Intractable Chronic Myringitis Treated With Carbon Dioxide Laser Microsurgery

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Objective: To determine the effect of carbon dioxide laser microsurgery in the treatment of intractable chronic myringitis (CM).

Design: Retrospective 10-year case note review.

Setting: Tertiary referral hospital.

Patients: We reviewed retrospective case notes for 30 treated ears in 29 consecutive patients with CM (ie, loss of the tympanic membrane for longer than 1 month, refractory to conservative medical treatment) who underwent carbon dioxide laser microsurgery between 1995 and 2004, excluding patients who had undergone previous otologic surgery such as tympanoplasty.

Interventions: Carbon dioxide laser microsurgery for resurfacing the nonepithelialized tympanic membrane was performed using local anesthesia.

Main Outcome Measures: Resolution of disease in the affected tympanic membrane.

Results: Of 30 affected ears, 22 demonstrated total resolution of CM, 7 demonstrated partial resolution, and the status of 1 ear remained unchanged at the end of follow-up (mean, 19.7 months). Revision laser therapy was performed in 3 ears, resulting in total resolution of disease in 1 ear. Time to total resolution of disease ranged from 1 to 16 months (mean, 2.95 months).

Conclusions: We used carbon dioxide laser microsurgery to treat intractable primary CM and describe its efficacy in a retrospective review of laser resurfacing covering 10 years. We believe that laser microsurgery has the advantages of less invasiveness and higher applicability compared with aggressive surgical treatment. In patients with CM refractory to conservative medical treatment, carbon dioxide laser microsurgery could be an effective alternative when aggressive surgical procedures are not under consideration.


CHRONIC MYRINGITIS (CM) is a poorly understood disease with refractory or recurrent otorrhea as the only clinical finding. It has been a challenge for the otolaryngologist since the late 1800s, when antibiotic therapy had not yet been developed. Politzer called it a rare disease of the ear, occurring as the result of primary acute myringitis, an aftereffect of previous otitis externa, or perforating inflammation of the middle ear. Most aspects of the disease are still controversial.

The literature includes many synonyms for CM, including myringitis granulosa, granular myringitis, polypoid myringitis, and tympanic membrane epithelitis. Schuknecht described it as a disorder characterized by focal or diffuse replacement of the dermis eardrum and adjacent canal wall by granulation tissue, with the underlying lamina propria remaining intact. Levinson stated that CM is a chronic vascular fibroproliferative and ulcerative dermatitis involving focal or diffuse areas of the tympanic membrane and adjacent canal wall. Blevins and Karmody defined CM as loss of tympanic membrane epithelium for longer than 1 month without evidence of disease within the tympanic cavity.

The etiology of CM remains unclear. Any condition resulting in desquamation and epithelial disruption of the squamous epithelium with exposure of the lamina propria, such as local trauma, dermatologic conditions involving the external ear canal, or infectious microbes, potentially can induce CM.

Various treatments have been suggested, including topical and systemic antimicrobial agents, antiseptic solutions, cauterizing agents, curettage, or more aggressive surgical procedures such as skin grafting or tympanectomy. The carbon dioxide (CO2) laser is a novel option used to treat CM and has been used with pre-
liminary success in both adult and pediatric patients with refractory diseases treated with handheld devices. The CO2 laser offers the advantages of enabling less invasive and more accurate procedures. However, stability and accuracy of the CO2 handheld laser system remain an issue. We present our results using CO2 laser microsurgery to treat intractable CM.

METHODS

A retrospective case note review was performed for the 10 years from January 1, 1995, to December 31, 2004. The patients had undergone laser microsurgery to treat intractable CM after conservative medical treatment administered for longer than 1 month failed. Patients with other ear diseases who had undergone previous otologic surgical procedures such as tympanoplasty, myringoplasty, canalplasty, or mastoidectomy were excluded from the study. No topical treatment was given until 1 month after CO2 laser treatment when the eardrum conditions remained unchanged.

