Is There a Better Way to Do Laser-Assisted Uvulopalatoplasty?

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

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

Patients and Interventions: Twenty-five patients underwent a modified procedure of LAUP termed one-stage LAUP, and a matched control group of 24 patients underwent uvulopalatopharyngoplasty.

Main Outcome Measures: Subjective analysis of LAUP included a preoperative and 2 postoperative evaluations of the state of snoring (4 weeks and after a mean±SD of 12.2±9.9 months). A score on 5 other sleep-related symptoms was recorded before and after completion of LAUP. The objective polysomnographic outcomes were compared with a control group undergoing uvulopalatopharyngoplasty.

Results: In 25 patients, improvement in the state of snoring significantly declined from 76% (n=19) to 32% (n=8), and worsening increased from 12% (n=3) to 32% (n=8) (P<.001). Evaluation of 5 other sleep-related symptoms showed that 52% of patients (n=13) improved and 20% (n=5) worsened. Polysomnography of LAUP patients showed that the mean postoperative respiratory disturbance index worsened significantly (33.1±23.1) compared with the preoperative one (25.3±14.3) (P=.05); also, 20% of the procedures were successful and 36% revealed marked worsening. The respiratory disturbance index of uvulopalatopharyngoplasty patients changed from 26.0±18.0 to 18.7±21.3, yet improvement did not reach statistical significance (P=.09). Furthermore, 58% (n=14) of the surgical procedures were successful and only 8% (n=2) revealed marked worsening.

Conclusions: The favorable, subjective, short-term results of modified LAUP deteriorated over time. The procedure might also lead to aggravation of existing apnea. These findings are probably related to progressive palatal fibrosis and velopharyngeal narrowing originated by the laser beam.


Laser-assisted uvulopalatoplasty (LAUP) was initially designed for the management of snoring; gradually, it has been extended to treating various degrees of obstructive sleep apnea (OSA). Laser-assisted uvulopalatoplasty is an office procedure performed with the patient under local anesthesia and requires several sessions until satisfactory results are achieved. During surgery, which has been extensively described by Krespi et al, vertical trenches are created on either side of the uvula into the soft palate, coupled with shortening and trimming of the uvula. Several studies have examined the efficacy of the technique, recognized as standard LAUP, and reported comparable results to uvulopalatopharyngoplasty (UPPP). However, other studies found that LAUP was ineffective, had deleterious effects on the respiratory dynamics and may trigger the generation of OSA in formerly nonapneic patients who only snored, or lead to deterioration of existing sleep apnea.

Dickson and Mintz introduced a modified technique of LAUP, which they termed one-stage LAUP. This modified technique was designed to reduce the overall pain of the patients and the cost of standard LAUP. During surgery, a curvilinear horizontal incision is made under the palatal dimple, and ultimately the same amount of soft palate tissue is removed as in UPPP. The authors reported excellent short-term subjective results and a successful objective response. Seemann et al also used one-stage LAUP and reported encouraging results. Ryan and Love, on the other hand, concluded that the response to this technique was varied and unpredictable, and only a few patients achieved a satisfactory outcome.

In view of the discrepancy, the present study, which forms part of a research
The study population consisted of 25 patients with bothersome snoring and various degrees of OSA who had completed LAUP treatment between June 1, 1994, and March 31, 1995, at the outpatient clinic of Meir Hospital, Sapir Medical Center, Kfar Saba, Israel. All patients were generally healthy, without a cleft lip or palate; none had undergone prior mandibular or maxillary surgery. They consented to participate in the study and undergo treatment after being informed of the known benefits, risks, alternatives, and complications of the procedure. Inclusion in the study was contingent on completion of all diagnostic studies.

PREOPERATIVE EVALUATION

Patients’ detailed histories and bed partners’ reports relevant to upper airway obstruction were obtained in structured interviews. As previously reported,9,10 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: night awakening, morning fatigue, daytime somnolence, breathing pauses, and involuntary body movements during sleep. Questions on the first 3 symptoms were addressed to the patient 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 nasopharyngoscopic examination of the nose, pharynx, and larynx, and nocturnal polysomnography with simultaneous electroencephalography, electrocardiography, electromyography, and surface-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 patients as (1) nonapneic 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. Maximal snoring intensity was measured with a microphone located above the patient’s head at a distance of 1 m and connected to a sound level meter (model 2700; Quest Electronics, Oconomowoc, Wis). The output from the sound level meter was parallel recorded on a calibrated chart (40 to 80 dB) recorder at a paper speed of 10 cm/h. It should be indicated that a low preoperative RDI and normal saturations were treated only when maximal snoring intensity disrupted sleep and affected marital harmony and patients’ state of health. Furthermore, patients were photographed intraorally on 3 occasions: immediately after treatment, 4 weeks after treatment, and at the final follow-up period (mean±SD, 12.2±9.9 months), with the use of the previously described camera.

