

**An assessment of the impact of large goitres on
perioperative and postoperative airway management**

A retrospective review

By

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LIST OF ABBREVIATIONS

CT: Computerised tomography

CXR: Chest x-ray

GSH: Groote Schuur Hospital

ICU: Intensive care unit

LTOI: laryngotracheal oral intubation

RLN : Recurrent laryngeal nerve

RSG: Retrosternal goitre

PART A : STUDY PROTOCOL

As approved by the Departmental Research Committee and Human Research Ethics Committee, University of Cape Town.

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It is widely assumed in the literature that large thyroid goitres pose a significant risk to the airway at the time of induction of anaesthesia, during surgery, and in the postoperative period. Complications that have been described include difficult tracheal intubation, difficulty managing airway patency during the surgical procedure, and postoperative airway problems due to postoperative haemorrhage, laryngeal nerve injury and tracheomalacia. However, the incidence, severity and predictive signs of these events have not been well documented, particularly in a developing country where patients may present very late in an advanced disease state.

The purpose of this research proposal is to analyse the available documentation on patients who have undergone anaesthesia and surgery for goitre in whom there were preoperative signs and symptoms of airway compromise and to assess the incidence of perioperative airway management difficulties.

Method:

An electronic review will be conducted of the surgical operative notes of all patients who have undergone thyroid surgery between January 2010 and June 2016. From these records, those patients with thyroid malignancies will be excluded. The patient records will then be scrutinised for evidence of preoperative airway compromise, including airway related symptoms and distortion of the airway on radiological examination.

The selected patient records will then be examined by a team consisting of an anaesthetist and a surgeon for the presence of perioperative airway difficulties. These will be defined as follows:

1. Difficult tracheal intubation
2. Intraoperative surgical difficulties, including problems mobilising the gland, excessive bleeding and difficulties in protecting the recurrent laryngeal nerves.
3. Operative estimation of tracheal damage from the enlarged gland.
4. Postoperative airway problems including the following:
 - 4.1. Laryngeal nerve injury with, or without airway compromise.
 - 4.2. Postoperative bleeding into the neck leading to airway compromise.

4.2.1. Should this be detected, details of the management and outcome of this complication will be noted.

4.3. Tracheomalacia requiring airway support.

4.4. Any other airway compromise.

From the resultant dataset, the incidence of airway compromise from any cause will be determined and an attempt made to identify possible predictive markers that could identify such risks in advance.

Data to be collected:

1. Patient demographics

1.1. Age

1.2. Sex

1.3. Weight

1.4. Comorbidities

1.5. ASA

1.6. BMI

2. Symptomatology

2.1. Stridor

2.2. Dysphagia

2.3. Positional dyspnoea

2.4. Voice changes

- 2.5. SVC syndrome
- 3. Assessment of goitre
 - 3.1. Size
 - 3.2. Retrosternal extent
 - 3.3. Asymmetry (either lobe > 2x size of other lobe)
- 4. Preoperative assessment
 - 4.1. Airway risk assessment
 - 4.2. Radiology
 - 4.2.1. CT findings
 - 4.2.2. Chest x-ray
- 5. Anaesthetic data
 - 5.1. Method of induction
 - 5.2. Difficult mask ventilation
 - 5.3. Tracheal intubation
 - 5.3.1. Awake or asleep
 - 5.3.2. Additional aids required?
 - 5.3.2.1. Bougie
 - 5.3.2.2. Additional airway visualisation aids
 - 5.4. Cormack and Lehane classification
 - 5.5. Difficult or failed intubation
 - 5.6. Difficulty with ventilation after intubation

5.7. Difficulties after tracheal extubation.

6. Surgical data

6.1. Procedure performed

6.2. Need for sternotomy

6.3. Intraoperative blood loss

6.4. Need for blood transfusion

6.5. Identification of recurrent laryngeal nerve

6.6. Identification of clinically significant tracheomalacia

7. Postoperative data

7.1. Need for re-intubation with reasons

7.2. Postoperative bleeding requiring reoperation

7.2.1. Airway compromise by haematoma

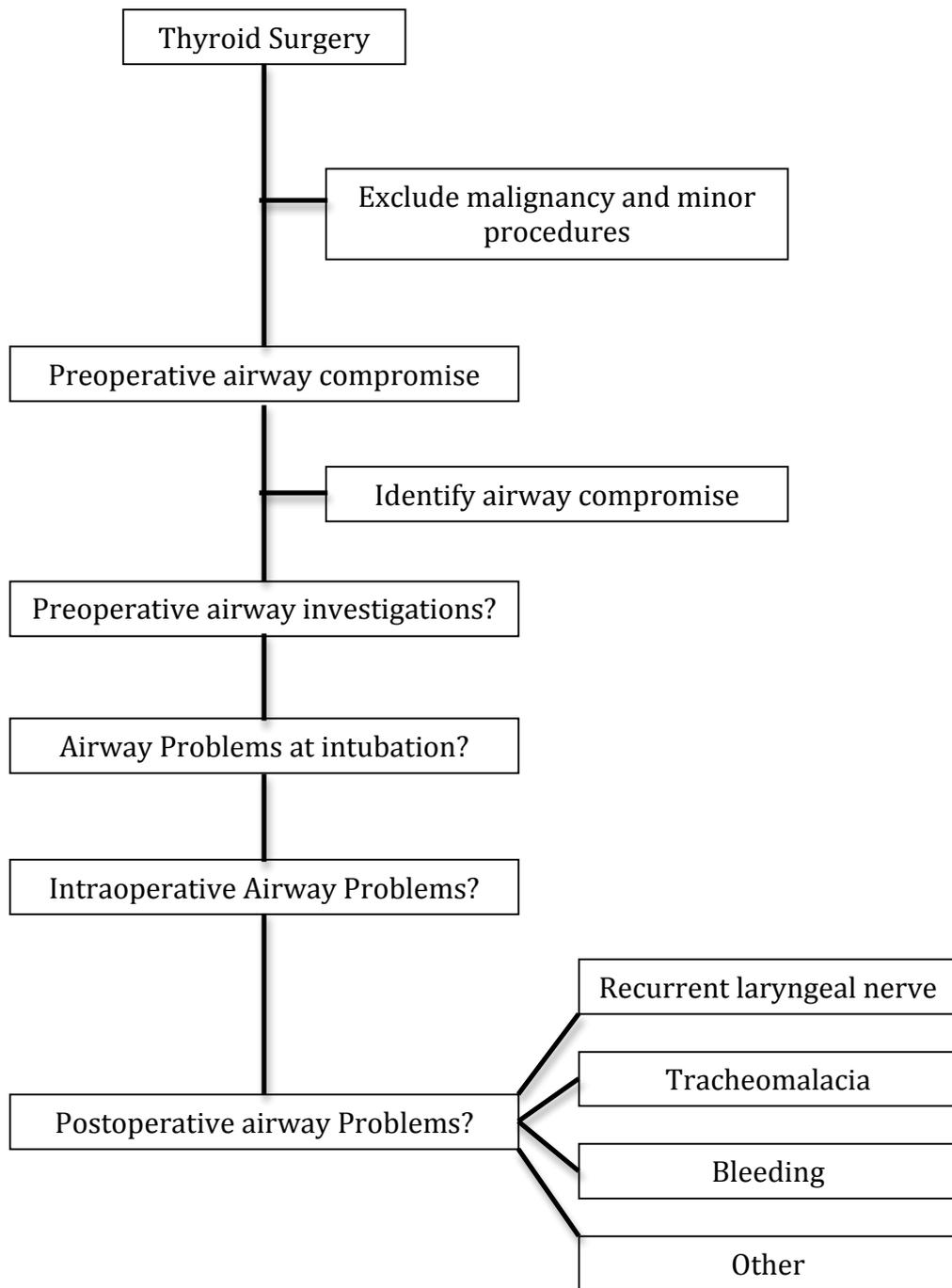
7.3. Need for critical care/high care admission

