*The Laryngoscope*
Lippincott Williams & Wilkins, Inc.


# Use of Er,Cr:YSGG Versus Standard Lasers in Laser Assisted Uvulopalatoplasty for Treatment of Snoring

Vaclav Pavelec, MD; Pavel Polenik, MD, PhD

***Objectives:*** **The aim of this study was to compare the effectiveness of the Er,Cr:YSGG (Waterlase) laser with KTP and $CO_2$ lasers in laser assisted uvulopalatoplasty (LAUP) for treatment of snoring.** ***Study Design:*** **This is a prospective study of 63 patients who were treated for snoring by LAUP either with Er,Cr:YSGG (n = 21) or with KTP (n = 21) or $CO_2$ lasers (n = 21). Histologic analysis was performed, and the effects of KTP and Waterlase on soft tissue were compared.** ***Methods:*** **Patients were examined by an ENT surgeon and tested with polysomnography. Probands who suffered from obstructive sleep apnea or had an apnea-hypopnea index of 15 or greater were excluded from the study. The remaining patients were assigned to either Er,Cr:YSGG, KTP, or $CO_2$ laser therapy. The three lasers were compared from a postoperative recovery point of view by immunohistochemical examination.** ***Results:*** **Pain medications were used on average for 4.1, 6.5, and 10.1 days, and the times to return to normal diet were on average 4.5, 6.8, and 8.6 days in the Er,Cr:YSGG, KTP, and $CO_2$ groups, respectively. Two cases of bleeding were observed in the $CO_2$ group. Foreign body sensation occurred in 14%, 19%, and 19% of subjects in the Er,Cr:YSGG, KTP, and $CO_2$ groups, respectively. Velopharyngeal insufficiency was noticed in one KTP treated patient; however, it was transient. Snoring and apnea-hypopnea index was significantly reduced in all groups. Significantly larger coagulation of soft tissue was found in the KTP group than in the Waterlase group.** ***Conclusions:*** **Patients treated with Waterlase recovered more quickly in comparison with patients in the KTP and $CO_2$ groups, which was confirmed by immunohistochemical findings. The laser techniques did not differ in effectiveness.** ***Key Words:*** **Er,Cr:YSGG, KTP, $CO_2$, LAUP, snoring, palatal surgery, histology.**

***Laryngoscope,*** **116:●●●–●●●, 2006**

## INTRODUCTION

Laser assisted uvulopalatoplasty (LAUP) is the most frequently performed surgical procedure for reduction of snoring. Laser techniques widen the retropalatal space, and subsequent healing leads to reinforcement of the free edge of palate. Although the effectiveness of this method is high, the postoperative period is often associated with pain, dysphagia, and odynophagia. Early pain and difficulties in swallowing are partially caused by the pharyngeal component of the surgery.[6] The extent of the discomfort depends on the depth of damage in the soft tissue. The more sensitive nerve endings are harmed, the greater the odynophagia. LAUP can be performed by different type of lasers. LAUP by $CO_2$ or KTP laser has been used for treatment of pure snoring since 1999. Until recently, Er,Cr:YSGG laser treatment has been used only in dentistry. However, this laser system is gaining popularity mainly because of its efficiency in a variety of dental conditions. Reduced pain and better healing has been reported when Waterlase was used compared with conventional stomatologic methods.[1] Since 2004, Waterlase has been also used in ENT for snoring management. **AQ: 1**

The purpose of this study was to introduce a device that would have the basic characteristic of a power laser (precision in cutting) and would also reduce thermal damage to the soft tissue. Four additional goals were stated in this study: 1) to initiate studies of the Waterlase laser in ENT, 2) to find out whether the Waterlase laser is a suitable method for LAUP, 3) if it is, to determine whether the Waterlase laser has any advantages/disadvantages compared with the power lasers used in otolaryngology, and 4) to perform a histologic analysis of KTP and Er,Cr:YSGG in separated uvula.

## MATERIALS AND METHODS

Patients included in the study had complaints of loud, disturbing snoring and negate daytime somnolence. All patients were extensively questioned about symptoms related to snoring, such as sleepiness, decreased daytime alertness, irritability and short temper, headaches, forgetfulness, mood changes, depression, and decreased interest in sex. All patients were investigated by an ENT surgeon and a pneumologist and tested by polysomnography both preoperatively and postoperatively. Their bed partners classified the extent of snoring on the basis of the visual analogue scale. **AQ: 2**

From ENT Clinic (V.P.), Charles University Hospital, Plzen, Czech Republic, and Stomatological Clinic (P.P.), Charles University Hospital, Plzen, Czech Republic.

