

## Original Research Article

# Multiple laser puncture for Reinke's edema: surgical outcome and voice assessment

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## ABSTRACT

**Background:** The two important principles in Reinke's edema treatment are minimal intervention and superficial resection with evacuation the edema and preservation the medial edge of the vocal fold to improve the voice quality. The aim of this study was to evaluate a novel surgical technique in treatment of Reinke's edema and its effect on subjective and quantitative voice characteristics. The study design was a prospective clinical series.

**Methods:** We evaluated 67 patients from 19 to 73 years (mean, 47.7 years) with Reinke's edema. The patients were divided into 3 types, mild, moderate and sever. Clinical voice assessment was composed of stroboscopy, subjective voice evaluation (GRBAS hoarseness scale) and quantitative voice evaluation were evaluated pre- and postoperatively. All patients underwent endolaryngeal CO<sub>2</sub> laser puncturing for treatment of Reinke's edema.

**Results:** 67 patients diagnosed as Reinke's edema were classified by H. Yonekawa classification into three types. Type I 25 (37.3%) patients, type II 30 (44.8%), type III 12 (17.9%). Out of 67 patients, fifty two (77.6%) were smoker. In all the patients, the laryngostroboscopic findings showed an improvement of mucosal wave patterns with little vocal fold scarring. Significant vocal improvement was also noted in subjective and objective voice assessments.

**Conclusions:** The laser puncture technique is safe, effective and less invasive to treat Reinke's edema with significant improvement in vocal performance after surgery.

**Keywords:** Reinke's edema, Polypoid corditis, Polypoid laryngitis, Polypoid degeneration. Co<sub>2</sub> laser puncture

## INTRODUCTION

Reinke's edema (RE) is a chronic, benign laryngeal disease of the superficial layer of the vocal folds. It is common disease of the vocal folds ultimately causing change in voice quality. It was first described by Hajek in 1891 as edema of the larynx.<sup>1</sup> In 1895, Reinke reported about injection of fluids into the vocal fold in an excised human larynx study, creating an artificial edema similar to the clinically well-known vocal fold edema.<sup>2</sup> Its causes are multifactorial: mechanical, pathological, chemical,

genetical, Smoking, vocal abuse and gastro-esophageal reflux have been identified as potential risk factors.<sup>3-6</sup> Individuals with Reinke's edema describe the gradual onset of a rough and abnormally low pitched voice because the mass-loaded folds oscillate at an inordinately low frequency. Females present more frequently than do men and undergo phono microsurgical management more frequently because of the greater discrepancy from their normal fundamental frequency.<sup>3</sup> Major stroboscopic findings in Reinke's edema appear typically, as extensive swelling that is situated on the superior surface of the

musculo membranous vocal fold. The swelling is typically bilateral but often asymmetric in volume filled with fluid of variable viscosity sessile and mobile during phonation. Airway symptoms are unusual if the arytenoids abduct normally, because the edema is confined to the anterior glottal aperture. Epithelial pliability and mucosal wave characteristics vary greatly between patients and are dependent on the viscoelasticity of the pathologic sub-epithelial space. Histological examination reveal the lack of cellularity and presence of epithelial basement membrane thickening, edematous lakes, extravascular erythrocytes and increased thickness of sub mucosal vessels.<sup>7</sup> The treatment of Reinke's edema varies depending on the severity of edema and vocal dysfunction. Initially can be treated conservatively by (vocal hygiene, stop smoking, treatment for the gastro-esophageal reflux disease and voice therapy). In most of the cases surgical treatment is needed and there is some disagreement to the best approach. In the past stripping of the edematous redundant mucosa has been advocated. And because of scarring and fibrosis of the mucosa with loss of mucosal wave and glottal insufficiency most of the Authors state that there is no role for "vocal fold stripping" for the treatment of Reinke's edema.<sup>4</sup> Others proposed removal of fluid through aspiration with preservation of vocal fold medial edges mucosa, and recently many authors investigate the laser coagulation of the epithelial and sub-epithelial layers.<sup>8</sup> Up to our knowledge no study reported multiple laser puncture technique as primary treatment of Reinke's edema.

The purpose of this study was to evaluate our surgical technique in a group of patients affected by Reinke's edema, according to the changes of the subjective and quantitative voice characteristics.

