Laser-Assisted Uvulopalatoplasty for the Management of Obstructive Sleep Apnea

Myths and Facts

Yehuda Finkelstein, MD; Gideon Stein, MD; Dov Ophir, MD; Rachel Berger, BA; Gilead Berger, MD

Objective: To assess medium- to long-term subjective and objective results of laser-assisted uvulopalatoplasty (LAUP) for patients with obstructive sleep apnea.

Design: A nonrandomized prospective before-after trial.

Subjects and Interventions: Twenty-six patients underwent LAUP by means of vertical trenches along either side of the uvula and reduction of the uvula.

Main Outcome Measures: Subjective analysis included a preoperative and 2 postoperative evaluations of the state of snoring: 4 weeks and a mean±SD of 12.3±9.1 months after completion of treatment. In addition, a score on 5 other sleep-related symptoms was recorded before treatment and after 12.3±9.1 months; at that time, patients also estimated their overall satisfaction with the procedure. Objective analysis included preoperative polysomnographic studies that were repeated postoperatively.

Results: A significant decline in snoring improvement from 88% (23/26) to 65% (17/26) was recorded; furthermore, the state of snoring worsened from 4% (1/26) to 12% (3/26). Reevaluation of 5 other sleep-related symptoms after completion of LAUP uncovered a 50% improvement rate (13/26), and a 15% (4/26) worsening rate. Overall satisfaction from the procedure was 58% (15/26). Postoperative objective studies revealed that only 31% (8/26) of the procedures were successful, while 31% were associated with worsening of respiratory disturbance index. Fifty-four percent (14/26) of the patients had a sensation of pharyngeal dryness. In addition, 1 patient developed velopharyngeal stenosis.

Conclusions: The favorable subjective short-term results of LAUP deteriorated in time. Postoperative polysomnography revealed that LAUP might lead to deterioration of existing apnea. These findings are probably related to velopharyngeal narrowing and progressive palatal fibrosis inflicted by the laser beam.


Laser-assisted uvulopalatoplasty (LAUP), since its introduction in 1990, has become a popular treatment for the management of snoring. Gradually, the use of the procedure has been extended to treating various degrees of obstructive sleep apnea (OSA). Several studies have examined the efficacy of laser treatment for OSA and reported comparable results to uvulopalatopharyngoplasty (UPPP). However, there is growing controversy over the use of LAUP for this type of sleep-related breathing disorder. Ryan and Love have recently shown that a large proportion of the patients developed significant worsening of the objective sleep parameters. The authors concluded that the response to LAUP was varied and unpredictable, and only a few patients achieved a satisfactory outcome. Likewise, Lauretano et al. found that LAUP was ineffective in these patients. It was also shown that LAUP was associated with a considerable number of subjective delayed failures as well as objective aggravation of sleep parameters (ie, de novo OSA) in formerly nonapneic patients who snored.

The present study forms part of a comprehensive research project on the late anatomic, histopathologic, and clinical results of LAUP and includes a combination of subjective and objective measures to evaluate the short- and medium- to long-term results of the procedure for patients with OSA. Special emphasis was placed on (1) the durability of the subjective results over time, and (2) the postoperative objective outcome of the procedure.

There were 21 men and 5 women ranging in age from 22 to 71 years (mean±SD}
PATIENTS, MATERIALS, AND METHODS

The study population consisted of 26 patients who suffered from bothersome snoring and various degrees of OSA and completed LAUP treatment between June 1, 1994, and March 30, 1995, at the outpatient clinic of Meir Hospital, Sapir Medical Center, Kfar Saba, Israel. All patients consented to participate in the study after being informed of the known benefits, risks, and complications of the procedure. Patients were generally healthy without a cleft lip or palate, and none had undergone prior mandibular or maxillary surgery.

PREOPERATIVE EVALUATION

Patients' detailed histories and bed partners' reports relevant to upper airway obstruction were obtained in structured interviews. As previously described,13 interviewees were asked to describe their state of snoring and to indicate the absence (0) or existence (1) of the following 5 other sleep-related symptoms: (1) night awakening, (2) morning fatigue, (3) daytime somnolence, (4) breathing pauses, and (5) involuntary body movements during sleep. Questions on the first 3 symptoms were addressed to the patients, and the remainder to their bed partners. A total score from 0 to 5 was calculated for each patient.