Twenty-nine consecutive patients were included in the study, with a total of 30 affected ears. Detailed notes were obtained concerning the medical history of each patient. Thorough otolaryngologic examination including the ears, nose, throat, and neck were performed. Patient information was recorded including age, sex, duration of symptoms and previous treatment, presence of eardrum perforation, results of preoperative and postoperative audiologic examinations, laser settings, complications of laser therapy, and duration of follow-up. The eardrum conditions in each ear were determined at microsurgery (Figure 1A).

All laser therapies were performed in the operating room using local anesthesia and with microscopy guidance. A surgical draping (OpSite; Smith & Nephew PLC, London, England) was used to fix the ear speculum (Figure 2). The eardrum was painted with gentian violet (GV) to delineate the extent of the epithelium defect (Figure 1B) and was wiped off with a cotton-tipped swab immediately. A CO2 laser (model 1041; Sharplan Lasers Inc, Allendale, New Jersey) with a micromanipulator (AcuSpot 1041s; Lumenis Inc, Santa Clara, California) was used to irradiate the lesion area, with an initial setting of 3 to 5 W, single mode, with a spot size of 0.5 mm. Initially, we aimed the laser at the thickest area with 3-W power and evaluated the depth of the laser spot, then defocused the model or increased the power up to 5 W depending on the laser effect. In practice, vaporizing all of the stained tissue plus 1 spot beyond the diseased area is sufficient. In effect, the treatment encompasses a more extensive area than the margins defined by the GV to ensure resurfacing of epithelium (Figure 1C). The

Figure 1. A, Epithelium defect of the eardrum at microscopy. The exact extent cannot be clearly defined. B, Application of gentian violet to the eardrum. Because gentian violet will coat only the area of epithelium defect, leaving the area of intact eardrum uncoated, we could delineate the margins of epithelium defect accurately before surgery. C, Carbon dioxide laser resurfacing of the eardrum epithelium defect. With use of gentian violet, we could precisely perform the laser procedure on the area of the epithelium defect. The extent of the operation should be larger than the lesion so that reconstitution of adjacent epithelium can occur. D, Results 1 month after laser surgery. The epithelium healed well, and the defect is no longer seen.
thinner part of the eardrum identified by powerful microscopic light, which could be the remaining inner mucosal layer, should be spared when impending perforation is apparent.

Postoperatively, the ear was evaluated for the following 3 different results: total resolution of disease, or good epithelialization of the entire eardrum without any discharge; partial resolution of disease, or at least 50% decrease in the diseased area with improvement of subjective symptoms; and unchanged status, or less than 50% decrease in the area of myringitis with persistent symptoms. The postoperative status of the ear was recorded at 1 and 3 months and at the end of observation (Figure 1D).

RESULTS

Twenty-eight patients with unilateral CM and 1 patient with bilateral CM were included in the study. Patient age at diagnosis of CM ranged from 20 to 78 years (mean age, 58.2 years) (Figure 3). There were 19 men and 10 women; 20 lesions were in the right ear and 10 lesions were in the left ear. Follow-up ranged from 1 to 92 months (mean, 19.7 months).

The duration of symptoms before CO₂ laser therapy ranged from 1 month to more than 10 years. Otorrhea was the most common symptom, noted in 29 ears (96.7%), followed by subjective hearing impairment (11 ears; 36.7%), otalgia (3 ears; 10%), tinnitus (3 ears; 10%), aural pruritus (3 ears; 10%), and aural fullness (1 ear; 3.3%).

Three patients had a history of chronic rhinosinusitis with polyposis. One patient had undergone an operation because of colon cancer. None of the patients had diabetes or any history of immunocompromise.

Otomicroscopic findings revealed a moist area with absent epithelium. The precise area of epithelium defect can be delineated with GV. The desquamated area ranged from 15% to 90% (mean area, 51.3%). Careful cleaning of the eardrum revealed granulation tissue in 19 ears. Eardrum perforation was noted in 4 ears before CO₂ laser therapy; 1 had healed by the end of follow-up. Of the remaining 26 ears, 3 developed perforation during laser surgery; all healed by the end of follow-up. No patient developed acquired atresia or other complications during follow-up.

