

# The middle ear pressure does not change after adenotonsillectomy in children younger than 10 years old

Bertha Beatriz Montaña-Velázquez,\* Laura Alejandra Villanueva-Padrón,\*\* Ernesto Conde-Vázquez,\*\*\*  
Edith Álvarez-Romero,\*\*\*\* Jaime Gaspar Romero-Asato,\*\*\* Kathrine Jáuregui-Renaud\*

\* Unidad de Investigación Médica en Otoneurología, \*\* Servicio de Audiología y Otoneurología,  
\*\*\* Servicio de Otorrinolaringología, Hospital General del Centro Médico Nacional La Raza, IMSS.  
\*\*\*\* Servicio de Otorrinolaringología, Hospital General de Zona 25, IMSS.

## ABSTRACT

**Objective.** In children aged less than 10 years, to assess whether adenotonsillectomy has some permanent or transitory effect on middle ear pressure. **Material and methods.** 20 children aged 4 to 9 years old (13 girls and 7 boys) participated in the study. The day before surgery and on days 1, 7, 14 and 21 after adenotonsillectomy both tympanometry and pure tone audiometry were performed. During surgery, medication consisted in dexamethasone, atropine, propofol and sevoflurane. **Results.** Before surgery, the middle ear pressure was within the range of  $0 \pm 99$  daPa. On day 1 of the follow-up study, the average right and left middle ear pressure decreased less than -99 daPa in 6 patients aged 4 to 9 years old (2 girls and 4 boys), with a body mass index from 11.9 to 16.6. At day 7 of follow-up, the middle ear pressure increased and none of the patients showed a pressure less than -99 daPa. Before surgery and during the 21 days of follow-up, hearing thresholds were always  $\leq 20$  dB nHL. No significant difference was observed between children with or without an average middle ear pressure lower than -99 daPa on their age, weight, height, body mass index or duration of the surgery. **Conclusions.** After adenotonsillectomy, children aged 4 to 9 years old who received dexamethasone, atropine and sevoflurane might develop negative middle ear pressure with no hearing loss, which may resolve in 1 week. After adenotonsillectomy, in patients with otalgia or risk factors for middle ear disease, closer evaluation of middle ear pressure may be advisable.

**Key words.** Tonsillectomy. Adenoidectomy. Middle Ear. Eustachian tube. Sevoflurane.

## *La presión del oído medio no cambia después de la adenoamigdalectomía en niños menores de 10 años de edad*

### RESUMEN

**Objetivo.** Identificar, en niños menores de 10 años, si la adenoamigdalectomía tiene algún efecto temprano o permanente en la presión del oído medio. **Material y métodos.** Participaron 20 niños de cuatro a nueve años de edad (13 niñas y siete niños) a quienes se les realizó adenoamigdalectomía, con anestesia general inducida con propofol y mantenida con sevoflurane con la administración de dexametasona perioperatoria. El día previo a la adenoamigdalectomía y a los días 1, 7, 14 y 21 del postoperatorio, se les efectuó audiometría de tonos puros y timpanometría. **Resultados.** Antes de la cirugía, la media de la presión de los oídos medios derecho e izquierdo se encontró dentro del intervalo de  $0 \pm 99$  daPa. Al día siguiente de la cirugía, la media de la presión disminuyó a menos de -99 daPa en seis pacientes (dos niñas y cuatro niños) de cuatro a nueve años de edad. Al día 7 de seguimiento, la presión del oído medio se incrementó y en ningún paciente se observó presión menor a -99 daPa. Antes de la cirugía y durante los 21 días del seguimiento, los umbrales auditivos fueron siempre  $\leq 20$  dB nHL. No se observaron diferencias significativas entre los niños con y sin disminución de la presión del oído medio a menos de -99 daPa en la edad, el peso, la talla, el índice de masa corporal o la duración de la cirugía. **Conclusiones.** Los niños de cuatro a nueve años de edad, después de adenoamigdalectomía con dexametasona perioperatoria y anestesia con propofol y sevoflurane, pueden presentar presión negativa transitoria en el oído medio, sin pérdida auditiva, la cual se resuelve en la primera semana. Después de adenoamigdalectomía, en pacientes con otalgia o factores de riesgo para otitis media, se sugiere evaluar la presión del oído medio.

**Palabras clave.** Amigdalectomía. Adenoidectomía. Oído medio. Tuba de Eustaquio. Sevoflurano.

## INTRODUCTION

In western countries, adenotonsillectomy is a common major surgery performed in children.<sup>1,2</sup> Because adenoids are thought to affect the Eustachian tube opening, several studies have evaluated the middle- and long-term effects of packing the nose and adenoidectomy with or without tonsillectomy on the middle ear.<sup>3,4</sup> However, studies evaluating the early effects of adenotonsillectomy on the middle ear pressure of children younger than 10 years old are scarce.