7.3.1. Planned versus unplanned

7.4. Length of hospital stay

7.5. Identification of prolonged recurrent laryngeal nerve palsy

Flow Diagram for data capture



1. Aims and objectives

To assess the impact of large goitres on perioperative and postoperative management.

Our secondary objectives are to identify possible predictive markers or patient characteristics associated with difficult intubation.

2. Background to study

It is widely assumed in the literature that large thyroid goitres pose a significant risk to the airway perioperatively. Our current practice is to anticipate difficulty in the perioperative management of large thyroids, thyroids with compressive features on history/examination/or CT, or retrosternal thyroids. The concern for the anaesthetist relates to difficulty with bag mask ventilation, tracheal intubation, ventilation and post thyroidectomy tracheomalacia. Surgical related concerns include increased risk of haemorrhage, haematoma formation, and laryngeal nerve injury.

It is taught that these patients are at high risk for difficult or failed intubations and, often, awake fiberoptic intubations are considered. Experience has indicated that this is not always the case. In this study we assess the likelihood of difficult intubation using standard laryngotracheal intubation, difficulty with ventilation, and the incidence of complications postoperatively. We also hope to determine if there are any markers that we can use to identify these patients in the future.

3. Scientific design

The study will be a retrospective folder study of all patients undergoing thyroidectomy or lobectomy at Groote Schuur Hospital (GSH) in Cape Town between January 2010 and June 2016.

The data will be collected from the surgical notes, anaesthetic chart, operating note, histology and radiography.

3.1. Subject selection

The study will include all patients with goitres undergoing thyroidectomy or lobectomy.

The inclusion criteria are as follows:

- 1) Thyroidectomy or lobectomy
- 2) Non-malignant thyroid
- 3) Size of thyroid 50mm or greater in one dimension

The exclusion criteria are as follows:

- 1) Malignant goitre
- 2) Thyroid specimen less than 50mm in one dimension

3.2. Measurement and statistical analysis

All data were entered into an EXCEL spreadsheet and the occurrence of various factors associated with airway difficulty counted using pivot tables. The significance of differences in frequency with which factors associated with difficult intubation occurred in those with and without difficult intubation was to be tested using Fisher's Exact test, using STATISTICA Version 13 (Dell Inc, Tulsa, OK, USA). It is important to note that the anticipated incidence of observed events would be too low for meaningful multivariate regression analysis, and this proved to be the case.

3.3. Additional data collection

The following data will also be collected from each study subject:

1. Age, gender, weight and BMI
2. Comorbidities
3. Presenting complaints relating to thyroid mass
4. Anaesthetic ASA grade, airway assessment risk
5. Type of induction, awake/asleep, difficulty with BMV, intubation or ventilation.
6. Type of surgery performed, intraoperative blood loss, visualisation of recurrent laryngeal nerve
7. Postoperative complications: wound haematoma, tracheomalacia, recurrent laryngeal nerve injury
8. Need for planned or unplanned high care or ICU admission
9. Length of stay

4. Confidentiality

Identification of folders will be by means of numbers which will correspond to each patient.

5. Conflicts of interest

There are no conflicts of interest to declare.

PART B: STRUCTURED LITERATURE REVIEW

REVIEW AND CRITICAL APPRAISAL OF THE LITERATURE:

1. Objectives of the literature review

The main objectives of this literature review are to critically review both older and current published literature about patients presenting for thyroid surgery and the incidence of adverse events related to airway management and perioperative complications as a result of a large goitre.

2. Literature search strategy

A PubMed literature search was performed using Endnote. The free text and MeSH thesaurus terms used included ‘thyroid’ or ‘goitre’ with ‘airway management’ and ‘difficult intubation’. Literature published up to 2016 was included. 219 journal articles were found, of which 43 were relevant to this study.

3. Review and critical appraisal of the literature

The thyroid gland lies anterior to the trachea in the neck. It is made up of a right and left lobe, which are connected by a narrow band of thyroid tissue. A goitre is a benign, enlarged thyroid gland – either one or both of the lobes can be enlarged. It can be asymptomatic or can cause compression of surrounding structures such as the trachea and/or oesophagus. Surgery is recommended for goitres with compressive symptoms (dyspnoea, orthopnoea, dysphagia), as studies have demonstrated improved swallowing and breathing after thyroidectomy. Close collaboration between an experienced surgical and anaesthesia team is essential as complications such as airway distress, bleeding, recurrent laryngeal nerve injury may arise (Chen, 2014).

The prevalence of goitres causing airway obstruction is not new. As early as 1821, Hedenus reported successful thyroidectomies in six patients for goitres, which he described as “suffocating” (Kolawole and Rahman, 2006). Large thyroids still remain an uncommon cause of upper airway obstruction, especially in developing countries where goitres are often neglected due to ignorance and a lack of ready access to affordable medical services (Kolawole and Rahman, 2006). Their slow, but steady growth, leads to compression of the oesophagus, trachea, vascular and neural structures, thus producing symptoms such as dysphagia, dyspnoea, stridor, dysphonia and superior vena cava syndrome. The severity of symptoms depends on the degree of compression, with some patients being asymptomatic (MFM James, 2010).

