Nasotracheal Prolonged Safe Extubation Reduces the Need of Tracheotomy in Patients with Acute Respiratory Failure following Thyroidectomy

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Abstract

Objectives: Acute respiratory failure (ARF) is a complication following thyroid surgery; its incidence is reported as high as 0.9%. Through an illustrative case series, we present an alternative treatment of this peculiar ARF: the nasotracheal Prolonged Safe Extubation (PSE).

Methods: Patients treated at our Intensive Care Unit for ARF following thyroid surgery from January 2004 to December 2009, were reviewed. Demographic data including gender, age, clinical presentation, laryngoscopic findings, management and outcome during a 24-months follow-up after treatment were collected and evaluated. The strategy for prolonged nasotracheal safe extubation is presented.

Results: Twelve out of the 1713 patients scheduled for thyroid surgery (0.7%) at our university hospital, developed post-operative ARF. All of them were treated by nasotracheal prolonged safe extubation. The success rate in avoiding highly invasive treatment was of 83.3%, since only 2 patients needed tracheotomy (16.7%).

Conclusions: The prolonged safe extubation reduced the amount of expected tracheotomies in patients with ARF following thyroid surgery. Thanks to its minimal invasiveness, and to the high degree of comfort, it was well tolerated.

Keywords: Nasotracheal safe extubation; Total thyroidectomy; Acute respiratory failure; Laryngoscopy; Nasotracheal tube; Prolonged safe extubation

Introduction

Incidence of Acute Respiratory Failure (ARF) following thyroid surgery is reported as high as 0.9% [1-4]. This life-threatening condition is often only temporary, and it may recover spontaneously. Position of the paralyzed vocal cords can vary from paramedian to lateral, so determining the variable impairment of the laryngeal function and the severity of dyspnea.

The most common factors responsible for post-tyrodectomy ARF are: bilateral Laryngeal Recurrent Nerve (LRN) injury due to traction, compression (neuropraxia) or neurotmesis, i.e. complete nerve section, unilateral LRN paresis associated with laryngeal edema (venous stasis, Reinke's edema), local hemorrhage (paratracheal hematoma) directly compressing airways, tracheomalacia and laryngeal edema [5-7]. Also the operating position during thyroid surgery, with the neck fully extended, may cause lesions of vocal cords and tracheal walls, since the tracheal axis is inversed to the endotracheal tube [8].

Severe post-operative ARF is characterized by dyspnea, inspiratory airways distress and hypoxia. The standard management of this condition consists in orotracheal intubation and safe extubation, or eventually tracheotomy [9,10]. Nevertheless, the compression applied by the orotracheal large size tube may cause lesions of vocal cords and tracheal walls worsening the pre-existing edema. This delays ventilation, phonation and deglutition recovery [8,11]. Extubation trials (safe extubation), generally performed using airway exchange catheters (AEC), can lead to displacement, self-extubation, aspiration, laryngotracheal or bronchial lesions or perforations, determining sometimes life-threatening complications such as hemoptysis or pneumothorax [12-14]. Tracheotomy rapidly resolves ARF but it is highly invasive and therefore burdened with considerable morbidity and, as a consequence, poorly satisfactory for the patients. The aim of this study is to evaluate the "nasotracheal prolonged safe extubation" as an alternative and less invasive therapeutic approach to post-tyroidectomy ARF, in order to avoid some complications related to the temporary tracheotomy and to an undesired prolonged orotracheal intubation, and to assess its ability in reducing the number of expected tracheotomies. A case-report about perioperative glottis edema with severe upper airway obstruction, reported the feasibility and the effectiveness of this technique [15]. Patients treated for post-tyroidectomy ARF with this method at our institution were reviewed.

Patients and Methods

Study design

Under approval of the internal ethical board (ethical committee, n. 395), we conducted an observational retrospective study according to

the principles established in the Helsinki Declaration. Patients, or their next of kin, were asked for informed consent.