Composed of a bony ostium from the middle ear and a distensible cartilaginous segment that links the tympanic cavity to the nasopharynx, the Eustachian tube is horizontal at birth and it grows to be at an incline of 45 degrees in adulthood; additionally, as compared with the adult, in children it has less volume, greater cell density, and a decreased amount of elastin in the cartilage.<sup>5</sup>

Bonding and Tos (1981) investigated middle ear ventilation by tympanometry in different groups of patients with impaired air current in the upper airways.<sup>3</sup> Among adult patients with bilateral anterior packing and total blocking of the nose, 46% had clinically significant negative pressure in the middle ear. Unilateral posterior packing produced changes in 50% of ears, and tonsillectomy in 60% of ears. Hone, *et al.* (1997) investigated changes in middle ear pressure following tonsillectomy and examined whether any change may be related to the degree of postoperative pain and the presence of otalgia.<sup>4</sup> The day following tonsillectomy, 12 of 31 patients aged > 10 years developed middle ear pressure lower than -99 daPa that was not related to the degree of throat pain. However, the two studies were performed on patients older than 10 years, when acute middle ear disease is more prevalent in children, and adenotonsillectomy and adenoidectomy are frequently performed on children.<sup>6</sup>

This study was aimed to assess whether adenotonsillectomy has some deleterious effect on middle ear pressure in children younger than 10 years old, with no history or evidence of allergy, craniofacial anomalies or primary middle ear disease.

## MATERIAL AND METHODS

### Subjects

The study protocol was approved by the Local Research & Ethics Committee and each patient and caregiver received explanations concerning the pro-

cedure and signed a written informed consent form. Twenty children aged 4 to 9 years old (13 girls and 7 boys) participated in the study; their individual characteristics are described on table 1.

The children were selected after they were scheduled for adenotonsillectomy because of chronic adenoiditis and tonsillitis. None of the children had sinus or nasal disease (infectious or allergic), craniofacial anomalies or middle ear disease.

### Procedures

The day before adenotonsillectomy and at days 1, 7, 14 and 21 after adenotonsillectomy, the following studies were performed on both ears:

- Tympanometry (AT232, Interacoustics, Assens), with a 226 Hz tone and a peak pressure range of +300 to -300 daPa. The results were recorded as the air pressure of the ear canal corresponding to the peak of the tympanogram, by an Audiologist.
- Pure-tone audiometry (Grason Stadler Inc., Milford, NH 03055-3056, USA) was performed in a sound-treated booth to identify hearing thresholds at 0.25 to 8 kHz pure tones using 5 dB nHL steps, by an Audiologist.

Adenotonsillectomy was performed by dissection<sup>7</sup> by the same otolaryngologist. The adenoidectomy was performed by curettage, with removal of both central and lateral adenoid tissues. The tonsil and its capsule were separated from the peritonsillar tissues by cold dissection, mobilizing the upper pole of the tonsil at first. Haemostasis was achieved by ligation and diathermy. The duration of each surgery is shown on table 1. All children received pre-anaesthetic medication with atropine (0.01 mg/kg) and vecuronium bromide (0.05 to 0.10 mg/kg). Intraoperatively, intravenous dexamethasone (1 mg/kg up to 25 mg) was administered. Anaesthesia was induced with a bolus injection of 1 to 3 mg/kg propofol and maintained with sevoflurane (2% volume). The sevoflurane concentration was adjusted to maintain adequate anaesthesia, as judged by the anaesthesiologist based on blood pressure, heart rate readings and clinical signs.

### Statistical analysis

Statistical analysis was performed using the Friedman test and t test, p values lower than 0.05 were considered significant.

Table 1. General characteristics and middle ear pressure before and after adenotonsillectomy of 20 children aged 4 to 9 years old.

