Objective: To study the qualities of laser myringotomy (LM) as a treatment for middle ear ventilation problems.

Design: Prospective study and follow-up of consecutive cases of adults, children, and infants. Patients were observed for up to 2 years.

Setting: Children underwent LM, with or without adenoidectomy, under general anesthesia in the operating room. Adults and infants underwent LM under topical anesthesia, as an outpatient procedure.

Patients: All consecutive patients with either secretory otitis media (SOM) (adults and children) or acute otitis media (AOM) (infants) who agreed to participate were included without selection.

Intervention: Myringotomy was performed using new laser equipment, enabling a 0.1-second ablation with changeable diameter.

Outcome Measures: Close follow-up, with microscopic examination of all ears. Findings were noted on the medical charts.

Results: Among all age groups, 136 ears were followed up. Perforation lasted a mean 22 days in adults, 17 days in children, and 11 days in infants. Patient age was found to be a significant determining factor for duration of perforation ($P = .002$). Laser myringotomy in the anterior and inferior areas lasted longer than posterior LM ($P < .001$). In patients with SOM, during the time the LM was patent, all ears were ventilated. In children, 38% of SOM cases resolved after a single LM treatment. All infants with AOM recovered promptly without antibiotic treatment.

Conclusions: Laser myringotomy is a convenient, quick procedure that can be performed in the medical office with the use of topical anesthesia and is suitable for patients with AOM or for those who need short-term ventilation for SOM. It was found to be a safe alternative to ventilation tubes in these patients. In AOM, it was used instead of antibiotics and gave prompt relief from symptoms and cure of the AOM.


Laser myringotomy (LM) in human ears was first introduced by Goode in 1979, who used focused and defocused carbon dioxide laser beams. The pioneers of this method reported bloodless perforation lasting longer than myringotomy performed with a knife. The duration of the perforation seemed to be longer with increased size of the myringotomy. It was first performed on adults, using repeated single pulses of 0.1 to 0.2 seconds of a focused or defocused beam. Recently, a carbon dioxide laser system (OtoLAM; ESC/Sharplan, Tel Aviv, Israel) was introduced that enables a complete circular myringotomy to be ablated by a scanned single pulse of 0.1 to 0.2 seconds. With this tool, LM became an easy and practical procedure, performable under topical anesthesia, that was fitting for office use and suitable for children and infants with SOM or AOM. Results using this new instrument are presented in correlation with the previous literature.

In this article, acute (purulent) otitis media (AOM), or recurrent AOM, is defined as an acute purulent infection of the middle ear, with bulging of the tympanic membrane and fluid medial to it, as detected by microscopic otoscopy, frequently with redness and thickening of the tympanic membrane, together with symptoms of AOM such as pain and irritability. Secretory (serous) otitis media (SOM), or otitis media with effusion, is the presence of (nonpurulent) fluid medial to the tympanic membrane, without bulging, with symptoms of hearing loss, as diagnosed by microscopic otoscopy and tympanometry.

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PATIENTS AND METHODS

DEVICE DESCRIPTION

The carbon dioxide laser system was used (Figure). The system is a video-monitored laser otoscope with a circulating beam. After determining the necessary size of the myringotomy, a helium-neon circulating beam is directed to the desired site on the tympanic membrane, and the ablation is performed. The laser energy on every point of the ablated area is designed to be greater than 5 J/cm², the threshold level for char-free vaporization of tissue, creating a sharp margin encircling the perforation to a depth of 300 µm or more, which is the mean thickness of the tympanic membrane. The relevant settings are automatically plotted, and the procedure is monitored on a television screen and can be videotaped, if desired.

STUDY DESIGN

Included in this study were patients of different ages having middle ear ventilation or drainage problems who were found suitable for LM. Informed consent was obtained before the procedure. Patients were followed up frequently (every 2-3 days) for up to 1 week and then weekly until the perforation was closed. Follow-up was then continued according to the clinical course.

At each follow-up, both ears were examined using the operating microscope, with special attention to any damage (such as thinning or retraction) to the tympanic membrane or the middle ear. Findings were noted in special follow-up charts and illustrated on drawings, referencing the location of findings to the site of the LM.

Hearing tests and tympanometry were performed in all adults and children before LM and after the perforation closure. They were not done on infants.

The patients were divided into 3 age groups.

Adults

This group of patients included adults with SOM, those requiring myringotomy before hyperbaric oxygen treatment, and patients undergoing middle ear endoscopy. All underwent a hearing test before LM and after the closure of the perforation.

