The Journal of Laryngology & Otology (2013), ***127***, *897–901*.
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doi:10.1017/S0022215113001667

MAIN ARTICLE

The false thyroid capsule: new findings

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Abstract

Purpose: The false thyroid capsule is an important anatomical structure involved in thyroidectomy, yet it is rarely studied. This study aimed to define the anatomy of the false thyroid capsule, and its clinical significance.

Methods: A prospective study was performed involving 151 patients with goitre who underwent thyroid lobectomy. The anatomy of the false thyroid capsule was carefully documented intra-operatively.

Results: The false thyroid capsule enclosed the inferior and middle thyroid veins and the superior thyroid vessels, forming a mesentery-like structure by attaching to the gland. Once the unilateral lobe had been removed, the thyroid mesentery could be seen to have a C-shaped edge. The recurrent laryngeal nerve, inferior thyroid artery and parathyroid glands were located beneath the C-shaped edge of the thyroid mesentery.

Conclusion: The thyroid mesentery is a distinctive structure that can be used as a guide for surgical dissection.

Key words: Thyroid; Anatomy; Recurrent Laryngeal Nerve; Thyroidectomy

Introduction

Thyroidectomy is one of the most frequently performed procedures in general surgery. The cornerstone of safe and effective thyroid surgery is a thorough understanding of the thyroid anatomy.[1] Guillaume Dupuytren performed the first well-documented anatomical total thyroidectomy in 1808, and described dividing all four arteries and removing the goitre through sharp dissection.[2] However, truly safe and effective thyroid surgery came of age with Kocher and Halsted, who developed a standardised technique for thyroidectomy (i.e. dissection within the thyroid capsule).[3]

In the past century, the study of thyroid anatomy has focused on the recurrent laryngeal nerve (RLN), non-recurrent laryngeal nerve, external branch of the superior laryngeal nerve, parathyroids, tubercle of Zuckerkandl, and sympathetic to laryngeal nerve anastomosis, and has centred around safety. In addition, the importance of the thyroglossal tract and pyramidal remnants, thyrothymic thyroid rests, and anatomical variations of the thyroid has been discussed with respect to the completeness of surgery.[2]

However, the false thyroid capsule (also known as the surgical capsule or perithyroid sheath) has only rarely been described. It is a thin layer of fascia enveloping the thyroid gland, which needs to be dissected away from the thyroid during surgery.[4] Most anatomists and surgeons have described it as a thin capsule deriving from the pretracheal fascia.[1,2,4,5] The false thyroid capsule plays an important role in capsular dissection, as described by Gemsenjaeger.[4]

In the current study, we explored the anatomy of the false thyroid capsule during thyroid lobectomy, in order to further define its clinical significance.

Patients and methods

Patients

The study included 151 patients with goitre who underwent thyroid lobectomy in the department of thyroid and breast surgery of the affiliated Nanhai Hospital of Southern Medical University, Foshan, between April 2011 and February 2012. There were 124 women and 27 men, with a mean age of 38 years (range, 19–75 years). The patients' mean body mass index was 24.3 kg/m^2 (range, 21.7–28.2 kg/m^2).

Patients with a history of previous neck surgery or radiation exposure were excluded from the study.

All patients signed an informed consent form prior to study enrolment.

Patients were thoroughly evaluated via physical examination, thyroid function tests, thyroid ultrasonography, parathyroid hormone tests and indirect laryngoscopy, prior to surgery. Upon ultrasonography, the maximum thyroid gland diameter was 6.7 cm (range, 5.4–10.7 cm).

Accepted for publication 3 December 2012 First published online 8 August 2013

https://doi.org/10.1017/S0022215113001667 Published online by Cambridge University Press

Surgical procedures

Surgery was performed using Harmonic Focus curved shears (Ethicon, Cincinnati, Ohio, USA), monopolar electrocautery and dissecting forceps.

The lobectomy began by transecting the isthmus and mobilising the lobe in a medial to lateral direction and from the lower pole towards the upper pole.[5] Surgical dissection of the thyroid gland was performed using capsular dissection techniques as described by Gemsenjaeger.[4] The plane of dissection was the natural space between the true and false capsules. The thyroid vessels were individually identified, ligated and divided close to the true capsule. The transected vessels and the false capsule were dissected away from the gland. The parathyroid glands were identified and dissected posteriorly off the thyroid, with their blood supply preserved. After transection of Berry's ligament, the posterior capsular dissection proceeded towards the suspensory ligament and the trachea. Finally, the entire lobe was dissected out. If present, the pyramidal lode was routinely mobilised and dissected out.

