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Comparison of Laser-Assisted Uvulopalatopharyngoplasty to Electrocautery-Assisted Uvulopalatopharyngoplasty: A Clinical and Pathologic Correlation in an Animal Model

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Abstract

Objective: To determine if there are any pathologic or technical differences between laser-assisted uvulopalatopharyngoplasty (LAUP) and electrocautery-assisted uvulopalatopharyngoplasty (EAUP).

Design: A prospective randomized in vivo trial in an appropriate animal species.

Results: We found no gross difference in healing between the palates treated with laser and those treated with high-frequency electrocautery. However, there was consistently more thermal damage noted histologically in the hemipalates treated with LAUP. On the other hand, EAUP was faster to perform, more hemostatic, associated with less char formation, and had less histologic evidence of thermal damage.

Conclusions: These results raise the possibility that the beneficial effects of LAUP over traditional uvulopalatopharyngoplasty (UPPP) may be as a consequence of staging rather than the particular treatment modality used.

Sommaire

Objectifs: Déterminer s'il y avait des différences pathologiques ou techniques entre l'uvulopalatoplastie à l'aide du laser (LAUP) et l'uvulopalatoplastie à l'aide de l'électrocautère (EAUP).

Conception: Une essai prospectif in vivo au hasard chez une espéce animale appropriée.

Résultats: Nous n'avons pas trouvé de différences évidentes dans la cicatrisation entre les palais traités au laser et ceux traités avec l'électrocautère à haute fréquence. Toutefois, il y avait constamment plus de dommages thermiques notés à l'histologie dans les hémi-palais traités avec LAUP. D'un autre côté, l'EAUP était plus rapide à faire, plus hémostasiante, associée à moins de formation carbonisée et avait moins d'évidence histologique de dommages thermiques.

Conclusions: Les résultats soulèvent la possibilité que les effets bénéfiques de la LAUP sur l'uvulopalatopharyngoplastie traditionnelle (UPPP) pourraient être une conséquence du "staging" plutôt que de la modalité particulière de traitement employée.

Key words: electrocautery-assisted uvulopalatopharyngoplasty, laser-assisted uvulopalatopharyngoplasty

Snoring is a very common problem in our society. The incidence of sonorousness has traditionally been noted to increase almost linearly beyond 40 years of age. A wide variety of nonsurgical treatments—some proven, others postulated—have been in use for many years, including such diverse approaches as weight loss, use of a "snore-ball" (here, a tennis ball or similar object is sewn into the fabric on the back of the nightshirt, preventing the patient from rolling onto his/her back during sleep), pharmacotherapy (psychostimulants), and a variety of oral prosthetic devices (each in its own way designed to bring the tongue out of the oropharynx during sleep). However, it is only with the advent of appropriate surgical intervention that successful and reliable approaches were developed for the treatment of snoring.

Ikematsu,[1] in 1952, originally described what is now generally termed the uvulopalatopharyngoplasty

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(UPPP) operation. However, the procedure was not popularized in North America until it was reintroduced by Fujita[2] in 1981. Soon thereafter, UPPP and various modifications of UPPP became the standard surgical treatment for sonorousness. UPPP appeared to eliminate or improve snoring symptoms in about 75% of snorers.[3]

However, surgeons soon realized that traditional UPPP (generally performed with cold knife and electrocautery) was not without complications. This procedure necessitated the use of general anaesthesia, which has an inherent potential for risk and many adverse effects. Furthermore, as with any surgical procedure, there are risks of bleeding and a potential for adverse outcome secondary to the healing process (scar bands, nasopharyngeal stenosis, etc.). Finally, the possibilities of velopharyngeal insufficiency (usually temporary) and legendary postoperative pain deterred many suitable candidates from choosing traditional UPPP as a treatment for snoring.[4]

Despite previous problems, a new era in the surgical management of snoring was evolving. Kamani,[5] in 1989, introduced laser-assisted uvulopalatopharyngoplasty (LAUP). This procedure was performed in an outpatient setting and in a staged manner. This eliminated the risks of general anaesthesia and significantly decreased the risk of velopharyngeal insufficiency. Despite the fact that pain is a notoriously difficult criterion to objectify, the general consensus has seemed to indicate that LAUP is significantly less painful than traditional UPPP.[5,6] The most reasonable explanation for this decrease in pain is the fact that this is a staged procedure. Consequently, less tissue is damaged in each of a few sittings (formation of trenches and performance of a uvulectomy in LAUP), rather than approaching the entire resection (UPPP) at one time. By staging the procedure, not only is there a decrease in the frequency of adverse outcomes, but there also seems to be an increase in the overall success of the procedure to the 90% range.[5,6] Clearly, staging seems to allow the surgeon to fine tune his or her results much more than with UPPP.