| Case | Age (years) | Gender* | Weight (kg) | Height (m) | Body mass index | Time of surgery (min) | Middle ear pressure (daPa) |        |       |        |        |
|------|-------------|---------|-------------|------------|-----------------|-----------------------|----------------------------|--------|-------|--------|--------|
|      |             |         |             |            |                 |                       | Before                     | Day 1  | Day 7 | Day 14 | Day 21 |
| 1    | 4           | F       | 16          | 1.06       | 14.2            | 60                    | -47.5                      | -72.5  | -17.5 | -2.5   | 5      |
| 2    | 4           | M       | 16          | 1.18       | 11.5            | 55                    | 57.5                       | -30    | 0     | 27.5   | 25     |
| 3    | 4           | M       | 18          | 1.18       | 12.9            | 45                    | 20                         | -115   | 15    | 7.5    | -40    |
| 4    | 5           | F       | 16          | 1.16       | 11.9            | 55                    | 42.5                       | -142.5 | 10    | 40     | 22.5   |
| 5    | 5           | M       | 18          | 1.18       | 12.9            | 40                    | 15                         | -147.5 | 5     | 25     | 2.5    |
| 6    | 6           | F       | 21          | 1.19       | 14.8            | 60                    | -50                        | -57.5  | 5     | 22.5   | -70    |
| 7    | 6           | F       | 18          | 1.16       | 13.4            | 50                    | 12.5                       | -92.5  | -20   | 20     | -40    |
| 8    | 6           | F       | 18          | 1.18       | 12.9            | 60                    | 17.5                       | -50    | 22.5  | 17.5   | 15     |
| 9    | 6           | F       | 20          | 1.22       | 13.4            | 60                    | 17.5                       | 27.5   | 50    | 32.5   | 22.5   |
| 10   | 6           | M       | 18          | 1.18       | 12.9            | 60                    | 35                         | -17.5  | 25    | 25     | 20     |
| 11   | 6           | M       | 18          | 1.18       | 12.9            | 60                    | -30                        | -190   | 47.5  | 32.5   | -7.5   |
| 12   | 7           | F       | 22          | 1.22       | 14.8            | 45                    | 22.5                       | 2.5    | 7.5   | 10     | -20    |
| 13   | 7           | F       | 20          | 1.2        | 13.9            | 50                    | 20                         | 22.5   | 22.5  | 15     | -25    |
| 14   | 7           | M       | 18          | 1.18       | 12.9            | 50                    | -47.5                      | -210   | -5    | -97.5  | -85    |
| 15   | 8           | F       | 22          | 1.23       | 14.5            | 60                    | -42.5                      | 0      | 15    | 12.5   | 20     |
| 16   | 8           | F       | 25          | 1.27       | 16              | 60                    | 25                         | 25     | 42.5  | 35     | 35     |
| 17   | 9           | F       | 24          | 1.23       | 15.9            | 50                    | 5                          | -15    | 12.5  | 20     | 25     |
| 18   | 9           | F       | 28          | 1.26       | 17.6            | 50                    | -5                         | -97.5  | 10    | -215   | -52.5  |
| 19   | 9           | F       | 28          | 1.3        | 16.6            | 60                    | -47.5                      | -122.5 | 32.5  | 32.5   | 30     |
| 20   | 9           | F       | 24          | 1.26       | 15.1            | 50                    | 25                         | -92.5  | 17.5  | 10     | 10     |

\* F: female. M: male.

## RESULTS

Before surgery, the middle ear pressure was within the range of  $0 \pm 99$  daPa. At day 1 of follow-up, middle ear pressure decreased significantly (Friedman test,  $p \leq 0.001$ ) (Figure 1). Although, individual recordings showed a decrease in 16 patients (80%) (Table 1), at this time, the average right and left middle ear pressure was -99 daPa only in 6 patients (30%) (Figure 2), who were aged 4 to 9 years old (2 girls and 4 boys), with a body mass index from 11.9

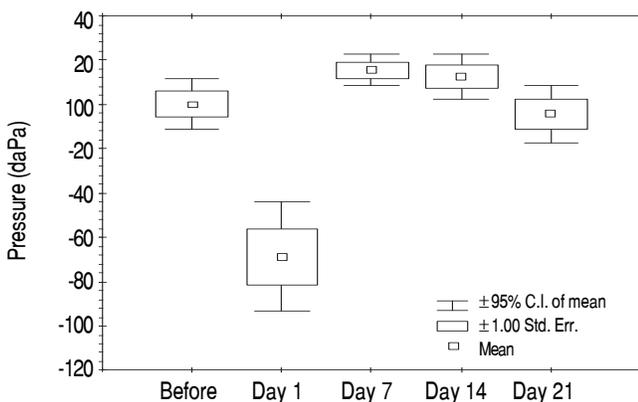


Figure 1. Mean and 95% confidence interval of the mean middle ear pressure of 20 children aged 4 to 9 years old before and on days 1, 7, 14 and 21 after adenotonsillectomy.

to 16.6 (Table 1). No significant difference was observed between children with or without an average middle ear pressure lower than -99 daPa on their age, weight, height, body mass index or duration of the surgery. At day 7 of follow-up, the middle ear pressure increased (Figure 1) and none of the patients showed a pressure lower than -99 daPa (Table 1). No further group changes were observed in the following recordings (Figure 1). Although, on day 14, one patient (case 18 on table 1) showed a unilateral middle ear pressure decrease that was related to pharyngitis.