SURGICAL METHOD

The modified LAUP procedure was performed 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 at the upper edges of the anterior tonsillar pillars. Similar to the Dickson and Mintz11 method, the carbon dioxide laser (Sharplan Lasers Inc, Allendale, NJ) was used in a focused continuous mode at 15 to 20 W to excise the uvular base below the dimple through the full palatal depth, while the levator muscles remained intact. The excision was extended bilaterally to the anterior and posterior tonsillar pillars, leaving the same amount of tissue at the end of surgery as in UPPP. To achieve a satisfactory outcome, in several cases treatment was repeated.

DEFINITION OF TREATMENT EFFECTIVENESS

Evaluation was based on commonly accepted definitions found in the literature.3,11,16 Surgery was considered successful when patients had at least a 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 as-

POSTOPERATIVE EVALUATION

All patients were reexamined 4 weeks and 5 to 48 months (mean±SD, 12.2±9.9 months) after completion of laser treatment. On both occasions, they were asked to compare current snoring with its preoperative state and to answer whether it was abolished or markedly reduced, remained the same, or 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 score indicated whether patients improved, remained unchanged, or worsened. Patients were also asked to estimate their overall satisfaction with the procedure with a yes or no answer. Polysomnography was repeated shortly before the follow-up visit, at the same sleep laboratory, with the use of previously determined criteria for evaluation. In addition, patients were photographed intraorally on 3 occasions: immediately after treatment, 4 weeks after treatment, and at the final follow-up period (mean±SD, 12.2±9.9 months), with the use of the previously described camera.

CONTROL GROUP

A matched control group of patients who underwent UPPP provided a basis for comparison of the objective finding of LAUP. The control group consisted of 24 patients who experienced bothersome snoring and various degrees of OSA and underwent a complete otolaryngologic examination, including flexible fiberoptic nasopharyngoscopic examination of the nose, pharynx, and larynx and nocturnal polysomnography. Surgical procedures were completed between February 1, 1993, and November 30, 1999, at the Meir Hospital, Sapir Medical Center, Kfar Saba, Israel. Similar criteria for inclusion described previously were applied. The procedure was discussed in the process of informed consent.

Uvulopalatopharyngoplasty was performed with the patient under general endotracheal anesthesia. Following tonsillectomy, the soft palate was resected just below the palatal dimple, thus avoiding injury to the levator veli palatini muscle sling. The incisions were then arched laterally through the full thickness of the tonsillar pillars. Careful suturing of the free edges of the anterior and posterior pillars completed surgery. Follow-up lasted 2 to 49 months (mean±SD, 9±10.5 months) after completion of surgery; shortly before that time polysomnography was repeated at the same sleep laboratory where all the other studies were performed.
Surgery was considered unsuccessful when postoperative RDI was reduced by less than 50% from preoperative value, postoperative RDI remained unchanged, or postoperative RDI values worsened.

STATISTICAL ANALYSIS

Comparisons were made by the paired t-test and the McNemar test. Measurements are expressed as mean±SD; P<.05 is considered statistically significant.

RESULTS

Twenty-two men and 3 women, ranging in age from 32 to 71 years (49.6±9.8 years), underwent LAUP treatment. Their preoperative mean body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters, was 27.5±3.2. Assessment at the end of the follow-up period revealed no significant change (27.5±3.6) of the BMI levels (P=.86). The preoperative maximal snoring intensity for the whole group was 64.6±5.0 dB. Eighteen (72%) of the 25 LAUP patients underwent 1 treatment, 5 (20%) needed 2 treatments, and 2 (8%) needed 3 (mean treatments, 1.4±0.6 treatments). The interval between sessions was approximately 6 weeks.