As the name implies, the instrument of choice in LAUP is the versatile carbon dioxide laser. In recent years, there has been a significant increase in the use of lasers for this and for a wide variety of other applications in otolaryngology—head and neck surgery.[7] It is generally believed that many of the beneficial outcomes of LAUP, compared to UPPP, may be attributed to the fact that a laser is used in the place of electrocautery (and cold knife). However, relatively little objective data exist comparing laser to traditional modalities in various applications, including LAUP. In this study, we sought to prospectively compare the pathologic tissue effects of high-frequency electrocautery (Erbe Icc100) with carbon dioxide laser, (Luxar Lx-20) in the soft palates of dogs.

Materials and Methods

Following the directives of the Canadian Council on Animal Care, all treatment protocols in this trial were formulated to allow for the humane and ethical treatment of animals. This study was fully approved by the University of Ottawa Animal Care Committee.

Dogs have long, thin, soft palates, much resembling those of humans (except the fact that they lack a uvula). Histologically, the dog's soft palate is essentially identical to that of a human. Thus, we believed that dogs were an appropriate animal model for studying the thermal effects of surgery utilizing electrocautery and laser. In addition, sonorousness has been very well documented in dogs for many of the same reasons that it is commonly seen in humans.[8] Finally, dogs are easy to manage and are large enough to facilitate all contemplated procedures.

For our trial, we obtained six mongrel dogs of approximately the same build and weight (average weight, 20.0 kg). Each dog acted as its own control. Under general anaesthesia, supervised by a veterinarian, the Erbe Icc100 high-frequency electrocautery system (effect mode 2 at 40 watts, constant power) was used to create a trench, of uniform size (approximately 1 cm) in one half of each dog's soft palate, while the Luxar Lx-20 (15 watts, continuous mode) was used to create a trench of equal size on the opposite half of the palate. The Luxar Lx-20 laser was chosen due to our positive experience with it. This is the laser that we have used with excellent success for treating sonorous patients in our outpatient clinics. We routinely utilize the laser set at 15 watts in our patients, and thus, the same power setting was used in the animal trial. All this was in an attempt to make the animal procedure as closely resembling what we normally would be doing in our human patients.

Randomization was used to determine which side of the palate would be treated by which modality in each dog. By creating trenches on either side of the free palatal edge, a neo-uvula was created. The dogs were then randomly allocated into three groups of two. These three groups were then subsequently followed for 2, 4, and 5 weeks, respectively. At the end of each group's observation period, the dogs were placed under a second general anaesthetic, at which time each dog's palate was evaluated for gross thermal damage and degree of scarring by a blinded observer. Following this evaluation, the entire soft palate was harvested and marked appropriately for microscopic analyses by a single blinded pathologist who examined the specimens using multiple serial sections.

Results

The formation of trenches was easy to perform with both LAUP and EAUP (Fig. 1). However, a self-limited

minor amount of bleeding was noted in the palates of a couple of the animals with both LAUP and EAUP. There was also noted to be noticeably more charring on the hemipalates that were treated with the laser. All of the dogs tolerated the procedure very well without the need for any analgesics in the postoperative period (as determined by the veterinarian). All dogs were eating solid food within a few hours of the procedure.

Regardless of the surgical method used, we noted that there were no gross differences in healing or scar formation during the observation period or at the time of palatal harvesting (Fig. 2).

