Post-thyroidectomy tracheomalacia: minimal risk despite significant tracheal compression

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Background. Tracheomalacia is a feared complication of goitre surgery, but considered rare in the Western World. This study aimed to estimate the risk of tracheomalacia in a contemporary series of patients with goitres causing significant tracheal compression.

Methods. A retrospective review was conducted of thyroidectomies performed in a UK tertiary referral centre over a 30 month period. Anaesthetic, operative, radiological, and pathological data were obtained from medical notes and hospital software systems.

Results. Of 334 patients who underwent thyroid surgery, preoperative CT scan was performed in 101 (30%). Tracheal compression was reported in 62 patients (19%) with minimum tracheal diameter ranging from 2 to 15 mm (mean 7.6 mm) due to multinodular goitre (n=50), malignancy (n=10), or thyroiditis (n=2). Critical compression <5 mm was observed in 18 patients (6%) and 35 patients had compression to 6–10 mm. Awake fibreoptic intubation was performed in eight patients (six of those with tracheas <5 mm) and asleep fibreoptic intubation was performed in one. Standard intubation was performed otherwise. All patients were recovered on a general surgical ward. None required tracheostomy or tracheal stenting. The incidence of tracheomalacia was 0 (95% confidence interval 0.0–4.8%). Mean length of stay was 2.4 days in those with tracheas <5 mm and 2.0 days in those >5 mm.

Conclusions. We found no evidence of tracheomalacia in high-risk patients with significant tracheal compression. This supports prior work on retrosternal goitres suggesting that the risk of tracheomalacia is minimal in modern thyroid surgery. For risk management, however, we would still advocate that such patients be managed in units with multispeciality support.

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Historically, it was considered that patients with very large goitres were at risk of developing post-thyroidectomy tracheomalacia (PTTM). This condition is secondary to longstanding extrinsic tracheal compression with subsequent loss of tracheal cartilage rigidity, culminating in dynamic airway collapse in excess of 50% of diameter.¹ It is commonly suggested in anaesthetic practice and training that removal of the compressive source (i.e. thyroidectomy) may precipitate life-threatening airway collapse (particularly during expiration) and potentially mandate emergency tracheostomy.¹ However, anecdotal evidence from surgeons with extensive experience suggests that this is almost never encountered. Furthermore, there is disparity in its reported incidence in the literature, which ranges from as low as 0% to as high as 10%.²

Most of the information and experience of PTTM derives predominantly from outside the Western World, often in areas of endemic and longstanding goitre.³ Risk factors considered to be associated with PTTM are the duration of goitre and retrosternal extension of goitres.³–⁶ Although tracheal compression is likely to be a causative variable in the development of PTTM,² this is not completely established.³ Few studies have specifically assessed the risk of tracheomalacia in contemporary series. Furthermore, no studies have attempted to stratify the risk of PTTM in patients with differing degrees of tracheal compression.

The aim of this study was to assess the incidence of tracheomalacia in patients with significant tracheal compression who were operated on in a UK tertiary referral centre for thyroid surgery.

Methods

A retrospective review was conducted of all patients who underwent thyroid surgery in our UK university tertiary referral centre over a 30 month period. All cases with preoperative computed tomography (CT) were identified. Those with tracheal compression (defined as a reduction in the size of the tracheal diameter by 25% or more) were included in the analysis. The incidence of tracheomalacia was calculated and compared with previous studies.
the tracheal lumen to <15 mm, as identified on cross-sectional imaging) were selected. Patient characteristics, radiological, operative, anaesthetic, and pathology data were then obtained from the patients’ medical notes and hospital computerized records. Confidence intervals for zero numerators were generated with Hanley and Lippman-Hand’s method. As this was a retrospective review of current clinical practice, ethical approval was not required.

**Results**

**Tracheal compression and aetiology**

Between January 2008 and July 2010, a total of 334 patients (265 females, 69 males) underwent thyroid surgery. Preoperative CT scan was performed in 101 patients (30.2%) based on clinical suspicion of airway compression \( (n = 58, 17.4\%) \), retrosternal extension \( (n = 48, 14.4\%) \), or for staging of known malignant tumours \( (n = 16, 4.8\%) \). Tracheal compression was seen in 62 patients \( (18.6\%) \) whose minimal tracheal diameter ranged 2–15 mm [mean 7.6 (SD 3.2) mm, median 7 mm]. Aetiology of the goitre in these patients was multinodular goitre \( (n = 50) \), malignancy \( (n = 10) \), and thyroiditis \( (n = 2) \). Critical tracheal compression to a diameter <5 mm was seen in 18 patients \( (5.4\%) \) with benign \( (n = 16) \) and malignant goitres \( (n = 2) \). Tracheal compression to a minimum of 6–10 mm was observed in a further 35 patients.