SUBJECTIVE OUTCOMES OF LAUP

During the interval between follow-up visits, improvement in snoring declined from 76% (19/25) to 32% (8/25), and worsening in snoring increased from 12% (3/25) to 32% (8/25). Three patients (12%) had no change in snoring at the first follow-up visit and 9 (36%) had no change at the last follow-up visit. Statistical analysis confirmed that the deterioration in the state of snoring during the time lapse between the follow-up visits was statistically significant (P<.001). Examination of the 5 other sleep-related symptoms at the final follow-up visit revealed that only 13 (52%) of 25 patients had improvement of symptoms, whereas 5 (20%) of 25 reported aggravation of symptoms. Seven patients (28%) experienced no change in symptoms. An assessment of patients’ overall satisfaction from LAUP, which was also performed at the last follow-up visit, established that 9 patients (36%) were satisfied, whereas the remaining 16 (64%) were dissatisfied and reluctant to undergo the procedure again.

OBJECTIVE OUTCOMES OF LAUP

Table 1 shows the objective findings recorded before treatment and at the conclusion of the follow-up. A comparison between the mean preoperative and postoperative RDI values of the whole group revealed a significant worsening in this respect (25.3±14.3 vs 33.1±23.1, respectively) (P=.05). Figure 1 demonstrates that only 5 patients (20%) had a successful surgery, whereas 3 (12%) had insufficient success (ie, reduction of RDI levels by less than 50% from preoperative value). Two patients (8%) had no change in the preoperative RDI. Furthermore, 15 patients (60%) had a worsening of

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Mean ± SD  12.2 ± 9.9   25.3 ± 14.3   33.1 ± 23.1   87.6 ± 6.1   84.9 ± 9.4

Abbreviations: LSAT, lowest oxygen saturation; NA, not applicable; RDI, respiratory disturbance index.
postoperative RDI, 6 (24%) of whom had a moderate worsening of RDI values that was not associated with a change of sleep apnea status, and 9 (36%) had a marked worsening of postoperative RDI values that was associated with a change of sleep apnea status from mild to moderate OSA (patients 9 and 15), from mild to severe OSA (patients 11 and 25), and from moderate to severe OSA (patients 4, 7, 13, 18, and 21). In 3 patients (4, 11, and 25), RDI worsening was greater than 100% from the preoperative value. Preoperative and postoperative mean lowest oxygen saturation levels were not significantly different (87.6%±6.1% vs 84.9%±9.4%, respectively) (P=.11). Nevertheless, patient 13 had a change of preoperative lowest oxygen saturation from 72% to 56%, a deleterious lowering consistent with the shift from moderate to severe OSA (Table 1). Intraoral photographs (Figure 2) demonstrate that the size of the oropharyngeal isthmus, which underwent a substantial enlargement shortly after surgery (Figure 2B and C), was reduced at the end of the follow-up period (Figure 2D). This reduction is related to a curtainlike medial traction of the posterior pillars and to a pulling of the lateral pharyngeal walls medially.

COMPLICATIONS AND ADVERSE EFFECTS OF LAUP

There were no life-threatening complications, including postoperative airway obstruction or hemorrhage. The most common adverse effect of LAUP was pain, which lasted from 5 to 21 days postoperatively (mean±SD duration, 9.7±3.8 days) and was severe enough to keep patients away from work for 7±2.6 days. At the end of the follow-up visit, 12 patients (48%) complained of persistent throat dryness or itching. One patient developed velopharyngeal stenosis and underwent corrective surgery to relieve obstruction.

OBJECTIVE OUTCOMES OF UPPP

A control group of 22 men and 2 women, ranging in age from 28 to 69 years (48.8±11.1 years), underwent UPPP. The preoperative BMI was 28.3±3.2. Assessment at the end of the follow-up period revealed no significant change of the BMI levels (28.6±3.1) (P=.34). The preoperative...
maximal snoring intensity for the whole group was 65.6±9.1 dB. Table 2 presents the objective findings recorded before treatment and at the conclusion of the follow-up. A comparison between the mean preoperative and postoperative RDI values of the whole group revealed an improvement in this respect, yet it did not reach statistical significance (26.0±18.0 vs 18.7±21.3, respectively) (P=.09). Fourteen patients (58%) had a successful surgery, whereas 3 (13%) had insufficient success (Figure 1). Seven patients (29%) had a worsening of postoperative RDI, 5 (21%) of whom had a moderate worsening of RDI values, whereas the remaining 2 (8%) had a significant worsening of postoperative RDI values associated with a change of sleep apnea status from mild to moderate OSA (patient 5) and from mild to severe OSA (patient 24). In patients 2 and 24, RDI worsening was greater than 100% from the preoperative value. Postoperative mean lowest oxygen saturation levels improved significantly (81.5%±11.4% vs 87.0%±6.7%, respectively) (P=.002) (Table 2).