Insofar as contralateral ear conditions, previous chronic otitis media status after tympanoplasty type 1 was noted in 1 patient, and otitis media with effusion previously treated with insertion of a ventilation tube was noted in another patient. Three patients had concomitant CM in both ears, which was treated simultaneously in 1 patient.

Bacteriologic and fungal studies were performed in 28 ears. *Staphylococcus aureus* was found in 14 ears, including 4 ears with methicillin-resistant clones; *Pseudomonas aeruginosa* was found in 3 ears, fungus in 2 ears, and *Enterobacter cloacae* in 1 ear.

Before definitive laser therapy, 25 patients received topical antimicrobial eardrops, including neomycin and polymyxin B sulfates, ciprofloxacin hydrochloride, or aminoglycoside agents. In addition, 28 patients received oral antibiotic agents. Treatment duration ranged from 1 to 20 months (mean, 3.8 months).

Pure-tone audiometry was performed in 25 ears. A small air-bone gap was found in 4 patients. Examination in those 4 patients demonstrated a minor gain in hearing acuity at the end of follow-up.

Postoperatively, 12 ears (40%) demonstrated total resolution of disease at 1-month follow-up and 16 ears (53.3%) demonstrated partial resolution; the status of the other 2 ears remained unchanged (Figure 4). At the 3-month follow-up in 25 ears for which data were available, 15 ears (60%) demonstrated total resolution of disease, 8 ears (32%) demonstrated partial resolution, and the status in 2 ears remained unchanged. In 3 ears, laser surgery was performed again because of persistent disease, which eventually led to total resolution of disease in 1 ear. At the end of follow-up at 92 months, 22 ears remained free of disease, 7 demonstrated partial resolution of disease, and the status in 1 ear remained unchanged. Time to total resolution of disease was 1 to 16 months (mean, 2.95 months).

COMMENT

The treatment of CM varies, and the ideal treatment remains controversial. Oral antibiotic agents are rarely helpful despite selection according to sensitivity results. Various antimicrobial agents and antiseptic solutions have

![Figure 2. A surgical draping (OpSite; Smith & Nephew PLC, London, England) is used to fix the ear speculum.](https://archotol.jamanetwork.com/)

![Figure 3. Age distribution of patients with chronic myringitis.](https://archotol.jamanetwork.com/)


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been advocated, including alcohol, boric acid, vinegar, formalin, steroids, phenol, and antimicrobial agents, as well as combinations of these agents. Topical application of caustic materials such as silver nitrate, trichloroacetic acid, and chromic acid may also be considered, as well as curettage of the lesion.

The CO₂ laser emits a wavelength of 10 600 nm, which occupies the infrared portion of the electromagnetic spectrum. Because light interacts with tissue in 4 different mechanisms, that is, transmission, reflection, absorption, and scattering, the latter 2 properties are applied in the desired treatment. A large portion of the eardrum is composed of water and is the target of the CO₂ laser. When the laser beam contacts the eardrum, intracellular and extracellular water is heated and the tissue is vaporized. Low-power laser energy causes denaturing of protein at 60°C, and fusion and shrinkage of collagen fibers at 80°C. When the absorbed laser beam heats the tissue to 100°C, intracellular water is vaporized, causing vacuole formation, craters, and tissue shrinkage. Heat from the laser causes epithelial ablation and collagen shrinkage, followed by reepithelialization and wound repair.

Laser resurfacing has been widely used by dermatologists. Most commonly used to treat rhytids and dyschromias, it is also used to remove other skin lesions or for facial rejuvenation. The laser resurfacing technique in otology was first reported by Fechner et al when they used CO₂ laser surgery to treat refractory myringitis. In 15 ears in 13 pediatric patients who had undergone previous otologic procedures, CO₂ laser surgery performed to treat refractory CM resulted in total resolution or improvement of disease in 14 ears; disease status remained unchanged in only 1 ear. In a series reported by Jang et al, 18 of 21 patients (86%) were cured with endoscopically aided CO₂ laser surgery, without adverse effects.