## METHODS

The present study done between the year 2001 and 2008 with patients age 19 to 73 years (mean: 47.7 years), at Department of Otolaryngology, Chang Gung Memorial Hospital, Kaohsiung Medical Center, Taiwan. Approval for this study was obtained from the hospital. The study was designed as a retrospective case series of patients treated at this hospital. Patient data were obtained, appropriate patients were identified by cross-matching diagnosis with the existence of a procedure. Sixty-seven patients with Reinke's edema were enrolled. Assessment was based on clinical examination carried out by the physician and speech therapist, this included videostroboscopy, subjective and quantitative voice assessment. (Videostroboscopy was carried out using a 90° Storz rigid endoscope and a stroboscopic light source (Storz company by a WolV stroboscope type 5052) in order to detect the Reinke's edema).

### Procedure

The CO<sub>2</sub> laser surgery was performed under general anesthesia, with an endotracheal tube No. 6. The power of

the micro spot laser beam was 10 W with a diameter of 150 microns. Redundant epithelial tissues were excised by microlaryngeal scissors, the free edges and contact surfaces of both vocal folds should be avoided. Then multiple laser puncture holes (approximately 2x2 mm in diameter and 3 mm in between) performed over the entire length of the membranous vocal folds over the edematous and swollen areas with suction and evacuation the serous, mucinous or myxoid fluids. Surgery was done to both vocal folds at the same time and the anterior commissure and free medial edge mucosa was preserved.

Postoperative re-epitheliazation process generally completed at 10 days following surgery patients were asked to remain on strict voice rest for at least 1 week and were continued on a rigorous antismoking and anti-reflux protocol. (Figure 1, 2, 3)

Statistical analysis was performed with Statistical package for social sciences (SPSS) 17 for Windows Paired-sample t-test was used to evaluate the differences in the same group before and after treatment in quantitative voice assessment. A significance level of  $p=0.05$  was used.

### Inclusion criteria

All patients with diagnosed Reinke's edema were considered for the procedure.

### Exclusion criteria

Patients were excluded if they were: less than 18 years old, had a history of laryngeal malignancy, had a history of a neuro-laryngologic disorder (example- cerebrovascular accident, amyotrophic lateral sclerosis, vocal tremor, or recurrent laryngeal or superior laryngeal nerve injury), had a history of airway stenosis and were unable to provide consent.

## RESULTS

A total of 67 patients with Reinke's edema underwent laser puncture of bilateral vocal fold and evacuation of edema which serous in some patients and gelatinous or mixed type in the others. Among these, 52 were smoking (77.6%) and 8 patients (11.9%) Non-smoker. There were 39 men (58.2%) and 28 (41.8%) women. Age ranged between 19-73 years, with a mean age of 47.7 years. The averaged duration of husky voice was 27.3 months. Postoperative follow up periods ranged from 2 to 36 months (mean 13 months). The videostroboscopic diagnosis of Reinke's edema was made and classified into type-I in 25 (37.3%), type II in 30 (44.8%) and type III in 12 (17.7%) patients. The pre and postoperative videostroboscopic recordings showed complete or nearly complete glottal closure and a decrement of mucosal wave and vibratory amplitude. Subjective rating revealed significant improvement in scale of grading, roughness, breathiness and strain after operation ( $p<0.000$ ) (Table 2). The results of acoustic and aerodynamic analysis are summarized in (Table 1). The

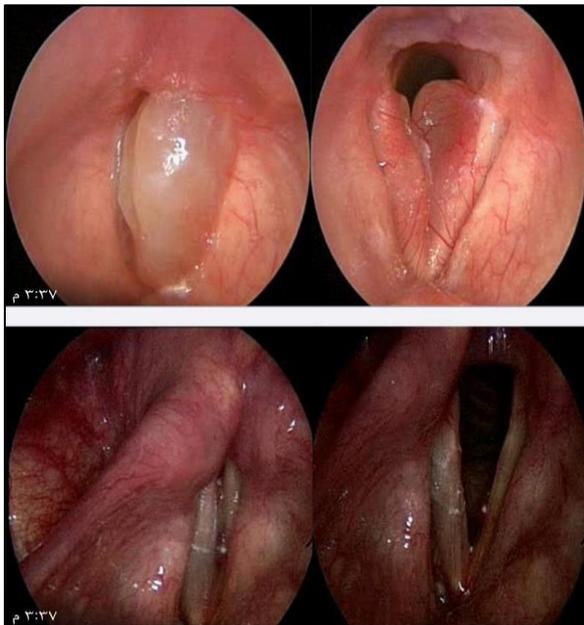
preoperative and postoperative mean fundamental frequencies were 163 Hz and 154.1 respectively.