Editor's Note: This Manuscript was accepted for publication March 8, 2006.

Send Correspondence to Dr. Vaclav Pavelec, Husova 3, Plzen, Czech Republic. E-mail: jarmila@uga.edu

**DOI: 10.1097/01.mlg.0000227958.81725.f4**

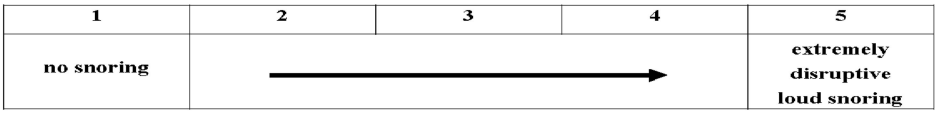



Fig. 1. Visual analogue scale of snoring score

The enrolled patients were divided randomly into three groups, each consisting of 21 probands. The group of Waterlase treated patients represented the experimental group, whereas the patients operated by KTP and $CO_2$ laser represented control groups.

### *Histology*

Histologic analysis was performed on uvula separated with either KTP or Waterlase lasers. Five specimens of KTP and five specimens of Er,Cr:YSGG separated uvula were randomly selected and stained with hematoxylin-eosin and examined under a light microscope. The experimental group of specimens was formed by Waterlase separated tissue. This was compared with the control group with tissue separated by KTP laser. The KTP laser was chosen over $CO_2$ laser because it is a gold standard of ENT lasers and because the $CO_2$ laser damages surrounding structures much more dramatically.

### *Inclusion Criteria*

Only pure snorers with apnea-hypopnea index (AHI) less than 15 were enrolled in the study. The indication for LAUP was made when prolonged or hypertrophic uvula, redundant mucosa in the soft palate, or curtain-like posterior arches or webbing was noticed. Other selection criteria included 1) no tonsillar hypertrophy, 2) no previous surgical treatment for snoring, 3) documented failure of attempts at conservative measures such as change in sleeping position and sleep hygiene, 5) proof of medical fitness adequate for surgery, and 6) a clear understanding and expectations of the risks, morbidity, and likely outcomes of surgery.

### *Snoring Level*

The candidates for surgical LAUP treatment were evaluated on the basis of history of snoring score and polysomnographic measurements. The scoring system used a 5 point scale ranging from 1 (no snoring) to 5 (extremely disruptive snoring). The 5 point visual analogue scale was chosen because of its correspondence with a scoring system familiar to patients used in public schools in the Czech Republic (Fig. 1). F1

### *Polysomnography*

A comprehensive sleep study, with constant night monitoring, was performed using a computerized polygraph to monitor electroencephalogram, left and right electro-oculogram, electrocardiogram, anterior tibialis electromyogram, abdominal and thoracic movement by inductive plethysmograph, nasal oral airflow, oxygen saturation ($SaO_2$) by pulse oxymetry, and throat sonogram. Apnea was defined as cessation of breathing for at least 10 seconds. Hypopnea was defined as decreased effort to breathe by 50% or more and decreased $SaO_2$ by 4% or more compared with baseline. The AHI was calculated as the sum of apneas and hypopneas per hour.

### *Physical Examination*

Patients underwent preoperative physical examinations that included a full assessment of upper airway with rigid nasopharyngoscopy, Stuckradt's laryngoscopy, fiberoptic nasopharyngolaryngoscopy including Mueller's maneuver, and standard examination focusing on the soft palate, tonsils, and root of the tongue. Body mass index (BMI) was calculated from weight (in kilograms) and height (in meters) recorded at the initial visit.

### *Surgical Technique*

In topically anesthetized patients (midazolam hydrochloride 0.1 mg/kg intramuscularly), the soft palate was infiltrated locally (Supracain 2 mL), followed by vertical incisions, vaporization of redundant mucosa of posterior arches, and subsequent creation of neo uvula by division of its hypertrophic parts (Figs. 2 and 3. Before discharge, patients were prescribed metamizolum natricum monohydricum in doses of 7 to 14 mg/kg every 6 hours as needed. The surgery took 15 to 20 minutes independent of the laser used. The cost of the surgery was similar in all laser techniques. F2 F3

### *Postoperative Follow-Up*

The number of days for which narcotic pain killers were used and the number of days until return to solid food were recorded by patients in a log. Check-ups were made at 1 and 2

Fig. 2. Preoperative, posterior arch webbing.