At the microscopic level, a pathologic evaluation confirmed that complete re-epithelialization had occurred in all specimens treated with EAUP (Table 1). However, two of the hemipalates that had been treated with LAUP were noted to have superficial ulceration with incomplete re-epithelialization (Figs. 3 and 4). Histologic criteria used to determine the level of tissue damage included the presence of fibrosis with deposition of new collagen and fibroblast ingrowth, the presence of entrapped disorganized muscle cells, and the presence of hemosiderin. Evidence of tissue damage was noted in every specimen examined. Interestingly, a blinded pathologist indicated that there was a significant difference in the depth of tissue damage (measured from the basement membrane) identified histologically, between the side of the palate treated with EAUP compared to the side treated with LAUP. In all but one specimen, there was more tissue damage noted with the carbon dioxide laser compared to the high-frequency electrocautery. A small amount of inflammatory infiltrate was noted in all specimens submitted for analysis.

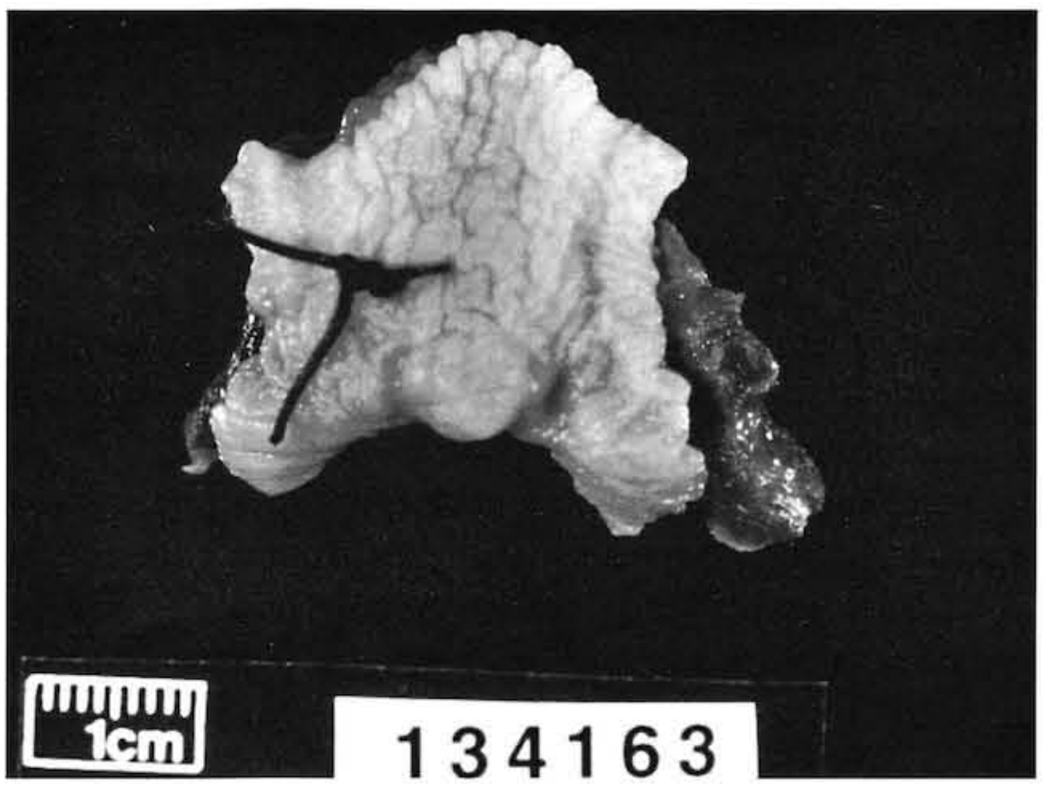

Figure 2 An example of a resected gross specimen (in formalin) is shown. Note that there is little if any observable difference between the two hemipalates.

Discussion

Modern-day modifications of electrogenerators have allowed them to become very finely tuned surgical tools allowing for very precise and controlled manipulation of tissue. It was William Bovie who introduced the first electrosurgery diathermy machine. This apparatus used high-frequency waves, unlike previous instruments, which used simple heat ("cautery") to destroy human tissue. In spite of this, many myths remain regarding "electrocautery." One of the most widely entertained beliefs in the lay public, as well as in some corners of the medical profession, is that utilization of the laser as the surgical instrument of choice allows for more precise tissue ablation and a lesser degree of unwanted thermal damage to the surrounding normal tissue.