Children

Included in this group were children with SOM, who underwent this procedure with or without adenoidectomy. Some children had thin and retracted tympanic membranes and were candidates for prolonged middle ear ventilation. They were included in this study to investigate the benefit of LM in such cases, or on parental request, or when ventilation tubes were clinically undesirable. All children underwent a hearing test before the procedure and after closure of the perforation.

Infants

Infants with AOM comprised this group. Antibiotic use in this group was avoided, and frequent follow-up visits were scheduled to ensure the infants’ well-being and to study the effectiveness of LM as a single treatment. Hearing was not tested in this group.

SUBJECTS

We report on 136 ears in 81 patients: (1) 23 ears in 18 adults (aged 16-83 years; mean age, 52 years); (2) 47 ears in 26 children with SOM (aged 2-7 years; mean age, 4.8 years); and (3) 66 ears in 37 infants with AOM (aged 1-30 months; mean age, 6.5 months).

The children’s group was the first to be treated by LM. Because it was a new technique, it was performed under general anesthesia in the operating room, in some cases with adenoidectomy. After gaining experience, we performed LM on adults and infants in the outpatient clinic, under topical anesthesia. In this setting, a piece of cotton dipped in 10% lidocaine hydrochloride was applied to the tympanic membrane for 30 to 60 minutes. When necessary, premedication with syrup of triclofos sodium was given. Patients reported a mild pain or “sting” after the procedure, lasting 2 to 3 minutes.

RESULTS

Hearing tests before and after LM showed no deviations from the expected findings in cases of fluid in the middle ear (air-bone gap and type B tympanometry) and after successful ventilation (data not shown). There was no deterioration in hearing after LM in any of the patients.

ADULTS

In this group of 23 ears, 17 had SOM, 2 (in 2 patients) had suspected cholesteatoma and needed middle ear endoscopy, 2 (in 2 patients) had AOM, and 2 (in 1 patient) required myringotomy before hyperbaric oxygen therapy. The diameter of the myringotomy ranged from 1 to 2.2 mm, with the larger size chosen when a longer duration was needed. The perforation closed in all ears within 1 to 6 weeks (mean±SD, 3.2±1.2 weeks; or 22.4 days). Patient follow-up ranged from 1.5 to 60 weeks (mean±SD, 10.2±14 weeks), depending on the medical problem.

All perforations closed and healed, but thinning of the drum was observed in 3 ears, without retractions. Seven of 17 ears with preexisting SOM ended with the same condition, but while the perforation existed, there was no fluid and hearing improved temporarily. In these cases, the cause of the SOM was unknown, but nasopharyngeal tumor presence was excluded.

The correlation between the size and duration of the perforation was tested by dividing the ears into 2 groups: those with perforations of 1 to 1.6 mm (8 ears) and those 1.8 to 2.2 mm (15 ears). In the first group, the perforation closed within a mean 3.2 weeks, and in the second,
The OtoLAM instrument (ESC/Sharplan, Tel Aviv, Israel).

3.27 weeks. This difference was not significant \( (P = .78; \) Mann-Whitney test).

CHILDREN

This group included 47 ears (26 patients). Children were aged 2 to 7 years \( (\text{mean} \pm \text{SD}, 4.8 \pm 1.3 \text{ years}) \). They had prolonged SOM \( (>3 \text{ months}) \) and originally had been scheduled for adenoidectomy and insertion of ventilation tubes before consideration of LM. Fourteen ears had moderate to severe thinning and retractions of the posterior and posterior superior areas. Therefore, this group was considered to have many severe cases of SOM.

Location of LM was noted and checked in 20 children (35 ears): in the posterior inferior quadrant in 21 ears, in the inferior quadrant in 6, and in the anterior quadrant in 8. The mean closure time was 1.9 weeks \( (13.3 \text{ days}) \) in the posterior location, 2.67 weeks \( (18.7 \text{ days}) \) in the inferior location, and 2.88 weeks \( (20 \text{ days}) \) in the anterior location. The posterior location was significantly shorter compared with the other 2 sites \( (P < .001, \) Kruskal-Wallis test).