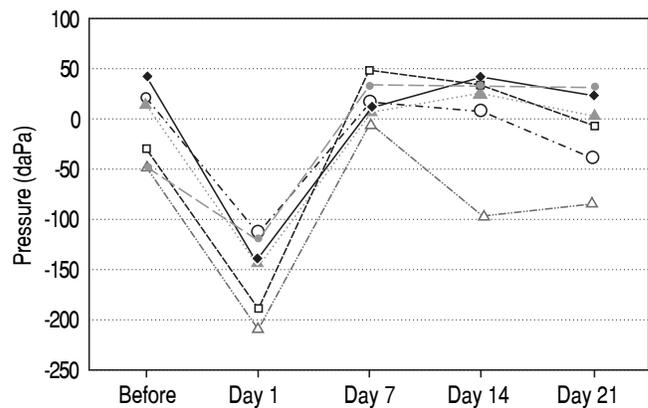


Figure 2. Mean middle ear pressure of 6 children aged 4 to 9 years old, before and on days 1, 7, 14 and 21 after adenotonsillectomy.

In the 6 patients with the initial significant decrease of the mean middle ear pressure, lower than -99 daPa, the follow up study showed a similar evolution in 5 of the patients (Figure 2), which was independent from their age or body mass index; only one male patient (7 years old, body mass index 12.9) showed a tendency towards a negative middle ear pressure.

Before surgery and during the 21 days of follow-up, the hearing thresholds of all of the children were always  $\leq 20$  dB nHL.

## DISCUSSION

Children aged 4 to 9 years old with no sinus or nasal disease (infectious or allergic), craniofacial anomalies or middle ear disease, might develop a negative middle ear pressure during the first day after adenotonsillectomy. However, this condition may resolve within 1 week, with no evidence of hearing impairment.

Previous studies in adults<sup>3</sup> and patients aged 10 years or older<sup>4</sup> have shown that about 39 to 60% of the patients may develop negative middle ear pressure following tonsillectomy, which returned to normal within a few days. In this study, 30% of children younger than 10 years undergoing adenotonsillectomy showed similar results. Although otalgia after tonsillectomy, frequently occurring within the first week, is generally considered to be due to referred pain from the throat,<sup>4,8</sup> these findings suggest a possible contribution of negative middle ear pressure. Therefore, in young children undergoing adenotonsillectomy, with otalgia or risk factors for middle ear disease, a follow up evaluation of middle ear pressure after surgery is advised.

In children, enlarged adenoids and/or tonsils have been related to Eustachian tube dysfunction with otitis media. However, studies assessing improvement in otitis media with effusion after adenoidectomy and or tonsillectomy have shown no consistent results,<sup>9,10</sup> supporting that, without surgery, 26% of the cases may resolve spontaneously within one year.<sup>10</sup> In this study, in children aged 4 to 9 years undergoing adenotonsillectomy, with no sinus or nasal disease (infectious or allergic), craniofacial anomalies or middle ear disease, we observed just a transient and inconsistent effect of adenotonsillectomy on the mean middle ear pressure. These results suggest that, in this group of children, the removal of the adenoids and tonsils by itself may have no direct effect on the middle ear pressure.

To explain the transient effect of the intervention on middle ear pressure, several factors have to be considered. The anatomic characteristics combined with the inflammatory changes occurring during the first days after adenotonsillectomy and painful and less frequent swallowing<sup>11</sup> may have an influence on Eustachian tube function. However, another factor to be considered is inhalant anaesthesia. Evidence has shown that sevoflurane may decrease middle ear pressure in children. In 25 male children scheduled for circumcision and receiving anaesthesia with either propofol or sevoflurane, tympanometry before anaesthesia and 10 min after anaesthesia showed an increase in middle ear pressure in the sevoflurane group.<sup>12</sup> Other medication that could have an influence on middle ear pressure was the administration of atropine, which may itself reduce both active and passive functions of the Eustachian tube.<sup>13</sup> Interestingly, we observed the occurrence of negative middle ear pressure happening without clinical symptoms, on the first day after the operation. This finding could be related to the routine use of dexamethasone, which is administered for reducing emesis and pain<sup>14-16</sup> and may also improve fluid clearance in the middle ear.<sup>17</sup>

Then, we conclude that after adenotonsillectomy, children aged 4 to 9 years old who received dexamethasone, atropine and sevoflurane might develop negative middle ear pressure with no hearing loss, which may resolve in 1 week. After adenotonsillectomy, in patients with otalgia or risk factors for middle ear disease, closer evaluation of middle ear pressure may be advisable.

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*Reimpresos:*

**Dra. Kathrine Jáuregui-Renaud**

Unidad de Investigación Médica en Otoneurología  
Edificio C "Salud en el Trabajo"  
Centro Médico Nacional Siglo XXI, IMSS  
Av. Cuauhtémoc, Núm. 330  
Col. Doctores  
06720, México, D.F.  
Tel.-Fax: (5255) 5627-6900, Ext. 21669  
Correo electrónico: kathrine.jauregui@imss.gob.mx

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