Hurwitz et al.[9] utilized high-frequency electrosection of full-thickness eyelid tissues and compared it to cold steel in the treatment of entropion and ectropion. They found the tissue cuts fashioned with the high-frequency electrocautery to be as clean and precise as those fashioned with cold steel. Microscopically, they found only very slight damage to the superficial cell layer, without any evidence of tissue sloughing or significant deep-plane damage. In another study, Butler et

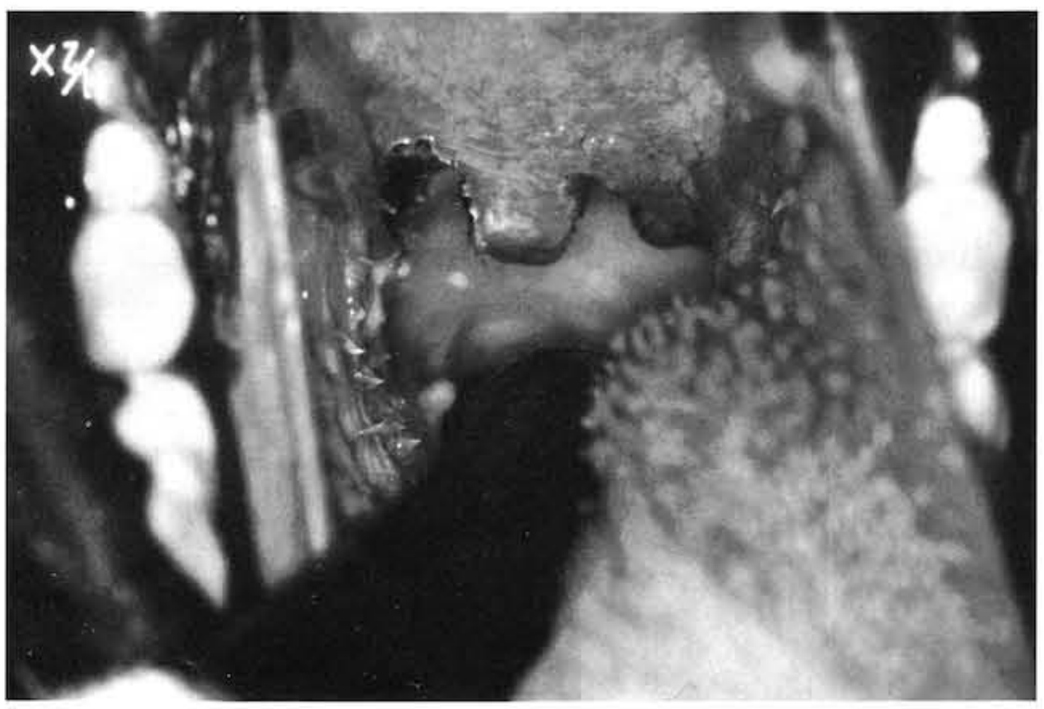

Figure 1 Completed trench on the right side of the palate and a nearly completed trench on the left side of the palate is shown.

Table 1 Gross Healing Results

	Depth of Palatal Thermal Tissue Damage/Scarring (mm)					
	2 Weeks		*4 Weeks*		*5 Weeks*	
Dog	*LAUP*	*EAUP*	*LAUP*	*EAUP*	*LAUP*	*EAUP*
1	0.7	1.0	—	—	—	—
2	1.2*	1.0	—	—	—	—
3	—	—	1.7	0.6	—	—
4	—	—	0.9*	2.25	—	—
5	—	—	—	—	3.8	1.4
6	—	—	—	—	3.2	2.5

*Superficial ulceration with incomplete re-epithelialization.