**Table 1: Results of acoustic and aerodynamic analysis.**

	Preoperative	Post operative	T value	P value
<b>F0</b>	163±46.06	154.1±37.63	5.77	0.00
<b>JITT</b>	2.85±1.76	1.5±1.25	1.99	0.51
<b>SHIMM</b>	0.72±0.49	0.42±0.30	5.07	0.00
<b>NHR</b>	0.19±0.11	0.22±0.59	0.37	0.71
<b>MPT</b>	6.7±3.38	7.4±3.37	1.87	0.66

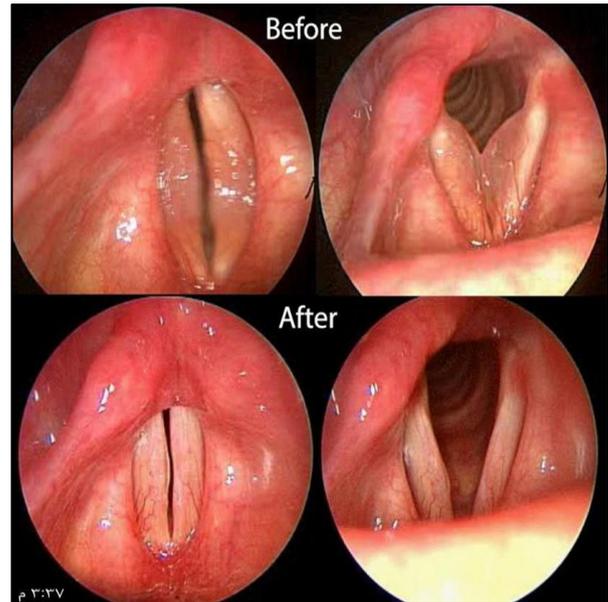
**Table 2: Subjective rating showing significant improvement in scale of grading, roughness, breathiness and strain after operation (p<0.000).**

	No. of patients	T value	P value
<b>Grading</b>	67	G pre – Gpost - 7.143	0.00
<b>Roughness</b>	67	R1-R2 - 7.747	0.00
<b>Breathiness</b>	67	B1-B2 - 6.482	0.00
<b>Asthenia</b>	67	A1-A2 - 6.405	0.00
<b>Strain</b>	67	S1-S2 - 7.143	0.00



**Figure 1: Pre-operative and Post-operative result of the patient.**

There was a statistically significant improvement in shimmer from the preoperative to the postoperative performance. There was a trend toward decreased mean jitter, noise to harmonic ratio and increase in the mean maximal phonation time after surgery, but this difference did not reach significance.



**Figure 2: Pre-operative and Post-operative result of the patient.**



**Figure 3: Pre-operative and Post-operative result of the patient.**

**DISCUSSION**

The treatment for Reinke's edema varies depending on the disease severity and the vocal and psychological needs of the patient. Treatment of Reinke's edema begins with elimination of predisposing risk factors. The treatment can consist of vocal hygiene, which includes strong recommendations to stop smoking. Behavioral and pharmacologic treatment to reduce throat clearing and coughing, treatment for gastroesophageal reflux disease when present and voice therapy to modify behaviors associated with phonotrauma may also be offered. Patients who follow this treatment regime are generally seen

regularly to determine changes in the condition of the vocal folds, voice quality and lifestyle adjustments.

In most of the cases surgical treatment has been the mainstay treatment. Vocal-fold stripping was designed as a one-handed, unmagnified treatment for Reinke's edema by means of a monocular laryngoscope and without general anesthesia. Unfortunately, this procedure is imprecise, and frequently, excessive superficial lamina propria (SLP) and epithelium are removed. This can result in a prolonged period of healing and, often, stiff scarred vocal folds. Although the vocal folds appear normal by means of a mirror or fiberoptic examination. Videostroboscopy reveals loss of epithelial pliability and lack of vibration.

In 1985, Hirano et al described a more precise technique that involves incising the epithelium lateral to the polypoid area, elevating the mucosa as a flap, reducing the gelatinous matrix within the subepithelial space that forms the bulk of the abnormal vocal fold, re draping the flap, and trimming the excess mucosa.<sup>9</sup> The gelatinous hypertrophied subepithelial space should then be carefully contoured and reduced to a more normal volume. This can be done by suctioning or by direct removal. Great care must be taken not to over reduce the sub epithelial space, which results in an inordinately stiff vocal system.<sup>10</sup> The vocal ligament should never be visualized directly. Overreduction of the SLP can result in a severely strained harsh voice, because these individuals already use high subglottal pressures to drive their floppy mass-loaded folds. Micro flap cytoreduction avoids removing excessive amounts of mucosa, and healing time is therefore shortened. Current surgical technique emphasize the preservation of the middle and deep layers of the lamina propria by approaching lesions through the superficial layer of the lamina propria via lateral micro flap. The goal of this technique is restoration of normal vocal fold anatomy and physiology with minimal disruption of the normal surrounding structure.<sup>8</sup>