Fig. 3. Postoperative, no bleeding.

TABLE I.
Demographic Data of 63 Patients Operated by Er,Cr:YSGG, KTP, and $CO_2$ Laser.

| | | Age (yr) | | BMI (kg/m$^2$) | | |
|---|---|---|---|---|---|---|
| | n | Mean | SD | Mean | SD | M/F |
| ErCR | 21 | 45.62 | 11.66 | 29.86 | 4.32 | 16/5 |
| $CO_2$ | 21 | 42.67 | 10.31 | 28.33 | 2.71 | 17/4 |
| KTP | 21 | 41.76 | 11.81 | 29.38 | 4.15 | 18/3 |

TABLE II.
Postoperative Indices of 63 Patients Operated by Er,Cr:YSGG, KTP, or $CO_2$ Laser.

| | | Narcotic Pain Medication (days) | | Return to Normal Diet (days) | |
|---|---|---|---|---|---|
| | n | Mean | SD | Mean | SD |
| ErCR | 21 | 4.10 | 1.95 | 4.48 | 1.50 |
| $CO_2$ | 21 | 10.05 | 3.56 | 8.57 | 2.99 |
| KTP | 21 | 6.52 | 2.23 | 6.81 | 1.63 |

weeks and at 3 months. At each interval, patients were examined and queried concerning complications, side effects, and complaints. Polysomnography was performed at 3 to 6 months after the surgery.

### *Statistical Analysis*

Means and standard deviations of age, BMI, and sex ratio are presented in Table I. Figure 4 shows distribution of snoring score before and after the surgery. The statistical significance ($P < .01$) of differences in age, BMI, and AHI before and after the surgery among the lasers was assessed using Student's t test with the PROC GLM procedure of SAS (Cary, NC).[11] Differences in sex ratios among the lasers were analyzed with the chi-square test with the PROC FREQ procedure of SAS.[11] Difference in snoring score before and after the surgery among the lasers was tested by the Kruskal-Wallis test with the PROC NPAR1WAY procedure of SAS.[11]

## RESULTS

Sixty-three patients (Er,Cr:YSGG = 21, KTP = 21, $CO_2$ = 21) ranging in age from 20 to 67 years were reviewed for the study. There were no statistically ($P > .05$) significant differences in sex, age, BMI, and preoperative snoring score among the three groups.

### *Postoperative Morbidity*

The number of days of pain medication use and the time to return to normal diet were used as indicators of recovery from surgery. As given in Table II, patients undergoing Er,Cr:YSGG assisted uvulopalatoplasty used narcotics pain medication for significantly ($P < .01$) fewer days compared with KTP and $CO_2$ patients (4.1 ± 1.9, 6.5 ± 2.2, and 10.1 ± 3.5, respectively). Return to normal diet was significantly ($P < .01$) earlier after Er,Cr:YSGG than after KTP and $CO_2$ lasers (4.5 ± 1.5, 6.8 ± 1.6, and 8.6 ± 2.9, respectively). Statistically significant ($P < .01$) differences in return to normal diet and narcotic pain medication were found between KTP and $CO_2$ lasers.

### *Complications*

Bleeding occurred in two cases operated with $CO_2$ laser and was stopped by cauterization. One KTP LAUP patient had suffered from temporary velopharyngeal insufficiency that resolved spontaneously within 3 days. Three months after the surgery, globes sensation was present in two Er,Cr:YSGG, four KTP, and four $CO_2$ patients (Fig. 5) The most common complaints in all groups were dry throat, inability to clear the throat, or mild dysphagia.

### *Histology*

The postoperative course corresponds with our histologic findings, which show better healing and less pain in Er,Cr:YSGG group. There was deeper and more extensive tissue damage noticed in KTP specimens. This was clearly seen in the destroyed structure of minor salivary glands as well as in connective tissue (Figs. 6 and 7).