All patients underwent a complete otolaryngologic examination, including flexible fiberoptic nasopharyngoscopy examination of the nose, pharynx, and larynx, and had nocturnal polysomnography with simultaneous electroencephalography, electrocardiography, electromyography, and surface-electrode electro-oculography. Airflow at the nose and mouth was monitored with thermistors, and respiratory effort was assessed with inductive plethysmography. Oxygen saturation was measured with continuous finger pulse oxymetry. Severity of OSA was expressed in terms of a respiratory disturbance index (RDI), and calculated as the average number of apneas plus hypopneas per hour of sleep. The study defined 4 grades of RDI: (1) 0 to 5, (2) 6 to 20, (3) 21 to 40, and (4) greater than 40; accordingly, patients were considered as nonapneic snorers, mildly obstructed, moderately obstructed, or severely obstructed.

SURGICAL METHOD

The LAUP procedure was done in the office setting, while the patient was in an upright sitting position. Topical anesthesia included 1.5% lidocaine spray applied to the oropharynx and the oral cavity followed by local infiltration of a mixture of 1% lidocaine and 0.01% adrenaline into either side of the base of the uvula and the base of the uvula. Laser surgery was performed by means of through-and-through, full-thickness vertical trenches measuring 1 to 2 cm on the free edge of the soft palate on either side of the uvula at a power setting of 15 to 20 W. With the use of a SwiftLase scanner (Sharplan Lasers Inc, Allendale, NJ) attached to the carbon dioxide laser, the core of the uvula was vaporized from the bottom up in a “fish mouth” manner, while the mucosa of the uvula was preserved. Eventually, the uvula was shortened and thinned by up to 80% to 90% of its original size. Enlarged tonsils were also ablated.18

POSTOPERATIVE EVALUATION

All patients were reexamined 4 weeks and 5 to 45 months (mean ± SD, 12.3 ± 9.1 months) after completion of the last laser treatment (Table 1). On both occasions, they were asked to compare current snoring to its preoperative state and to answer whether it (1) was abolished or markedly reduced, (2) remained the same, or (3) had worsened. In addition, the 5 other sleep-related symptoms were assessed at the end of the follow-up period, and a total score from 0 to 5 was calculated for each patient. Possible variations between the preoperative and postoperative scores indicated whether patients (1) improved, (2) remained unchanged, or (3) worsened. Patients were also asked to estimate their overall satisfaction with the procedure with a yes-no answer. Polysomnography was repeated at the last follow-up visit at the same sleep laboratory with the use of previously determined criteria for evaluation.

DEFINITION OF TREATMENT EFFECTIVENESS

There is a lack of standard guidelines to assess the outcome of LAUP for the management of OSA. Therefore, evaluation was based on commonly accepted definitions found in the literature.6,10,19 We considered surgery successful when patients had a greater than 50% reduction of their postoperative RDI compared with the preoperative value, or when it dropped below 20 events per hour (an RDI above which OSA may be associated with significantly increased morbidity and mortality). We considered surgery unsuccessful when (1) postoperative RDI was reduced by less than 50% from the preoperative value, (2) postoperative RDI remained unchanged, or (3) postoperative RDI values worsened.

STATISTICAL ANALYSIS

Measurements were expressed as mean ± SD. Comparisons were made by the paired t test and the McNemar test. Probability values lower than .05 were considered significant.

SUBJECTIVE ASSESSMENT

Table 2 lists comparisons for the changes in the state of snoring and the changes between the preoperative and postoperative scores of each patient in 5 other sleep-related symptoms. During the interval between follow-up visits, improvement in snoring declined from
88% (23/26) to 65% (17/26), and worsening in snoring increased from 4% (1/26) to 12% (3/26). Statistical analysis confirmed that the deterioration in the state of snoring during the time lapse between the follow-up visits was statistically significant (\(P = .02\)). Notably, several investigators have reported a similar trend (ie, a progressive decline in the initially subjective favorite outcome) worsening was detrimental enough to change the grade of RDI from mild to moderate OSA in 2 patients, from mild to severe OSA in 1, and from moderate to severe OSA in 1. In patients 7 and 9, the RDI worsening was greater than 100% from the preoperative value. Preoperative and postoperative mean lowest oxygen saturation levels were not significantly different (85.4%±8.5% vs 87.3%±7.9%, respectively) (\(P = .28\)). Nevertheless, patient 25 had a change of preoperative lowest oxygen saturation from 76% to 60%, a deleterious lowering consistent with the shift from mild to moderate OSA.

### COMPLICATIONS AND ADVERSE EFFECTS

There were no life-threatening complications, including postoperative airway obstruction or hemorrhage. The most common adverse effect of LAUP was pain that lasted up to 20 days postoperatively (mean±SD duration, 9.8±4.1 days) and was severe enough to keep patients away from work for 7.2±4.2 days. At the end of the follow-up visit, 14 patients (54%) complained of persisting throat dryness or itching. Patient 13, who underwent 3 successive LAUP sessions, developed velopharyngeal stenosis, and after 22 months underwent UPPP to relieve obstruction.

