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Endoscopic carbon dioxide laser turbinoplasty

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Abstract
In the present work we describe the management of hypertrophied inferior turbinates using CO_2 laser in the UniPulse mode. The laser beam is delivered through the nasal probe delivery system, and the procedure is performed using the 0° endoscope. The UniPulse mode allowed fine-tuned, char-free tissue ablation, and the nasal probes allowed delivery of laser energy to the posterior parts of the inferior turbinates.

The procedure was performed on 149 patients. The one-year post-operative follow-up period revealed good functional results in 131 patients (88 per cent). The minimal nasal cross sectional area increased significantly from 0.52 cm^2 to 0.81 cm^2. The average decongestive effect, on the other hand, decreased from 0.26 cm^2 to 0.07 cm^2 indicating significant laser-induced fibrosis. The operation can be performed as an out-patient procedure with little or no morbidity.

Key words: Laser Surgery; Nasal Cavity; Turbinates

Introduction

Several procedures have been described for reducing the size of hypertrophied turbinates in patients refractory to medical treatment indicating the lack of one completely acceptable procedure.[1–5]

In the last two decades, several lasers have been used for the surgical treatment of hypertrophied turbinates. Among these lasers, the CO_2 laser has rapidly become very popular.[6–8] One of the main negative points of the carbon dioxide laser is that it cannot be delivered along fibre-optics. This caused very limited accessibility to the posterior parts of the inferior turbinates and persistence of nasal obstruction post-operatively. The introduction of the nasal probe delivery system has overcome this shortcoming by delivering the laser beam along hollow wave-guides.

Also, improved results have been achieved by using the laser in certain modes or in combination with certain apparatuses that modify certain parameters. Papadakis *et al.*[9] have used the Swiftlase apparatus. In this series we used the nasal probe delivery system, in the UniPulse mode, and the nasal endoscope. The one-year post-operative results are presented and discussed.

Materials and methods

Patients

The procedure was performed on 149 patients suffering from hypertrophic inferior turbinates, who had not responded to systemic or local medical treatment. Of the patients, 101 were men and 48 were women, their ages ranging from 18–56 (mean age 36.5). Atopic patients were excluded by skin allergy tests and the radioallergosorbent test (RAST).

Pre-operative evaluation

The pre-operative evaluation included full history taking and clinical examination. Rigid and flexible endoscopy was performed to exclude other causes of chronic nasal obstruction.

The minimal nasal cross sectional area was calculated by acoustic rhinometry (Eccovision Acoustic Rhinometer Model AR-1003) before, and after, decongestive using oxymetazoline (0.5 mg/ml), two puffs in each nostril. According to our standard protocol, all measurements were repeated after 1.5 hours and the average values were calculated to minimize the effect of the nasal cycle.

Ethical approval was obtained from the local Director of Medical Education and Research, and all patients gave written informed consents.

Procedure

Turbinate reduction is usually carried out under local anaesthesia in the out-patient clinic. Only in selected cases or on request, is general anaesthesia used. Local anaesthesia was achieved by inserting cotton pledgets, immersed in a solution of four per cent pontocaine with adrenaline 1:1000. The pledgets