### *Subjective Symptom Elimination*

Subjective assessment of snoring severity by either bed partners or patients was collected preoperatively and

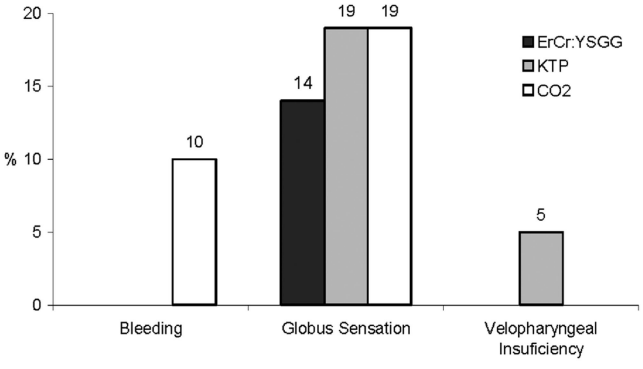



Fig. 4. Distribution of snoring score of patients treated with Er,Cr:YSGG, KTP, and $CO_2$ lasers.

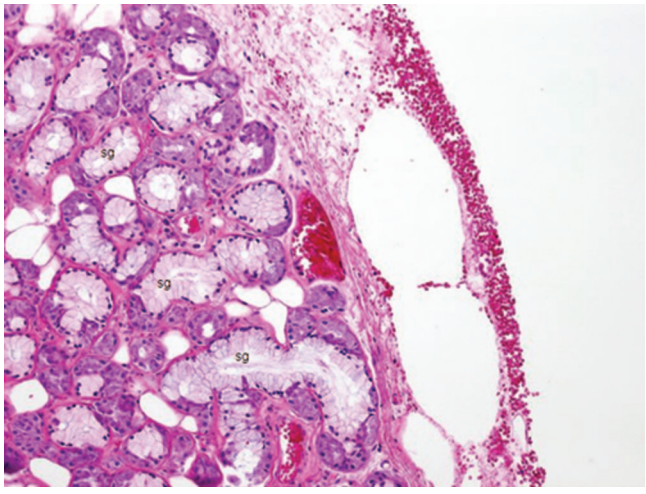
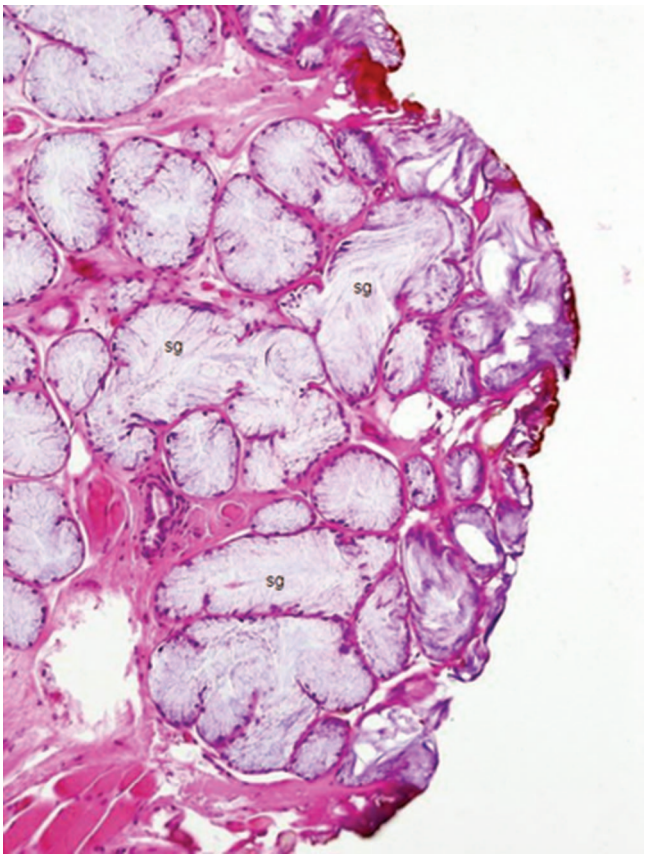



Fig. 5. Frequency of complications in laser assisted uvulopalatoplasty patients treated with Er,Cr:YSGG, KTP, and $CO_2$ lasers.