### COMMENT

Nineteen (76%) of 25 patients who underwent one-stage LAUP to treat symptoms of snoring and OSA experienced an initial subjective improvement of the state of snoring. Comparable findings were recorded in nonapneic patients who snored (79%, 11/14) irrespective of the type of laser surgery and in apneic patients (88%, 23/26) who underwent standard LAUP. However, similar to the latter, there was a significant deterioration of the early favorable results and a significant aggravation of the state of snoring after 12.2±9.9 months. Assessment of 5 other sleep-related symptoms at the end of the follow-up revealed a low success rate (52%, 13/25) and a 20% failure rate (5/25) that accorded with the poor results found earlier. Wareing and Mitchell17 and Wareing et al18 also pointed out that LAUP was associated with delayed failures in a sizable number of patients, with reappearance of socially disruptive snoring in one fifth of the patients who earlier had benefited from the procedure.

The late objective findings of one-stage LAUP were disappointing and in keeping with the subjective ones. Statistical analysis confirmed that the mean postoperative RDI values were significantly higher than the preoperative ones (P=.05), indicating a genuine worsening in this respect. Evaluation of surgery disclosed that only 5 (20%) of the 25 patients had a successful surgery, whereas 15 (60%) had either moderate or marked worsening of RDI values. Ryan and Love13 obtained a good response in only 27% of the patients, a partial response in 9%, a poor response in 34%, and worsening in 30%.

Our data substantially differ from those of Dickson and Mintz,11 who reported a 75% to 100% improvement in snoring by 83% of the patients. Only 14 patients underwent preoperative and postoperative polysomnography, 10 (71%) of whom responded successfully to LAUP. Seemann et al12 recently found a significant objective improvement in 60% of the patients by apnea index criterion and a 32% improvement by RDI criterion, after an average follow-up of 9.4 weeks, and concluded that LAUP is an effective and safe treatment for sleep-disordered breathing. Evidently, methodologic dissimilarities re-
Regarding the length of the follow-up period exist among the studies. Although our mean follow-up period lasted for more than 12 months, in the Dickson and Mintz study, it was approximately 3 to 4 months for the subjective symptoms and not recorded for the objective ones; in the study by Seemann et al, the follow-up period was much shorter. In fact, the findings of both studies resemble our initial results and significantly differ from the medium- to long-term ones.

In the current study, a focused, continuous beam at a power setting of 15 to 20 W was used to vaporize the soft palatal tissues. The literature reveals that Kamani, the originator of LAUP; Dickson and Mintz, who developed the one-stage LAUP; and multiple other researchers have used comparable wattages. Troell et al developed the one-stage LAUP; and multiple other researchers have used comparable wattages. Troell et al even used a higher power setting of 18 to 24 W. On the other hand, Lauretano et al and Pribitkin et al operated at a lower power (14 to 18 W and 10 W, respectively).

