Flexible Optical Fiber CO₂ Laser Stapedotomy for Otosclerosis: Results of 105 Consecutive Cases

Robert M. Owens, MD; Cherie L. Booth, MD
Owens Ear Center, Dallas, TX.

ABSTRACT

Lasers have become widely used in otosclerosis surgery. For most surgeons, the laser is used to create a stapedotomy without the need for mechanical extraction of the footplate. In 1989, Lesinski and Palmer published a series of articles that introduced new developments in the CO₂ laser system. By modifications of the existing laser, a small beam could be produced that could be focused accurately enough for ear surgery. The advantage of this laser was that it absorbed well by water. It thus, worked well on body tissues, including bone, and did not penetrate into a fluid-filled inner ear vestibule. The CO₂ laser, because of its long wavelength, is rapidly absorbed by tissues or fluid regardless of color, with little scatter or penetration. If the proper energy parameters are used, the CO₂ laser beam will not penetrate perilymph. Lesinski performed experimental stapedotomies in the laboratory using Argon, KTP-532 and CO₂ lasers, the CO₂ laser appears to be safer to the perilymph by not raising the temperature significantly. The CO₂ laser energy can now be delivered via a handheld fiberoptic system allowing the surgeon to be more precise and accurate when performing a stapedotomy for otosclerosis and reports the audiometric findings.

INTRODUCTION

Lasers have become widely used in otosclerosis surgery. For most surgeons, the laser is used to create a stapedotomy without the need for mechanical extraction of the footplate. In 1989, Lesinski and Palmer published a series of articles that introduced new developments in the CO₂ laser system. By modifications of the existing laser, a small beam could be produced that could be focused accurately enough for ear surgery. The advantage of this laser was that it absorbed well by water. It thus, worked well on body tissues, including bone, and did not penetrate into a fluid-filled inner ear vestibule. The CO₂ laser, because of its long wavelength, is rapidly absorbed by tissues or fluid regardless of color, with little scatter or penetration. If the proper energy parameters are used, the CO₂ laser beam will not penetrate perilymph. Lesinski performed experimental stapedotomies in the laboratory using Argon, KTP-532 and CO₂ lasers, the CO₂ laser appears to be safer to the perilymph by not raising the temperature significantly. The CO₂ laser energy can now be delivered via a handheld fiberoptic system allowing the surgeon to be more precise and accurate when performing a stapedotomy for otosclerosis and reports the audiometric findings.

METHODS AND MATERIALS

Patients: This study is a retrospective chart review of 105 consecutive primary CO₂ laser stapedotomies for otosclerosis that were treated at the Owens Ear Center in Dallas, Texas from January 2008 through July 2010. 91 patients were included in the study and the hearing status was assessed preoperatively, and at 5 weeks and post-operatively every 3 months. All revision operations and primary stapedotomies without the laser were excluded. The patients' ages ranged from 12 to 84 with a mean of 46.3 years.

Surgery: All procedures were performed by the senior author (R.M.O.). In all cases, a transcanal approach was used. A flexible fiber CO₂ laser (OmniGuide® BeamPath flexible CO₂ laser, Omnipath SD, Cambridge, MA) was used to vaporize the stapedial tendon and crura of the stapes. The laser was used to make a rosette in the footplate, with settings for all cases of 5 W, 0.1-second pulse duration, single pulse mode. The stapedotomy was then enlarged with a Sotelo microdrill drum (0.7 mm-diameter diamond burr). After stapedotomy, an appropriate-sized prosthesis was placed and crimped onto the incus. Subsequently, the oval window was sealed with autologous blood as described by Perkins, Fisch and Lesinski.

Date: Data consisted of patient demographics, pre- and post-operative air and bone conduction thresholds, speech discrimination scores (SDS), postoperative complications, and prosthesis used.

RESULTS

Preoperative results: The preoperative bone PTA ranged from 3.75 to 60 dB with a mean of 24.89 dB (standard deviation (SD) = 10.86). The preoperative air PTA ranged from 15 to 96.2 dB with a mean of 51.74 (SD = 14.42). The preoperative Air-Bone Gap (ABG) ranged from 3.75 to 51 dB with a mean of 26.72 (SD = 10.71). Preoperative speech discrimination scores (SDS) ranged from 8% to 100% with a mean of 94.33% (SD = 12.31).