Indications for thyroidectomy:

- Suspected or proven thyroid malignancy

- Obstructive symptoms
- Retrosternal goitre
- Hyperthyroidism unresponsive to medical management
- Cosmetic reasons

Anaesthetic techniques for thyroidectomy:

1. Regional:

- Anaesthesia achieved using superficial and deep cervical plexus blocks, with or without sedation.
- Not routine and not recommended anymore due to risk of inadequate anaesthesia or wearing off of the effect of local anaesthetics (Bajwa and Sehgal, 2013).
- There is no difference in respect to length of stay, discharge time or complication rate between general anaesthesia and local anaesthesia, however pain appears earlier and is more severe in the patients receiving local anaesthesia (Belitova, 2012)

2. General anesthesia:

- Advantages of: patient comfort, amnesia, immobility and control of the airway.

Anatomic concerns:

The thyroid gland is situated at the base of the anterior neck, in close proximity to major vascular structures, including the internal jugular veins and the carotid arteries.

The thyroid gland wraps around the trachea in a nearly circumferential fashion. Large thyroid masses sometimes compress the tracheal lumen or distort the subglottic or supraglottic airway.

Complications of thyroid surgery that have been described include:

- Difficult tracheal intubation due to tracheal deviation, compression or retrosternal extension.
- Problems managing airway patency during the surgical procedure
- Postoperative airway problems due to haemorrhage
- Laryngeal nerve injury
- Tracheomalacia

Airway Management

Airway management is an essential part of anaesthesia and failed intubation is associated with serious complications. This makes preoperative detection of patients at risk for difficult intubation essential. Thyroid surgery is usually considered a risk factor for difficult intubation: “Patients with large goitres are considered to be more likely to present difficulty at intubation, particularly if the goitre has produced tracheal deviation or has retrosternal extension” (Wakeling, Ody, Ball BJA 1998).

Total occlusion of the airway leading to cardiopulmonary arrest has been shown to be a fatal complication in patients with tracheal compression caused by mediastinal

tumours (Wang, 2009). The airway occlusion can occur during induction of anaesthesia, surgical resection, extubation or by a change of posture (Wang, 2009). Many authors have highlighted the dangers of inducing general anaesthesia in patients with airway obstruction, without prior securement of a reliable airway access. When muscle tone decreases and voluntary control of the airway is lost following loss of consciousness, unexpected and often total airway obstruction may occur. (Kolawole and Rahman, 2006). However, the role of an enlarged thyroid in complicating airway management remains controversial. Traditional anaesthetic teaching warns of difficult airway management in patients with enlarged thyroids: goitres may distort the laryngeal inlet, produce deviation of the trachea, and erode tracheal rings. The loss of tissue tone caused by the anaesthetic agents and muscle relaxants may lead to obstruction of the airway and the inability to ventilate with a facemask. However, the widely held perception that there is an increased potential for difficult laryngeal visualization is based more on assumption than on fact (MFM James, 2010). More recent studies have shown low incidence of difficult intubation in patients with goitre. Bouaggad et al (Bouaggad A, 2004) studied 320 patients scheduled for thyroidectomy in an analysis of potential factors helpful for predicting difficult endotracheal intubation. Endotracheal intubation was found to be easy in 36.9% of patients and the investigators encountered only minor difficulties in 57.8% of the study group. The incidence of difficult intubation in the presence of large goitre has consistently shown to be low: 5.3% (O., 2004 Aug), 6% (Farling, 2000), 5.3% (Frick, 2012) suggesting that the presence of a large goitre is not itself predictive of a difficult endotracheal intubation.

The feared difficult airway scenarios seem to be encountered more in malignant thyroid glands due to tracheal invasion and tissue infiltration causing fibrosis as well as the tethering of soft tissue structures making laryngoscopy extremely difficult (Bajwa and Sehgal, 2013) (Bacuzzi et al., 2008). In fact, two criteria which have consistently been recognized as independent risk factors for difficult endotracheal intubation are Cormack and Lehane Grade III or IV and malignant goitre (Bacuzzi et al., 2008) (O., 2004 Aug). There are few reports of serious airway management problems at the time of intubation with benign thyroid enlargement, with the conclusion that a large goitre is not associated with a more frequent difficult endotracheal intubation (O., 2004 Aug).

In many circumstances, where the anaesthetic team considers that tracheal intubation may prove difficult, awake fibreoptic intubation is regarded as the technique of choice. A compromised airway and a large anterior neck mass precluding tracheostomy under local anaesthesia provides few safe strategies for airway management for general anaesthesia other than awake fibreoptic intubation (Dabbagh, 2008). However, the value of fibreoptic intubation in large goitres has been questioned in a recent publication by Loftus, et al (Loftus et al., 2014) where the charts of 112 patients undergoing thyroidectomy for goitre were reviewed, looking at the method of intubation and success or failure of intubation attempts. Interestingly, difficulty with intubation was more common with fibreoptic approaches than with direct laryngoscopy and oral intubation. The planned fibreoptic intubation was aborted six times and converted to laryngotracheal oral intubation (LTOI), whereas LTOI was successful in every case (Loftus et al., 2014). Liou reports the case of a patient for thyroid surgery for malignancy with preoperative stridor. Due to airway

concerns, extracorporeal circulation membrane oxygenation was set up prior to induction under local anaesthesia. Two attempts to intubate the trachea with fiberoptic bronchoscopy failed before success was achieved with traditional laryngoscopy and a glidescope (liou, 2014). One of the patients in our study, with an extremely large, compressive thyroid mass, was put on cardiopulmonary bypass following the failure of a fiberoptic intubation. Initiation of femoral-femoral cardiopulmonary bypass, under local anaesthesia, ensured adequate oxygenation and allowed for intubation with a rigid bronchoscope. Cardiopulmonary bypass has been suggested as a safe solution for airway control when intubation or a surgical airway is either unsuccessful or too hazardous (Belmont, 1998).

Large, compressive goitres are usually removed as an elective procedure, but what of the patient requiring emergency surgery? Fairweather wrote up a case of a young woman with a pre-existing goitre who presented for non-thyroid surgery. She developed acute thyroid swelling following intubation. The cause of the swelling was believed to be intrathyroid bleeding from cricoid pressure, which distorted the airway and necessitated an emergency thyroidectomy. Intubation in this patient was not difficult (Fairweather, 2003)

Studies have attempted to identify specific predictive criteria that could be used preoperatively to identify patients likely to have difficult laryngoscopy. In a study by Amathieu et al (Amathieu, 2006), the incidence of difficult intubation in 324 patients undergoing thyroid surgery was found to be 11.1%. Specific predictive criteria, such as palpable goitre, retrosternal goitre, airway deviation, airway compression and thyroid malignancy, were not associated with an increased rate of difficult intubation.