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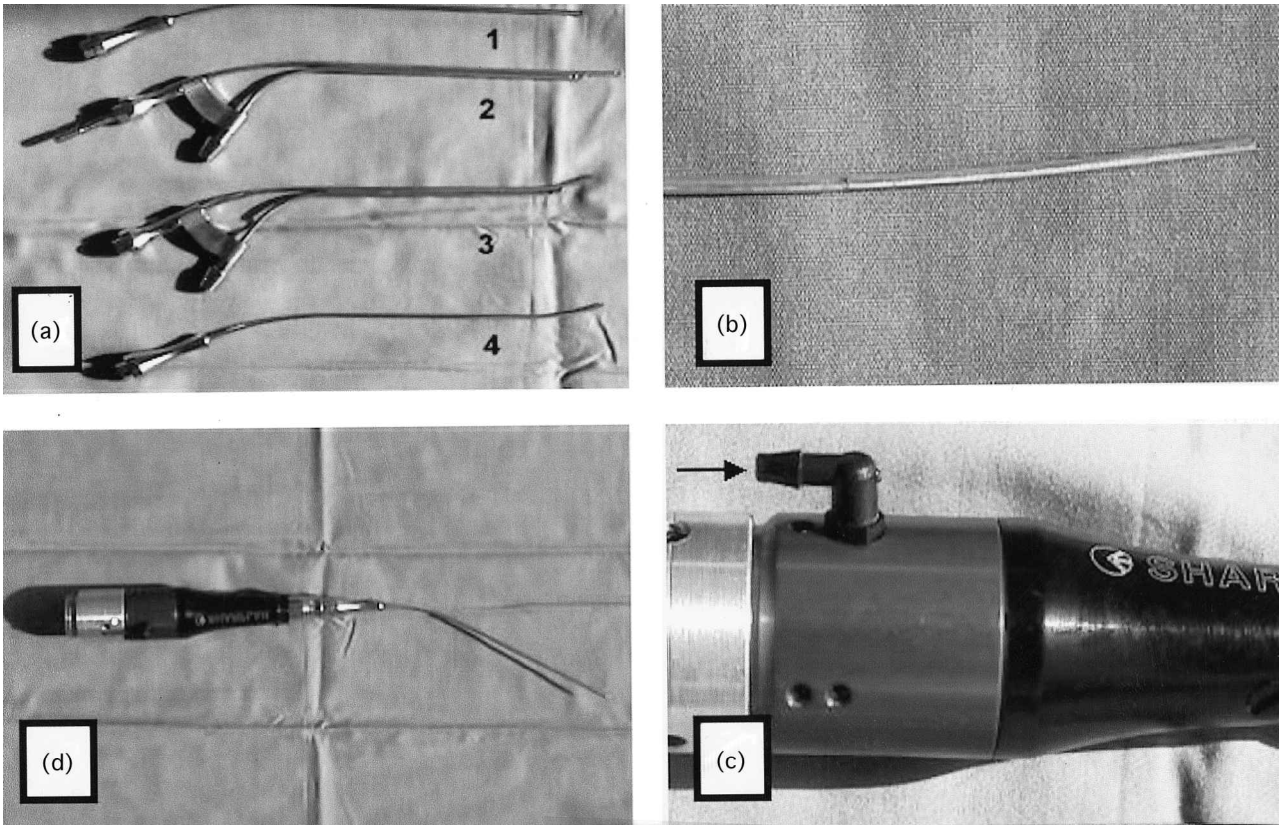

Fig. 1

The nasal probe delivery system. (a) Nasal probes: 1 – Straight probe; 2 – Straight probe with smoke evacuation; 3 – Straight probe with 90° right hand mirror; 4 – 20° angled probe. (b) Fibre insert. (c) Nasal probe fibre coupler. It consists of lens holder and Quick Connector. The laser unit gas tube is connected to the gas nipple on the lens holder (arrow). (d) The nasal probe delivery system assembled.

are placed along the whole length of the inferior turbinates and are left in place for 10 minutes.

The patient's face is protected by wet gauze, leaving only the nostril exposed. The complete laser surgery safety protocol is implemented. The nasal probe delivery system (Figure 1) is assembled and firmly connected to the articulating arm. For proper operation and safety of the fibre insert, a constant flow of air or other cooling gas must be ensured while the laser unit is in the READY state. Also the

