IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 1 Ver. 4 (January. 2019), PP 52-62
www.iosrjournals.org

Stroboscopic Evaluation of Endotracheal Intubation Changes In Vocal Folds

DR.S.V.Sharannya[1], PROF.DR.K.Shoba[2], DR.Anand Pandyaraj[3]
[1](Department of Otorhinolaryngology, Saveetha institute of medical and technical sciences, India)
[2](Department of Otorhinolaryngology, Saveetha institute of medical and technical sciences, India)
[3](Department of general surgery, Sri Ramachandra institute of higher education and research, India)
Corresponding author: DR.S.V.Sharannya

Abstract: *The post intubation voice change is generally assumed to be the result of vocal fold damage. Videostroboscopy isslow motion, magnified comprehensive evaluation of vibratory characteristics of the vocal fold. Our study aims to examine the effects of short-term endotracheal intubation on the vocal fold vibratory pattern using videostroboscopy. This prospective observational study was conducted in patients posted for elective surgical procedures under general anesthesia with endotracheal intubation in department of otorhinolaryngology between march 2017 – 2018. A total of 100 patients were included in the study and compared the videostroboscopic parameters at three intervals that is one day before intubation ; one day and one week after extubation. Short term endotracheal intubation causes a statistically significant change in the videostroboscopic parameters on the first postoperative day. But, one week after surgery there was nostatistically significant changes in the videostroboscopic parameters compared to the preoperative findings. Therefore, in our study noted that the videostroboscopic changes on vocal fold following short term endotracheal intubation was temporary. Most patients recoveredwithin 1 week of endotracheal intubation.*

Date of Submission: 20-12-2018 Date of acceptance: 06-01-2019

I. Introduction

Just like the beating of hummingbird wings, human vocal folds vibrate at a rate that is faster than can be perceived by the human eye. The evaluation of vocal fold anatomy, mucosal colour, and gross movement can be performed while illuminating the vocal folds with a constant light source. But the evaluation of vocal fold vibration requires special imaging technology to "slow down" vibration for assessment. The most widely used technique for assessing the vibratory characteristics of the vocal folds is videostroboscopy, which has become an accepted and essential component of the comprehensive evaluation of voice disorders. The image obtained with videostroboscopy is magnified, allowing a more detailed assessment of the vocal fold anatomy than is possible with indirect or flexible laryngoscopy. Video camera in videostroboscopy can record a digital high-definition format with phenomenal image quality.1 A detailed review of the recording once the examination is completed, with slow motion or frame-by-frame analysis, allows for a comprehensive evaluation of the examination findings and provide a early and accurate findings that are missed in videolaryngoscopy. Recorder laryngeal stroboscopic evaluation is used to follow changes in the glottal vibratory pattern over days, weeks and years. This 'interval examination' helps determine the effects of behavioral, medical and surgical interventions in the larynx. Thus, videostroboscopy is indicated to document and compare the changes in the vocal fold vibratory pattern before and after endotracheal intubation. Examination, documentation and patient education have both become important indications for videostroboscopy. Stroboscopy gives insight to further detailed view of larynx like glottal closure pattern, amplitude, mucosal wave, presence of non vibrating segments, phase symmetry and regularity than videolaryngoscopy. Thus, Laryngeal videostroboscopy is the gold standard for the evaluation of laryngeal structure and function during voicing. The post-intubation voice change is generally assumed to be the result of vocal fold damage. Endotracheal intubation may produce various degrees of temporary and sometimes permanent damage to the vocal fold mechanism, ranging from microscopic alterations of the mucosal surfaces to gross tissue damage of the mucosa, connective tissues and muscles and vocal fold paralysis. It is important to make an early diagnosis of vocal fold changes postoperatively and to adopt treatment and preventive measures. Casiano et al. found that in patients with voice complaints and no abnormality identified on indirect laryngoscopy (previously diagnosed with a "functional voice disorder"), videostroboscopy resulted in a change of diagnosis in 44%. Furthermore, 20% of those patients diagnosed as having benign vocal fold lesions on indirect examination had a change in diagnosis after videostroboscopy. There was only a 3 to 5% rate of change in diagnosis in patients with malignant lesions of the vocal cords and neurologic disorders of the larynx, respectively, indicating that invasive vocal fold carcinoma and vocal fold paralysis are correctly identified on indirect laryngoscopy. In 70% of the cases where videostroboscopy resulted in a change of diagnosis, a previously unappreciated benign vocal fold lesion was found. In another 19%, vocal fold bowing that had not been appreciated on indirect examination was identified.2

II. Aim And Objectives

Aim:
To examine the effects of short-term endotracheal intubation on the vocal fold vibratory pattern using videostroboscopy.

Objectives:
This compare the videostroboscopy parameters at three intervals that is one day before intubation; one day and one week after extubation.
To aid the early detection of vocal fold changes.

III. Materials And Methods

RESEARCH DESIGN:
This is a prospective observational study carried out on 100 consecutive patients posted for elective surgical procedures under general anaesthesia with endotracheal intubation in the department of ENT, Saveetha Medical College and Hospital from March
2017-2018.

