Laser-Assisted Uvulopalatoplasty for Snoring

Medium- to Long-term Subjective and Objective Analysis

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Objective: To assess the subjective and objective medium- to long-term results of laser-assisted uvulopalatoplasty for snoring.

Design: A nonrandomized, prospective, before-after trial.

Subjects and Interventions: Fourteen patients underwent laser-assisted uvulopalatoplasty surgery; 2 surgical techniques, which differ with respect to the mode of midline palatal vaporization, were used.

Main Outcome Measures: Subjective analysis included a preoperative and 2 postoperative evaluations of the state of snoring: 4 weeks and 10.1±7.9 months (mean±SD) after completion of last laser treatment. In addition, a score on 5 other sleep-related symptoms was recorded before treatment and after 10.1±7.9 months; at that time, patients also estimated their overall satisfaction with the procedure. Objective analysis included preoperative nocturnal polysomnographic studies that were repeated postoperatively.

Results: A decline in snoring improvement from 79% (11/14) to 57% (8/14) was recorded; furthermore, state of snoring worsened from 7% (1/14) to 21% (3/14). Likewise, reevaluation of the 5 other sleep-related symptoms at the final follow-up visit uncovered a 57% improvement rate. Overall satisfaction with the procedure was 43%. The results of the postoperative objective studies corresponded to those of the subjective ones and demonstrated significant worsening of respiratory disturbance index in 3 (21%) of the 14 patients, who became mildly apneic. These findings were encountered with both laser techniques.

Conclusions: The favorable subjective short-term results of laser-assisted uvulopalatoplasty deteriorated with time. In addition, postoperative nocturnal polysomnography showed that the procedure caused mild obstructive sleep apnea in a considerable number of patients who formerly were nonapneic snorers. These findings may be related to velopharyngeal narrowing and progressive palatal fibrosis, caused by the thermal damage inflicted by the laser beam.


Sno ring is a common phenomenon and may be associated with restless sleep, night awakening, morning fatigue, daytime somnolence, and hypoxemia. Snoring, even without apnea, can be a risk factor for hypertension, angina pectoris, cerebral infarction, pulmonary hypertension, and congestive heart failure. This has led to the search for a compatible solution to a socially vexing problem and its potentially life-threatening pathologic consequences.

Laser-assisted uvulopalatoplasty (LAUP) is considered a popular and well-received surgical procedure to eliminate snoring and to treat obstructive sleep apnea (OSA). Reports on the efficacy of the procedure for snoring were promising, with a clinical success rate ranging from 70% to 95%.

There is, however, a scarcity of medium- to long-term data regarding the durability of these favorable results. Wareing and Mitchell, Wareing et al., and Ellis, for example, demonstrated that LAUP was associated with a considerable number of delayed failures. Furthermore, the available reports included subjective data to analyze the effectiveness of LAUP for snoring, while postoperative polysomnography (PSG) has been regularly excluded. This tendency probably derives from the encouraging results reported for LAUP and the high cost of the sleep studies. Consequently, the surgeons evaluated the procedure in terms of whether it eliminated snoring, but lacked information regarding possible changes in the objective sleep parameters.

This clinical study forms part of a research project conducted on the late anatomic and histopathologic changes of the
PATIENTS AND METHODS

The study population consisted of 14 patients who had bothersome snoring and completed LAUP treatment between June 1, 1994, and March 30, 1995, at the outpatient clinic of Meir General 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. There were 10 men and 4 women, ranging in age from 40 to 66 years (mean±SD, 51.2±7.5 years). They were generally healthy, and their mean body mass index (calculated as weight in kilograms divided by the square of height in meters) was 26.7±3.7 (Table 1).

PREOPERATIVE EVALUATION

Patients’ and bed partners’ detailed histories relevant to upper airway obstruction were obtained in structured interviews. They were requested to describe their snoring state and to indicate the absence (0) or existence (1) of 5 other sleep-related symptoms. The first 3 were addressed to the patients and the remaining 2 to their bed partners and included (1) night awakening, (2) morning fatigue, (3) daytime somnolence, (4) episodes of sleep apnea, and (5) involuntary body movements during sleep. A total score from 0 to 5 was calculated for each patient.