CO2 laser enucleation of the mucosal surfaces has been proposed Twenty years ago, the super pulse or Ultra Pulse micro spot CO2 lasers have brought distinct advantages to microscopic laryngeal surgery. The small spot decreases the contact to the normal surrounding tissue, restricting the laser energy to the mucosa and the superficial layer of the lamina propria, thus avoiding injury to the deep layer of the lamina propria and muscle.<sup>11</sup> A previous study of laser-assisted surgery to treat Reinke's edema found that the use of the laser required longer recovery time than that of patients undergoing cup forceps stripping or the Hirano technique.<sup>12</sup> Surgery using the CO2 laser have improved due to refinement in laser technology, micro laryngeal instrumentation, and the development of the micro spot laser. These improvements coupled with improved surgical technique have resulted in a high cutting effect, reduced thermic effect, and minimum scarring for treating benign vocal disease. The multiple laser puncture of Reinke's edema together with aspiration of edema and

microdissection of redundant mucosa has been used to evacuate the edema effectively with preserving the vocal fold mucosa, minimize scaring and preserve a good voice quality, we found that this technique was effective treatment for Reinke's edema, this technique is minimally invasive with minimal damage to viscoelastic properties to preserve good vocal fold vibration. Multiple hole in focal fold with intact mucosa in between which appear like mesh used in split thickness skin grafting that's allow good healing with minimal scaring and act as good drains to remnant fluids in the Reinke's space intra-operatively and early days postoperatively. The results of the study showed there was a significant improvement in most of the parameters of vocal function and voice quality at 3 months or more after surgery.

The extension of vocal fold edema was classified according to H. Yonekawa classification who classifies Reinke's edema into 3 types. Type I: edematous swelling is observed on the upper surface of the vocal folds, while potency of glottis is adequately preserved. Type II: edematous swelling extends from the upper to the lower surface beyond the margins of both vocal folds, which are partly in contact with each other. Type III: edematous swelling is further advanced so that opening can be seen only at the posterior portion of the glottis.<sup>12,13</sup> Subjective judgments of voice quality were made according to GRBAS scale (three items of the scale were assessed: G-grade of dysphonia, R- roughness, A- asthenia, S- strain, according to the 4 point severity scale (0 – none, 1 – mild, 2 – moderate, 3 – severe); Quantitative voice parameters were obtained from analyzed recorded sample on the kay CSL model 150 using the multidimensional voice profile (MDVP) analysis program, from sustained vowel measures of mean fundamental frequency (F0), jitter, shimmer and noise to harmonic ratio (NHR) were obtained. The audio / video recording protocol was usually conducted preoperative and 3 months after surgery.

Surgical lasers fall into 2 broad categories: cutting / ablating lasers and photoangiolytic lasers. Reinke's edema is characterized in part by vascular congestion and stasis within the superficial lamina propria.<sup>14-16</sup> While the exact mechanism of the laser-tissue interaction in benign lesions remains under investigation, it is theorized that photoangiolytic laser energy is effective in improving polypoid degeneration by ablating damaged microvasculature within the SLP, ultimately inducing regression of nonvascular pathologic tissue.<sup>17</sup> It has been proposed that localized energy delivery causes a nonspecific inflammatory response, leading to selective and time-dependent expression of inflammatory cytokines such as transforming growth factor beta 1 and cyclooxygenase as well as procollagen / collagenase genes such as matrix metalloproteinases.<sup>14,18-20</sup> These changes are thought to result in favorable alterations in tissue remodeling. As such, in contrast to classical surgical interventions designed to physically remove excessive tissue, laser therapy is thought to induce a favorable

biochemical shift—a biological solution for a biological problem.

### Limitations

Our study has several important limitations. Since it's a retrospective analysis, without a control group, we cannot determine whether changes in voice parameters observed after treatment were actually due to the intervention or simply reflect normal temporal variation of the disease. Second, our sample size is still modest, in future some bigger trial can be done to authenticate our method and result.

### CONCLUSION

Reinke's edema has a multifactorial genesis and Successful management requires control of risk factors: smoking, phono trauma, and reflux and precise surgical technique. Multiple puncture of Reinke's edema is safe, minimal invasive and effective procedure for treatment Reinke's edema.

