the removal of nasal pack, there was marked improvement in middle ear pressure, and all the ears were normal. These findings are similar to the findings of our study. They postulated the possible mechanism for Eustachian tube dysfunction that the nasal packing may lead to dysfunction by causing peritubal inflammation or stasis of peritubal lymphatics. There may be deficiency of surfactant, which facilitates opening of Eustachian tubes. This material is inactivated by inflammation, which occurs following nasal packing. Reduced swallowing in the postoperative period due to pain leads to restrictive opening of the Eustachian tube.

In our study, 12 ears remained in negative middle ear pressure even after 30 days of removal of nasal pack. Chronic nasal obstruction seems to have a detrimental effect on middle ear pressure, which may not return to normal even after removal of chronic obstruction. Patients who have nasal obstruction of more than 6 months had negative middle ear pressure.

Bonding et al. investigated middle ear ventilation by repeated tympanometry. Patients with bilateral nasal packing had negative middle ear pressure, which returned to normal level after removal of nasal packing.

Mohan et al. evaluated 40 patients requiring anterior nasal packing by tympanometry. Their study shows that nasal packing results in Eustachian tube dysfunction and negative middle ear pressure, which is reversible in nature.

The results of all the studies by Thompson et al., Low et al., Johannessen et al., Salvinelli et al., and Huang et al. were in agreement with the present study.

In this study, mostly there were cases of deviated nasal septum and antrochoanal nasal polyp, that is, 48 patients (96%). Middle ear pressure of the patients suffering from antrochoanal polyp was in normal range in 15 ears and less than –100 dapa in 13 ears. Middle ear pressure was increased after 48 hours of nasal packing in 22 ears and was in normal range in 6 ears. Seven days after removal of nasal pack, it improved and was within normal range in 18 ears and remained abnormal in 10 ears. After 30 days of nasal pack removal, the middle ear pressure remained the same, 18 ears were normal and 10 ears had negative middle ear pressure.

Bhuiyan et al. who measured middle ear pressure after nasal packing had examined three patients of antrochoanal polyp. All the three ears showed no improvement even after 5 days of pack removal. These results were similar to our result on the patients suffering from antrochoanal nasal polyp.

In this study, we have included 100 ears, which were evaluated by tympanometry. Before the nasal pack 18 ears had middle ear pressure less than –100 dapa. After 48 hours of nasal pack, 87 ears had negative middle ear pressure. Seven days after the removal of nasal pack, 16 ears had abnormal middle ear pressure, and 30 days later, 12 ears had negative middle ear pressure (Graph 2).

Middle ear pressure between –100 and 0 dapa was seen in 61 ears before nasal packing. After nasal packing for 48 hours 10 ears had pressure between –100 and 0 dapa. Seven days and 30 days after removal of nasal pack, 75 and 56 ears had pressure between –100 and 0 dapa respectively.

The pressure between 0 and 100 dapa was seen in 21 ears prepack and in three ears after 48 hours of nasal packing. Seven days and 30 days after removal of nasal packing, 9 and 32 ears had pressure between 0 and 100 dapa respectively (Table 6 and Graph 3).

The mean and standard deviation of middle ear pressure of all the 100 ears was calculated before the nasal pack, after 48 hours of nasal pack, 7 days after the removal of nasal pack and 30 days after removal of nasal pack.
Mean and standard deviation of all 100 ears prepack was $-42.96 \pm 72.63$. After 48 hours of nasal pack, the mean and standard deviation was found to be $-151.62 \pm 82.20$. Seven days after removal of nasal pack, the mean and standard deviation was $-50.25 \pm 60.51$ and 30 days after the removal of nasal pack the mean and standard deviation was $-18.42 \pm 51.63$. The middle ear pressure and standard deviation was significantly seen after 48 hours of nasal pack ($p < 0.0001$), and 30 days after removal of nasal pack ($p < 0.0001$) (Table 7 and Graph 4).

There was significant change seen statistically on applying paired t test (Table 8) preoperatively, after 48 hours of nasal pack, and 30 days after removal of nasal pack, while it was not significant 7 days after removal of nasal pack.

Mean and standard deviation of all 100 ears before nasal pack was $16.25 \pm 7.30$, after 48 hours of nasal pack the mean and standard deviation was $19.06 \pm 8.07$. After 7 and 30 days of nasal pack removal, the mean and standard deviation was found to be $16.92 \pm 7.29$ and $16.27 \pm 6.55$ respectively. The mean hearing threshold and standard deviation was extremely significant at 48 hours of nasal pack ($p < 0.0001$) (Table 9 and Graph 5).

We observed that the mean hearing threshold with standard deviation increased significantly ($19.06 \pm 8.07$) after 48 hours of nasal pack, compared with mean hearing threshold with standard deviation of prepack ($16.25 \pm 7.30$) (Table 4). On applying paired t test, there was significant change seen preoperatively and after 48 hours of nasal pack (Table 10) and no significant change seen after 7 days and 30 days of pack removal.
The range of middle ear pressure was also observed in all the patients, negative middle ear pressure developed in 95 ears (95%) and in 5 ears (5%) there was positive middle ear pressure. Change in pressure of ranges between 0 and –100 dapa was seen in 40 ears, pressure between –101 and –200 dapa was observed in 45 ears. Eight ears had change of pressure between –201 and –300 dapa and one ear had change of –376 dapa and one had change of pressure –427 dapa. So, in this study, it was observed that in most of the ears the change in middle ear pressure ranged between 0 and –200 dapa after nasal packing (Table 11).

**Table 11:** Range of change in middle ear pressure after pack

<table>
<thead>
<tr>
<th>Range of MEP</th>
<th>Number of ears</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to –100</td>
<td>40 (40%)</td>
</tr>
<tr>
<td>–101 to –200</td>
<td>45 (45%)</td>
</tr>
<tr>
<td>–201 to –300</td>
<td>8 (%)</td>
</tr>
<tr>
<td>–301 to –400</td>
<td>1 (%)</td>
</tr>
<tr>
<td>–401 to –500</td>
<td>1 (%)</td>
</tr>
</tbody>
</table>

**Table 10:** Table showing statistics of Pure Tone Audiometry during pre pack and after removal of nasal pack

<table>
<thead>
<tr>
<th>Audiology</th>
<th>Prepack</th>
<th>48 hours</th>
<th>t-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>16.2596</td>
<td>19.0641</td>
<td>5.2859</td>
<td>p&lt;0.0001 statistically significant</td>
</tr>
<tr>
<td>S.D.</td>
<td>7.3036</td>
<td>8.0772</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E.X</td>
<td>0.7304</td>
<td>0.8077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>16.2596</td>
<td>16.7289</td>
<td>1.0752</td>
<td>p = 0.2849 not significant</td>
</tr>
<tr>
<td>S.D.</td>
<td>7.3036</td>
<td>7.299</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E.X</td>
<td>0.7304</td>
<td>0.7299</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>16.2596</td>
<td>16.2729</td>
<td>0.025</td>
<td>p = 0.9801 not significant</td>
</tr>
<tr>
<td>S.D.</td>
<td>7.3036</td>
<td>6.5581</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E.X</td>
<td>0.7304</td>
<td>0.66558</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONCLUSION**

There is an increase in middle ear pressure transiently for a few days while the nasal pack is in situ, which returns to normal in a month after the pack removal. However, in chronic nasal obstruction cases, such as nasal polyps, there is persistent negative middle ear pressure probably due to irreversible changes in the Eustachian tube function.

**REFERENCES**