We reviewed data from patients treated at our Intensive Care Unit from January 2004 to December 2009. Admission diagnosis was severe ARF following thyroid surgery with failed extubation on awakening from anesthesia and need of tracheal reintubation. Of these, them who had previous ischemic heart disease, mild-severe heart failure (NYHA>2), severe or relapsing chronic obstructive pulmonary disease, fever with tachypnea, infiltrative laryngeal tumor, infiltrative extraglandular masses, were excluded from the observation, in order to focus only on the post-tyroid surgery related causes of ARF. LRN impairment was diagnosed by laryngoscopy. Failure of oxygenation, carbon dioxide clearance, or both of these, associated with an increase in hydrogen ion concentration in the plasma (pH<7.30) were considered as acute respiratory failure [16,17]. Each patient was treated by PSE; if ARF did not recover after the 4th endoscopic check (8 days), a tracheotomy was placed.

On the advice of the ENT specialist, voice therapy was indicated in patients with true vocal cords impairment. Recurrent laryngeal nerve palsy was considered permanent if there was no recovery six months after surgery. Clinical status, laryngoscopic pictures and outcome during a 24-month follow-up were also reported.

PSE technique

After ICU admission, all patients were standard monitorized (ECG, hearth rate, blood pressure, pulsoximetric O_2 saturation), underwent corticosteroidal therapy (methylprednisolone 20 mg/i.v. every 12 hours) and cuff-leak test, according to Miller and Cole [18]. Afterwards, PSE was started according to the described procedures for safe-extubation [14,15]. Firstly, we injected 3 ml of a mixture of lidocaine 2% and mepivacaine 2% into the nasal cavity and the upper airways. We removed the tracheal tube leaving a guidewire (Baxter®, hydrophilic Teflon™, ID 0.035, length 150 cm) in the airway to facilitate emergency re-intubation. Next we performed a diagnostic rhino-laryngoscopy by a video bronchoscope Pentax FB 18, Ø 6 mm
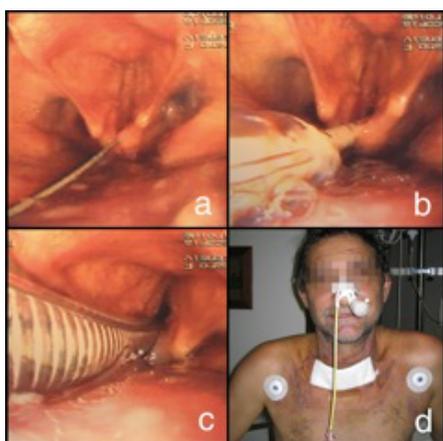

Figure 1: Prolonged safe extubation (PSE) in a patient with acute respiratory failure after thyroid surgery. Panel a) fiber optic video laryngoscopy through nasal cavity (rlFBS) view shows bilateral adductive vocal cord paresis and a guidewire placed in the airway in order to facilitate a potential emergency re-intubation, while orotracheal tube is removed; panel b) rlFBS view shows an airways exchange catheters (AEC) placed over the guidewire and a nasotracheal cuffless tube (NT) while is getting placed over the AEC; panel c) NT placed under the vocal cords; panel d) the patient adapted in spontaneous breathing with the phonetic valve and NT placed.
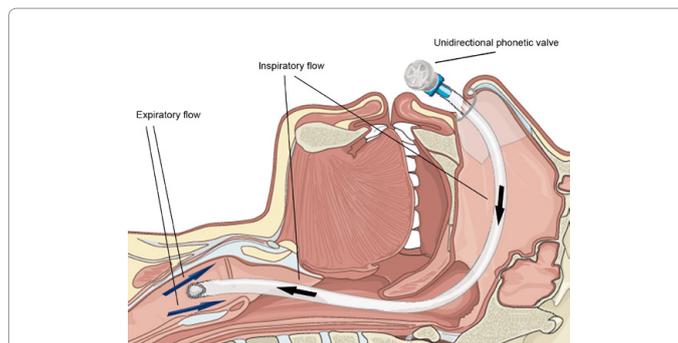

Figure 2: Head and neck in sagittal section which shows the passage of inspiratory flow through the tube and expiratory flow through natural airway; the second one is possible thanks to the presence of the unidirectional phonetic valve applied on the nasotracheal tube.