Inclusion criteria:
Patients age between18 to 50 years.
Patients scheduled for elective surgical procedures under general anaesthesia (endotracheal intubation).

Exclusion criteria:
Patients with present or previous history of voice complaints.
Patients with past history of prolonged endotracheal intubation.
Patients who had undergone laryngeal surgeries, emergency surgeries and thyroid surgery in the past.
Patients who have pre existing laryngeal lesions.

IV. Methodology

With above conditions, patients who are enrolled for elective surgical procedure were subjected to detailed history, consent to undergo stroboscopy examination and explained about the procedure and benefits of examination. A standard 90-degree rigid videostroboscopic unit was used which consists of a stroboscopic light source, contact microphone, a video camera, an endoscope, and a video recorder.

Procedure:
The patient was asked to be nil per oral for 1 hour prior to examination and to take foods after 30 to 45 minutes of examination because of local anaesthetic effect to avoid aspiration.

Patient was explained that she/he will be scheduled for stroboscopic examination 1 day before surgery; 1 day and 1week after surgery.

In the examination room, the patient was asked to sit in the examination chair and raising the level of the chair to the appropriate height, so that chair to eye level enables better visualisation of the patient's mouth. Topical anaesthesia (10% lignocaine) was sprayed to the posterior aspect of the anterior tongue as well as the posterior oropharynx to control the gag reflex. The patient was introduced to the scope by holding it parallel to the body so that patient is not frightened. The patient was explained that I will be placing the scope in his or her mouth and not down the throat. Telling the patient that I will be holding his or her tongue with a gauze pad, just to keep it out of the way, and that he or she will be saying "e-e-e-e" during the exam. The purpose of the neck microphone was explained and turn the strobe light on to demonstrate the sound and the flashing light, so that the patient will be familiar with this during the actual exam.

During examination, the patient was instructed to breathe through the mouthbecause attempt to breathe through the nose cause a posture that invites the tongue to block the oral cavity and impede the view of the scope. The scope was aligned properly on the camera base, allowing a straight, midline view. After alignment was confirmed, the camera was white-balanced by placing the scope 2 inches to 3 inches from a white sheet of paper with black text, turn on the light source, and prolong press of the white balance button in the camera.

The tip of the scope was warmed prior to insertion into the mouth, by gently holding the scope under warm running water for a few seconds or by immersing it into a cup of warm water results in defogging.

The nonscoping hand was used to anchor the tongue and to create a fulcrum on which the scope can tilt, slide, or rotate. After hand position, the scope was slowly introduced into the mouth, advanced until initial landmarks such as the base of the tongue, the pyriform sinus, and the arytenoid cartilages were seen on the computer screen.

Following vibratory parameters are observed:
Symmetry
Regularity(periodicity)
Glottic closure
Amplitude
Mucosal wave
Nonvibratory portion
Ventricular folds.

VIDEOSTROBOSCOPY EVALUATION FORM

SMCH
Dept. of ENT

Last Name: xx
Age: 28
Address: --
Phone: xxxxxx
Email --

Name: xx
. --

Date: 10/10/2018
Chart: stroboscopy
Requested by: --
, --
Institution: smch

STROBOSCOPIC FINDINGS

1- Fundamental Frecuency: _ Hz

2- Symmetry
O Symmetrical
O Asymetrical
Asymetrical in amplitude: □ + □ - □ R<>L
Asymetrical in phase: □ + □ - □ R<>L

3- Regularity (periodicity): O Regular O Irregular O Inconsistent (sometimes regular, sometimes irregular)

4- Glottic closure: O Complete O Incomplete O Inconsistent (sometimes regular sometimes incomplete

5- Amplitude
Right: O Great O Normal O Small O Zero
Left O Great O Normal O Small O Zero

6- Wave
Right O Great O Normal O Small O Absent
Left O Great O Normal O Small O Absent

7- Nonvibrating portion:
Right O None O Occasionally, partially O Always, partially
O Occasionally, entirely O Always, entirely
Left O None O Occasionally, partially O Always, partially
O Occasionally, entirely O Always, entirely

8- Ventricular folds:
Hyperabduction O Present O Absent

9- Other Findings: O None O noted

Comments:

Observations of changes with pitch: ___

Observations of changes with loudness: ___

Observations of changes with Ax probes: ___

SCORING CHART:

<table>
<tr><th>Parameters</th><th>Scoring</th></tr>
<tr><td>Symmetry</td><td>1-Symmetrical
2-Asymmetrical</td></tr>
<tr><td>Regularity</td><td>1-Regular
2-Irregular
3-Inconsistent</td></tr>
<tr><td>Glottic closure</td><td>1-Complete
2-Incomplete
3-Inconsistent</td></tr>
<tr><td>Amplitude</td><td><table>
<tr><td>Score</td><td>Right</td><td>Left</td></tr>
<tr><td>1</td><td>Normal</td><td>Normal</td></tr>
<tr><td>2</td><td>Great</td><td>Great</td></tr>
<tr><td>3</td><td>Small</td><td>Small</td></tr>
<tr><td>4</td><td>Zero</td><td>Zero</td></tr>
</table></td></tr>
<tr><td>Wave</td><td><table>
<tr><td>Score</td><td>Right</td><td>Left</td></tr>
<tr><td>1</td><td>Normal</td><td>Normal</td></tr>
<tr><td>2</td><td>Great</td><td>Great</td></tr>
<tr><td>3</td><td>Small</td><td>Small</td></tr>
<tr><td>4</td><td>Absent</td><td>Absent</td></tr>
</table></td></tr>
<tr><td>Non-vibratory pattern</td><td><table>
<tr><td>Score</td><td>Right</td><td>Left</td></tr>
<tr><td>1</td><td>None</td><td>None</td></tr>
<tr><td>2</td><td>Occasionally</td><td>Occasionally</td></tr>
<tr><td>3</td><td>Always</td><td>Always</td></tr>
</table></td></tr>
<tr><td>Ventricular folds hyperabduction</td><td>1-Present
2-Absent</td></tr>
</table>

Anesthesia:

All patients underwent intubation by a senior anesthestic. This was done to rule out skill based bias. The senior anesthestic was not made aware that vocal function assessments were being performed to avoid experimental bias. A different combinations of anesthetic medications, a variety of anesthetic techniques and endotracheal tube sizes were used.

Analysis:

All videostroboscopic parameters were evaluated and scored using scoring chart that is minimum number is given for normal structure. All patients whose preoperative score was 10 otherwise normal were selected to continue the study and undergo videostroboscopic examination in the 1 day and 1 week after surgery to compare the effects of short-term endotracheal intubation on the vocal fold vibratory pattern. All the results were entered onto a MS Excel sheet and comparison done by paired t test.

Sample size: 100.

Potential risks:

There is no potential risk in this study but the patient may have gagging, nausea, vomiting and difficulty in swallowing due to local anaesthesia effect.

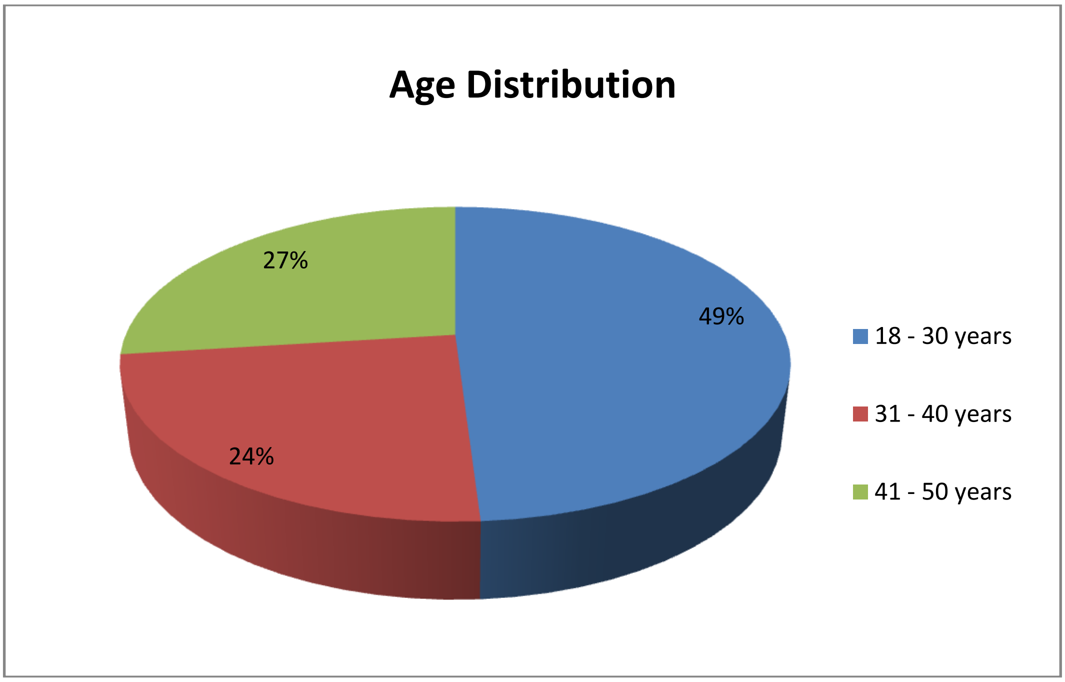
Duration of the research project: 1 year 6 months.

Period of data collection: March2017-March2018.

Period of analysing the data: 6 months.

Probable date of initiation: March 2017.