All subjects underwent a complete otolaryngologic examination, including flexible fiberoptic nasopharyngoscopy examination of the nose, pharynx and larynx, and had nocturnal PSG with simultaneous electroencephalography, electrocardiography, electromyography, and surface-electrode electro-oculography. Air flow 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. The severity of OSA was expressed in terms of a respiratory disturbance index (RDI), calculated as the average number of apneas plus hypopneas per hour of sleep. The study defined patients as (1) snorers when RDI was 0 to 5, (2) mildly obstructed when RDI was 6 to 20, (3) moderately obstructed when RDI was 21 to 40, and (4) severely obstructed when RDI was greater than 40. All patients were categorized as nonapneic snorers if they had an RDI of 5 or less. Patients were photographed intraorally immediately and 2 weeks after completion of the last laser treatment. A total score from 0 to 5 (as described earlier) was calculated for each patient. Possible variations between the preoperative and postoperative score indicated whether patients (1) improved, (2) remained unchanged, or (3) worsened. They were also asked to estimate their overall satisfaction with the procedure with a yes-no answer.

POSTOPERATIVE EVALUATION

All patients were reexamined 4 weeks and 3.5 to 36 months (mean±SD, 10.1±7.9) after completion of the last laser treatment. On both occasions, they were asked to compare snoring with its preoperative state and to answer whether it (1) was abolished or markedly reduced, (2) remained the same, or (3) had worsened. Furthermore, 5 other sleep-related symptoms were assessed at the end of the follow-up period, and a total score from 0 to 5 (as described earlier) was calculated for each patient. Possible variations between the preoperative and postoperative score indicated whether patients (1) improved, (2) remained unchanged, or (3) worsened. They were also asked to estimate their overall satisfaction with the procedure with a yes-no answer.

The PSG was repeated immediately after the last follow-up visit, at the same sleep laboratory, with the use of previously determined criteria for evaluation. All patients were photographed intraorally immediately and 2 weeks and 10.1±7.9 months after last laser treatment.

STATISTICAL ANALYSIS

Measurements were expressed as mean±SD. Comparisons were performed by paired t test and nonparametric Mann-Whitney test. Probability values of P<.05 were considered significant.

RESULTS

SUBJECTIVE ASSESSMENT

Table 2 compares the changes in snoring state and the score of each patient in the 5 other sleep-related symptoms. During the interval between follow-up visits, improvement in snoring declined from 79% (11/14) to 57% (8/14), and worsening in snoring increased from 7% (1/14) to 21% (3/14). Analysis of the 5 other sleep-related symptoms at the final follow-up showed a similar success rate (57%). One patient had deterioration of symptoms in this respect. Patients’ overall satisfaction with LAUP, which was also assessed at the last follow-up visit, established that only 6 patients (43%) were satisfied, while the remaining 8 (57%) were dissatisfied and reluctant to go through the procedure again.

SURGICAL METHODS

Two surgical techniques of LAUP were used, differing with respect to the mode of midline palatal vaporization. Nine patients underwent the first technique (type 1), in which a focused continuous beam of 15 to 20 W was used to excise the uvular base, through the full palatal depth, and then extended bilaterally to the anterior and posterior tonsillar pillars. Serial laser tonsillectomy was also performed. It was carried out in 1 to 2 sessions, with a mean of 1.22.

Five patients underwent the second technique (type 2), in which through-and-through full-thickness vertical trenches were created 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, as described by Krespi et al,4 the core of the uvula was removed from the bottom up, in a “fishmouth” 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. This technique was carried out in 1 to 2 sessions, with a mean of 1.4.

POSTOPERATIVE EVALUATION

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OBJECTIVE ANALYSIS

The mean lowest oxygen saturation did not differ significantly between preoperative and postoperative measurements (92.3%±5.9% vs 92.9%±5.4%). Yet, in 1 patient (patient 12), there was a significant lowering of postoperative lowest oxygen saturation, from 100% to 83%, that was consistent with the RDI elevation from 0 to 11.

Intraoral photographs demonstrated that the oropharyngeal isthmus, which was substantially enlarged immediately after surgery, was reduced in all patients at the end of the follow-up period. After type 1 procedures, this reduction was related to a curtainlike medial traction of the posterior pillars and a pulling of the lateral pharyngeal walls medially (Figure 1). After type 2 procedures, the mechanism was linked to a progressive approximation of the tonsillar pillars from the upper narrowest part of the vertical trench in a zipperlike manner, leading to posterior traction of the velum and medial traction of the lateral pharyngeal walls (Figure 2).