(rlFBS) (Figure 1a); during rlFBS, the guidewire was removed from the oral cavity, and replaced in the trachea through the endoscope operative channel. Then rlFBS was removed, leaving the guidewire *in situ*. An AEC (Cook® No. 11; ID 4 mm) was placed over the guidewire. A small cuffless nasotracheal (NT) tube (Rüsch® SilkoClear Flex™ ID 4.5 mm or 5 mm, length respectively 25 or 26 cm) was inserted by a twisting movement over the AEC (Figures 1b and 1c); another rlFBS was performed (through the contralateral nostril) to assess the position of the NT tube. Usually, its tip has to be positioned at least 2 cm under the vocal cords. AEC and guidewire were removed and a phonetic valve was placed on the NT tube, which was fixed to the nose by VBM® Endofix Nasal™ tube holder (Figures 1d and 2). Patient spontaneously breathed through the NT tube and an oxygen support was added. A nasogastric tube for enteral feeding was positioned (Figure 1d), intravenous post-operative pain therapy and thoracic physiotherapy were started.

Airway and vocal cord conditions were reassessed every 48 hours by rlFBS. When breathing resumed without inspiratory airways distress, dyspnea and hypoxia, and upper airway edema and vocal function improved, the NT tube was definitively removed. Guidewire alone was left for 6 hours longer, and it was finally removed in absence of relevant clinical events. To prevent complications and to assess oral feeding, the patient was observed for 24 hours longer. If airway obstruction persisted at the 4th reassessment, and endoscopic pattern or clinical conditions did not improved, a tracheotomy was performed. Patients had ENT laryngoscopy during long-term follow-up to assess vocal cord function and ventilation recovery. The patients with 1 vocal cord paresis were submitted to voice therapy. The protocol was performed twice a week for 6 months; in particular, hard glottal attacks and pushing, half-swallow boom and abdominal breathing exercises were applied [19,20]. Voice therapy aimed to improve glottal closure without causing supraglottic hyperfunction, developing abdominal support for breathing and improving intrinsic muscle strength and agility.

Statistical analysis

Data were compared with a chi-square test. Statistical significance was defined as p>0.05 with a Confidence Interval (CI) at 95%.

Results

All 1713 patients-1370 women and 343 men with a f/m ratio=4/1 and a mean age of 48 years-underwent thyroid surgery at our university hospital. Twelve patients (0.7%), 10 women and 2 men with a mean

age of 56 years (range 36-65), who underwent total thyroidectomy for multinodular goiter (n=7), cervicomediastinal goiter (n=2) or differentiated thyroid carcinoma (n=3), developed post-operative ARF and were enrolled in the study. The mean Simplified Acute Physiology Score (SAPS) II was 15.10. The cuff-leak test was positive in 8 out of 12 patients.

The first laryngoscopic evaluation for diagnostic purposes showed:

- Glottis edema and hyperemia of the vocal cords in all patients (100%);

- Bilateral vocal cords with hypokinesia in paramedian position in 6 patients (50%);

- Hyokinesia of the right vocal cord in 2 patients (16.7%);

- Hypokinesia of the left vocal cord in 1 patient (8.3%);

- Bilateral vocal cord adduction paresis in 3 patients (25%).

Subsequently, only 2 women of the 12 observed patients (16.7%), with a mean SAPS II 15.18-corresponding to 0.1% of the population undergone thyroid surgery-affected by ARF due to bilateral vocal cords adduction paresis, underwent temporary elective tracheotomy. Their vocal cord function recovered respectively 30 and 90 days later; tracheotomy tubes were then removed and stoma spontaneously closed.