**Operative details**

Of the 62 patients with trachea <15 mm, 23 underwent thyroid lobectomy and 39 underwent total thyroidectomy. Four patients required median sternotomy for large retrosternal extension of the goitre. All but two patients had an elective operation at a mean \( (s_o) \) of 18 (16) weeks after the CT scan. Two patients presented with stridor and underwent urgent operations. Mean goitre weight was 185.9 g. There was no difference in weight of the gland between those with compression <5 and >5 mm (170.8 vs 192.0 g, respectively).

**Anaesthetic management**

Awake fibreoptic intubation was performed in eight patients \( (of whom six had tracheas <5 mm) \) because they experienced worsening dyspnoea on lying flat. Asleep fibreoptic intubation was performed in one patient with a trachea of 7 mm because it was the preference of the anaesthetist involved. Standard i.v. induction, bag-mask ventilation, and intubation were performed otherwise \( (n = 53) \) and no difficulty was encountered. The tracheal tube used was size 6 \( (n = 7) \), 6.5 \( (n = 4) \), 7 \( (n = 33) \), 7.5 \( (n = 10) \), and 8 \( (n = 8) \).

**Postoperative recovery**

All patients were recovered on a general surgical ward, with the exception of those undergoing sternotomy \( (n = 4) \) who were recovered overnight on the Cardiothoracic Critical Care Unit before transfer to a general surgical ward. There were no admissions to the intensive care unit. No patients developed any immediate respiratory difficulties, none required tracheal stenting, and none had evidence of postoperative tracheomalacia [95% confidence interval (CI) 0.04–0.8%]. Morbidity in this cohort of patients was similar to that observed in patients without tracheal compression. One patient was readmitted on the third postoperative day with a progressive neck collection/abscess. One patient developed a seroma and another a minor wound haematoma; neither mandated airway intervention. One patient developed postoperative hypocalcaemia. One patient suffered a recurrent laryngeal nerve palsy (sacrificed to allow goitre excision).

Mean length of stay (LOS) was 2.4 days in those with tracheas <5 mm and 2.0 days in those >5 mm. This LOS is longer than the average for our unit (1.1 days) but similar to the national average LOS for thyroidectomy reported by the third national British Association of Endocrine and Thyroid Surgeons’ audit (2.7 days).

**Discussion**

This study explored the risk of PTTM in patients with tracheal compression and aimed to stratify and quantify the underlying degree of tracheal compression. We found zero incidence of PTTM (95% CI 0.0–4.8%), including in those with critical tracheal compression. The perioperative morbidity in our series was in keeping with current surgical standards, and while length of hospital stay was greater in those with tracheal compression than our unit’s average, it was less than the current UK national average.

Tracheomalacia was first described by Czyhlarz in 1897, and remains a heterogeneous condition with no universally accepted definition and stratification. Adult-acquired tracheomalacia is most commonly post-traumatic due to prolonged or recurrent intubation, tracheal fractures, or chronic inflammation such as chronic obstructive pulmonary disease. Extrinsic compression by bronchogenic carcinoma, aortic aneurysm, and goitres may also be causative. Although definitive criteria are lacking, a cut-off of a 50% reduction in tracheal lumen is usually considered a prerequisite for diagnosis. This relies largely on dynamic imaging, either CT or MRI. However, in patients with extrinsic compression such as those due to goitre, tracheomalacia may theoretically only become apparent following removal of their compressive agent. Consequently, tracheomalacia may present unheralded as an emergency after thyroidectomy; hence historically, it has been feared as a complication of thyroidectomy.