Results

A total of 151 unilateral thyroid lobectomies were completed without complication. Of these cases, pathology results indicated that 115 patients had multinodular goitres, 26 had thyroid adenomas and 10 had papillary carcinomas (including 6 cases of microcarcinoma).

All false capsules were fully mobilised, and no tumour invasion or adhesion was seen.

Ten patients received parathyroid autotransplantation. In three cases, parathyroid tissue was found within the thyroid gland during pathological evaluation.

All patients recovered well from surgery and showed no evidence of RLN injury, bleeding or hypoparathyroidism.

Anatomy of the false thyroid capsule

During the above procedures, the observed anatomy of the false thyroid capsule was as follows.

At the level of the coronal plane of the inferior thyroid vein, middle thyroid vein (97 cases identified) and superior thyroid vessels, the false thyroid capsule enclosed the vessels and extended to form a thin membrane attached to the gland. The membrane then extended infero-medially and became the pretracheal fascia. It encircled the ventral medial branches of the superior vessels and extended to overlie the cricothyroid space supero-medially in all cases.

After transection of the membrane, a natural space between the true and false capsules could be identified in all cases. This space was narrow and located near the branches of the inferior thyroid artery (142 cases could be found), superior parathyroids, inferior parathyroids (78 cases) and postero-medial aspect of the gland (the tubercle of Zuckerkandl could be found in 52 cases).

After removal of the gland through capsular dissection, the false capsule remained intact and showed a smooth appearance in all cases. When the membrane was lifted, the thyroid fossa was clearly visible at the supero-lateral aspect in 81 cases and not clearly visible in 70 cases, and the edge of the membrane formed a 'C' shape at the superior portion of the fossa to encircle the gland. The membrane was found to be shortest at the superior thyroid vessels and usually difficult to recognise, and was longest and thickest at the level of the inferior thyroid vein. The ends of the transected thyroid vessels, such as the inferior and middle thyroid veins (97 cases) and the superior thyroid vessels, could be seen (Figure 1). The lateral part of the C shape was attached to the sternal thyroid muscle in 141 cases and was independent in the other 10 cases.

In the C-shaped area, we found that the superior parathyroid glands lay within the fossa in all cases, while the inferior parathyroid glands lay within the fossa in 78 (51.6 per cent) cases. The RLN could be seen beneath the false capsule in 132 cases (87.4 per cent); in 34 of these cases, only the entry point of the RLN (less than 1 cm) could be seen. The RLN could be seen within the fossa (i.e. more than 1 cm) in 98 cases (Figure 2). In the remaining 19 cases, the RLN could not be seen, and was exposed after dissection of two layers of fascia: a superficial layer made up of fat tissue and a deep layer made up of dense connective tissue. In the 142 cases in which the inferior thyroid artery penetrated the false capsule, this artery could be seen within the fossa.

Discussion

According to the neck photomicrographs published by Pool and Falk in 1916, the deep cervical fascia is divided into two layers at the posterior aspect of the lobe.[6] The posterior layer extends posterior to the oesophagus to form the prevertebral fascia. The anterior

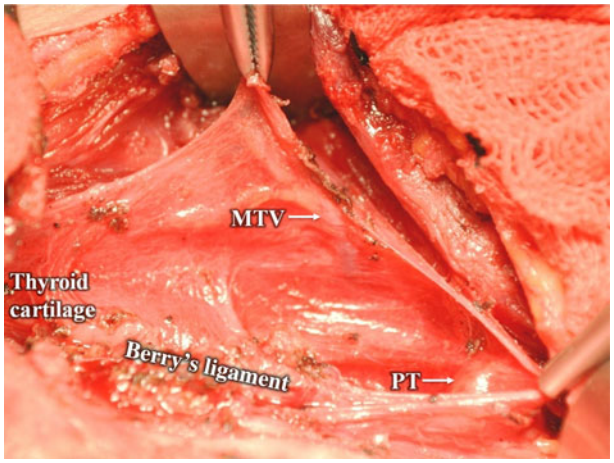


FIG. 1

Surgical photograph taken after thyroid lobectomy, showing that the false capsule constitutes a C-shaped thyroid mesentery encircling the gland. The middle thyroid vein is enclosed in a double layer of fascia derived from the thyroid mesentery. MTV = middle thyroid vein; PT = inferior parathyroid

https://doi.org/10.1017/S0022215113001667 Published online by Cambridge University Press