Kalezic et al, however, looked at the incidence of difficult intubation in 2000 patients scheduled for thyroid surgery and found that true difficult intubation, which they defined as “impossible visualisation of the glottis with direct laryngoscopy (grade III and IV)”, occurred in 110/2000 patients (5.5%), the majority of whom had multinodular goitre. The incidence of difficult intubation was also higher amongst men (8.8%) than women (4.9%) (Kalezic, 2009).

Voyagis looked at various risk factors for difficult intubation. In contrast to the other studies, he found that, of the risk factors evaluated, large goitre was found to contribute occasionally to a difficult airway, with a positive predictive value of 61.5% (Voyagis et al., 1995). In 1997, statistical analysis of a study in which Voyagis was again involved, revealed an increased risk of difficult intubation amongst patients who had a goitre compared with patients with no risk factors at all. Difficulty in intubation in the goitre group occurred only in patients with radiologic evidence of tracheal deviation (22 patients). However, tracheal deviation occurred in 56 patients making it a positive predictor, but not an invariable association. Of note, no patient presented a “can’t intubate, can’t ventilate” scenario, suggesting that facemask ventilation, in general, is not a problem. (Voyagis, 1997)

Imaging:

As the thyroid gland enlarges, it generally displaces the trachea posteriorly and pushes the larynx in a cephalad direction, making the laryngeal inlet easier to view despite lateral displacement. Tracheal intubation should always be performed with an

armoured endotracheal tube; the size based on the preoperative chest x-ray views. However, the gland compressing the trachea is soft and a trachea that appears narrow on X-ray may dilate easily and be able to accommodate a fairly large endotracheal tube. (MFM James, 2010).

Bourdeaux discussed a case study where an asymptomatic male patient with marked tracheal deviation on CXR developed “bronchospasm” during an elective thyroid lobectomy. Bronchoscopy revealed that the opening of the tracheal tube was completely abutting the deviated tracheal wall. When the tracheal tube was advanced beyond the deviation, the distal opening was no longer obstructed and there was immediate resolution of the problem (Bourdeaux and Benton, 2003).

In a reported case of a 55 year old male with retrosternal goitre and worsening stridor (Rodrigues et al., 2013), the CT scan proved to be the most useful tool showing the nature and extent of the lesion. In a recent publication, the CT scan was considered the gold-standard preoperative radiological investigation (Rodrigues et al., 2013).

The use of prone CT changed the perioperative management of airway obstruction in a 65-year-old female with critical airway obstruction (severe stridor and dyspnoea) caused by multinodular goitre. The initial plan had been to perform the thyroidectomy in cardiac theatre with large femoral lines in place and cardiopulmonary bypass immediately available. However, the less marked tracheal deviation reassuringly shown on the prone CT, meant surgery was undertaken in the main theatre suite with standard IV induction. Surgery proceeded uneventfully, suggesting that even tracheal deviation/attenuation does not necessarily equate to a difficult airway (Hunt and

English, 2013). This low incidence of airway morbidity is supported by Findlay and colleagues' observation that, in 62 patients with significant tracheal compression secondary to goitre, 85% had uncomplicated IV induction and intubation.

Multi-slice CT data were used for a patient undergoing a thyroidectomy in Japan. Three-dimensional figures of the trachea were obtained from multi-slice CT to evaluate the stenotic region as well as a virtual bronchoscopic movie to simulate fibreoptic tracheal intubation. Based on these findings, they were able to assess that the tracheal stenosis could be extended easily and the patient was subsequently induced with propofol and a tracheal tube successfully passed through the stenotic region under the guide of a fibreoptic scope as simulated in the virtual movie (Toyota, 2004).

Retrosternal extension:

Retrosternal goitre is any goitre that descends below the plane of the thoracic inlet or extends more than 2cm into the anterior mediastinum. Retrosternal extension of the gland frequently creates concern and raises the possibility of an anterior mediastinal compression syndrome. This is deemed important as it can cause SVC obstruction resulting in (McCulloch, 1995):

- Airway oedema
- Dependence on spontaneous respiration for venous return
- Haemodynamic instability
- Pemberton's sign

However, the thyroid gland always enlarges into the superior mediastinum rather than the anterior mediastinum, therefore it should not produce the problematic situation of airway obstruction below the level of the carina or right atrial inflow obstruction (MFM James, 2010).

Three studies looking at the incidence of difficult airway management in patients with retrosternal goitre showed scant evidence of difficult intubation or postoperative tracheomalacia. Dempsey found a low incidence of difficult tracheal intubation, difficult mechanical ventilation and postoperative respiratory difficulties in patients with massive retrosternal goitre and mid-tracheal compression from benign multinodular goitre (Dempsey et al., 2013).

Bennett et al reported only 6 difficult intubations out of 18 anaesthetics for removal of retrosternal goitre (Bennett AM, 2004). Gilfillan looked at the anaesthetic induction technique and airway management of 4572 thyroid surgery patients, of which 919 had retrosternal goitre. They showed only two cases of early postoperative tracheomalacia (one in the retrosternal group) and no patient required tracheostomy or cardiopulmonary bypass. 87.5% of the patients suspected preoperatively as having a difficult airway had clearly visible laryngeal inlets with direct laryngoscopy. They concluded that there was “no good evidence that thyroid surgery in patients with retrosternal goitre present the experienced anaesthetist with an airway that cannot be managed using conventional techniques” (Gilfillan et al., 2014).

PERIOPERATIVE COMPLICATIONS OF THYROID SURGERY:

Laryngeal nerve injury

Laryngeal nerve injury is a major complication of thyroid surgery appearing early or late in the postoperative period. Damage can be caused by traction, transaction, entrapment or ischemia. Narrowing of the glottic opening as a result of recurrent laryngeal nerve (RLN) injury may cause airway obstruction. A unilateral RLN palsy would not produce significant respiratory compromise if the contralateral nerve and vocal cord function normally. However, bilateral nerve injury can produce complete closure of the glottis and respiratory obstruction (Longnecker, 2012). Complete bilateral nerve transection usually results in the vocal cords adopting the 'cadaveric' position leading to a hoarse voice and failure of airway protection.