COMPLICATIONS AND ADVERSE EFFECTS

There were no major complications, including postoperative hemorrhage. The most common adverse effect of LAUP was pain that lasted from 5 to 14 days (mean, 9.7±3.5 days) postoperatively and was severe enough to keep patients away from work for 4.5±3.1 days. Five patients (36%) complained of persistent throat dryness or itching; in addition, 3 patients (21%) exhibited difficulty in nasal breathing, of whom 1 had a preexisting nasal obstruction.

According to its advocates, LAUP represents a significant improvement over uvulopalatopharyngoplasty (UPPP), which has an 86% success rate for treatment of snoring but is not without morbidity and troublesome complications. This less radical alternative is a blood-

## Table 1. Anthropometry of the Study Group*

<table>
<thead>
<tr>
<th>Patient No./ Sex/Age, y</th>
<th>Preoperative BMI, kg/m²</th>
<th>Type of Operations</th>
<th>No. of Operations</th>
<th>Follow-up, mo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LAUP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/F/45</td>
<td>28.7</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2/F/47</td>
<td>24.1</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>3/M/50</td>
<td>30.9</td>
<td>1</td>
<td>1</td>
<td>3.5</td>
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<td>4/M/40</td>
<td>29.4</td>
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<td>1</td>
<td>8</td>
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<td>5/M/56</td>
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<td>1</td>
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<td>9</td>
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<td>28.5</td>
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<td>8/M/45</td>
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<td>2</td>
<td>10</td>
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<td>13</td>
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<td>25.4</td>
<td>2</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>12/M/50</td>
<td>21.8</td>
<td>2</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>13/F/83</td>
<td>27.6</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>14/M/45</td>
<td>23.8</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Mean ± SD/10 M, 4/F/51.2±7.5</td>
<td>28.7 ± 3.7</td>
<td>NA</td>
<td>1.3 ± 0.5</td>
<td>10.1 ± 7.9</td>
</tr>
</tbody>
</table>

*BMI indicates body mass index; LAUP, laser-assisted uvulopalatoplasty; and NA, not applicable.

## Table 2. Changes in the State of Snoring and in the 5 Sleep-Related Symptoms

<table>
<thead>
<tr>
<th>No. (%) of Patients*</th>
<th>First Follow-up Visit, Snoring State</th>
<th>Last Follow-up Visit, State of Snoring</th>
<th>5 Sleep-Related Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improvement (79)</td>
<td>8 (57)</td>
<td>8 (57)</td>
</tr>
<tr>
<td></td>
<td>No change (14)</td>
<td>3 (21)</td>
<td>5 (36)</td>
</tr>
<tr>
<td></td>
<td>Worsening (7)</td>
<td>3 (21)</td>
<td>1 (7)</td>
</tr>
</tbody>
</table>

*Because of rounding, percentages may not all total 100.
less office procedure, carried out under local anesthesia, and has a low complication rate. Being mostly performed in stages, it is well controlled and allows optimal tissue removal benefit, with minimal danger of overexcision. Also, it is considered a low-cost procedure compared with UPPP. Data showed that the success rate of LAUP for the treatment of snoring was comparable with or exceeded that of UPPP. Nevertheless, the follow-up period was not recorded in previous studies or was based on a short period ranging from 4 to 6 weeks.

Our subjective data concerning the state of snoring reaffirmed that the initial results were encouraging (79% success rate) and compatible with those reported by other investigators. This may imply that our technique and surgical skills are similar to those in other studies and that LAUP is universally associated with early favorable results. Our series, however, demonstrated that, at the end of the follow-up period, improvement of snoring was found only in 57% of the patients. In addition, analysis of the 5 other sleep-related symptoms, done at the final visit, also showed only a 57% improvement rate. Wareing and Mitchell and Wareing et al pointed out that, similar to UPPP, LAUP was also associated with delayed failures in a sizable number of patients. Not only did the failure rate in snoring double between 1 and 6 months postoperatively, but evaluation of the same cohort 24 months after operation disclosed a further decline, with reappearance of socially disruptive snoring in one fifth of the patients who earlier were considered to have benefited from the procedure. Consequently, the overall success rate at this time was 55%. Likewise, El-

