Ain Shams University
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Use of Co2 Laser versus conventional microlaryngeal surgery in treatment of vocal fold benign lesions

META-ANALYSIS

Submitted for partial fulfillment for Master Degree in Otorhinolaryngology

Presented By

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2019

ACKNOWLEDGEMENT

First and foremost thanks are due to **ALLAH** the beneficent and merciful of all.

I would like to express my deep gratitude and appreciation to **Prof. Dr. Hesham El-Halaby,** *Professor of Otorhinolaryngology, Faculty of Medicine - Ain Shams University*, for his continuous help and unlimited support.

I am greatly indebted and grateful to **Dr. Marwa El-Begermy,** *Assistant Professor of Otorhinolaryngology, Faculty of Medicine - Ain Shams University*, for her continuous encouragement to bring this work to the attempted goal.

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2019

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LIST OF ABBREVIATIONS

ABB.	Full-term
CO_2	carbon dioxide
EMS	endolaryngeal microsurgery
KTP	potassium titanyl phosphate
NVU	non-professional voice users
PVU	professional voice users
TE	trachea-oesophageal
VF	vocal fold
VHI	voice handicap index

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Abstract:

Background: Benign superficial lesions of vocal fold (nodule, polyp, cyst and Reinke's edema) arise from the epithelium and the lamina propria. Vocal abuse and misuse presumably lead to excessive mechanical stress and trauma in the membranous portion of vocal fold, resulting in wound formation. Wound healing leads to remodeling of the superficial layer of the lamina propria. This tissue remodeling leads to formation of benign vocal fold lesions. These lesions are classically treated by conventional microsurgery and recently by CO_2 laser. The use of the CO_2 laser for the surgical treatment of Minor Associated Pathological Lesions (MAPL's) is still controversial. Some preferred cold instruments, whereas others appreciate CO_2 laser as a novel alternative to conventional microsurgery for benign vocal fold lesions. To summarize the reviewed literature the issue of CO_2 laser versus cold instruments is still controversial and the stage is open for more studies.

Aim: The aim of this study is to investigate the effect of Co2 Laser versus cold instruments in the treatment of benign lesions of the vocal folds regarding voice outcome & vocal fold function.

Methodology: A meta-analysis study is done to assess the use of Co2 Laser versus conventional microlaryngeal surgery in treatment of vocal fold benign lesions.

Results: This study does not reveal any detectable differences in clinical outcomes in patients with nodules, polyps and cysts who underwent excision via CO2 laser or cold instruments.

Conclusion: There is no sufficient evidence to determine if conventional surgery or CO2 assisted surgery is better.

Keywords: CO_2 laser, Benign vocal fold lesions, Conventional microlaryngosurgery.

INTRODUCTION

The vocal folds are subject to several forms of mechanical stress during phonation. Vocal fold vibration during phonation leads to impact stress during collision between the left and right vocal fold surfaces ***(Titze, 1994)***.

Vocal overuse (excessive quantity of voice use), abuse (yelling), and misuse (vocal hyperfunction with excessive muscular tension) presumably leads to excessive mechanical stress and trauma in the mid-membranous vocal fold, resulting in wound formation. Wound healing leads to remodeling of the superficial layer of the lamina propria and, to a lesser extent, the vocal fold epithelium. It is this tissue remodeling that results in the formation of vocal fold nodules, polyps, and cysts ***(Gray, 1989)***.

Currently, excision of vocal fold benign lesions by endolaryngeal microsurgery (EMS) is a standard approach. EMS is performed with a microscope and thus provides perfect exposure, bright light, binocular vision, bimanual instrumentation, and magnification for precise surgical manipulations ***(Uloza, 1999)***.

EMS is performed with either cold or hot (laser) tools. Cold instruments have been used for many years in EMS. The CO_2 laser was first used in the early 1970s ***(Strong and Jako, 1972)***; however, the diode laser has been used since the end of the 1990s for otolaryngological interventions ***(Newman and Anand, 2002)***.

The diode laser has found use in recent years and has been applied at increasing rates for EMS.Surgical intervention for vocal folds can lead to difference in voice by either altering normal physiology or correcting abnormal circumstances. Literature has proven that voice analysis methods are able to measure the response to therapy and also compare preoperative and postoperative results. These methods can be divided into two parts as subjective and objective tests. Subjective methods include the evaluation of patient voice by physicians with the GRBAS scale (Grade, Roughness, Breathiness, Asthenia, Strain) and assessment of the patient's own voice with the voice handicap index (VHI) questionnaire ***(Thomas et al., 2007)***.

Voice analysis programs are the most important test among the objective methods. Acoustic measurement variables such as Jitter, Shimmer, and noise-to-harmonic ratio (NHR) are used by many voice laboratories ***(Uloza, 1999)***.