### COMMENT

It is commonly accepted that untreated patients with an RDI of 20 or higher are susceptible to the perils of angina, cardiac arrhythmias, myocardial infarction, stroke, and aggravation of congestive heart failure because of the stress placed on the heart during sleep. In an attempt to alleviate snoring and lessen episodes of apnea, 26 patients in the present study underwent a series of LAUP treatments by means of vertical trenches. Initial subjective results were encouraging, and as many as 88% (23/26) of the study population improved their state of snoring. However, after a mean±SD of 12.3±9.1 months, there was a significant deterioration in the favorable results (improvement decreased to 65% [17/26]) and a significant aggravation of the state of snoring (increased from 4% [1/26] to 12% [3/26] \(P = .02\)). Notably, several investigators have reported a similar trend (ie, a progressive decline in the initially subjective favorite outcome)
regarding the efficacy of LAUP for nonapneic snorers.\textsuperscript{12-15} Furthermore, assessment of 5 other sleep-related symptoms at the end of the follow-up treatment in the present study revealed a 50% success rate (13/26) and a 15% failure rate (4/26). These discouraging findings suggest that LAUP is associated with early favorable results, but that in the long run patients may exhibit a decline in the subjective parameters of the procedure, a contingency not mentioned by earlier reports owing to their short-term follow-up period.

Multiple studies have dealt with objective data regarding the effectiveness of LAUP for the treatment of OSA. Most of the authors found that the success rate ranged from 40% to 50%,\textsuperscript{2-11} yet the length of the follow-up period was either not specified\textsuperscript{22} or lasted from a mean of 60 to 112 days.\textsuperscript{3-6,8-11} It stands to reason that differences in the follow-up period are responsible for the divergent objective results: successful results in our study were recorded in only 8 (31%) of 26 patients 13.2±9.3 months after the last laser treatment. In addition, there was a worsening of objective sleep parameters in 8 patients (31%), 4 of whom also experienced a postoperative deterioration of RDI grading. These data resemble those of Ryan and Love,\textsuperscript{10} who obtained, according to their terminology, a good response in only a small proportion of the patients, a poor response in 34%, and worsening in 30%. Likewise, Lauretano et al\textsuperscript{11} concluded that LAUP showed little or no benefit for OSA. Interestingly, Walker et al,\textsuperscript{3,8} Mickelson,\textsuperscript{4} and Mickelson and Ahuja\textsuperscript{9} recommended LAUP as an effective treatment for OSA, although they noted an RDI deterioration in 21% to 27% of their cases.

Of interest is the source of the gap in the present series between the subjective improvement in snoring (65%; 17/26) and the objective favorable results (31%; 8/26). It was reported that LAUP reduced the maximum-, average-, and low-frequency respiratory noise loudness, and increased the fundamental frequency of the snoring sound. In addition, LAUP did not change the snoring index (ie, number of snores per hour of sleep).\textsuperscript{20} Apparently, the considerable number of subjective favorable responses of patients and bed partners in our study can be explained by the change in the snoring sound quality, which becomes less annoying to the human ear after surgery. Lauretano et al\textsuperscript{11} elaborated on the issue and argued that LAUP may convert symptomatic snoring into “asymptomatic snoring,” a scenario whereby episodes of obstruction continue masked and undetected. Ryan and Love\textsuperscript{10} compared the phenomenon to a “placebo effect.” In other words, although surgery offers a newly agreeable form of snoring, the subjective results may not correlate with the reduction in the prevalence of snoring events or an improvement in the upper airway patency.

