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Mahmoud Ahmed Nagy Mohamed

*Otorhinolaryngology department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt,*  
mahmoudnagy2050@gmail.com

Ayman .A. El-Shehally

*Otorhinolaryngology department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt*

Ali khalaf Mahrous

*Otorhinolaryngology department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt*

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# Variables Influencing the Extrusion Rate of Ventilation Tubes

Mahmoud Ahmed Nagy Mohamed\*, Ayman Abdelaziz El-Shehally, Ali khalaf Mahrous

Department of Otorhinolaryngology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

## Abstract

**Background:** Otitis media (OM) with effusion is a frequent pediatric disorder. It is the most common cause of conductive hearing loss in children.

**Aim and objectives:** The study aimed to determine the factors which might affect the extrusion rate of ventilation tubes.

**Patients and methods:** This is a prospective study to determine the factors which might affect the extrusion rate of ventilation tubes. The study was conducted on 88 patients who were diagnosed with persistent bilateral otitis media with effusion. They were collected from Ear, nose and throat (ENT) clinics of AL-Hussein University Hospital and Mansheyat EL-Bakry General Hospital. They underwent myringotomy with ventilation tubes insertion, during the period from December 2019 to April 2022.

**Results:** There were no statistically significant difference between age, sex, recurrent postoperative upper respiratory tract infection, adenoidectomy needed or not, presence of cleft palate or not, grade of surgeon, and the time of tube extrusion among study group, there was a statistically significant difference between site of tube insertion and the time of tube extrusion among study group  $P$  value = 0.009, postero-inferior insertion has more rapid tube extrusion than antero-inferior and antero-superior insertion. There was a statistically significant difference between type of grommet and the time of tube extrusion among study group  $P$  value = 0.0001, as regards type of grommet the shepard has more rapid tube extrusion than Armstrong's grommets with statistical significant difference.

**Conclusion:** The current study showed a statistically significant correlation between ventilation tube extrusion rate and the site or type of grommets inserted.

**Keywords:** Armstrong's grommets, Otitis media with effusion, Tympanic membrane adhesions, Ventilation tube extrusion

## 1. Introduction

Otitis media (OM) is one of the most common diseases of childhood. Up to 70–83% of children eventually have at least one episode of OM.<sup>1</sup> OM is defined as fluid in the middle ear (ME) without acute infection signs or symptoms and the condition is considered chronic when it lasts for three months or more from the date of onset or the date of diagnosis. It is also named as serous, secretory, or nonsuppurative otitis media. The fluid in the ME can be serous (thin) or mucoid (thick) and if it is very thick, the condition is called a 'glue-ear'.<sup>2</sup>

OM with effusion is characterized by the collection of serous or mucous fluid behind an intact tympanic membrane cavity during an inflammatory process and the lack of acute signs and symptoms of infection.<sup>3</sup>

Otitis media with effusion (OME) is a common cause of conductive hearing loss in children. It results in variable degrees of lost of hearing which can affect the auditory system development during this early and important period of life.

For the child who is not at a high risk, 3-month period of watchful waiting from the date of effusion onset (if known) or diagnosis (if onset is unknown)

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\* Corresponding author at: Department of Otorhinolaryngology, Faculty of Medicine, Al-Azhar University, Cairo, 11618, Egypt. Fax: 20225065579. E-mail address: [mahmoudnagy2050@gmail.com](mailto:mahmoudnagy2050@gmail.com) (M.A.N. Mohamed).

is recommended, in order to avoid any unnecessary surgery, and its complications.<sup>4</sup>

However, children with recurrent acute otitis media (AOM), chronic otitis media with effusion (COME), tympanic membrane adhesions to middle ear structures, or complications of AOM frequently require tympanostomy tubes for resolution of their disease. Tympanostomy tube placement is currently the most frequent Ear, nose and throat (ENT) surgical procedure used, that requires a general anesthetic.<sup>1</sup>

It is usually stated that ventilation tubes in current use tend to remain in place on an average for 6–7 months before being spontaneously extruded, but their tenure is highly variable, sometimes days, sometimes years.<sup>5</sup>

The study aimed to determine the factors which might affect the extrusion rate of ventilation tubes.

## 2. Patients and methods

The prospective of this study is to determine the factors which might affect the extrusion rate of ventilation tubes. The study was conducted on 88 patients who were diagnosed with persistent bilateral OME. They were collected from ENT clinics of AL-Hussein University Hospital and Mansheyt EL-Bakry General Hospital then underwent myringotomy with ventilation tubes insertion with or without adenoidectomy, during period from December 2019 to April 2022.