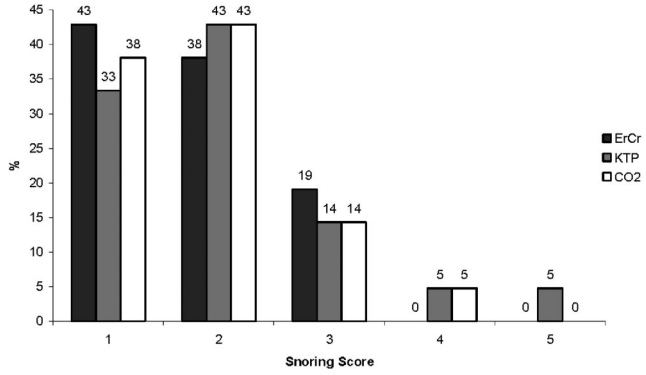



6. Hematoxylin-eosin staining, intact salivary glands (sg), Er,Cr:
G, 5W, 35% air, 8% water, G9 tip.

at the time of the 3 month postoperative follow-up examination. There were no significant ($P > .05$) differences in either preoperative or postoperative snoring level between the three groups (Figs. 1 and 4). Patients' snoring score was significantly ($P < .01$) improved by the surgery in all groups (Fig. 8). F8

### *Polysomnography*

The AHI was not significantly different ($P > .05$) among the three groups in either pre- or postoperative




7. Hematoxylin-eosin staining, destroyed salivary glands (sg), 8W, superpulsed, fiber 0.6 mm.

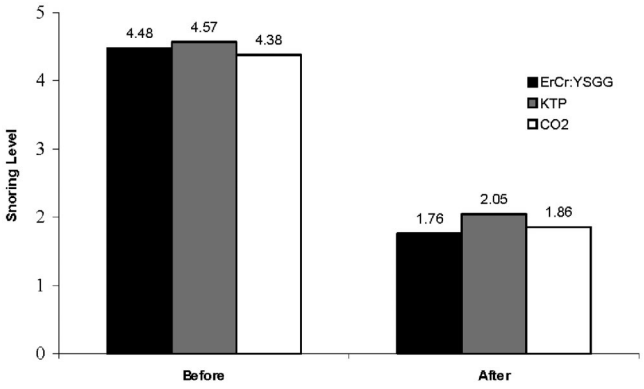



Fig. 8. Average snoring score of patients before and after surgery with Er,Cr:YSGG, KTP and $CO_2$ lasers.

measurements (Table III). However, the index was signif- T3
icantly ($P < .01$) improved by surgery in all groups.

## DISCUSSION

This is the most thorough study of LAUP patients treated for snoring by Er,Cr:YSGG laser. The purpose of LAUP in the treatment of snoring and obstructive sleep apnea syndrome is to reduce obstruction through elimination of redundant mucosal folds, soft palate webbing, and shortening of the uvula. The morbidity of procedures performed in the region of oropharynx is significant in the early postoperative period.[2–4] This fact is in agreement with our findings. As shown in this study, there are differences in postoperative course of recovery, not only among surgical procedures but also among lasers. Early morbidity, including pain and dysphagia, is at least partially caused by damage to posterior arches[3,5,6] but may differ with the depth and extent of the destroyed surrounding tissue. This also correlates with our histologic findings. LAUP does not expose the patient to an increased risk of postoperative bleeding compared with cold steel methods.

Conventional lasers allow cutting more precisely than other methods, such as radiofrequency thermoablation and uvulopalatopharyngoplasty and its modifications. Classical power laser assisted performances were accompanied with postoperative pain. This is not the case with the Er,Cr:YSGG laser, as mentioned earlier. The number of days of pain medication use and the time to return to normal diet were used as indicators of recovery from surgery. Patients undergoing Er,Cr:YSGG assisted uvulopalatoplasty used pain medication (metamizolum)

TABLE III.
Apnea-Hypopnea Index of 63 Patients Operated by Er,Cr:YSGG, KTP, or $CO_2$ Laser.

| | | Preoperation | | Postoperation | |
|---|---|---|---|---|---|
| | n | Mean | SD | Mean | SD |
| ErCR | 21 | 7.47 | 5.76 | 4.91 | 4.18 |
| $CO_2$ | 21 | 6.95 | 5.51 | 5.01 | 4.63 |
| KTP | 21 | 7.06 | 5.43 | 4.65 | 3.86 |

for significantly fewer days compared with KTP and $CO_2$ treated patients (4.1 ± 1.9, 6.5 ± 2.2, and 10.1 ± 3.5, respectively). The return to a normal diet was significantly earlier after Er,Cr:YSGG than after KTP and $CO_2$ lasers (4.5 ± 1.5, 6.8 ± 1.6, and 8.6 ± 2.9, respectively). Statistically significant ($P < .01$) differences in the time to return to normal diet and the time of narcotic pain medication were also found between KTP and $CO_2$ lasers.