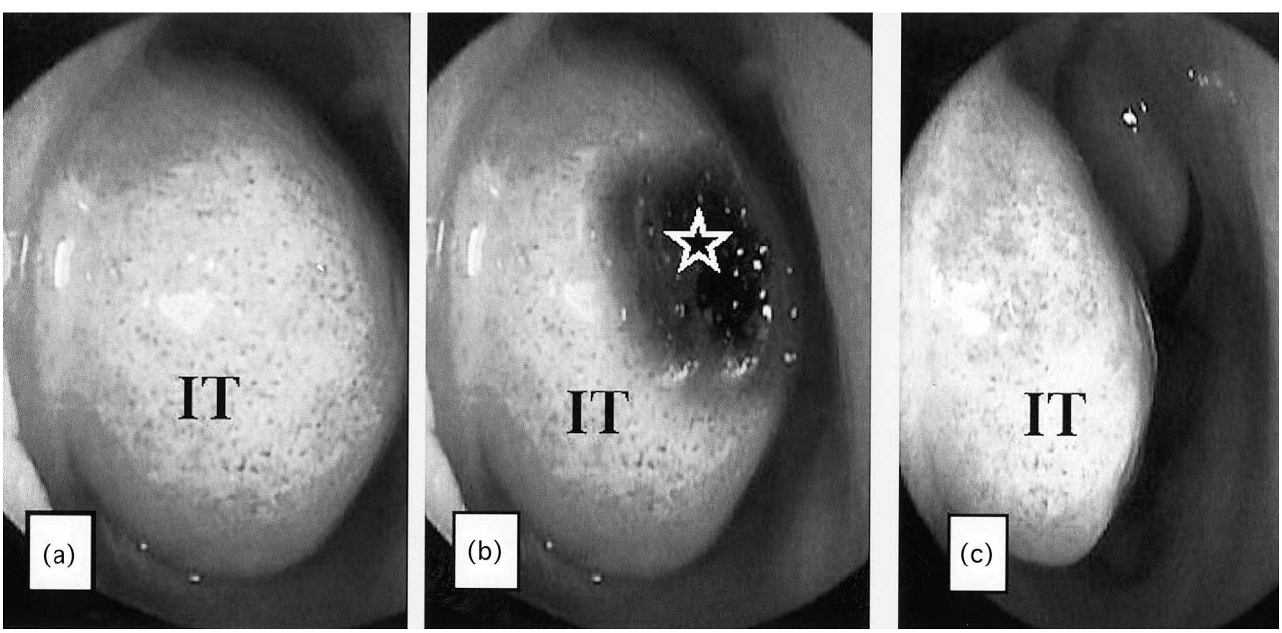

Fig. 2

Endoscopic view of the inferior turbinate. (a) Pre-operative; (b) During the procedure. The star marks the laser-treated island.; (c) One year post-operatively. A wide space is present between the inferior turbinate (IT) and the nasal septum.

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coupler should be properly aligned. The laser machine is set to the repeat coagulating UniPulse mode at a power between eight and 15 watts. Visualization is achieved by the 0° rigid endoscope. The tip of the fibre insert is held at a distance of 2–3 mm from the mucosa (near-contact). The laser probe should be kept on the same plane as the endoscope.

Under clear endoscopic vision and proceeding from anterior to posterior, the hypertrophied parts of the mucosa are vaporized taking care not to damage the deep sinusoids. This creates several laser-treated vaporization islands on the surface of the whole length of the inferior turbinates with areas of intact mucosa between the islands.

The use of probes with suction channels greatly facilitates evacuation of the fumes from the operative field. Nasal packing is usually not required at the end of the procedure and the patients can leave hospital immediately after the surgical procedure.

Post-operative follow-up

Post-operative follow-up involved removal of crusts and mucus, and saline washes. None of the patients was kept under permanent drug therapy. The patients were examined weekly for one month and every two months for a year. Any complications related to the procedure were registered.

At the end of the follow-up period all patients were evaluated using nasal endoscopy, acoustic rhinometry, and a patient questionnaire. The patency of the nasal airway was graded on a 0–3 scale as follows:
0: Nasal breathing became worse.
1: No change.
2: Partial or moderate improvement.
3: Significant improvement.
The student *t* test was used for statistical analysis and statistical significance was defined as $p<0.05$.