In the group of patients successfully treated by PSE, in which ARF resolved without tracheotomy, composed of 8 women and 2 men, with a mean SAPS II 15.09, definitive extubation was performed after a mean of 5 days (2÷9 days). In each patient the NT tube was well tolerated. The PSE success rate in avoiding the tracheotomy was 83.3%. Rosato reported a success rate in avoiding tracheotomy following orotracheal intubation and safe extubation of 50% [21]. So, the PSE success rate in avoiding tracheotomy was significant higher than orotracheal intubation trial by Rosato (χ^2=4.48, p=0.034). ENT laryngoscopic assessments, performed during the follow-up, showed a resolution of the edema and hyperemia of the vocal cords, along with the complete recovery of the vocal cords motility in all patients (Figure 3). A monolateral hypokinesia in 3 patients (25%), and a bilateral hypokinesia in 4 patients (33.3%), were observed. An incomplete functional recovery was observed in 2 patients with bilateral hypokinesia (16.7%) and in all patients with bilateral paresis (3 patients, 25%), who were referred to voice therapy. Two patients with bilateral hypokinesia and 1 patient with bilateral paresis had complete functional recovery; a monolateral recovery was observed in 2 patients with bilateral paresis.

No patient experienced complications associated with the PSE procedure, and none developed clinically significant changes in

Figure 3: ENT video laryngoscopy assessment, performed during the follow-up, shows resolution of the edema and of the hyperemia of the vocal cords, along with a complete recovery of their motility.

vital signs during the procedure. All patients showed an excellent compliance during the treatment and reported a high level of comfort.

Discussion

Incidence of ARF, reported by a multicentric study in a large population of patients (9599 patients) who underwent thyroidectomy, was 0.6% (58 cases). A "classical" orotracheal intubation was always carried out, while a tracheotomy was finally necessary in 29 patients (50%), representing 0.3% of the population undergoing thyroidectomy [21]. In our study ARF occurred after total thyroidectomy in 0.7% of cases (12 out of 1713 patients). All ARF patients were treated by PSE procedure, and only two out of 12 (16.7%), representing 0.1% of the population undergoing thyroidectomy, required a tracheotomy.

On the basis of the clinical evidence and of the data compared between our findings and those reported by Rosato et al. (χ^2=4.48, p=0.034), PSE resulted more effective than standard management in preserving airways and avoiding tracheotomy. In fact, our success rate in avoiding tracheotomy was 83.3% compared to the 50% following orotracheal intubation reported in the Italian series [21]. In our experience, PSE procedure, compared to the classical ARF treatments, also showed several advantages. When orotracheal reintubation is preferred, edema reversion is delayed by the presence of a large-caliber tube across the larynx and close to the vocal cords [8]. This observation explains the authors' choice, based on previous experience with translaryngeal open ventilation (TOV) [22], about the use of a smaller caliber NT tube sized between 4.5 and 5 mm ID. It resulted less invasive and more compliant with the larynx anatomy. Moreover, we chose a reinforced silicone tube manufactured by Rüsch® SilkoClear Flex™ (Figures 1b and 1c) because it presented the lowest external/internal diameter ratio (1.4 mm). A NT tube of this size, better tolerated by the patient and less reflexogenic than the orotracheal one, tends to place itself in the posterior interarytenoid space. As a consequence, it greatly reduces vocal cords compression, local edema and the risk of decubitus as well. Moreover, because of its smaller size, it does not fully occlude nasal meati, so preventing sinuses and nasal cavities infections. The reported advantages may favor a spontaneous breathing (Figure 1d), avoiding mechanical ventilation, sedation and curarization. The same advantages are barely achievable by orotracheal or standard nasotracheal tubes, which require analgosedation.

Even if the PSE procedure was always effective in our series, its use could have some limitations. In case of respiratory failure associated with reduced breathing force, i.e. chronic obstructive pulmonary disease (COPD), the procedure maybe uneffective since the resistance to the flow increases because the diameter of the NT tubes is smaller than the orotracheal one [23]. In order to maintain the flow we would have to increase the pressure gradient as needed [23] but this would cause dynamic hyperinflation in patients with COPD. TOV, instead, through the NT tube, would be effective also in those patients, as described by Skrobik and Gregoretti [24]. The circumstances that make the patients unable to be awake and spontaneously breathing, such as psychiatric disorders (i. e. severe anxiety), non compliance to the NT tube and/or to the nasogastric tube needed for feeding when NT tube is *in situ*, also could be a limitation for the PSE use. Other limitations could be represented by anatomic abnormalities making impossible the NT tube positioning (i. e. turbinate hypertrophy, nasal polyps, narrow nasal cavity) and by all the conditions causing hyperventilation, hyper secretion and severe cough (i. e. smoking, severe asthma). Although, the patients undergoing PSE need a close monitoring since the NT tube, especially in the first hours of ARF, guarantees the airway patency and a sudden, accidental extubation causes a new ARF. These limitations and