**Inclusion criteria:** we included only patients with bilateral OME, of any age or sex.

**Exclusion criteria:** unilateral OME, revision cases of previous myringotomy with ventilation tube insertion or cases of myringotomy with T-tubes insertion.

### 2.1. Methods

Through full history taking from the patients or the parents followed by full ENT clinical examination, those patients who fulfilled the inclusion criteria were enrolled in our study. The diagnosis was made by otoscopic examination, audiological assessment (pure-tone audiometric measurements or ABR according to age), and radiography nasopharynx. Patients with otoscopic signs of COME, a type B tympanogram and any conductive hearing loss were considered positive for COME. Myringotomy with bilateral tympanostomy tubes insertion operation was performed on patients whose COME lasted more than 3 months not responding to treatment. Adenoidectomy also was

done if needed for patients with hypertrophied adenoid showed in nasopharynx radiography.

All cases were examined postoperatively at ENT clinics in our hospitals once in every month until extrusion of tympanostomy tubes.

The eight items fulfilled and recorded with each patient: age, sex, presence of cleft palate or not, adenoidectomy was needed with myringotomy operation or not, site of tube insertion in each tympanic membrane, type of tympanostomy tube, grade of surgeon (consultant, specialist, resident), and recurrence of postoperative upper respiratory tract infection.

Just 80 patients came regularly to ENT clinics of our hospitals every month after surgery until ventilation tubes were extruded (8 patients were not regular follow-up, so they were excluded from the study).

This study was approved by ethical committee of ENT department, Faculty of Medicine, Al Azhar University.

### 2.2. Statistical methods

Data were coded and entered using the statistical package for the social sciences (SPSS) pass11 program. Data was summarized using mean, median and SD. *P* values less than 0.05 were considered at statistically significant.

## 3. Results

This study is a prospective study to determine the factors which might affect the extrusion rate of ventilation tubes. The study was conducted on 88 patients who were diagnosed with persistent bilateral OM with effusion. They were collected from ENT clinics of AL-Hussain University Hospital and Mansheyt EL-Bakry General Hospital then underwent myringotomy with ventilation tubes insertion with or without adenoidectomy. Just 80 patients came regularly to ENT clinics of our hospitals every month after surgery until ventilation tubes were extruded (8 patients were not regular follow-up, so they were excluded from the study).

This study shows that there is no statistically significant relation between sex and rate of tube extrusion among study group (Fig. 1).

This study shows that there were very weak positive correlation with no statistically significant relation between age and duration of tube extrusion of study group by using *r* test.

This study shows that there is no statistically significant relation between postoperative recurrent

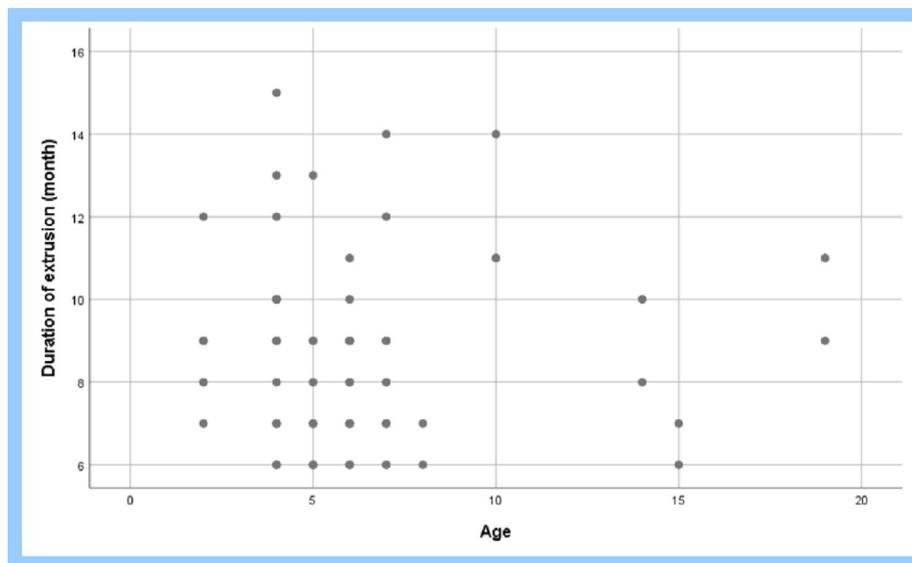


Fig. 1. Shows relation between age and duration of tube extrusion among study group.