Estimates of the overall incidence of unilateral temporary RLN palsy after major thyroid surgery range from 1.2% - 1.4%, to 5.1% - 8.7%. Estimates of the incidence of permanent nerve palsies range from 0.4% - 0.6%, to 0.9% - 1.4%. Factors associated with an increased likelihood of RLN injury include:

- Surgery for thyroid cancer or Graves disease
- Re-operation
- Extensive neck and lymph node dissections

(Longnecker, 2012).

Haemorrhage

The thyroid bed is extremely vascular and inadequate haemostasis may result in the formation of haematomas. Post-thyroidectomy haematoma is a rare, but life threatening complication of thyroid surgery leading to life-threatening airway obstruction. In a case report of a patient with a huge goitre undergoing a total thyroidectomy, the development of a post-thyroidectomy haematoma results rapidly in near fatal airway obstruction, pulmonary oedema and cardiac arrest. The haematoma was evacuated immediately and patient was resuscitated successfully. (Parate et al., 2014)

Tracheomalacia

Acute collapse of the trachea following thyroid surgery is a rare, but potentially serious complication. It may not be apparent until the patient becomes distressed after tracheal extubation. Pressure atrophy and erosion of the cartilaginous tracheal rings is caused by a large sized goitre compressing the trachea for a long duration. Once the thyroid is removed, the tracheal wall loses that surrounding support and can collapse leading to respiratory obstruction (Bajwa and Sehgal, 2013) characterized by wheezing and difficult breathing. Hence, historically, it has been feared as a complication of thyroidectomy. Multiple preoperative risk factors include goitre for more than 5 years, preoperative recurrent laryngeal nerve palsy, retrosternal extension, and significant tracheal narrowing/deviation (Mayilvaganan, 2014). One

case study describes the management of a patient with tracheomalacia and supraglottic obstruction following a total thyroidectomy. The patient had symptomatic tracheal compression preoperatively, and, following the thyroidectomy, the ETT was replaced with an LMA. Spontaneous breathing was observed bronchoscopically through the LMA and collapse on respiration was documented. Patient was re-intubated (Lee et al., 2011).

Tracheomalacia is regarded as a rare complication in Western medicine, however, in Africa several studies state that thyroidectomy for a large goitre carries a relatively high risk of postoperative respiratory obstruction which may necessitate tracheostomy. A study by Rahim, Ahmed and Hassan concludes that multiple preoperative risk factors, namely goitre for >5yrs, preoperative recurrent laryngeal nerve palsy, significant tracheal narrowing/deviation, retrosternal extension, difficult endotracheal intubation and thyroid cancer, may help predict the need for planned tracheostomy following thyroidectomy. The study states that a planned tracheostomy at the end of the thyroidectomy should be considered if four or more of the predictive factors are present.

PART C: MANUSCRIPT

TITLE PAGE

**An assessment of the impact of large goitres on perioperative and postoperative
airway management – a retrospective review.**

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STRUCTURED ABSTRACT:

It is widely assumed in the literature that large thyroid goitres pose a significant risk to the airway perioperatively. The anticipated difficulty relating to intubation, ventilation and post-thyroidectomy tracheomalacia makes them of great concern to anaesthetists. The anticipated risk of difficult dissection and increased risk of surgical complications including haemorrhage, recurrent laryngeal nerve injury and tracheomalacia makes them a concern to surgeons.

Objectives:

To analyse the folders of patients who have undergone anaesthesia and surgery for large, non-malignant goitre, in order to assess the impact of large goiters on perioperative and postoperative management. An attempt will also be made to identify possible predictive markers/ patient characteristics associated with difficult intubation.

Design:

A retrospective folder review

Setting:

Groote Schuur Hospital

Participants:

All patients who had thyroidectomies performed at Groote Schuur Hospital between Jan 2010 and June 2016 for large, non-malignant goitres.

Measurements and main results:

Of the patients who underwent a thyroidectomy procedure at Groote Schuur Hospital between Jan 2010 and June 2016, 206 were identified as having non-malignant goitre and size in one dimension of greater than fifty millimeters. On investigation of these 206 folders, 10 were excluded from the study due to incomplete data. There were seven documented difficult intubations and only one case of failed intubation. This case was subsequently put onto cardiopulmonary bypass and intubated successfully using a rigid fibreoptic bronchoscope.

Of the 196 cases with complete data, four were intubated using a fibreoptic bronchoscope, eight with a videolaryngoscope, and six cases with a bougie. All other patients underwent uneventful tracheal intubation via direct laryngoscopy. All thyroid glands were removed via a collar incision with no requirement to proceed to sternotomy. There was only one patient requiring blood intraoperatively and only four reported cases of postoperative haematomas. There were no instances of tracheomalacia. Two patients suffered long term recurrent laryngeal nerve injury with voice changes.

Conclusion:

The data shows that, in patients with large, benign goitre undergoing thyroidectomy, airway difficulties at intubation and surgical and anaesthetic complications post-

extubation are rare. Intravenous induction and direct laryngoscopy is a safe technique in appropriately experienced hands.

MAIN TEXT

INTRODUCTION:

Thyroid surgery was first described in Italy in the 12th century. The French Surgeon, Pierre Joseph Desault, performed the first successful partial thyroidectomy in 1791 during the French Revolution. The first total thyroidectomy followed in 1808 (Dupuytren), but the patient died 36 hours after the operation. In 1821, Hedenus, a German surgeon, reported the successful removal of six large goitres, a feat not equaled for forty years (Fleming, 2010).

The surgical approach to goitre remained shrouded in misunderstanding and superstition, despite these limited descriptions of early successes. Infection and haemorrhage meant that thyroid surgery in the 19th century carried a mortality of around 40% even in the most skilled surgical hands. German authorities called for restrictions on such ‘foolhardy performances’ and The French Academy of Medicine actually banned thyroid surgery in 1850. Leading surgeons avoided thyroid surgery if at all possible, and would only intervene in cases of respiratory obstruction. Samuel Gross wrote in 1848:

“Can the thyroid in the state of enlargement be removed? Emphatically experience answers no...every stroke of the knife will be followed by a torrent of blood and lucky...if his victims lived long enough for him to finish his horrid butchery. No honest and sensible surgeon would ever engage it”(Fleming, 2010).

It is widely assumed in the literature that large thyroid goitres pose a significant risk

to the airway at the time of induction of anaesthesia, during surgery, and in the postoperative period (Amathieu, 2006), (Dempsey et al., 2013). The concerns lie in the maintenance of airway patency during the surgical procedure, and potential postoperative airway problems due to haemorrhage, laryngeal nerve injury and tracheomalacia (Bajwa and Sehgal, 2013). However, the incidence, severity and predictive signs of these events have not been well documented particularly in a developing country where patients may present very late in an advanced disease state.