Non-compliant patients (i.e. severe anxiety)	
Impossible NT tube positioning caused by anatomic abnormalities (i.e. turbinate hypertrophy, nasal polyps, narrow nasal cavity).	
Hyperventilation is not allowed because of the small Inner Diameter of NT tube, even if it is adequate for spontaneous breathing at rest (it could be necessary to sedate the patient and apply PSV).	
Need for nasogastric tube because of the impossible oral feeding (the presence of NT tube causes incomplete closure of the glottis during swallowing).	
Dangerous accidental dislodgment (i.e. in case of hypersecretion with severe cough). It causes a rapid re-obstruction of the glottis with new ARF.	

Table 1: Limitations and shortcomings of PSE technique.

shortcomings are represented in Table 1.

During the classic safe extubation it is possible to oxygenate, and not to ventilate the patients through the AEC [12,14]. In contrast, during the PSE procedure, patients, ventilating spontaneously through the NT tube, could be oxygenated by increasing FiO_2 and, if needed, it is possible to support breathing by applying a ventilator. When planning the procedure, to reduce the permanence of the AEC in the airways, we preferred a guidewire that was left "alone" during the last phase of the PSE procedure (final 6 hours) to facilitate an emergency reintubation. We preferred this procedure for the following reasons: to reduce the risk of AEC complications, extensively described by Benumof et al. [12] and reported more recently by Loudermilk et al. [14]; to enable the fiberoptic assessment of the glottis in absence of any device; to increase patient comfort and to allow walking during intensive care, thus reducing muscle hypotrophy.

Our study confirmed also a good patient tolerance to the soft silicone NT tube, and thanks to a physiological drainage of bronchial secretions, no patient experienced respiratory distress. Comparing this approach to a classic safe extubation, according to Loudermilk et al. [14], who maintains an AEC in the patients' airways for 24 hours before discharging, it must be remarked that 3% of the observed patients (one out of 40) required AEC removal. Tolerance to NT tube may be higher than to AEC, but further studies are needed to substantiate these findings. During the procedure we utilized a phonetic valve that, in addition to enable phonation, also improved the drainage of bronchial secretions on the outer surface of the tube, maintaining its patency. This is due to the patient capacity to inhale only through the NT tube since, in presence of edematous laryngeal mucosa, it collapses on the tube walls during inhalation. Exhalation, instead, can only occur outside the tube because the unidirectional phonetic valve eliminates all endoluminal flow (Figure 2). The exhalation flow splays the soft edematous mucosa tissue generating enough space for the drainage of secretions, avoiding endoluminal deposits, a frequent cause of respiratory distress in mechanically ventilated patients.

The main limit of this retrospective study was the small number of treated patients and the absence of a control group treated with conventional procedures. Therefore, our results do not allow to drawn definitive conclusions and must to be cautiously considered and confirmed in a larger multicentric series.

Considering that it is very debated whether the most common therapeutic option for ARF is tracheotomy, in the observed ARF population the need of tracheotomy was of 16.7% and so, according to our knowledge, PSE procedure reduced the number of expected tracheotomies in ARF following thyroid surgery patients, with a "near zero" risk of morbidity. Thanks to its minimal invasiveness and to the high degree of comfort, it was also well tolerated.

From a clinical perspective, our results validate the favorable characteristics attributed to PSE in a previous study [15]. Allowing good respiratory ability and walking during hospitalization, it may favor fast clinical resolution of the laryngeal functional impairment.

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