Upper respiratory tract (URT) infections and rate of tube extrusion among study group.

This study shows that there is no statistically significant relation between presence of cleft palate or not and rate of tube extrusion of study group.

This study shows that there is no statistically significant relation between Adenoidectomy and rate of tube extrusion of study group.

This study shows that there is a statistically significant relation between site of tube insertion and duration of tube extrusion among study group  $P$  value = 0.009. By using post hoc test, the ANOVA test revealed that there is a statistically significant difference between Antero-inferior and postero-inferior insertion as  $P$  value = 0.049 and there is a statistically significant difference between posterior inferior and antero-superior insertion as  $P$  value = 0.017, so postero-inferior insertion has lower duration of tube extrusion than Anterior-inferior and antero-superior insertion.

This study shows that there is a statistically significant relation between the type of grommet and duration of tube extrusion among study group, as there is a statistically significant difference between shepard and Armstrong's grommets  $P$  value = 0.0001 as regards type of grommet the shepard has more rapid tube extrusion than Armstrong's grommets with statistical significant difference (Tables 1–4).

According to the results of our research, there is no correlation that can be considered statistically significant between the sex and the rate of tube extrusion among the study group (Table 5).

Using the  $r$  test, our research demonstrates that there was only a very weak positive connection, and

Table 1. Demographic data of study group (80 patients) as regard age and sex

| Variables           | Study group $N = 80$ |
|---------------------|----------------------|
| Age:<br>(mean + SD) | 6.4 + 3.19           |
| Sex                 |                      |
| Male                | 51 (63.75%)          |
| Female              | 29 (36.25%)          |

Table 2. Percentages of postoperative recurrent upper respiratory tract infections, adenoidectomy, cleft palate among study group.

| Variables                               | Study group $N = 80$ |
|---|----------------------|
| Postoperative recurrent (URT infection) |                      |
| +ve infection                           | 55 (68.75%)          |
| none                                    | 25 (31.25%)          |
| Adenoidectomy                           |                      |
| Needed and done with myringotomy        | 71 (88.75%)          |
| Not needed and not done                 | 9 (11.25%)           |
| cleft palate                            |                      |
| Present                                 | 12 (15%)             |
| Not Present                             | 68 (85%)             |

URT, Upper respiratory tract.

there was no statistically significant association between the age of the study group and the length of time it took for tube extrusion (Table 6).

According to the findings of our research, there is no correlation that can be considered statistically significant between postoperative recurring URT infections and antibiotic use (URT infection and rate of tube extrusion among study group) (Table 7).

According to the findings of our research, there is no statistically significant connection between having an adenoidectomy and the rate of tube extrusion among the study group (Table 8).

Table 3. Percentages of Site of insertion, type of grommet, Grade of surgeon and mean duration of extrusion among study group.

| Variables               | Study group<br>tubes = 160 | Number of |
|-------------------------|----------------------------|-----------|
| Site of tube insertion: |                            |           |
| Postero-inferior        | 52 (32.5%)                 |           |
| Antero-inferior         | 64 (40%)                   |           |
| Antero-superior         | 44 (27.5%)                 |           |
| Type of grommet:        |                            |           |
| Shepard                 | 100 (62.5%)                |           |
| Armstrong's grommets    | 60 (37.5%)                 |           |
| Grade of surgeon:       |                            |           |
| Resident                | 55 (34.4%)                 |           |
| specialist              | 59 (36.9%)                 |           |
| consultant              | 46 (28.7%)                 |           |
| Duration of extrusion:  |                            |           |
| mean + (SD)             | 8.45 + 2.1                 |           |

SD, Standard deviation.

According to the findings of our research, there is a correlation between the site of tube insertion and the length of time it takes for the tube to be extruded from the study group, and the *P* value for this correlation is 0.009. By using the post hoc test in the ANOVA test, it was discovered that there is a statistically significant difference between Antero-inferior and postero-inferior insertion with a *P* value of 0.049, and that there is a statistically significant difference between posterior inferior and antero-superior insertion with a *P* value of 0.017. As a result, postero-inferior insertion has a shorter duration of tube extrusion (Table 9).