We present the results of primary CM treated with CO₂ laser microsurgery during 10 years. None of the patients included in this series had undergone previous otologic surgical procedures. Laser therapy was performed in the operating room using local anesthesia and with microscopic guidance. With application of GV on the eardrum, the extent of the lesion can be characterized well because the stain coats only the area of epithelium defect; areas with intact epithelium covering will not be coated. GV (hexamethyl pararosaniline chloride) in aqueous solutions dissociates into positive (GV⁺) and negative (Cl⁻) ions. The colored stain over the desquamated area may be the result of ionization of the cell wall and membrane, as with Gram stain. It is not known whether there is interaction between GV and laser heating, but the laser has shown ability to eradicate the microorganism and increase the microcirculation to enhance wound healing. Although GV has antifungal activity and could work synergistically with laser heating, such antifungal effect seems to have a small role in the treatment results because there were only 2 ears with fungal infection in our series.

Under microscopy, we can control the surface area and depth of tissue vaporization precisely by varying the laser settings for power, exposure time, and spot size. Laser therapy should always extend beyond the margins of the lesion as indicated by GV staining to enhance reepithelialization. The desired depth of vaporization depends on the degree of eardrum thickening and the presence of granulation tissue. Initially, the power is set at 3 W and exposure time is 0.1 seconds. The power can be increased if the operative area is thick. When the given energy level has been applied and the eardrum seems to rupture, the energy level can be lowered or the lens adjusted to a defocus setting. In theory, vaporization should reach the epidermal layer in cases of epithelial defect (and the level of the lamina propria in cases of granulation formation) so that reepithelialization of the peripheral healthy eardrum can ensue. With repeated intraoperative assessment of each laser shot, the surgeon can control the operative field and avert drum perforation. Although 3 ears still developed perforation during the operation, all had healed by the end of follow-up.

Laser therapy can be used as a salvage treatment when all other conservative treatment has failed. Aggressive surgery had an important role when conservative treatment failed. We previously reported experience with surgical treatment in 14 patients with granular myringitis. In 3 groups of patients, cure without recurrence of disease was achieved with excision of the eardrum lesion, free ear canal skin autografting (8 cases), temporalis fascia with free ear canal skin autografting (4 cases of eardrum perforation during operation), and a silicon sheet covering of the denuded eardrum (2 cases). Similar success was also obtained in other series; only 2 recurrences occurred in 48 patients.

Compared with the series of Fechner et al in which a handheld laser delivery system was used and of Jang et al in which a handheld endoscopy set was used, we performed CO₂ laser surgery with microscopy. The advantages of microsurgery are stability and accuracy. With higher magnification views provided by microscopy, the area and depth of laser therapy can be tailored with precision by adjusting the laser power, lens focus, and spot size promptly, achieving precise resurfacing of the affected eardrum.

Because CM has a tendency for remission or exacerbation during long intervals, the relatively short fol-
CONCLUSIONS

We believe that laser microsurgery in the treatment of CM has the advantages of less invasiveness and higher applicability compared with aggressive surgical treatment. We present the results of primary CM treated with CO₂ laser surgery. In patients with CM refractory to therapy or in whom conservative medical treatment fails, CO₂ laser microsurgery could be an effective alternative when aggressive surgical procedures are not under consideration.

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Author Contributions: Drs Cheng and Shiao had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Shiao. Acquisition of data: Shiao and Cheng. Analysis and interpretation of data: Shiao and Cheng. Drafting of the manuscript: Cheng. Critical revision of the manuscript for important intellectual content: Shiao. Statistical analysis: Shiao and Cheng. Administrative, technical, and material support: Shiao. Study supervision: Shiao.

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