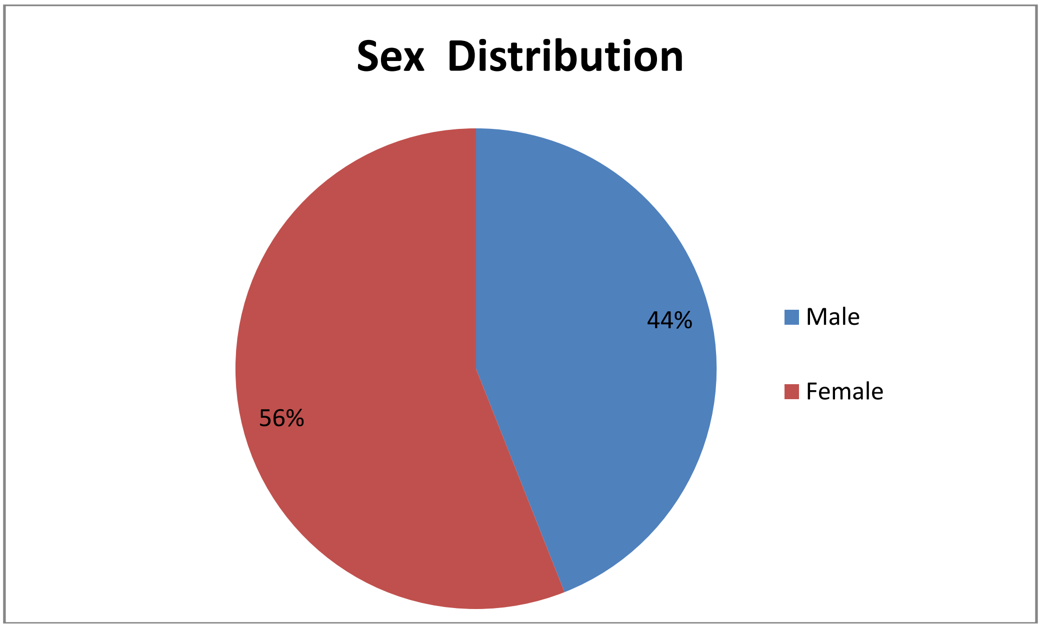
V. Observations



Distribution of patients according to age

Age Distribution

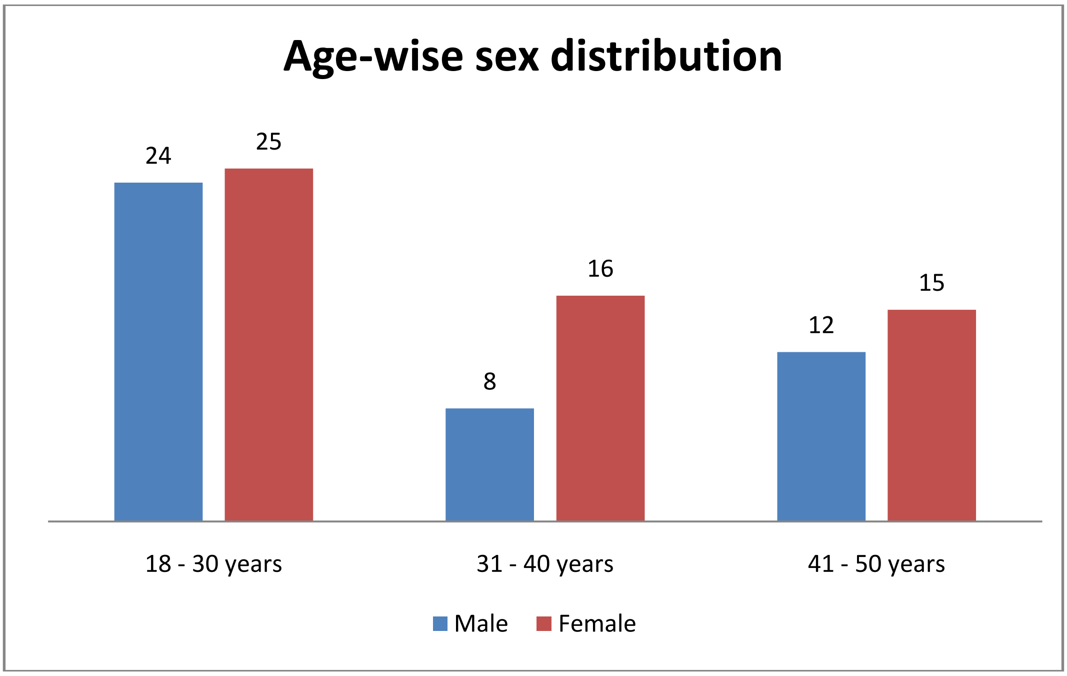
The distribution of the age groups of candidates who enrolled for the study were between 18–50 years. The candidates in the 18–30 years age group were 49%, the 31–40 years age group were 24% and 41-50 years age group were 27%.



Distribution of patients according to sex

Sex Distribution:

Out of 100 candidates, 56% were male and 44% were female.