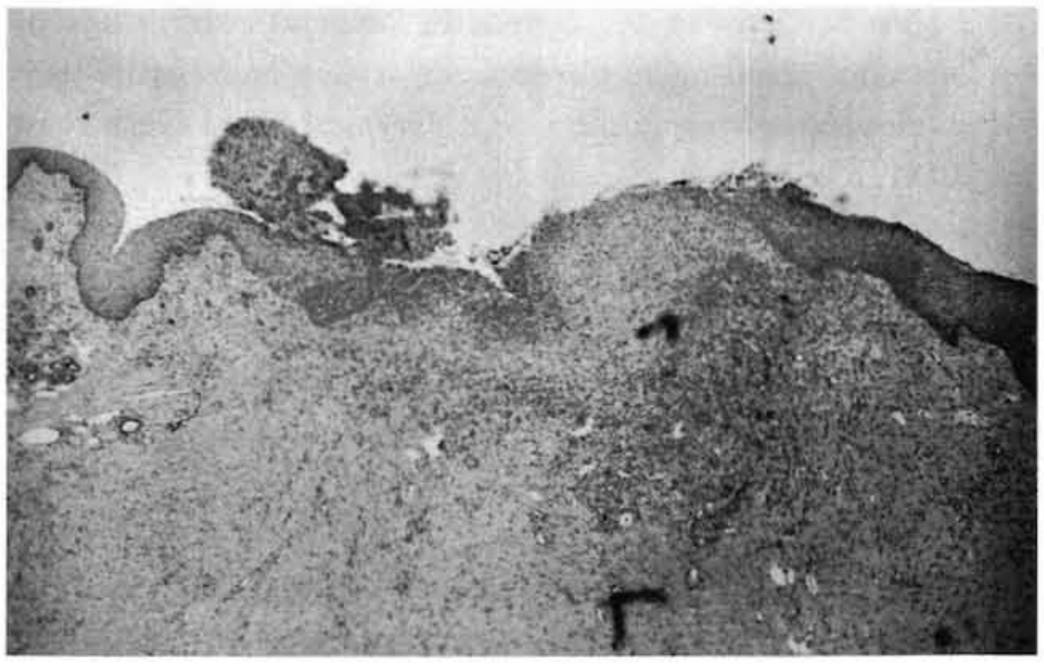

Figure 3 On this hemipalate treated with laser, note the presence of incomplete re-epithelialization and superficial ulceration with a significant underlying inflammatory infiltrate (hematoxylin-eosin stain, original magnification × 10).

al.[10] found that the rate of re-epithelialization and final tensile strength of incisions fashioned in the skin of mice was equivalent when performed with either a scalpel or high-frequency electrosurgery. Butler et al. attributed these results to the increased availability of precise instrument tips for electrosurgery.

The gynecologic literature similarly offers insight into the comparative tissue effects of carbon dioxide laser and loop electrosurgical excision of cervical tissue. Wright et al.[11] analyzed the resected specimens for evidence of immediate thermal injury. They found no significant difference between the degree of charring, carbonization, or peripheral tissue coagulation between the two surgical modalities. Similar findings were noted in recent animal and in vitro studies.[12,13]

In our study, we followed the animals temporally to see if there would be any observable differences visible in the degree of palatal scarring. We were able to identify that there appeared to be no significant gross difference between palatal tissue treated with either high-frequency electrocautery or carbon dioxide laser. However, histologically, in five of the six specimens, there was consistently less tissue damage seen with EAUP compared to LAUP. Thus, given our pathologic findings, which suggested no healing advantage to LAUP, we believe that, theoretically, similar surgical and clinical outcomes may be achieved with the use of either modality.

There are readily identifiable advantages to possible EAUP surgery compared to LAUP. The equipment necessary to perform EAUP is considerably less expensive than standard portable carbon dioxide lasers (roughly one tenth of the cost). Most importantly, these monetary savings could serve to increase the feasibility of equipment acquisition for many otolaryngologists and henace, an increased accessibility for patients seeking treatment for snoring. Furthermore, the cost, time, and potential adverse effects associated with standard laser precautions followed during LAUP are not an issue during EAUP. During our animal trial, we noted that making the trenches in the palate with high-frequency electrocautery was considerably faster, more hemostatic, and associated with less char formation than with the carbon dioxide laser. This may be potentially beneficial in patients with a hypersensitive gag reflex. Finally, otolaryngologists have found a multitude of uses for carbon dioxide laser in the head and neck region (e.g., excision of vascular skin lesions, turbinate reduction, skin rejuvenation, etc.). Similarly, high-frequency electrocautery equipment has a significant, often unrealized, potential for use in a variety of applications within the head and neck (e.g., minor surgical office procedures that would benefit from portable hemostasis).