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### REFERENCES

- Hajek M. Anatomische Untersuchungen u"ber das Larynxo "dem. *Langenbecks Arch Chir.* 1891;42:46-93.
- Reinke F. Untersuchungen u"ber das menschliche Stimmband. *Fortschr Med.* 1895;12:469-78.
- Voli SV, Klapan I. Sven Seiwerth; Tihana Ibrahimpaši Extracellular matrix of reinke's space in some pathological conditions *Acta Otolaryngol.* 2004;124:505-8.
- Zeitels SM, Hillman RE, Bunting GW, Vaughn T. Reinke's edema: Phonatory mechanisms and management strategies. *Ann Otol Rhinol Laryngol.* 1997;106(7):533.
- Duflo SM, Thibeault SL, Li W, Smith ME. Differential Gene Expression Profiling of Vocal Fold Polyps and Reinke's Edema. *Ann Otol Rhinol Laryngol.* 2006;115(9):703.
- Marcotullio D, Magliulo G, Pezone T. Reinke's Edema and Risk Factors: Clinical and Histopathologic Aspects. *Am J Otolaryngol.* 2002;23(2):81-4.
- Hantzakos M, Remacle FC, Dikkers JC, Delos DM, Friedrich GA, Giovanni N. Rasmussen Exudative lesions of Reinke's space: a terminology proposal *Eur Arch Otorhinolaryngol.* 2009;266:869-78.
- Kosokovi F, Cepelja I, Veerina SA, Krajina Z. Experience with Reinkes's Oedema *Acta Otolaryng.* 1974;78:150-4.
- Hirano M, Shin T, Morio M. An improvement in surgical treatment for polypoid vocal cord: sucking technique. *Otologia (Fukuoka).* 1976; 22:583-9.
- Zeitels SM, Hillman RE, Bunting GW. Reinke's edema: phonatory mechanisms and management strategies. *Ann Otol Rhinol Laryngol.* 1996;106:533-43.
- Benninger, Michael S. Microdissection or Microspot CO2 Laser for Limited Vocal Fold Benign Lesions: A Prospective Randomized Trial. *Laryngoscope.* 2000;110(2):1.
- Šiupšinskienė N, Skumanienė M. Phonatory characteristics following different surgical techniques in the treatment of Reinke's edema *MEDICINA.* 2002;38(10).
- Yonekawa H, Ohta F, Hirose H. Clinical classification of Reinke's edema. *Folia phoniatrica et Logopedica.* XXIIInd Wold Congress of IALP. 1992;44:92.
- Marcotullio D, Magliulo G, Pezone T. Reinke's edema and risk factors: clinical and histopathologic aspects. *Am J Otolaryngol.* 2002;23:81-4.
- Yan Y, Olszewski AE, Hoffman MR. Use of lasers in laryngeal surgery. *J Voice.* 2010;24:102-9.
- Martins RH, Dominques MA, Fabro AT, Dias NH, Santana MF. Reinkes' edema: immunoexpression study of fibronectin, laminin and collagen IV in 60 cases by immunohistochemical techniques. *Braz J Otorhinolaryngol.* 2009;75:821-5.
- Mallur PS, Tajudeen BA, Aaronson N, Branski RC, Amin MR. Quantification of benign lesion regression as a function of 532-nm pulsed potassium titanyl phosphate laser parameter selection. *Laryngoscope.* 2011;121:590-5.
- Branski RC, Barbieri SS, Weksler BB. Effects of transforming growth factor-beta1 on human vocal fold fibroblasts. *Ann Otol Rhinol Laryngol.* 2009;118:218-26.
- Lin Y, Yamashita M, Zhang J, Ling C, Welham NV. Pulsed dye laser-induced inflammatory response and extracellular matrix turnover in rat vocal folds and vocal fold fibroblasts. *Lasers Surg Med.* 2009;41:585-94.
- Mallur PS, Branski RC, Amin MR. 532-nanometer potassium titanyl phosphate (KTP) laser-induced expression of selective matrix metalloproteinases (MMP) in the rat larynx. *Laryngoscope.* 2011;121:320-4.
- Koszewski IJ, Hoffman MR, Young WG, Lai YT, Dailey SH. Office-Based Photoangiolytic Laser Treatment of Reinke's Edema: Safety and Voice Outcomes. *Otolaryngology–Head and Neck Surgery.* 2015; 6 (152):1-7.

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