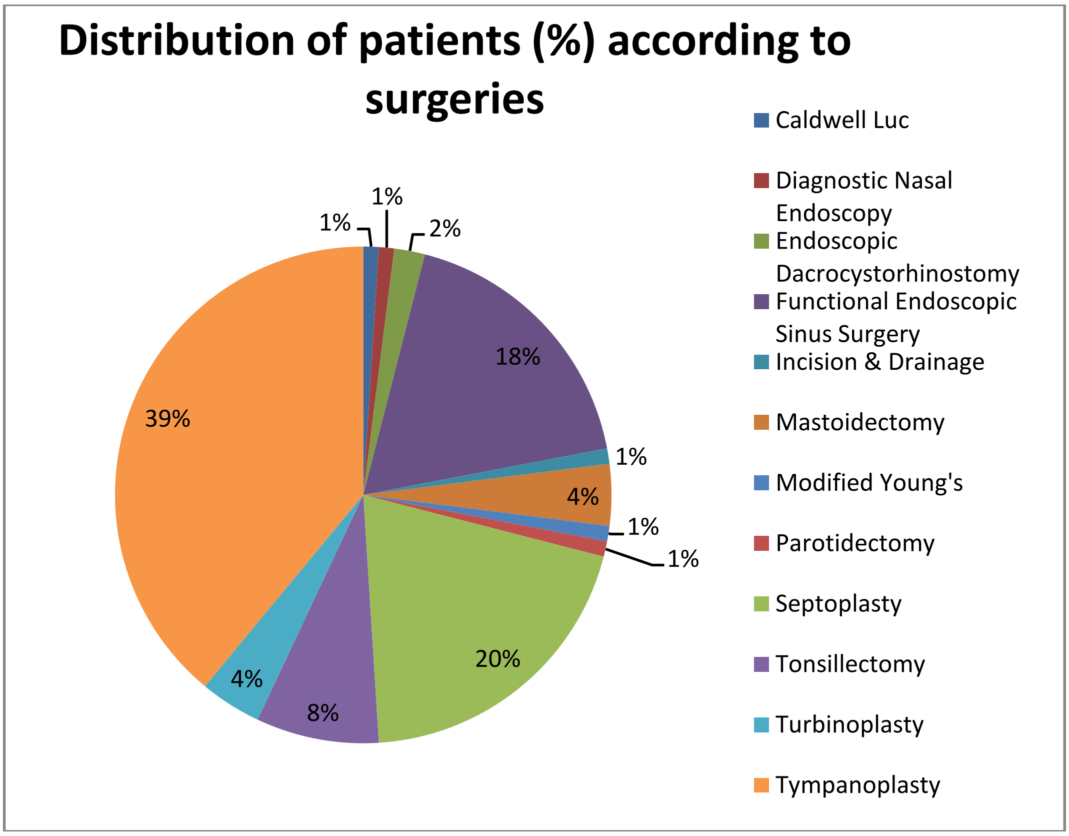


Age-wise sex distribution

Age-wise sex distribution:
In the age group between 18 – 30 years, 24 candidates were males and 25 were females.

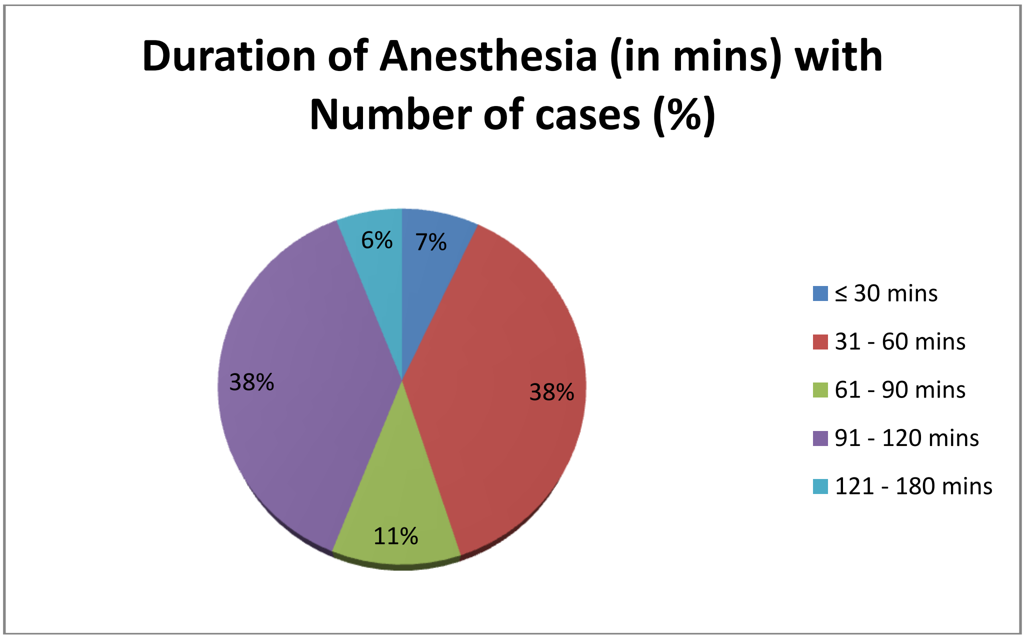
In the age group between 31– 40 years, 8 candidates were males and 16 were females.

And the age group between 41– 50 years, 12 candidates were males and 15 were females.



Distribution of patients(%) according to surgeries

Distribution of patients according to surgeries:
Out of 100 candidates, 39% underwent tympanoplasty, 20% Septoplasty,18% Functional Endoscopic Sinus Surgery, 8%tonsillectomy,4%Turbinoplasty, 4% Mastoidectomy,
2% Endoscopic Dacrocystorhinostomy and 1% Caldwell Luc, Diagnostic Nasal Endoscopy, Incision and Drainage, Modified Young's procedure and Parotidectomy.