The size of the myringotomy was 1.4 to 1.6 mm in 7 ears, 1.8 mm in 7 ears, 2.0 mm in 29 ears, and 2.2 mm in 4 ears. The time to closure ranged from 1 to 5 weeks \( (\text{mean} \pm \text{SD}, 2.46 \pm 0.77 \text{ weeks}, \) or 17 days). When grouped according to the diameter of the perforation, the closure time was 2.64 weeks for 1.4- to 1.6-mm perforations and 2.3 weeks for those 1.8 to 2.2 mm. Again, the difference was not significant \( (P = .42, \) Mann-Whitney test).

Follow-up in this group ranged from 2 to 100 weeks \( (\text{mean} \pm \text{SD}, 70.0 \pm 43.3 \text{ weeks}) \). Twenty-three of the children completed 2 years of follow-up.

All ears remained dry and ventilated while the perforation was patent, but in 29 ears, fluid recurred within 2 months after closure. Over time, fluctuation in the presence or absence of effusion in some of the ears was noticed \( (\text{data not shown}) \), as is expected in the natural course of SOM. In one ear, the perforation lasted 4 months and then closed. This ear was excluded from calculation of the mean closure time of the whole group.

Fourteen of the ears had retractions and thinning before LM was performed. In 6 of these ears, the thinning and retraction disappeared after the procedure. However, 3 ears without preexisting thinning had thinning after the procedure. In 2 ears, myringotomy was repeated on the same site under topical anesthesia, with no resultant thinning.

INFANTS

In this group there were 37 infants (66 ears), ranging in age from 1 to 30 months \( (\text{mean} \pm \text{SD}, 10.3 \pm 6.5 \text{ months}) \).

In this group with AOM, an LM 1 to 2 mm in diameter was created in the inferior part of the tympanic membrane. The procedure was performed only in symptomatic infants \( (\text{otalgia and other AOM symptoms}) \) with bulging tympanic membranes, leaving ears with SOM intact.

The perforations remained open from 4 to 28 days, \( (\text{mean} \pm \text{SD}, 11 \pm 4 \text{ days}) \). Forty-eight ears had a perforation 1 to 1.4 mm in diameter; 16 ears, 1.6 to 1.8 mm; and 2 ears, 2 mm in diameter. The mean time to closure in the first group was 11 days and 15 days in the second and third groups. The difference was not significant \( (P = .08, \) Kruskal-Wallis test).

Laser myringotomy caused expulsion of exudate. The ear usually drained for a few days and then stopped. Follow-up ranged from 1 to 25 weeks \( (\text{mean} \pm \text{SD}, 3.9 \pm 5.5 \text{ weeks}) \). No antibiotics were prescribed. The mothers of all the infants reported that AOM symptoms disappeared, with a return to their child’s normal well-being immediately after the procedure. At the end of the follow-up, 7 ears were normal and ventilated, 49 had SOM, and 10 demonstrated AOM \( (\text{with bulging tympanic membrane}) \). In the latter ears, LM was repeated once more, with resultant SOM. The difference between the number of ears with AOM before and after the treatment \( (\text{first LM}) \) was significant \( (P < .001, \) sign test). No thinning was observed in any of the ears, and there was no permanent perforation. Follow-up in this group ranged from 1 to 25 weeks \( (\text{mean} \pm \text{SD}, 3.9 \pm 5.5 \text{ weeks}) \).

SIZE AND LOCATION

The longevity of the perforation in this group of 20 children (35 ears) significantly depends on its location. In the anterior and inferior location, the closure time was longer than that in the posterior part. It is not always easy to create the myringotomy in the anterior part, especially in infants. The size, on the other hand, did not affect the longevity of the perforation. In all 136 ears, patient age correlated with the time to closure of the perforation, with older age associated with longer closure time for all sizes of perforations \( (P = .002, 2\text{-way analysis of variance}) \). This correlation was also observed between older and younger adults, but the numbers were too small for statistical analysis within this group.
In 120 ears without preexisting thinning, LM resulted in thinning in 5 (4%), in 2 adults and 3 children. In the literature, damage to the tympanic membrane, including thinning, after insertion of ventilation tubes has been reported in up to 77% of cases.\textsuperscript{8-19} In contrast, findings by Soderberg-Olsen et al\textsuperscript{8} of this morbidity in only 28% of LM cases indicate LM to be significantly less harmful ($P=0.001$, binomial test). Many severe cases of SOM, with preexisting thinning, were in the children’s group in our study; therefore, we believe the incidence of thinning after LM should be minimal in children with more moderate SOM. Also in our study, 6 of 14 ears in this group recovered from preexisting thinning after the procedure, and 1 ear developed thinning away from the site of the LM. Thus, it appears that LM can improve a thin drum. In this study, follow-up examination for thinning was carefully performed with the operating microscope. Although we have no explanation why some thinning seems to have disappeared, it may be that, when there was no retraction, no clear border was visible and thus the area looked like a normal tympanic membrane.