There is a statistically significant difference between shepard and Armstrong's grommets with a *P* value of 0.0001 as regards type of grommet as shepard has more rapid tube extrusion than Armstrong's grommets, and our research demonstrates that there is a statistically significant relation between the type of grommet and the duration of tube extrusion among the study group.

#### 4. Discussion

OME is the most common cause of conductive hearing loss in children. It results in variable degrees of hearing loss which can affect the auditory system development during this early and important period of life. Dai and colleagues.<sup>6</sup> OME is a frequent pediatric disorder. The diagnosis is essentially clinical and is based on otoscopy

Table 5. Relation between age and duration of tube extrusion among study group.

| Age (6.4 + 3.1)                           | <i>r</i> test <sup>a</sup> | <i>P</i> value |
|---|----------------------------|----------------|
| Duration of tube extrusion<br>(8.4 + 2.1) | 0.066                      | 0.558          |

<sup>a</sup> Pearson Correlation test \*Statistically significant at *P*-value < 0.05.

and audiological assessment, Mulvaney and colleagues.<sup>7</sup>

The study was conducted on 88 patients who were diagnosed with persistent bilateral OME. They were collected from ENT clinics of AL-Hussain University Hospital and Mansheyt EL-Bakry General Hospital then underwent myringotomy operation with ventilation tubes insertion with or without adenoidectomy, during period from December 2019 to April 2022.

The present study showed that 63.7% of patients were male while 36.3% were female and the minimum age was 2 and the maximum age of study group was 19, as mean age of patients are 6.4 years old. There was no statistically significant relation between sex and rate of tube extrusion among study group. There was very weak positive correlation with no statistically significant relation between age and duration of tube extrusion of study group. The present study showed 68.8% of patients had post-operative recurrent URT infections, 11.2% of patients had adenoidectomy with myringotomy and 11.3 of patients had cleft palate. There is no statistically significant relation between postoperative recurrent URT infections and rate of tube extrusion among study group. There is no statistically significant relation between Adenoidectomy or presence of cleft palate and rate of tube extrusion of study group.

Our results were supported by study of Song and colleagues<sup>8</sup> as they reported that the extrusion time tended to increase with an increase of adenoid hypertrophy (grade 0, 202 days; grade 1, 231 days; grade 2, 266 days; grade 3, 307 days). However, there was no statistical significance (*P* = 0.362). There was no difference in the extrusion time between the patients who had ventilation tube (VT) insertion accompanied by adenoidectomy (mean, 272 days) and those who had VT insertion without adenoidectomy (mean, 252 days; *P* = 0.516).

Table 4. Relation between sex and duration of tube extrusion among study group.

| Variables                   | Male patients N <sup>a</sup> = 51 | Female patients N = 29 | t test | <i>P</i> value |
|-----------------------------|-----------------------------------|------------------------|--------|----------------|
| Duration of extrusion: tube |                                   |                        |        |                |
| Mean + SD                   | 8.49 + 2.08                       | 8.38 + 2.2             | 0.296  | 0.82           |

Statistically significant at *P*- value < 0.05, SD, Standard deviation.

<sup>a</sup> N=Number.

Table 6. Relation between recurrent post-operative upper respiratory tract infections and duration of tube extrusion among study group.

| Variables                        |      | URT infection recurrent postoperative |                         | t test | P value |
|----------------------------------|------|---------------------------------------|-------------------------|--------|---------|
| Duration of extrusion: Mean + SD | tube | +ve N = 55<br>8.42 + 2.05             | –ve N = 25<br>8.5 + 2.3 | 0.198  | 0.844   |

\*Statistically significant at P- value < 0.05, SD, Standard deviation.

Table 7. Relation between Adenoidectomy and duration of tube extrusion among study group.

| Variables                        |      | Adenoidectomy                        |                               | t test | P value |
|----------------------------------|------|--------------------------------------|-------------------------------|--------|---------|
| Duration of extrusion: Mean + SD | tube | Needed and Done N = 71<br>8.35 + 2.1 | Not needed N = 9<br>9.2 + 1.9 | 1.16   | 0.249   |

\*Statistically significant at P- value < 0.05.

Table 8. Relation between site of tube insertion and duration of tube extrusion among study group.

| Variables                             | Site of tube insertion               |                                      |                                       | Test of Significance | P value |
|---------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|----------------------|---------|
| Duration of tube extrusion: Mean + SD | Postero-inferior N = 52<br>7.7 + 1.5 | Antero-inferior N = 64<br>8.6 + 2.03 | Antero-superior N = 44<br>8.95 + 2.57 | ANOVA test*          | 0.009** |

\*Statistically significant at P- value < 0.05.