AIM OF WORK

The aim of this study was to investigate the effect of CO_2 Laser versus cold instruments in the treatment of benign lesions of the vocal folds regarding voice outcome (perceptual and acoustic) and vocal fold function.

ANATOMY OF THE VOCAL FOLDS

The vocal folds are located in a subsite of the larynx, called the glottis. The glottis includes the true vocal folds, the anterior commissure and the posterior commissure. From medial to lateral the vocal folds consist of the mucosal surface, the vocal ligaments and the intrinsic laryngeal muscles (vocalis muscle and thyroarytenoid muscle). The anterior commissure is the midline area where the folds meet anteriorly and where they are attached to the thyroid cartilage. The posterior commissure is the mucosal surface anterior to the cricoid cartilage in between the arytenoid cartilages. Posteriorly, the vocal folds are attached to the arytenoid cartilages and laterally to the inside surface of the thyroid lamina. The medial margins are free to permit the opening and closing of the airway. During quiet respiration the folds are in a relaxed, abducted state. Breath-holding brings the folds together in an adducted midline position (***Ten Donkelaar et al., 2007)***

Vocal fold shape and movement are primarily the result of intrinsic laryngeal muscle activity (Figure 1). To a lesser degree, extrinsic laryngeal muscles also affect vocal fold shape and movement. The muscles that act to adduct or close the vocal are the lateral cricoarytenoid, thyroarytenoid, and interarytenoid muscles. The lateral cricoarytenoid muscle originates on the lateral aspect of the cricoid cartilage and inserts onto the muscular process of the arytenoid cartilage. The thyroarytenoid muscle arises from the inner thyroid cartilage and inserts on the vocal process of the arytenoid cartilage. The posterior cricoarytenoid muscle is the only muscle that abducts or opens the vocal . It originates from the posterior surface of the cricoid cartilage and inserts onto the muscular process of the arytenoid. When both posterior cricoarytenoid muscles become denervated (eg, in bilateral recurrent laryngeal nerve injury from thyroidectomy surgery), serious airway obstruction can ensue. The cricothyroid muscle narrows the gap between the thyroid and cricoid cartilages, thereby stretching of the vocal . Professional singers rely particularly on proper cricothyroid muscle control to reach higher pitches while singing ***(Noordzij and Ossoff, 2006).***

Compartmentalization of the intrinsic laryngeal muscles allows for ultrafine control of the vocal fold position. The posterior cricoarytenoid, cricothyroid, and thyroarytenoid muscles all have subdivisions, each with separate nerve branches. The division of the thyroarytenoid muscle into superior and inferior subcompartments, which appear to contract independently, allows the human larynx to produce sounds with a variety of intensities, registers, and qualities that would not otherwise be possible ***(Noordzij and Ossoff, 2006).***