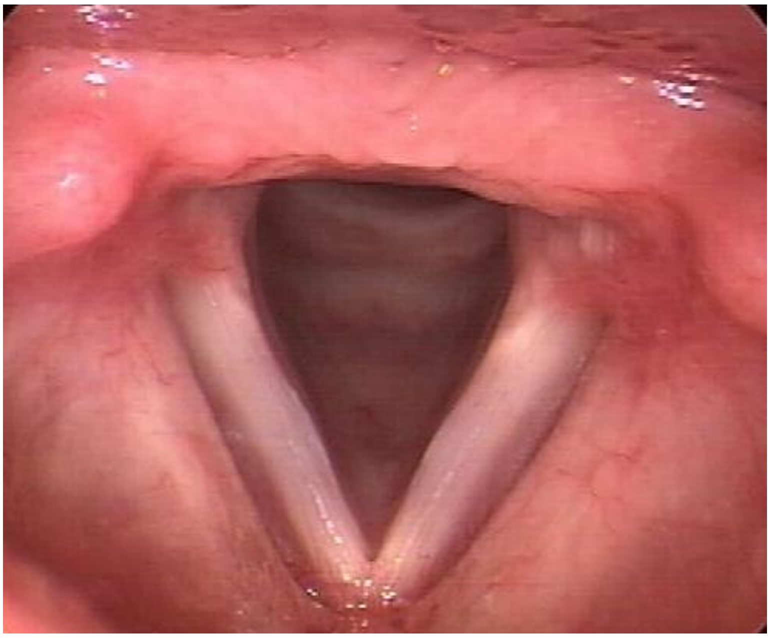
Duration of Anesthesia (in mins) with number of cases(%)

Duration of Anesthesia (in mins) with number of cases(%):
In 7% of patients, the duration of anesthesia was≤30 mins, in 38% of patients it was31-60 mins, in 11% of patients it was 61-90 mins, in 38% of patients it was 91-120 mins and in 6% of patients it was 121-180 mins. Thus, the average duration of anesthesia is 84 mins.

VI. Result

Pre operatively, all 100 patients achieved a score of 10 which was considered normal. In day 1 postoperative, out of 100 patients 70% scored 10, 20% scored 11, 9% scored 12 and 1% scored 13. In 20% (n1=20) of patients who scored 11, 90% (n1a=18) showed irregular periodicity and 10% (n1b=2) showed asymmetry(n1 = n1a+1b). In 9% (n2=9) of patients who scored 12,55% (n2a=5) showed small amplitude and 45% (n2b=4) showed both asymmetry and irregular periodicity (n2=n2a+2b). In 1% (n3=1), the candidate who scored 13 showed both asymmetry and small amplitude. One week postoperative, all 100 patients underwent videostroboscopy in which 5% of patients scored 11, showed residual minimal asymmetry were still present. Drop out rate was zero.

Pre-operative videostroboscopy picture.



Day 1 Postoperative Videostroboscopy picture showing variable amplitude and asymmetry between the two vocal fold vibration.

Day 1 Postoperative Videostroboscopy picture showing variable periodicity of the mucosal wave.

Paired t-test statistical analysis				
Parameter	Mean	Std. Deviation	Std. error	p value
Pre-op Score / Day 1 Post-op Score	10.41	0.7	0.07	0.0001
Day 1Post-op Score / 1 week Post-op Score	10.01	0.1	0.01	0.0001
Pre-op Score / 1 week Post-op Score	10.01	0.1	0.01	0.3197

Thus, a statistically significant difference (p = .0001) was found in videostroboscopic parameters when comparing preoperative and day 1 post-operative scores and also a statistically significant difference (p=.0001) was found when comparingday1and 1 week postoperative scores. There was no statistically significant difference (p=.3197) was found when comparing preoperative and 1 week postoperative scores.

VII. Discussion

Beckfordet al3.,1990, studied the effects of short-term endotracheal intubation on vocal function in 10 patients scheduled for outpatient gynecological procedures under general anesthesia preoperatively and postoperatively. In this study he used an age-matched control who did not have surgery or general anesthesia. He assessed fundamental frequency, frequencyperturbation, electroglottography, subjective speech analysis in addition to endoscopy (including laryngeal stroboscopy. He noticed that mucosal wave propagation and amplitude were decreased in 40% of patients in the post operative period. In my study, 100 patientswere assessed by videostroboscopy andnoticed 30% changes in vocal fold onthe firstpostoperative day.

Preschel and Eysholdt's4., 1993, studied the endoscopic and stroboscopic picture of the larynx as well as the voice analysis pre-operatively and on the first or second post-operative day in 75 patients who had been anaesthesized with intubation. The stroboscopic findings were evaluated according to the criteria suggested by Schürenberg (1990). The quality of the voice was estimated with a voice purity index (Moser 1984) and the dynamic and frequency range of the voice was measured. After intubation, he found alterations of the mucous membrane in 73% of the patients: increased amount of visible blood vessels, bleeding into the vocal cords or the trachea, bruises at the processusvocalis or the arytenoid cartilages. The stroboscopic picture showed deterioration; pre-operatively large amplitudes and/or mucosal waves became even larger postoperatively, small amplitudes and mucosal waves decreased even further. The timing and the spatial symmetry of the vocal cord movements also deteriorated. In my study, out of 100 patientsvocal fold changes were noted in 30% of which 18% showed irregular periodicity, 5% showed small amplitude, 4% showed both asymmetry and irregular periodicity, 2% showed asymmetry and 1% showed both asymmetry and small amplitudeon the first postoperative day. One week postoperative, all 100 patients underwent videostroboscopy without dropout in which 5% showed residual mild asymmetry.