Results

Clinical assessment

Analysis of the patients' response one year after the operation showed that endoscopic laser turbinectomy (ELT) improved nasal airway significantly in 88 per cent of patients (Table I). No post-operative bleeding occurred. Post-operative discomfort or headache was virtually non-existent, as no packing was required. Also there was no incidence of atrophic changes or adhesions. Complete healing was observed three to four weeks after the operation.

TABLE I

RESULTS OF PATIENTS' QUESTIONNAIRE ONE YEAR AFTER THE OPERATION

Nasal breathing	Number	Percentage
Significant improvement	131	88
Moderate improvement	14	9
No change	4	3
Become worse	0	0
Total	149	100

TABLE II

THE PRE-OPERATIVE AND POST-OPERATIVE NASAL MINIMAL CROSS-SECTIONAL AREAS (MCA)

MCA	Pre-operative (cm^2)	Post-operative (cm^2)
Without decongestion	0.52	0.81
With decongestion	0.78	0.88

Acoustic rhinometry

The minimal nasal cross-sectional area (MCA) was located at 2.93 cm from the nostril, and it measured 0.52 ± 0.15 cm^2. After surgery it increased significantly to 0.81 ± 0.06 cm^2 ($p<0.05$) and relocated anteriorly at a distance of 2.18 cmn from the nostril. The mean decongestive effect was calculated as the difference between the mean nasal cross-sectional areas before and after decongestion. Analysis of the results showed that this effect decreased from 0.26 cm^2 to 0.07 cm^2 after complete healing.

Discussion

The introduction of CO_2 laser as a surgical tool has offered a new way to improve the results and overcome the drawbacks of conventional laser surgery. However, our early experience with laser turbinate surgery has shown that patients' satisfaction does not always justify the costs of the expensive instrumentation.[1] This was partly due to improper selection of patients, and partly due to limitations of the laser delivery system.

Several CO_2 laser turbinate surgical techniques have been described in the literature.[1,10–12] However, the posterior end of the turbinates was often inaccessible to the laser beam. It is known that CO_2 laser energy can be only delivered in a straight path, and cannot pass through a fibre-optic carrier. The introduction of the nasal probe delivery system has overcome to a great extent and allowed delivery of CO_2 laser energy in contact, near-contact, or non-contact modes to any part of the nasal turbinates. When the tip of the fibre insert is used in contact with the mucosa it will produce a cutting effect. When backed slightly so that it is in near-contact, the effect is mostly vaporization. When into a totally non-contact mode, the effect is purely coagulation. For turbinate surgery, the near-contact mode is the most suitable.

The UniPulse mode is a specially engineered 'SuperPulse' mode. It enables the surgeon to 'fine tune' the tissue effect produced by the laser system. The UniPulse mode has been designed to deliver short-duration micropulses, which have high power level at a high repetition rate ranging from 30–1000 pulses per second. Between each micropulse is a non-lasting interval, in which the tissue cools. The reduced pulse duration, high peak powers, and interpulse cooling act to minimize thermal build-up in the tissues, that in turn produce a more precise tissue ablation with minimal carbonization or char.

From a clinical point of view, the results of the procedure were satisfactory, with 88 per cent of patients still having improved nasal breathing one year post-operatively. The stability of the long-term results is probably due to the prominent scar formation, that is characteristic of laser-treated turbinates.[7] The intense laser-induced fibrosis is also responsible for the significant decrease of the decongestive effect of oxymetazoline post-operatively. Anterior relocation of MCA indicated successful reduction of the size of the posterior part of the turbinate. It is to be noted the post-operative acoustic rhinomanometric changes were much greater than those that might be attributed to the nasal cycle that should have the same effect on the pre-operative and post-operative results. Furthermore, repeating the measurements and calculating the average result have minimized the effect of the nasal cycle.

The procedure, as described, has several advantages compared to other CO_2 laser techniques. These include: 1) better accessibility to the posterior end of the turbinates, 2) fine-tuned tissue ablation, and 3) minimal char. The procedure also shares with other techniques the well-documented advantages of laser turbinate surgery such as minimal morbidity and being an office procedure.

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