This study reports the most suitable setting and tips for LAUP performances. We conclude that the best fitting tip depends on the goal of the operation.[10] When there is a redundant tissue to be removed, we prefer a chisel shaped tip. Chisel tips deliver a sufficient amount of power to the tissue and enables precise and quick cutting. When a better view of the operation field is needed, G9 or G6 tips are used. The G9 tip is most suitable when either the oral cavity is small or faucial isthmus is narrowed. The 9 mm tip widens the gap between the tissue and the hand piece. The headpiece ending can sometime reduce required view. This situation can be prevented by G9 tip use.

Thicker layers including mussels are vaporized by 5 W of energy, 25% to 35% air and 8% water. Thin mucosa can be easily divided by 4 W in the same regime. Bleeding is minimal. Active stopping of bleeding is achieved by reducing air down to 5% to 10%.

Perioperative complications were rare in all groups. Because the number of complications was very low, it was not tested statistically. Bleeding occurred in two cases treated with the $CO_2$ laser and was stopped by cauterization. One KTP LAUP patient had suffered from temporary velopharyngeal insufficiency that resolved spontaneously within 3 days. Three months after surgery, there was globes sensation present in two Er,Cr:YSGG patients, four KTP patients, and four $CO_2$.

This study demonstrated significant short-term effect of LAUP. This was logically tested on the basis of a subjective visual analogue scale because the impact on the life quality either of the patients or their bed partners is more important than the laboratory measured number of snoring episodes. The decrease in snoring score was statistically significant ($P < .01$) in all three groups. The Er,Cr:YSGG laser is a new laser that can be used in LAUP with much lower morbidity and postoperative difficulties when compared with other techniques.[7–10]

## CONCLUSIONS

Patients treated with Waterlase recovered more quickly than patients treated by KTP or $CO_2$ lasers. Histology revealed a faster recovery in the Waterlase group. However, effectiveness of the method was not different according to type of laser used. The Er,Cr:YSGG laser is a new type of laser that can be used in oropharyngeal surgery and is a promising tool in other ENT procedures. Further study is required to confirm these possibilities.

## BIBLIOGRAPHY


1. Stock K, Hobst R, Keler U. Comparison of Er:YAG and Er:YSGG laser ablation of dental hard tissues. *SPIE* 1997; 3192:277–786.
2. Mickelson SA, Hakim I. Is postoperative intensive care monitoring necessary after uvulopharyngoplasty? *Otolaryngol Head Neck Surg* 1998;119:352–356.
3. Virtaniemi J, Kokki H, Nikanne E, Aho M. Comparison of postoperative pain between laser/assisted uvulopalatoplasty, uvulopalatopharygoplasty, and radiofrequency volumetric tissue reduction of the palate. *Otolaryngol Head Neck Surg* 2000;122:402–409.
4. Escalmando RM, Glenn MG, Mc Culloch TM, et al. Perioperative complications and risk factors in the treatment of obstructive sleep apnea syndrome. *Laryngoscope* 1989;99: 1125–1129.
5. Hicklin LA, Tostevin P, Dasan S. Retrospective survey of the long term results and patient satisfaction with uvulopalatopharyngoplasty for snoring. *J Laryngol Otol* 2000;114: 675–678.
6. Friedman M, Ibrahim H, Lowenthal S, et al. Uvulopalatoplasty (UP2): a modified technique for selected patients. *Laryngoscope* 2004;114:441–449.
7. Friedman M, Landsberg R, Tanyeri H. Submucosal uvulopalatopharyngoplasty. *Op Tech Otolangol Head Neck Surg* 2000;11:26–29.
8. Sher E, Kenneth B, Jay F. The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. *Sleep* 1996;19:156–177.
9. Emery EB, Flexon BP. Radiofrequency volumetric tissue reduction of soft palate: a new treatment of snoring. *Laryngoscope* 2000;110:1092–1098.
10. Pavelec V, Polenik P. Laser assisted uvulopalatoplasty with Waterlase in comparison with standard lasers [Abstract]. WCLI meeting, Munich, Germany, 2004.
11. SAS Institute Inc. *SAS/STAT User's Guide*, version 8. Cary, NC: SAS Institute, 1999.