It is thought that the late decline in the improvement of snoring, aggravation of the sleep-related symptoms, and the overall failure in the objective measures in our study is attributable to progressive fibrosis inflicted on soft palate tissues by the thermal damage of the laser beam. Laser-assisted uvulopalatoplasty, which is based on cutting and vaporizing palatal tissues, leaves a raw surface that subsequently undergoes scarring. These wounds take longer to heal than those created with a scalpel.\textsuperscript{21} The effectiveness of surgery, therefore, should be assessed months later, when the healing process has stabilized. Indeed, a study on the long-term histopathologic changes after LAUP\textsuperscript{17} found that various components of the soft palate underwent extensive changes, which increased with each additional treatment. The loose connective tissue in the lamina propria was replaced by diffuse fibrosis that also extended to the central layer on the expanse of seromucous glands and muscle fibers.\textsuperscript{17} Palatal fibrosis after LAUP was clinically encountered in 27% of the patients in the Carenfelt study.\textsuperscript{22} These observations are complementary to those found in another study\textsuperscript{16} that compared the shape and dimensions of the velopharyngeal valve between UPPP and LAUP by means of peroral measurements and photographs, nasopharyngoscopy, and cephalometry performed at least 3 months after last laser treatment. It was ascertained that after LAUP, the pharyngeal scar contraction occurred in the centripetal direction and caused medial traction of the posterior tonsillar pillars or even of the lateral pharyngeal walls. Eventually, the pharyngeal cross-sectional area went through major anatomic changes that included narrowing of the lumen, increased rigidity, decreased compliance, and loss of the distensibility needed during inspiration.\textsuperscript{10} These deficiencies presumably have deleterious effects on the res-

### Table 3. Objective Results of Laser-Assisted Uvulopalatoplasty* \(^{10}\)

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Preoperative RDI (%)</th>
<th>Postoperative RDI (%)</th>
<th>Preoperative LSAT, %</th>
<th>Postoperative LSAT, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>9</td>
<td>90</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
<td>88</td>
<td>NA</td>
<td>88</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>38</td>
<td>78</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>25</td>
<td>100</td>
<td>91</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
<td>23</td>
<td>89</td>
<td>88</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>17</td>
<td>83</td>
<td>90</td>
</tr>
<tr>
<td>7</td>
<td>11</td>
<td>23</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>8</td>
<td>65.8</td>
<td>52</td>
<td>63</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
<td>56</td>
<td>90</td>
<td>85</td>
</tr>
<tr>
<td>10</td>
<td>62.1</td>
<td>42.8</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>11</td>
<td>13</td>
<td>7.4</td>
<td>86</td>
<td>88</td>
</tr>
<tr>
<td>12</td>
<td>16.8</td>
<td>14.5</td>
<td>75</td>
<td>83</td>
</tr>
<tr>
<td>13</td>
<td>11.3</td>
<td>11.2</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>14</td>
<td>36</td>
<td>24</td>
<td>87</td>
<td>93</td>
</tr>
<tr>
<td>15</td>
<td>19</td>
<td>13</td>
<td>91</td>
<td>92</td>
</tr>
<tr>
<td>16</td>
<td>35</td>
<td>18</td>
<td>87</td>
<td>81</td>
</tr>
<tr>
<td>17</td>
<td>38</td>
<td>15</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td>6</td>
<td>93</td>
<td>97</td>
</tr>
<tr>
<td>19</td>
<td>35</td>
<td>7</td>
<td>90</td>
<td>93</td>
</tr>
<tr>
<td>20</td>
<td>35</td>
<td>27</td>
<td>89</td>
<td>84</td>
</tr>
<tr>
<td>21</td>
<td>34.9</td>
<td>35.2</td>
<td>82</td>
<td>84</td>
</tr>
<tr>
<td>22</td>
<td>8</td>
<td>13.5</td>
<td>94</td>
<td>91</td>
</tr>
<tr>
<td>23</td>
<td>24.8</td>
<td>43</td>
<td>81</td>
<td>82</td>
</tr>
<tr>
<td>24</td>
<td>41</td>
<td>10.3</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>25</td>
<td>15.4</td>
<td>25.8</td>
<td>76</td>
<td>60</td>
</tr>
<tr>
<td>26</td>
<td>23</td>
<td>6</td>
<td>92</td>
<td>86</td>
</tr>
</tbody>
</table>

* RDI indicates respiratory disturbance index; LSAT, lowest oxygen saturation; and NA, not available.
piratory dynamics and may deteriorate existing OSA. Contrary to these findings, Ryan and Love used videofluoroscopic images and studied 4.5 months after LAUP a significant increase of the hypopharyngeal cross-sectional area and its anteroposterior diameter. Nevertheless, the authors also demonstrated a considerable number of failures and aggravation of OSA objective measures that might have resulted from the changes described earlier.