A number of studies have assessed the risk of tracheomalacia as part of post-thyroidectomy respiratory complications. Although some have investigated the impact of tracheal compression on respiratory complications, no studies have attempted to correlate this variable with risk of PTTM or stratify its severity. In a 2004 review of 1969 patients from 12 studies, Bennett and colleagues found 19 (0.9%) required tracheostomy with 6 (0.3%) suffering tracheomalacia. All six of these cases had been reported within
one study based on a prospective cohort study of 103 patients from Sudan, who underwent thyroidectomy for large goitres with neck circumferences >40 cm.6 Of these, 21 patients had radiological evidence of tracheal compression, although it is not clear how many of these developed PTTM. The authors were able to identify a duration of goitre for more than 5 yr, the presence of radiological deviation/compression of the trachea, retrosternal extension, and difficulty in intubation to be risk factors for tracheostomy (rather than PTTM).

A number of other studies have included patients with significant tracheal compression, although again this was not quantified or stratified. In the largest single study reported to date (a retrospective analysis of 199 thyroidectomies for retrosternal goitre), 118 were found to have a degree of tracheal compression.16 PTTM was reported in two patients (1.0% overall), although whether either had tracheal compression was not stated. In 2005, Grainger and colleagues17 performed a retrospective review of the role of preoperative CT imaging in predicting the requirement for sternotomy. Of 24 patients, 20 had some degree of tracheal compression; none developed PTTM, and the presence of tracheal compression did not increase the need for sternotomy. In a retrospective analysis in 2004, Shen and colleagues15 identified 60 patients with retrosternal goitre. Of these 21 had an undisclosed degree of tracheal compression; none developed PTTM. Also in 2004, Erbil and colleagues16 reviewed 170 cases with retrosternal goitre; of these, 50 were noted to have either tracheal deviation, compression, or both (although not quantified further), but none developed PTTM. Most recently, in 2007, Agarwal and colleagues2 found an incidence of PTTM in 28 of 900 thyroidectomies (3.1%). Although it is implied that a number had tracheal distortion (either compression or displacement), the number of patients within this subgroup was not published.

Our finding of zero incidence of PTTM despite significant tracheal compression adds weight to a growing consensus that PTTM remains almost mythical within modern thyroid surgery in the Western world. The reasons underlying this are unclear. The pathophysiology of acquired adult tracheomalacia has yet to be conclusively elucidated. Although a reduction in the tracheal cartilagesoft tissue ratio from 4.5 to 2:1 has been demonstrated,1 and additional aetiological factors suggested such as loss of longitudinal elastic fibres in the pars membranacea and cartilage fragmentation, many of the pathological components remain obscure.15 20 Consequently, while tracheal compression has been labelled as a likely culprit, PTTM may indeed occur in its absence, and it may be that other factors are more important.

Our current study has a number of limitations. In addition to its retrospective nature, such studies are further limited in power on account of the size of study populations available. While goitres are common, those causing significant anatomical distortion—particularly tracheal compression—are not. Consequently, the availability of these subgroups for study is limited, and may make interpreting the clinical significance of zero incidences difficult. However, were we to assume an incidence of 3.1% as suggested by Agarwal and colleagues in the largest series of at-risk patients to date, the probability of PTTM not occurring individually would be equal to 0.969. The probability of PTTM occurring in none of our population of 62 (i.e. the risk of type II error) would be 0.9690.142 or 14.2%.7 Despite this, our study represents the largest series to specifically assess and quantify goitres causing major degrees of tracheal compression, a group historically considered to be at high risk of PTTM. While anatomical factors such as distortion and compression may theoretically modulate the risk of PTTM, there may be additional as yet unidentified variables. In addition to providing greater power, larger (and therefore most likely multicentre) prospective studies would be able to examine any such putative factors. Future studies may also be able to examine and quantify more complicated structural data, for example, incorporating the length, location, degree of deviation, and resultant cross-section and morphology into the stratification of tracheal compression. Ultimately, these studies would aim to translate this into clinical relevance; i.e. accurately predicting the risk of PTTM and respiratory complications in order to manage operative risk.

In conclusion, there is little definitive evidence regarding the risk of PTTM. There have been few prospective trials, and studies have varied greatly as regards methodology and study population. Attempts to establish the true risk of PTTM have been fraught with such heterogeneity, and compounded by a lack of universal definitions and diagnostic criteria. Our study suggests that the risk of PTTM is indeed minimal within modern thyroid surgery, and furthermore that thyroidectomy can be performed safely on patients with critical degrees of tracheal compression. However, more highly powered (and ideally prospective) studies are necessary. Until the risk of PTTM can be elucidated definitively, we would advocate performing such procedures in centres with the requisite multispecialty expertise.

**Conflict of interest**

None declared.

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