![Figure 1. Preoperative and postoperative intraoral photographs of a patient who underwent type 1 laser-assisted uvulopalatoplasty. A, Preoperative view. B, Immediate postoperative view. C, Late postoperative view; note severe medial curtainlike traction of the posterior pillars (white arrows).](image1)

![Figure 2. Preoperative and postoperative intraoral photographs of a patient who underwent type 2 laser-assisted uvulopalatoplasty. A, Preoperative view. B, Two weeks after treatment, the healing process is in progress and the zipper phenomenon takes place (black arrows). C, Late postoperative view; note that the zipper is completed, leaving 2 white longitudinal scars (black arrows). The shortened posterior pillars are now retracted, pulling the velum posteriorly (white arrows).](image2)
lis" reported early good snoring control in 14 of 16 patients but observed a further relapse in 3 patients 18 months postoperatively. Thus, the data cited above suggest that, in the long run, patients exhibit a decline in the success rate of LAUP.

Of interest is the source of the 14% gap between the rates of symptom improvement (57%) and patients’ satisfaction with the procedure (43%). A question is raised as to why some of the patients, who benefited from laser treatment with respect to elimination of snoring, morning fatigue, daytime somnolence, restless sleep, etc, remained dissatisfied. The severe and prolonged pain these patients had suffered may have overshadowed symptom improvement. Indeed, the most common postoperative adverse effect in the present study was pain, which lasted up to 14 days and was severe enough to keep patients away from work for an average of 4.5 days. Wareing and Mitchel1 also dealt with the issue and found that only 74% (25/34) of the patients who were satisfied with the procedure would be willing to go through it again because of pain and other side effects.

The results of the present study showed that, in addition to a diminished rate of snoring control, there was actual worsening of symptoms and signs in a fairly large proportion of the patients. Thus, at the end of the follow-up period, more than one fifth of them (21%) showed subjective aggravation of their initial snoring state. Furthermore, postoperative PSG performed at the same time demonstrated that 3 patients whose former RDI was 5, 5, and 0 underwent a significant worsening of their status and became mildly apneic, with an RDI of 15, 10.1, and 11, respectively. Three articles have recently reported the same finding.16-18 Lauretano et al10 examined the efficacy of LAUP in 12 snorers and performed postoperative sleep studies in 3 of them. Measurements were statistically insignificant, but they showed more than a 2-fold increase in the mean RDI (4.2 vs 9.3). Walker et al17 found a 23.7% deterioration of RDI after LAUP, from the mildest to the more severe degrees of OSA. Ryan and Love18 studied the efficacy of LAUP in 44 patients with symptomatic mild to moderate OSA. Polysomnography performed before and at least 3 months after surgery showed a significant worsening of RDI in 30% of the patients. Hence, it is thought that, since laser treatment aggravated OSA in apneic patients, the same could apply to snorers.

Postoperative PSG has usually been excluded from the studies of LAUP for snoring. The reasons to omit these tests from the agenda probably lie in the high cost of the nocturnal studies and the remarkable success rate of previous evaluations, which were based on a short follow-up period. Our work showed that PSG was an indispensable tool to examine the sequelae of LAUP for snoring, as it uncovered deterioration of breathing parameters, namely, de novo precipitation of OSA. This trend was observed in both types of laser surgery. However, because of our small sample size, the data presented herein should be interpreted with caution, and further study to confirm these findings is warranted.

Another form of thermal energy was also associated with aggravation of objective sleep parameters. Coleman and Smith19 assessed the safety and efficacy of radiofrequency tissue reduction of the palate for the treatment of snoring and mild sleep-disordered breathing, and their study showed an elevation of postoperative RDI in 6 of the 12 patients enrolled in the study; 2 of them, who were classified as snorers, developed mild obstructive sleep apnea (from 0 to 9 and from 4 to 9).