In the present study, patients experienced pain that lasted for an average of 9.8 days and was severe enough to keep patients away from work for an average of 7.2 days. These results are supported by the observations of Troell et al, who compared postoperative pain between various methods of palatal surgery. In patients with snoring, upper airway resistance syndrome, and mild apnea, and reported a mean of 13.8 and 14.3 days with pain after LAUP and UPPP, respectively. To ease pain, all patients also consumed narcotic analgesics. The authors concluded that LAUP showed little difference in the severity or duration of posttreatment pain when compared with UPPP. Laser-assisted uvulopalatoplasty was also associated with annoying pharyngeal dryness and discomfort in 14 (54%) of our 26 patients. Other reports also noted that excessive dryness of the mouth and discomfort in the throat were the most prominent postoperative complaints after LAUP. The reason for the sensation of dryness is the destruction during LAUP of multiple serous glands in the uvula and the posterior portion of the soft palate, which provide continuous lubrication to the oropharynx and probably to the vocal cords. Indeed, any surgical intervention that diminishes the amount of glandular tissue may culminate in pharyngeal dryness and surface irritation of the vocal cords, especially LAUP, which is associated with a marked decrease in the amount and function of velar glands because of extensive palatal fibrosis and glandular destruction.

A similar sensation of dryness in the throat along with speech articulation problems were demonstrated in patients who underwent UPPP. Salas-Provance and Kuehn ascribed the changes in the voice quality to pharyngeal dryness. Of special note is the development of severe sialorrhea resulting in velopharyngeal stenosis in one patient (4%), who underwent 3 sessions of LAUP. This patient had later UPPP surgery to resect excessive scar tissue and relieve obstruction. Huet et al evaluated the results of LAUP for snoring with an aerophonescope (a noninvasive method to assess palatal function) and found that 3 patients (12%) had scar fibrosis and narrowing of the nasopharyngeal aperture. Carenfelt also reported that 2 patients (1%) of a similar cohort had this condition.

CONCLUSIONS

An American Sleep Disorders Association Report in 1994 withheld recommendation of LAUP as a suitable surgery to treat OSA, declaring it an experimental procedure because of insufficient data. An update for 2000 issued by the Board of Directors of the American Academy of Sleep Medicine and based on review of the literature stated that LAUP is not recommended for the treatment of OSA. A recent meta-analysis based on new evaluations published in peer-reviewed articles also concluded that LAUP should not be recommended for the treatment of any severity of OSA.

Although LAUP has gained much popularity, there is lack of unequivocal evidence that it provides a lasting remedy for OSA, a common yet potentially life-threatening syndrome. It is important to separate the myths from the facts; also there is a need to standardize outcome measures to evaluate the procedure. The procedure has been lately criticized, especially with regard to its inclination to aggravate patients’ pretreatment condition. Indeed, LAUP is not free of postoperative adverse reactions and complications. We achieved a surgical success in only one third of our patients and found a deterioration of existing OSA in a considerable number in addition to a late worsening of the subjective initial results. The facts presented herein are cause for concern and suggest that LAUP might not be an appropriate procedure to treat OSA.

Accepted for publication September 14, 2001.

We would like to thank Ilana Gelernter, MA, from the Statistical Laboratory of the School of Mathematics, Tel-Aviv University, for providing statistical consultation.

Corresponding author: Gilead Berger, MD, Department of Otolaryngology—Head and Neck Surgery, Meir Hospital, Sapir Medical Center, Kfar Saba 44281, Israel (e-mail: Berger-g@zahav.net.il).

REFERENCES

15. Berger G, Finkelstein Y, Stein G, Ophir D. Laser-assisted uvulopalatoplasty for...


Call for Photographs

ARCHIVES OF OTOLARYNGOLOGY--HEAD & NECK SURGERY Covers

With the January 2001 issue, the ARCHIVES OF OTOLARYNGOLOGY introduced nonmedical photographs as cover art for the journal. We are bombarded with medical and technical information every minute of every day and this is our way of offering you, our readers, a moment to reflect, smile, breathe a little more deeply, maybe even escape for just a second and relax a bit. Do you have a scenic photograph you have taken that you think would make a great cover shot? We’d love to see it! Submissions should be from our readers, reviewers, authors, or anyone affiliated with the journal, and MUST be formatted horizontally. They can be black and white or color and at least 3.5 x 5 in but no larger than 8 x 10 in. If you wish to submit a digital photograph, please call our office at (404) 778-2322 for guidelines. Due to legal concerns, no recognizable people should appear in the picture, and please include details about where the picture was taken, how you happened to be there, and anything else you think is interesting about the image. We need the photographer’s complete name, highest academic degree, city and state of residence, and a statement explaining how he or she is affiliated with the journal. Send submissions to ARCHIVES OF OTOLARYNGOLOGY, 1440 Clifton Rd NE, Suite 400, Atlanta, GA 30322. If you would like your photo returned, please enclose a self-addressed, stamped envelope. Cover photos will be chosen at the discretion of the ARCHIVES editorial staff.

Michael M. E. Johns, MD
Editor