The purpose of this study is to analyse available documentation on patients who have undergone surgery for goitre in whom there were preoperative signs and symptoms of airway compromise. From this I hope to show:

- The current position on thyroid intubation.
- The incidence of perioperative airway management difficulties.
- Presence of any patient characteristics associated with difficult intubation.

Intentional exclusions:

- Patients with thyroid malignancies.
- Goitres less than 5cm in size.

METHOD:

This is a retrospective folder review of all patients who have undergone thyroid surgery at Groote Schuur Hospital in Cape Town between Jan 2010 and June 2016. From these records, those patients with thyroid malignancies were excluded. The patient records were scrutinised for evidence of preoperative airway compromise

including airway-related symptoms and distortion of the airway on radiological examination. The selected patient records were examined by a team consisting of an anaesthetist and a surgeon for the presence of perioperative airway difficulties. These were defined as follows:

1. Difficult tracheal intubation
2. Intraoperative surgical difficulties including problems mobilising the gland, excessive bleeding and difficulties in protecting the recurrent laryngeal nerves.
3. Postoperative airway problems including the following:
 - a. Laryngeal nerve injury with, or without, airway compromise
 - b. Postoperative bleeding into the neck leading to airway compromise
 - i. Should this be detected, details of the management and outcome of this complication will be noted.
 - c. Tracheomalacia requiring airway support
 - d. Any other airway compromise

From the resultant dataset, the incidence of any form of airway compromise was determined and an attempt was made to identify possible predictive markers that could identify such patients in advance.

Formal ethical approval was acquired from the Research Ethics Committee prior to initiation of our study, HREC ref number 513/2013.

All included patients had non-malignant goitres with size equal to or greater than 50mm in one dimension. Cases were identified using the Groote Schuur Hospital

surgical database, then cross-referenced with the NHLS histology records. Of the patients identified for thyroidectomies at Groote Schuur from Jan 2010 to June 2016, 206 were identified as having non-malignant thyroid goitres greater than 50mm in size. 10 folders were excluded due to incomplete data, leaving 196 folders included in the study.

The data that was collected included:

1. Patient demographics: age, sex, weight, comorbidities, ASA, BMI
2. Symptomatology: Stridor, dysphagia, positional dyspnoea, voice changes, SVC syndrome
3. Assessment of goitre: size, retrosternal extent, asymmetry (either lobe more than twice the size of other lobe)
4. Preoperative assessment: airway risk assessment, radiology (CT findings, chest x-ray)
5. Anaesthetic data included:
 - 5.1 Method of induction
 - 5.2 Difficult mask ventilation
 - 5.3 Tracheal intubation: awake or asleep, additional aids required (bougie, videolaryngoscope)?
 - 5.4 Cormack and Lehane classification
 - 5.5 Difficult or failed intubation
 - 5.6 Difficulty with ventilation after intubation
 - 5.7 Difficulties after tracheal extubation
6. Surgical data:
 - 6.1 Procedure performed

- 6.2 Need for sternotomy
- 6.3 Intraoperative blood loss
- 6.4 Need for blood transfusion
- 6.5 Identification of recurrent laryngeal nerve
- 6.6 Identification of clinically significant tracheomalacia
- 7. Postoperative data
 - 7.1 Need for re-intubation with reasons
 - 7.2 Postoperative bleeding requiring reoperation
 - 7.3 Need for critical care/high care admission (planned or unplanned)
 - 7.4 Length of hospital stay
 - 7.5 Identification of prolonged recurrent laryngeal nerve palsy.

DEFINITIONS:

Large goitre:

- Histologically fifty millimeters or more in one dimension

Suspected difficult airway:

- Compressive symptoms such as stridor, dysphagia, positional dyspnoea
- Obstructive sleep apnoea
- Mallampati score 3 or 4
- Tracheal deviation/compression on CXR/CT
- Retrosternal extent

Difficult airway:

- The clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty in supraglottic device ventilation, difficulty with tracheal intubation, or all three (Force, 2013).

Difficult laryngoscopy

- Defined by Cormack and Lehane criteria: inadequate exposure of the glottis by direct laryngoscopy/ inability to visualize the vocal cords after multiple attempts at direct laryngoscopy (grade III or IV) (Force, 2013).

Difficult tracheal intubation:

- When proper insertion of the tracheal tube with conventional laryngoscopy requires more than three attempts or more than 10 minutes (Force, 2013).
- The use of a supplementary technique was also taken into consideration for a difficult airway (bougie, videolaryngoscope).

Failed intubation:

- Placement of the endotracheal tube fails after multiple attempts (Force, 2013)

Deviation of the upper part of the trachea on CXR:

- Deviation from the median line more than 1cm when the clavicles are symmetric and the head is in the neutral position.

RESULTS:

Mortality: no deaths were reported in this series.

Demographics: 196 folders were included in the study (Table 1). Fifty-seven (29%) patients underwent total thyroidectomies and one hundred and twenty-six (64%) underwent lobectomies. Eight patients (4%) had isthmectomies. Twenty-five patients were male and one hundred and sixty-five patients were female.

TABLE 1. Patient demographics and gland characteristics.

CATEGORY	NUMBER	% OF TOTAL
All patients	196	
Total thyroidectomy	60	31
Lobectomy	128	65
Isthmectomy	8	4
Sex female	170	87
Sex male	26	13

Size: Size of the lobe/thyroid gland may be associated with airway complications. The average largest dimension of the thyroid gland in patients with airway complications was 101mm and 79 mm in patients without airway complications

Difficult intubation: Overall, difficult intubation was noted with seven patients (3.6%) and only one patient had a failed awake fiberoptic intubation, but was later intubated on cardiopulmonary bypass with a rigid bronchoscope.

Comorbidities included:

Hypertension = 81

Diabetes Mellitus= 30

Graves disease= 5

COPD or asthma= 13

HIV= 11

Five of the seven patients with difficult intubations had hypertension (71%), one had diabetes mellitus (43%), one had HIV (14%) and two had asthma/COPD (29%).

Age association:

The age of the patients in the study ranged from 22 to 85 years.

Difficult/failed intubation: mean age 50.1 (SD 12.2).