All of the thin areas were small, and those that also retracted did so to a small degree, except for 1 ear in which the retraction augmented a preexisting one to form a retraction of about one third of the eardrum. We detected no thinning in the infants, and this may reflect a lesser tendency for it in this age group. We do not know for certain what the outcomes of repeated LMs are, or whether it is preferable to locate them in the same or in different sites. In our study, we performed the second LM in the same site as the previous one in 10 ears of each of the age groups, with no resultant thinning.

MINIMIZING DAMAGE

In our series, location of the LM was not associated with any increased risk of thinning or perforation. However, we consider the posterior superior quadrant unsuitable for LM because of its tendency to retract and the potential damage to the structures behind it. The anterior superior area is also unsuitable, as regeneration of this area is sometimes difficult. We therefore recommend the inferior section of the tympanic membrane for LM. It is technically easy to view and locate, especially in infants.

Based on the absence of significant association between size and longevity of LM, we recommend a size range of 1.4 to 1.6 mm for infants, 1.6 to 2.0 mm for children, and 1.8 to 2.2 mm for adults. In SOM, when prolonged ventilation is desired, LM should be performed in only 1 ear at a time to minimize the number of myringotomies while providing normal hearing in 1 ear.

EFFICACY OF LM

Laser myringotomy was effective for the short term, and in adults and children with SOM, repeated LM provided up to several months’ ventilation. Laser myringotomy was also effective for AOM. For prolonged SOM (especially with retractions), ventilation tubes may still be the preferred alternative.

LEVEL OF SAFETY

All age groups with SOM, especially when it is expected to be of short duration, can benefit from the procedure. For those requiring myringotomy before flight or before hyperbaric oxygen treatment, LM may be ideal. Laser myringotomy also permits bloodless endoscopic examination. We were gratified by the immediate good results of LM in all the infants with AOM, in whom antibiotics could be avoided and prompt relief obtained even in neonates aged 1 to 2 months.

ADVANTAGES OF LM

Antibiotics sometimes fail to resolve AOM.\textsuperscript{20,21} The increasing number of resistant bacteria bears epidemiologic and socioeconomic implications. One cannot be sure if antibiotic treatment is going to work, with 1, 2, or more days of treatment needed before improvement.\textsuperscript{22} In contrast, LM provides prompt, reliable treatment and avoids the side effects of antibiotics. This method has great potential as an alternative to use of antibiotics in AOM. Bluestone\textsuperscript{23} recently advocated surgical treatment for AOM instead of antibiotic use. As a surgical treatment, LM is the least invasive procedure for otitis media. With the success of this method, the past concepts of treatment of AOM may be reconsidered.

CONCLUSIONS

Laser myringotomy is a new and efficient modality for the ventilation or drainage of the middle ear, and it is a proven method of treatment. It can decrease the need for antibiotic treatment or ventilation tubes. It also enables inspections or focal treatments of the tympanic membrane or the middle ear.\textsuperscript{5} It is quicker and less painful than traditional myringotomy and is longer lasting ($\leq 11$ days). It also avoids the need for general anesthesia. With topical anesthesia, it is a quick office tool for treating AOM and an alternative to antibiotic use. For SOM, LM can improve hearing for several weeks, which can be extended to several months with repetition. However, cooperation of the patient is important and, thus, is still an obstacle to its becoming an easy, repeatable office procedure for children.

Thus, the advantages of LM as a quick and effective treatment under topical anesthesia make it a useful office-based tool for: (1) adults who need short-term ear ventilation; (2) children with SOM without retractions who need short-term ventilation (eg, before the summer season) or whose parents want to avoid general anesthesia or ventilation tubes; (3) a quick and effective tool for the treatment of AOM that avoids antibiotic use; and (4) any need for short (1-4 weeks) middle ear ventilation.

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REFERENCES


Correction

Author Name Omitted. Neal D. Futran, MD, DMD, should have been included in the byline of “Imaging Quiz Case 3” (2000;126:1501), which was published in the December issue of the ARCHIVES. The byline should have read “Eric J. Kezirian, MD; Ramsey Alsarraf, MD, MPH; Chris Lykins, MD; Neal D. Futran, MD, DMD; Seattle, Wash.”