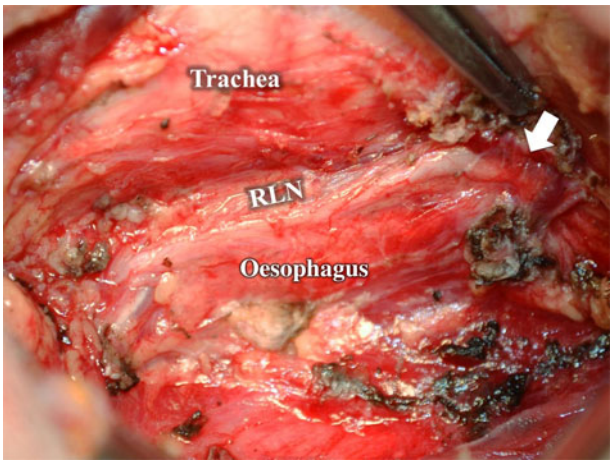


FIG. 2

Surgical photograph taken after thyroid lobectomy performed via capsular dissection. The recurrent laryngeal nerve (RLN) can be seen ascending in the tracheoesophageal groove through the thin, intact false thyroid capsule. White arrow = RLN entry point

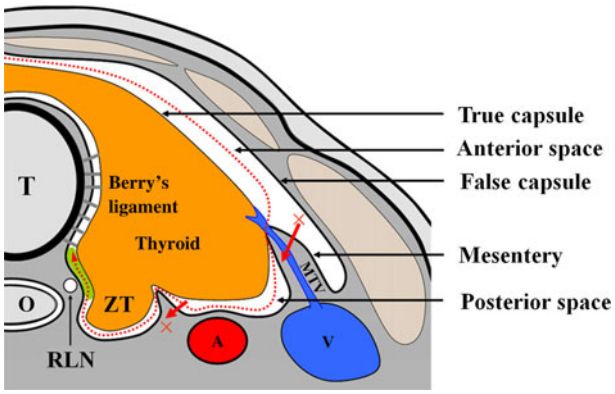


FIG. 3

Diagrammatic cross-section through the thyroid, along the middle vein. The false capsule encloses the vein and forms the thyroid mesentery. The red dotted line indicates the correct dissection path, while the red arrows indicate the incorrect path. The green zone indicates the area prone to recurrent laryngeal nerve (RLN) injury during capsular dissection. T = trachea; O = oesophagus; ZT = Zuckerkandl's tubercle; MTV = middle thyroid vein; A = common carotid artery; V = internal jugular vein

layer travels medially to the postero-lateral aspect of the trachea. The thyroid gland is entirely covered by the anterior layer (i.e. the false capsule or pretracheal fascia), near the cricoid cartilage and upper tracheal rings. This capsule condenses to form the posterior suspensory or Berry's ligament.[1]

Thyroid mesentery

In the current study, the false thyroid capsule was found not only to envelop the thyroid gland but also to enclose the inferior and middle thyroid veins and superior thyroid vessels, forming a double-layered, C-shaped structure similar to the mesentery seen in the peritoneal cavity. We have named this C-shaped capsule the thyroid mesentery. Like Berry's ligament, the thyroid mesentery is one of the fixation structures of the thyroid. Awareness of the thyroid mesentery is important because surgeons use the thyroid mesentery and the true capsule to identify the correct dissection plane. Dissection should stay close to the true capsule; otherwise, one may easily enter the wrong plane, outside the false capsule, and may injure the RLN and parathyroid glands (Figures 3 and 4). Some authors have suggested that the inferior pole of the thyroid gland is one of the most common sites of risk regarding RLN injury.[1] We believe that this may be because surgeons who are new to capsular dissection find it difficult to identify the correct dissection plane, and may enter an incorrect plane instead.