Postoperative results: The postoperative air PTA ranged from 2.75 to 86.25 dB with a mean of 28.04 dB (SD = 13.24). The postoperative ABG ranged from -23.75 to 40 with a mean of 3.56 dB (SD = 8.31). Postoperative speech discrimination scores (SDS) ranged from 4% to 100% with an average of 95.39% (SD = 12.59). The difference between the preoperative and postoperative SDS was calculated by subtracting the preoperative SDS from the postoperative SDS. Patients ranged from 1.36 with an average of 0.457% (SD = 6.5). The postoperative average ABG was 3.56 compared with the 26.72 preoperative ABG. The postoperative AC threshold was 28.04 dB compared with 51.74 dB preoperatively. The decibels of closure are a continuous variable from negative values (worse gap after treatment) to positive values (less gap). Our postoperative air-bone gap minus postoperative air-bone gap results ranged from -21.25 to 56 dB with an average of 23.38 (SD = 28.88). 95/105 (90.3%) patients had a postoperative ABG ≤ 10 dB, while 99/105 (94.3%) had a postoperative ABG ≤ 15 dB.

Complications: 30 patients (29%) complained of transient vertigo postoperatively. 27 patients (26%) reported no minimal postoperative vertigo lasting less than a week, while 3 patients (3%) reported vertigo lasting more than a week. 5 patients (4.8%) had transient taste disturbances. One patient had a transient facial palsy, while one other patient had a rent in the tympanic membrane that required a fascia graft. There were no anacoustic ears.

Table 1. Pre- and Post-operative data.

<table>
<thead>
<tr>
<th>Bone PTA (dB)</th>
<th>Air PTA (dB)</th>
<th>AEG (dB)</th>
<th>SDS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Op</td>
<td>25.02</td>
<td>15.47</td>
<td>26.72</td>
</tr>
<tr>
<td>Post-Op</td>
<td>24.48</td>
<td>28.04</td>
<td>3.56</td>
</tr>
</tbody>
</table>

Table 2. Stapes Prostheses

<table>
<thead>
<tr>
<th>Titanium Fluoroplastic Bucket Handle</th>
<th>89 (85%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richards Fluoroplastic Bucket Handle</td>
<td>1 (0.95%)</td>
</tr>
<tr>
<td>Robinson Bucket Handle</td>
<td>1 (0.95%)</td>
</tr>
<tr>
<td>Platinum Bucket Handle</td>
<td>11 (10.5%)</td>
</tr>
<tr>
<td>Titanium Bucket Handle</td>
<td>1 (1.9%)</td>
</tr>
<tr>
<td>Fluoroplastic Ribbon</td>
<td>1 (0.95%)</td>
</tr>
</tbody>
</table>

DISCUSSION

This study confirms the findings of previous investigators which documented the clinical safety and efficacy of the CO₂ laser system for primary stapedotomy. In this study, 89% of patients had a postoperative ABG of 10 dB or less, while 94.29% of patients had a postoperative ABG of 15 dB or less and there were no significant cases of sensorineural hearing loss. This is comparable to Buchman, et al who reported 88.5% of patients who had a postoperative ABG of 10 dB or less, and there were no significant cases of sensorineural hearing loss.

The main advantage of the laser in otosclerosis surgery is that it allows the surgeon to create an atraumatic, bloodless opening in the fixed or mobile footplate, thereby avoiding mechanical manipulation. By vaporizing the posterior crus of the stapes, the CO₂ laser possesses ideal tissue absorption characteristics for otosclerosis surgery. Lesinski performed experimental stapedotomies in the laboratory using Argon, KTP-532 and CO₂ lasers, the CO₂ laser appears to be safer to the perilymph by not raising the temperature significantly. The CO₂ laser energy can now be delivered via a handheld fiberoptic system allowing the surgeon to be more precise and accurate when performing a stapedotomy for otosclerosis.

CONCLUSIONS

CO₂ laser stapedotomy has a long track record as a safe and effective technique. The new OmniGuide® flexible fiber allows surgeons the ability to utilize the CO₂ laser as a handheld instrument and provides excellent precision. Our results of 105 consecutive cases demonstrate that the technique is extremely safe and effective. Utilizing the fiber in performing stapedotomy in this cohort of patients provided for excellent improvement in hearing with no incidence of total sensorineural hearing loss.

REFERENCES