Ghandour et al5.,2012, evaluated vocal function by videokymography in 40 patients undergoing elective surgical procedures under general anesthesia. They were 26 males from 17 to 61 years and 14 females from 16 to 54 years. They carried out at three intervals, 1 day before intubation, 1 day after extubation, and 1 week later.All the patients were free from laryngeal lesions before intubation. One day after extubation, traumatic laryngeal lesions noted in 15 patients,vocal fold congestion in 11 patients, increased vascular marking in 6 patients, vocal fold edema in 5 patients and vocal fold ulceration in three patients. One week after extubation, residual lesions were still present in 3 patients, mild vocal fold edema in 2 patients and vocal fold congestion in one patients.This study was also similar to our study where there was significant vocal fold changes in the postoperative period.

Paulauskiene et al6.,2013, assessed and perceived the vocal and pharyngeal symptoms and acoustic changes of voice after short-term endotracheal intubation and evaluated the relation between these changes and the endotracheal tube parameters, number of intubation attempts, duration of anaesthesia, experience of anaesthesiologist. A total of 108 patients were evaluated preoperatively, 1–2 and 24 h after extubation. The vocal and pharyngeal symptoms, voice acoustic characteristics and maximum phonation time (MPT) were evaluated to find the relationship with endotracheal tube parameters, number of intubation attempts, duration of anaesthesia, experience of anaesthesiologist. All vocal and pharyngeal symptoms increased significantly at 24 h of general anaesthesia. The vocal acoustic parameters changed significantly at 1–2 h: decrease of MPT and increase relative average perturbation were recorded. The day after the short-term intubation: only noise to harmony ratio and habitual pitch remains significantly changed. The most important endotracheal tube parameters that affects the vocal function significantly were the size of tube, cuff volume and number of intubation attempts. In relation to the anaesthesia, the changes of the acoustic parameters did not associate significantly with the anesthesia-related parameters. No statistically significant relationship between experience of an anaesthesiologist and changes of the voice after anaesthesia was detected. Though being short-term, endotracheal anaesthesia is an invasive procedure, and its temporary influence on vocal function is important.

Hamdanet al7.,2007, examined the vocal symptoms and acoustic changes perceived in the short period after endotracheal intubation, and the association between the changes with the endotracheal tube parameters. A total of 35 subjects were included. They were examined preoperatively, and 2 and 24 hours postoperatively. The vocal symptoms of hoarseness, vocal fatigue, loss of voice, throat clearing, globuspharyngeus, throat pain, and the acoustic variables mainly average fundamental frequency, relative average perturbation, shimmer, noise to harmony ratio, voice turbulence index, habitual pitch, and maximum phonation time (MPT) were assessed as such and in relation to the endotracheal tube parameters(duration of anesthesia, number of intubation attempts, size of the tube, cuff volume, cuff mean pressure). The association between anesthesia parameters with incidence of vocal complaints and changes in acoustic parameters were examined using logistic and linear regression. Vocal fatigue was associated significantly with the increase in cuff volume and the number of intubation attempts. Throat clearing was associated significantly with the increase in cuff mean pressure. Only the increase in habitual pitch was associated significantly with the increase in cuff volume. The acute short-term effect of endotracheal intubation on voice is significant. The most important endotracheal tube parameters that affect the vocal changes are the cuff mean pressure and volume. The laryngeal contribution to these vocal changes seems to be minimal. All vocal symptoms increased significantly except for globuspharyngeus at 2 hours postoperatively. The acoustic parameters did not change significantly except for a decrease in MPT. At 24 hours postoperatively, all vocal symptoms subsided with no significant difference to baseline value. The habitual pitch increased significantly, and the rest of the parameters remained comparable to baseline value.

Michael Hedden et al8.,1969, studied laryngotracheal damage after prolonged retention of orotracheal tubes (one to ten days) in adults was reviewed in 116 unselected patients admitted to an intensive care unit. Among the 59 survivors, all patients who had the tube in place for more than 48 hours had temporary difficulties with orally taken fluids for several hours after extubation. In two of five survivors having the tube in place for more than 72 hours, hoarseness (two patients) and aspiration (one patient) were irreversible. In 27 of 57 patients who died, the larynx and trachea were examined and scored postmortem for lesions. Scores increased with duration of intubation. Retention of tracheal tubes for less than 72 hours was rarely followed by serious lesions. Six of seven patients who had the tube in place for more than 72 hours showed high scores.