In our trial, we encountered no significant technical difficulties in performing EAUP. However, we did note self-limited muscular fasciculations in some of the anaesthetized dogs' palates during the procedure. This results from faradic effects on local nerve and muscle cells as they are stimulated by the electric current. It remains to be seen whether or not the presence of these fasciculations would be of any clinical significance in the topically anaesthetized human palate.

Conclusions

Our intent with this study was not to demonstrate that LAUP is not a useful or viable procedure. Since its advent, LAUP has been shown to be very efficacious in the treatment of snoring. Furthermore, it is a safe and simple procedure to learn and to master. Finally, it has gained widespread popularity in the public as the newest and best treatment modality available for troublesome snoring. Despite these factors, before a new modality is accepted as a superior treatment option, one needs to critically and prospectively evaluate any advantages over existing treatment options. In our in vivo trial, we uti-

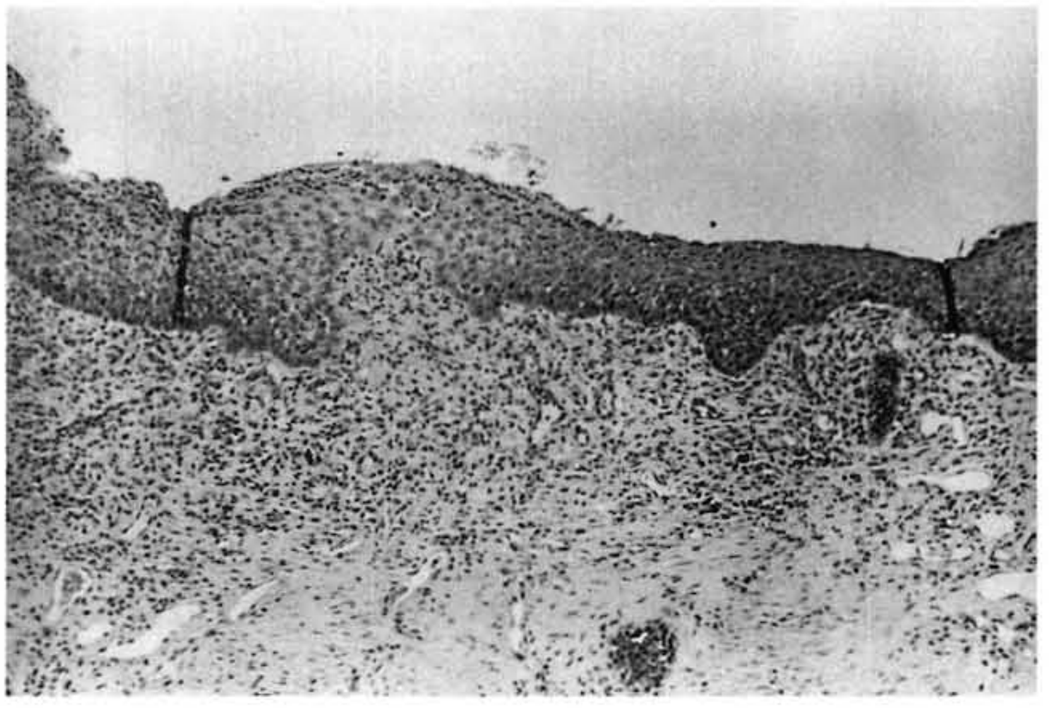

Figure 4 On this hemipalate of the same dog as in Figure 3, this side was treated with high-frequency electrocautery. Note that complete re-epithelialization has taken place (hematoxylin-eosin stain, original magnification × 10).

lized palatal tissue that is almost identical histologically to human tissue, and we observed no significant gross differences between tissue treated with LAUP and tissue treated with EAUP. However, there was consistently less thermal tissue damage noted (in five of the six dogs) with EAUP compared to LAUP. Furthermore, unlike LAUP, there was complete re-epithelialization present in all hemipalates treated with EAUP.

However, prior to making any definitive conclusions as to the clinical usefulness of high-frequency electrocautery in staged outpatient palatal surgery, a prospective human trial needs to be performed. Given the results of our study, we feel that such a trial is justified at this point in time. Should there be no significant differences noted clinically, then one needs to consider the possibility that the beneficial effects of LAUP over traditional UPPP are as a result of staging the procedure, rather than a consequence of the particular treatment modality used.

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