Similar to standard LAUP, intraoral photographs demonstrated a substantial enlargement of the oropharyngeal isthmus immediately after surgery, causing temporary relief of signs and symptoms in a considerable number of patients. However, with the passage of time there was a late decline in the improvement of snoring, aggravation of the sleep-related symptoms, and an overall failure in the objective measures. These results are attributable to the progressive fibrosis inflicted on soft palate tissues by the thermal damage of the laser beam, which leaves a raw surface that subsequently undergoes scarring. These wounds take longer to heal than those created with a scalpel. 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 disclosed that the various components of the soft palate underwent extensive changes, with replacement of the loose connective tissue in the lamina propria by diffuse fibrosis that also extended to the central layer, on the expanse of seromucous glands and muscle fibers. Palatal fibrosis after LAUP was also encountered in 27% of the patients in the study by Carenfelt. It was shown that the pharyngeal scar contracture occurred in the centripetal direction and caused a curtainlike medial traction of the posterior tonsillar pillars and a pulling of the lateral pharyngeal walls medially. Eventually, the pharyngeal cross-sectional area went through major anatomic changes that included narrowing of the lumen, increased rigidity, decreased compliance, and loss of distensibility needed during inspiration. These deficiencies have deleterious effects on the respiratory dynamics and may deteriorate existing OSA. The most common adverse effect was pain, which lasted up to 21 days postoperatively (9.7 ± 3.8 days); an almost identical finding has been found in standard LAUP. Troell et al showed a mean of 13.8 days with pain. The procedure was also associated with annoying pharyngeal dryness and discomfort in 12 patients (48%). Other researchers also noted excessive dryness of the mouth and discomfort in the throat after LAUP. The reasons for the sensation of dryness is the destruction of multiple seromucous 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. Of special note is the development of severe scarring, resulting in velopharyngeal stenosis in 1 patient. Huet et al and Carenfelt also found that in 3 patients (12%) and 2 patients (1%), respectively, LAUP was associated with scar fibrosis and narrowing of the nasopharyngeal aperture.

Dickson and Mintz disclosed that one-stage LAUP produces a postoperative picture indistinguishable from that of UPPP and that the technique combines the advantages of UPPP, removing a significant amount of tissue, and a greatly reduced morbidity seen with standard LAUP. Nevertheless, a comparison between patients who underwent one-stage LAUP and a control group undergoing UPPP by the same surgeons and matched by sex, age, preoperative BMI and RDI levels, preoperative maximal snoring intensity, and duration of follow-up period emphasizes appreciable differences. Although only 5 (20%) of the 25 modified laser procedures were successful, an approximate 3-fold increase in the success rate (14/24, 58%) was found in UPPP procedures. The latter is compatible with other reports. Furthermore, a greater proportion of the patients exhibited marked worsening of RDI levels (9/25, 36%) after modified laser procedure than after UPPP (2/24, 8%) (Figure 1). Thus, the study shows that UPPP is a more effective and a far less morbid procedure than one-stage LAUP. Moreover, the study posed the question of whether there is a better way to do LAUP. Based on the medium- to long-term current experience and that of standard LAUP, it can be concluded that both procedures were disappointing, yet the former was inferior to standard LAUP in every aspect. For example, improvement in the state of snoring was 32% (8/25) compared with 65% (17/26), and the overall satisfaction from LAUP was 36% (9/25) compared with 58% (15/26). Also, there was a significant worsening of the mean postoperative RDI compared with the preoperative one (33.1 ± 23.1 vs 25.3 ± 14.3, respectively, P = .05). However, in standard LAUP the mean postoperative RDI improved (25.0 ± 18.8 vs 29.6 ± 21.6, respectively, although this result was not statistically significant (P = .12). Notably, both procedures were performed in the same office setting and by the same surgeons; also, the findings were analyzed with similar criteria for evaluation. The differences among the studies probably derive from a greater narrowing of the velopharyngeal isthmus that occurred after one-stage LAUP. The measurements of Finkelstein et al, which have shown a significantly greater distance between the tonsilar pillars after standard LAUP compared with the modified procedure and after UPPP compared with the 2 LAUP techniques, support this contingency.

**CONCLUSIONS**

Laser-assisted uvulopalatoplasty has gained much popularity in the last decade as a cure for OSA, a common yet potentially life-threatening syndrome. It is commonly accepted that the subjective, short-term outcome of LAUP is successful; however, the procedure has shown an inclination to aggravate patients’ pretreatment condition in the medium to long term. In the present series, we...
found a significant worsening of the mean postoperative RDI, a surgical success in only one fifth of the patients (20%, 5/25), and a marked worsening of postoperative RDI values in 9 (36%), in addition to a late worsening of the subjective initial results. Furthermore, one-stage LAUP has proved inferior to UPPP and standard LAUP.

An American Sleep Disorders Association Report27 published 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 stated that LAUP is not recommended for the treatment of sleep-related breathing disorders, including OSA.28 No specification has been given as to the type of LAUP technique being evaluated. The facts and the recommendations presented herein are cause for concern and should be considered before practicing LAUP for the treatment of OSA.

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