No difficulty with intubation: mean age 50.0 (SD 13.0)

Not statistically significant

Presenting symptoms: Seventy-three patients presenting for surgery were asymptomatic, one hundred and twenty-three were symptomatic. Of the presenting complaints, stridor appears to be a good, significant predictor with 2/14 patients with stridor being ranked as difficult (14%) and 1/14 as failed (7%) intubations, compared to 5/144 without stridor (3%) ($p=0.024$, two-tailed Fisher's exact test).

TABLE 2: Presenting complaints of the seven patients with difficult intubations.

Patient number	33	40	71	156	191	193	202
Stridor	no	no	yes	no	no	yes	no
Dysphagia	yes	no	no	yes	no	no	no
Positional dyspnoea	yes	no	no	yes	no	no	no
Voice changes	no	no	no	yes	no	no	no
Superior Vena Cava syndrome	no	no	no	no	no	no	no

In one patient, awake fiberoptic intubation proved to be impossible and cardiopulmonary bypass was instituted prior to induction of anaesthesia. Following induction of general anaesthesia, rigid bronchoscopy was possible and the endotracheal tube was successfully inserted prior to surgery.

TABLE 3: Division of presenting symptoms between the difficult and non-difficult intubation groups.

PRESENTING SYMPTOM	TOTAL	DIFFICULT INTUBATION	NON-DIFFICULT INTUBATION	FAILED INTUBATION
Stridor	14	2	11	1
Dysphagia	70	2	68	
Positional dyspnoea	63	2	60	1
Voice changes	53	1	51	1
Superior Vena Cava syndrome	1	0	1	

Preoperative airway assessment: thirty-three patients were identified as high-risk preoperatively based on their presenting complaint, goitre size and radiological findings. Of these thirty-three patients, five were difficult to bag mask ventilate, four had difficult laryngoscopy (Cormack & Lehane grade 3 or 4), and five were difficult tracheal intubations. Reassuringly, only two patients identified as low risk actually were difficult to intubate.

TABLE 4: Incidence of difficult bag mask ventilation (BMV) or difficult intubation in patients assessed as high risk/ low risk preoperatively.

PRE-OP RISK ASSESSMENT	TOTAL	DIFFICULT BMV	C&L GR 3 OR 4	DIFFICULT INTUBATION
High risk	33	5	4	5
Low risk	148	0	3	2

Pre-operative assessment significantly predicted difficult intubation (p=0.0024, Fisher's exact test).

TABLE 5: Cormack and Lehane grading at laryngoscopy.

GRADE AT LARYNGOSCOPY	NUMBER
I	129
II	49
III	7
IV	1
With videolaryngoscope	2
Not charted	8

Radiological changes: A chest X-ray, despite a lack of evidence-based support, is often used prior to thyroid surgery to identify tracheal deviation and predict a possible difficult intubation (Hong, 2012). Our data does reflect a correlation between tracheal deviation on preoperative CXR/CT and difficult intubation in thyroid patients where

difficult intubation was encountered significantly more often in patients with radiological signs of tracheal deviation and/or compression.

TABLE 6: Patients with evidence of tracheal deviation or stenosis on CT or CXR.

TRACHEAL CHANGES ON CT	NUMBER	DIFFICULT BMV	DIFFICULT/ FAILED INTUBATION
DEVIATION	66	5	8
STENOSIS	57	5	8

Difficult intubation was encountered significantly more often in patients with radiological signs of tracheal deviation or stenosis ($p=0.0002$, Fisher's exact test).

Anaesthetic: Every case was anaesthetised by a registrar supervised by a consultant. Details of induction and intubation were available for all patients. They were grouped as follows:

1. Method of induction: Awake, inhalational, IV
2. Method of intubation: conventional laryngotracheal oral intubation (LTOI), fiberoptic intubation, oral intubation under visualization with a videolaryngoscope.

One hundred and sixty-three patients underwent intravenous induction of anaesthesia, twenty-seven patients had inhalational inductions, and two patients had awake fiberoptic intubations (only one of which was successful). In the one hundred and sixty-three patients who received IV inductions, one hundred and sixty-one patients

had their tracheas intubated uneventfully. Of the patients receiving inhalational induction, four were difficult intubations, the remaining twenty-two not. One inhalational induction was performed for difficult intravenous access. Muscle relaxant was used in all cases. Sugammadex was not available in theatre during the time that these surgeries were performed.

In the LTOI group, there were four difficult intubations out of one hundred and thirty-three patients (3%). The difficulty reported was that more than one attempt at intubation was required. Ultimately the airway was secured via LTOI, with no deviation from the original plan.

Six anaesthetic charts documented the use of a bougie for intubation, however it is not clear if the bougie was used to aid a difficult intubation or to strengthen the reinforced endotracheal tube during its insertion into the trachea.

Two of the eight patients who were intubated using a videolaryngoscope had difficult intubations (25%).

The fiberoptic bronchoscope was used for intubation of four patients, two awake and two asleep. In the asleep group, intubation using the fiberoptic bronchoscope failed in one of the patients, but was successful using a laryngoscope. In the awake group, one patient's trachea was intubated with a rigid bronchoscope on femoral bypass after awake fiberoptic intubation attempts failed.

There were no reported difficulties in instituting mechanical ventilation, further supporting the view of the safety of the airway in these patients.

Retrosternal extension: Retrosternal extension increased the risk of difficult intubation with 3/141 (2.1%) being ranked as difficult if there was no retrosternal extension, and 5/61 (8.2%) if there was retrosternal extension. Despite this, not one patient with retrosternal extension required a sternotomy for removal of the gland.

Surgical procedures: one hundred and twenty-six lobectomies and fifty-seven total thyroidectomies.

All operations were completed via a cervical approach with no need to progress to sternotomy.

Bleeding: Blood loss was poorly charted, but averaged less than 500ml. There was one requirement for blood transfusion intraoperatively after the patient bled approximately 1000ml. This was the same patient who had been put on bypass and subsequently intubated with a rigid bronchoscope. Postoperatively, there were four episodes of bleeding that required re-intubation and evacuation of haematoma. In all four cases, timing of postoperative bleeding was within the first 12 hours after surgery, suggesting that postoperative monitoring for haematomas should continue for at least 12 hours after surgery.

Acute postoperative hypocalcaemia: four patients were reported as having hypocalcaemia in the ward following their thyroidectomies. One presented with acute airway obstruction two days post surgery secondary to acute hypocalcaemia.

TABLE 7: Size and preoperative anaesthetic risk assessment in patients with postoperative bleeding.