The late decline in the subjective results and the development of OSA in our series are probably attributable to the progressive fibrosis inflicted on soft palate tissues by thermal damage from 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.20 The effectiveness of surgery, therefore, should be assessed months later, when the healing process has stabilized. Indeed, Berger et al21 have recently reported the long-term histopathologic changes after LAUP. They found that various components of the soft palate underwent extensive and progressive changes, which increased with every additional treatment. The loose connective tissue present in the lamina propria was replaced by diffuse fibrosis. These changes also extended to the central layer, on the expanse of seromucous glands and muscle fibers. The authors also found that the nature and extent of thermal damage to the palate by horizontal incision across the palate (type 1) or by vertical trenches and trimming of the uvula (type 2) resulted in similar pathologic changes. Palatal fibrosis after LAUP was clinically encountered in 27% of the patients in Carenfelt’s study.22 Furthermore, Finkelstein et al23 ascertained that pharyngeal scar contracture occurred in the centripetal direction and caused medial traction of the posterior pillars, or even of the lateral pharyngeal walls. Eventually, the pharyngeal cross-sectional area went through major anatomic changes, with narrowing of the lumen, increased rigidity, decreased compliance, and loss of distensibility needed during inspiration. All of these deficiencies presumably have deleterious effects on the respiratory dynamics and may trigger the generation of OSA.

As previously described, LAUP is in most cases a staged procedure, requiring several sessions to achieve significant reduction of snoring and reversal of daytime sleepiness. Several authors addressed the issue of the number of treatments in snorers and in apneic patients. Dickson and Mintz11 used a technique that resembled our description of type 1 and recommended only 1 stage of LAUP. Other researchers performed the “classic” procedure and used a technique resembling our description of type 2. Krespi et al24 advocated 2 to 3 sessions for snorers and 4 to 5 for apneic patients; likewise, Walker et al25 used a mean of 2.6 sessions for snorers compared with 3.8 for apneic patients. Wareing and Mitchell26 did not expand on the number of procedures they used, yet they discussed the various principles that dictated the completion of treatment, ie, disappearance of snoring, patients’ refusal to continue surgery, and the removal of an adequate amount of palatal tissue in previous laser surgery that rendered further trimming unsafe. Nine of our patients were operated on by a method similar to Dickson and Mintz’s technique (type 1), with a mean of 1.22 applications. The other 5 underwent type 2 technique, with a mean number of 1.4 applications. No patient had more than 2 sessions, as almost 80% of them were initially sat-
satisfied with their snoring control. In addition, some refused further therapy because of severe pain; others showed signs of fibrosis and progressive narrowing of the velopharyngeal isthmus in a zipperlike manner as early as 2 weeks after treatment.8

The human uvula and the posterior portion of the soft palate harbor numerous seromucous glands that provide continuous lubrication to the oropharynx and probably to the vocal cords. Therefore, any surgical intervention that diminishes the amount of glandular tissue may culminate in pharyngeal dryness and surface irritation of the vocal cords. Indeed, LAUP is associated with a marked decrease in the amount and function of velar glands because of extensive palatal fibrosis and glandular destruction; consequently, 5 (36%) of our patients had annoying pharyngeal dryness and discomfort at the end of the follow-up. Similarly, patients who underwent UPPP had a sensation of dryness in the throat and speech articulation disorders. Salas-Provance and Kuehn, for instance, ascribed the changes in the voice quality to pharyngeal dryness.

Appearance or worsening of nasal breathing difficulty was recorded in 3 patients (21%). This late complication may be related to the progressive palatal fibrosis and its concomitant velopharyngeal narrowing, which hampers the airflow and increases airflow resistance in a retrograde fashion from this segment up to the nose. Although the nasal passages are patent, a sensation of blockage ensues because of respiration under abnormal air pressure.

The data are based on a small number of cases, and the sequelae of LAUP surgery for snoring deserve further investigation. Nevertheless, the study demonstrated that (1) the subjective short-term results were favorable, but with the passage of time, improvement in snoring deteriorated; (2) the procedure may lead to mild OSA in a considerable number of patients; (3) postoperative PSG was necessary to assess the objective results of the procedure; (4) the oropharyngeal isthmus, which was markedly enlarged after surgery, narrowed at the end of the follow-up period; (5) both techniques of surgery were associated with similar clinical outcomes; and (6) dryness of the throat was not an uncommon phenomenon.

The full implications of the procedure are yet to be established; hence, the decision to perform LAUP for snoring should be approached with caution.

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REFERENCES