Ha IW et al9.,2011,studied how often and why voice change last more than 72 hours after intubation conducted for general anesthesia. The study enrolled 80 patients who undergo general anesthesia at the Seoul Paik Hospital from Aug. 2009 to May 2010. The patients were examined through stroboscopic examination and voice analysis before surgery. Three days after the surgery, the same tests were performed again to single out patients whose results were abnormal; thus a proportion could be calculated.7.5% of the patients suffered from voice change longer than 3 days. Three factors, namely, cuff pressure, duration of anesthesia and patient age demonstrated statistically significant relationships among them. Surgeons and anesthesiologists need to cooperate closely by taking the patient age, duration of anesthesia and cuff pressure into account in order to limit postoperative voice change to the minimum extent.

Rangachari et al10.,2006,evaluated laryngeal lesions in patients after prolonged intubation (>24 h), correlated these lesions with the variables involved in the process of intubation and to determine the risk factors. This is a prospective study for 1 year in 51 patients who were intubated for more than 24 h in critical care unit. Patients underwent laryngeal video endoscopy on the day of extubation and after 3 weeks by an ENT surgeon who was blinded to the intubation variables. Laryngeal abnormalities were seen in 41 patients on the day of extubation. At the end of third week after extubation, only 10 patients had abnormal laryngeal findings. A multivariate stepwise regression model showed that bigger tube size, longer duration of intubation and emergency intubation was associated with higher incidence of laryngeal complications on the day of extubation. At the end of third week, laryngeal findings were influenced only by the duration of intubation. Thus, laryngeal sequelae after extubation is directly associated with duration of intubation.

VIII. Summary

The 100 consecutive patients who underwent ENT procedure under general anesthesia were included in the study. Stroboscopy was done 1 day before; 1 day and 1 week after surgery. All patients with normal stroboscopic findings in the preoperative period were continued in the study. In the first postoperative day, the vocal fold changes were noted in the 30% of patients that is 18%had irregular periodicity, 5% had small amplitude, 4% had both asymmetry and irregular periodicity, 2% had asymmetry and 1% had both asymmetry and small amplitude. One week after the surgery, only 5% of patients had residual mild asymmetry. A statistically significant difference (p=.0001) was found in videostroboscopic parameters when comparing preoperative and day 1 postoperative scores; day 1 postoperative and 1 week post operative scores. There was no statistically significant difference (p=.3197) was found when comparing preoperative and 1 week postoperative scores.

IX. Conclusion

Short term endotracheal intubation causes a statistically significant change in the videostroboscopic parameters on the first postoperative day. But, one week after surgery there was no statistically significant changes in the videostroboscopic parameters compared to the preoperative findings. Therefore, in our study noted that the videostroboscopic changes on vocal fold following short term endotracheal intubation was temporary. Most patients recovered within 1 week of endotracheal intubation.

BIBLIOGRAPHY

[1]. Tsunoda A, Hatanaka A, Tsunoda R, Kishimoto S, Tsunoda K. A full digital, high definition video system (1080i) for laryngoscopy and stroboscopy. J LaryngolOtol 2008;122:78–81.

[2]. Casiano RR, Zaveri V, Lundy DS. Efficacy of videostroboscopy in the diagnosis of voice disorders. Otolaryngol Head Neck Surg 1992;107:95–100.

[3]. Beckford, N.S., Mayo, R., Wilkinson, A., and Tierney, M. (1990). Effects of short-term endotracheal intubation on vocal function. Laryngoscope 100 (4), 331-336.
[4]. Preschel U, Eysholdt U. Short-term changes of larynx and voice after intubation. Laryngorhinootologie. 1993;72:93–97.
[5]. Ghandour HH, Shoeib RM, Nassar JF, El-Shafei MM. Assessment of the short-term effects of endotracheal intubation on vocal functions. Egypt J Otolaryngol 2012;28:251-61.
[6]. Paulauskiene, I., Lesinskas, E. &Petrulionis, M. The temporary effect of short-term endotracheal intubation on vocal functionEur Arch Otorhinolaryngol (2013) 270: 205.
[7]. Hamdan, Abdul-Latif&Sibai, Abla&Rameh, Charbel&Kanazeh, Ghassan. (2007). Short-Term Effects of Endotracheal Intubation on Voice. Journal of voice : official journal of the Voice Foundation. 21. 762-8. 10.1016/j.jvoice.2006.06.003.
[8]. Hedden M, Ersoz CJ, Donnelly WH, Safar P. Laryngotracheal Damage After Prolonged Use of Orotracheal Tubes in Adults, JAMA. 1969;207(4):703-708.
[9]. Ha IW, Kim MC, Lee SJ, Kim AR, Chang JS, Jun BH, Choi IS. Effects and related factors of endotracheal intubation on voice change following general anesthesia. Korean J Otorhinolaryngol Head Neck Surg. 2011;54:137–141.
[10]. Rangachari V, Sundararajan I, Sumathi V, Kumar K K. Laryngeal sequelae following prolonged intubation: A prospective study. Indian J Crit Care Med 2006;10:171-5.

DR.S.V.Sharannya . "Stroboscopic Evaluation of Endotracheal Intubation Changes In Vocal Folds"." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 1, 2019, pp 52-62.