Table 9. Relation between Type of grommet and duration of tube extrusion among study group.

| Variables                             | Type of grommet               |   | t test | P value |
|---------------------------------------|-------------------------------|---|--------|---------|
| Duration of tube extrusion: Mean + SD | Shepard N = 100<br>7.78 + 1.7 | Armstrong's grommets N = 60<br>9.57 + 2.1 | 5.36   | 0.0001* |

\*\*Statistically significant at P- value < 0.05.

Adenoid hypertrophy and chronic or recurrent adenoiditis have been postulated as contributing factors in the development of recurrent AOM and chronic OME. Yet in relation to the removal of the adenoid, Iwaki and colleagues<sup>9</sup> reported that adenoidectomy did not influence the recurrence rate of OME.

Whereas in the study of Lin and colleagues<sup>10</sup> they reported that patients with predisposing factors, such as presence of gluey middle ear effusion, and no postoperative ear infections, had longer extrusion times compared with those without predisposing factors. The current study showed that there is no statistically significant relation between Grade of surgeon and rate of tube extrusion of study group.

In the present study, most of patients (40% of patients) had – site of insertion (Antero-inferior) and most of them (62.5%) of patients had shepherd as type of ventilation tube. Most operations were done by specialist (36.9%) and the mean duration of tube extrusion was 8.5 months.

There was a statistically significant relation between site of tube insertion and duration of tube extrusion among study group P value = 0.009. By

using post hoc test, the ANOVA test revealed that there is a statistically significant difference between Antero-inferior and postero-inferior insertion as P value = 0.049 and there is a statistically significant difference between posterior-inferior and antero-superior insertion as P value = 0.017, so postero-inferior insertion has lower duration of tube extrusion than Anterior-inferior and antero-superior insertion.

There was a statistically significant relation between the type of grommet and duration of tube extrusion among study group as there is a statistically significant difference between shepherd and Armstrong's grommets P value = 0.0001 as regards type of grommet the shepherd has more rapid tube extrusion than Armstrong's grommets with statistically significant difference.

Our results were supported by study of Lin and colleagues<sup>10</sup> as they reported that the extrusion process happened more quickly in smaller tubes than in larger ones in adults and children. In their study, a VT diameter larger than 1 mm was also found to increase the chance of maintaining the VT in place for more than 12 months in children. Therefore, a different tube size should be

considered when prolonged ventilation duration is required, and we recommend avoiding the usage of VTs with diameters less than 1 mm in children to prevent early extrusion.

Interestingly, a more recent article by Kim and colleagues<sup>11</sup> demonstrated that there was a significant increase in the time to extrusion in ears where a 1.02 mm-sized thermoplastic elastomer VT was inserted compared with that in the 1.14 mm-sized silicone VT. The authors stated that although, generally, the larger inner diameter of the tube lasts longer in the eardrum, the contrasting result is thought to be due to the different material properties of both VTs.

Paparella,<sup>12</sup> recommend choosing an appropriate VT size according to short-term or long-term purposes, as tubes with a diameter of approximately 1.1 mm maintain for 1 year and 1.5 mm tubes maintain for more than 1 year.

The study by Dingle and colleagues<sup>13</sup> and Shone and colleagues<sup>14</sup> demonstrated that the duration for the tube to be in place and functional was longer for titanium VTs compared with Teflon VTs.

However, it was also demonstrated that, as long as the middle ear cavity remained healthy, no significant difference was seen for transient dysfunction and tube extrusion rates between fluoroplastic and titanium tubes, although better biocompatibility was observed for the titanium tubes. While titanium tubes might be the better choice for adult patients lacking Eustachian tube dysfunction and OME, Handler et al. proposed that there were no differences in extrusion times between titanium VTs and silicone VTs and addressed the issue regarding the considerable cost differences between these 2 types of tubes Kisser and colleagues.<sup>15</sup>

#### 4.1. Conclusion

The current study showed factors that shorten ventilation tube extrusion time. There was a statistically significant difference between site of tube insertion, type of grommet tube and the time of tube extrusion. There was no statistically significant difference between age, sex, recurrent postoperative

upper respiratory tract infection, adenoidectomy needed or not, presence of cleft palate or not, grade of surgeon and the time of tube extrusion.

#### Conflict of interest

None declared.

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