	PATIENT 1	PATIENT 2	PATIENT 3	PATIENT 4
SIZE	95mm	80mm	110mm	70mm
RISK ASSESSMENT	low	low	low	low
BLOOD LOSS	Not charted	Not charted	Not charted	Not charted

As can be seen by the above table, neither goitre size nor anaesthetic risk assessment was able to predict which patients would bleed postoperatively.

Recurrent laryngeal nerve: No recurrent laryngeal nerve monitoring was used intraoperatively. In eleven cases, the surgical notes document that the recurrent laryngeal nerve was not visualised. All patients with hoarseness persisting at the surgical two-month follow up were referred to ENT clinic. Only two cases were diagnosed as having long-term nerve injury.

High care or ICU admission:

Of the fourteen High Care/ICU admissions, ten were planned and four were unplanned. Reasons for unplanned admission included:

1. Failed extubation likely secondary to residual muscle weakness from muscle relaxant.
2. Prophylactic tracheostomy for failed awake fiberoptic intubation requiring cardiopulmonary bypass and intubation with a rigid bronchoscope.

3. Emergency relook for wound haematoma
4. Upper airway obstruction managed with observation in high care.

EXTUBATION DATA:

An elective tracheostomy was performed in patient 115 who required cardiopulmonary bypass for intubation.

Patient 164 failed extubation twice and was transferred to ICU intubated. The reason was thought to be residual muscle weakness from muscle relaxant administered intraoperatively.

Elective admission to ICU for postoperative ventilation was planned for patient 141 due to retrosternal goitre and tracheal compression preoperatively. Extubation in theatre was not attempted.

Patient 71 was intubated at the day hospital for airway compromise and transferred to GSH where she underwent her surgery. She remained electively intubated postoperatively.

The Bailey manoeuvre is described as a method for extubation patients deep. The method involves placing an LMA before removing the endotracheal tube. The LMA keeps the airway patent while the patient wakes up. This manoeuvre was not performed in any of the patients included in the study.

DISCUSSION:

196 patients who underwent thyroid surgery at Groote Schuur formed part of our study. Of these, only seven patients were identified as being difficult to intubate and only one had a failed intubation. This patient had a body mass index (BMI) of 32, a massive goitre (145x90x100) and compressive symptoms (stridor, positional dyspnoea) necessitating careful thought on the safest anaesthetic strategy. An awake fibreoptic intubation was attempted and failed. The patient was then put on cardiopulmonary bypass and successfully intubated with a rigid bronchoscope.

An attempt was made to identify possible risk factors for perioperative airway difficulty. In our retrospective review of presenting complaints, only stridor was significantly associated with airway difficulty. Retrosternal extent did not increase the likelihood of sternotomy, tracheomalacia or haematoma formation. Hong's study in 2012 aimed to establish the utility of preoperative CXR to assess tracheal deviation. Patients without tracheal deviation on CXR were compared to patients with tracheal deviation. Those with tracheal deviation had larger thyroid glands and a higher rate of tracheal compressive symptoms, however, this did not translate into more difficult intubations or more intubation attempts (Hong, 2012). They raised the question of whether CXR for the sole purpose of identifying tracheal deviation in thyroid surgery candidates is, in fact, warranted? Our study, however, found that difficult intubation was encountered significantly more often in patients with radiological signs of tracheal deviation and/or compression on CXR/CT, indicating that pre-operative CXR or CT to identify tracheal deviation is indicated in thyroid surgery candidates.

Studies have demonstrated that compression of the airway and thyroid size are not associated with difficult intubation. In 2004, Bouaggad and colleagues reviewed a group of 320 patients who underwent thyroidectomies. This study concluded that large goitres were not associated with a higher frequency of difficult intubations (Bouaggad A, 2004). Similar to Bouaggad, a review of the literature by Bennett et al showed no evidence of difficult intubation in patients with large thyroid glands when undergoing surgical procedures (Bennett AM, 2004). Amathieu and colleagues found no correlation between difficult intubation and palpable goitre, retrosternal goitre, airway deformation or airway compression (Amathieu, 2006). Our study agrees with these previous findings and shows that neither thyroid size, tracheal compression, deviation nor retrosternal extent was significantly associated with intubation difficulty.

Our study suggests that the first-line method of intubation when securing the airway in patients with thyroid goitre should, in most cases, be laryngotracheal oral intubation, unless anatomical characteristics prevent traditional laryngotracheal oral intubation.

STRENGTHS AND WEAKNESSES OF STUDY:

STRENGTHS	WEAKNESSES
Large sample size	Different anaesthetists with differing levels of skill anaesthetising each patient
Findings can be generalised as the sample is representative of the study population	Incomplete anaesthetic charts were encountered with missing information such as BMI and blood loss

Data relatively easy to analyse	Large sample size meant that data collection was time consuming
Data is consistent, precise and reliable	
Data collection was cost efficient	

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PART D: SUPPORTING DOCUMENTS

DATA COLLECTION FORM:

Date of surgery Jan 2010 – June 2016
Number allocated to patient 1 - 206
Age
Sex
Weight
Comorbidities: Grave's
Comorbidities: HPT
Comorbidities: DM
Comorbidities: HIV
Comorbidities: asthma
ASA
BMI
Stridor
Dysphagia
Positional dyspnoea
Voice changes
SVC syndrome
Goitre size
Retrosternal extent
Assymetry
Airway risk assessment
CT retrosternal extent
CT: tracheal displacement
CT: airway compression
CXR: tracheal deviation
CXR: tracheal compression
Induction
Difficult mask vent
Awake intubation
Additional airway aids
Cormack & Lehane
Difficult or failed intubation
Difficult ventilation
Difficulty post extubation
Procedure: Total thyroidectomy
Procedure: Lobectomy
Procedure: isthectomy
Sternotomy
Blood loss
Blood transfusion
Recurrent laryngeal nerve seen
Tracheomalacia
Reintubation

Post op bleeding
Airway compromise
High care/ICU planned
High care/ICU unplanned
LOS (days)
Long term nerve injury

ETHICS APPROVAL FORM:

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27 August 2013

HREC REF: 513/20Lg

Dr R Haylett
D23
Anaesthesia
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Dear Dr Haylett

PROJECT TITLE: AN ASSESSMENT OF THE IMPACT OF LARGE GOITRES ON PERIOPERATIVE AND POST-OPERATIVE AIRWAY MANAGEMENT. A RETROSPECTIVE REVIEW

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has formally approved the above-mentioned study. Approval is granted for one year til the 30th August 2014

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/research/humanethics/forms)

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC. REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN ETHICS
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IR800001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice(ICH GCP) and Declaration of Helsinki guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

s.thomas