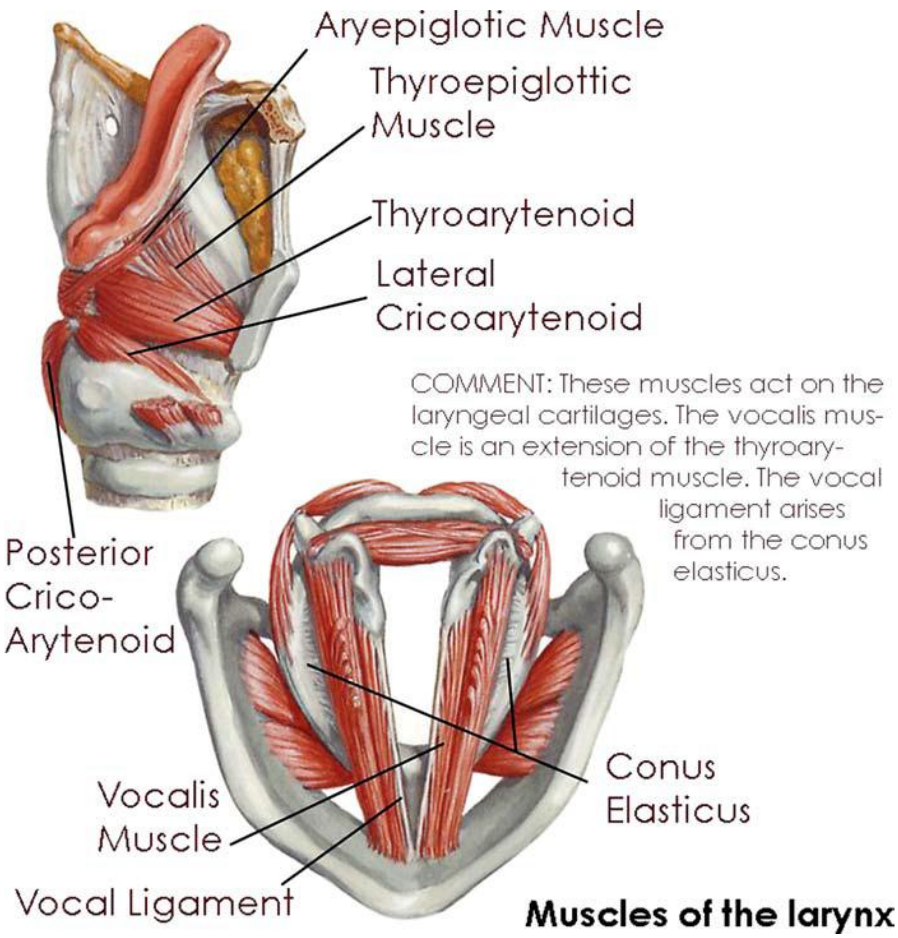

Fig. (1) The muscles of the larynx larynx ***(Noordzij and Ossoff, 2006).***

Directly cranial to the vocal folds, the slit-like opening of the laryngeal ventricles separates the true vocal folds inferiorly from the false vocal folds superiorly. The movement of the vocal folds is controlled by the intrinsic laryngeal muscles. All intrinsic laryngeal muscles except the cricothyroid muscle are innervated by the recurrent laryngeal nerves, which are branches of the vagal nerves. The vagal nerve (cranial nerve X) exits bilaterally from the medulla oblongata just lateral to the oliva through the olivary sulcus ***(Myssiorek, 2004)***.

There are three nuclei within the medulla that receive and transmit information from and to the vagal nerve. The nucleus ambiguus gives rise to motor fibres to the larynx and is located just dorsally to the inferior olive, lateral and ventral to the lower part of the fourth ventricle. After exiting the medulla, the vagal nerve courses through the pre-medullary cisterns towards the pars vascularis of the jugular foramen. The nerve exits the skull through the pars vascularis of the jugular foramen and then runs within the carotid sheath together with the internal carotid artery, which lies medially to the nerve, and the jugular vein, which lies laterally. Upon entering the upper mediastinum the right vagal nerve crosses the right subclavian artery ventrally and then courses medially and dorsally toward the right side of the trachea. Just caudally to the right subclavian artery, the right recurrent laryngeal nerve branches from the vagal nerve. The right recurrent laryngeal nerve then runs dorsally to the right subclavian artery in a cranial and medial direction to reach the larynx via the right trachea-oesophageal (TE) groove. The left vagal nerve lies ventrally to the left subclavian artery upon entering the upper mediastinum ***(Ten Donkelaar et al., 2007).***

It remains on top of the subclavian artery and runs over the aortic arch on the left side. The left recurrent laryngeal nerve branches from the vagal nerve just below the ligamentum arteriosum at the level of the aorto-pulmonary (AP) window and moves dorsally under the aortic arch in the direction of the left TE groove. From there, like the recurrent laryngeal nerve on the right, it moves upward to the larynx. Both recurrent laryngeal nerves enter the larynx through the inferior constrictor muscles at the level of the cricothyroid joint. Since the left recurrent laryngeal nerve is longer than the right nerve (12 cm versus 6 cm), left VCP is more commonly encountered ***(Yumoto et al., 2002)***.

PHYSIOLOGY OF VOICE PRODUCTION

Physiologically, the human larynx is required for airway protection, respiration, swallowing, and phonation. During phonation, the vocal act as an energy transducer that converts aerodynamic power generated by the chest, diaphragm, and abdominal musculature into acoustic power that is heard as the voice. This energy transformation occurs primarily in the space between the vocal ; however, it is also influenced by subglottic and supraglottic parameters. For normal phonation, adequate respiratory support, appropriate glottal closure, a normal vocal fold cover, and control of vocal fold length and tension are required ***(Noordzij and Ossoff, 2006).***

The vibratory motion of vocal is a complex cycle that results in voice production. The modulation (ie, glottal opening and closing) of the air stream during phonation is what results in voice production. As the subglottic pressure increases against closed vocal , this pressure eventually opens the glottis. At its maximum opening, the upper lip of the vocal fold continues to move laterally, while the lower lip begins to move medially. Eventually the upper lip also begins to move medially. The medial movement of the vocal results from a passive recoiling force (because of an innate elasticity of the vocal), a drop in subglottic pressure, and the negative pressure caused by the Bernoulli effect. This negative pressure pulls the vocal toward each other. The initial recontact occurs at the lower lip of the vocal . The contact area of the vocal increases until the subglottic pressure becomes high enough to push the vocal apart ***(Noordzij and Ossoff, 2006).***