The external branch of the superior laryngeal nerve descends outside of the false capsule, and the relationship between the nerve and the superior pole and vessels can vary greatly.[7] In patients with large goitres, the superior pole pushes upwards and the external branch of the superior laryngeal nerve crosses the superior pole to enter the larynx.[8] Cernea *et al.* have proposed the anatomical categories of type 2A (in which the external branch of the superior laryngeal nerve lies 1 cm above the superior pole) and 2B (in which the external branch of the superior laryngeal nerve lies below the superior pole).[9] In cases with either of these anatomical arrangements, division of the vessels near the thyroid capsule can reduce the risk of nerve injury (Figure 4). In this series, we observed no injuries to the external branch of the superior laryngeal nerve.

Surgical planes of lobectomy

Based on the above findings for the thyroid mesentery, we propose that there are two distinct surgical planes in thyroid lobectomy. The anterior plane is the space between the thyroid mesentery and the strap muscles. Dissection within this plane is safe and usually bloodless. The right and left sides are separated by the cervical linea alba. The posterior plane is the narrow space between the true and false capsules, posterior to the posterior portion of the thyroid.

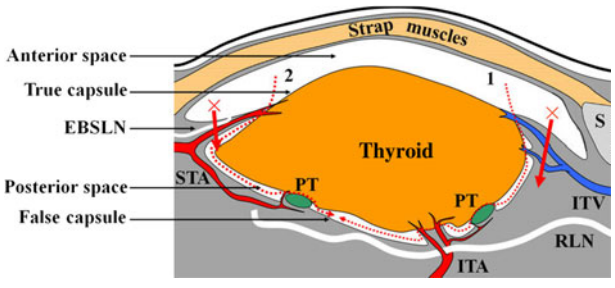


FIG. 4

Diagram showing lateral view of the thyroid gland. The false capsule encloses the superior thyroid artery and inferior vein and forms the thyroid mesentery. The red dotted line indicates the correct route of capsular dissection, 1 and 2 indicate entry points, and red arrows indicate incorrect entry points. EBSLN = external branch of the superior laryngeal nerve; S = sternum; STA = superior thyroid artery; PT = parathyroid; ITV = inferior thyroid veins; RLN = recurrent laryngeal nerve; ITA = inferior thyroid artery

https://doi.org/10.1017/S0022215113001667 Published online by Cambridge University Press

We believe that the purpose of capsular dissection is to expose the anterior space, transect the thyroid mesentery close to the true capsule in order to enter the posterior space, ligate and divide the terminal branches of the inferior thyroid artery, divide and preserve the parathyroid glands, and transect the whole lobe from Berry's ligament, leaving the entire false capsule intact and the RLN uninjured. At the most posterior portion of the lobe, the existence of the tubercle of Zuckerkandl has been reported in nearly two-thirds of patients.[10,11] The anatomy of the RLN may be distorted by an enlarged tubercle of Zuckerkandl. In these cases, it is important to continue the plane of dissection along the surface of the tubercle, elevating it progressively.

Thyroid mesentery and thyroid vessels

The thyroid mesentery is longest and thickest at the level of the inferior thyroid vein. We believe that this may be due to multiple branches arising from the vein.[12] We also found the thyroid mesentery to be present in patients whose middle thyroid vein was absent. We believe that an understanding of the C shape of the thyroid mesentery is beneficial to surgeons. After removal of the whole thyroid lobe by ultrasonic scalpel, it can be difficult to locate the broken ends of vessels without the use of markers, such as thread. Knowledge of the C shape of the thyroid mesentery helps mitigate this difficulty.

C-shaped area and parathyroids

The parathyroid glands are commonly located between the true and false capsules.[4] Pool and Falk divided them into three types based on the distance between the parathyroids and the thyroid.[6] Abboud *et al.* reported that the parathyroids are located within the thyroid gland in up to 24 per cent of patients, between the true and false capsules in up to 39 per cent, and outside the false capsule in up to 37 per cent.[13] The superior parathyroid glands are consistently located between the true and false capsules, but the location of the inferior parathyroids may vary.[14]

Recently, more attention has been paid to the accidental removal of the parathyroids.[13,15] It has been reported that the use of capsular dissection can reduce inadvertent parathyroid excision.[15] Classically, there are four parathyroid glands in close association with the thyroid. In a thorough anatomical study, Akerstrom *et al.* reported a 13 per cent incidence of a supernumerary fifth parathyroid gland, and a 3 per cent incidence of only three glands.[16] As mentioned above, parathyroids are always located in the thyroid fossa and can be seen by lifting the thyroid mesentery. Using this method, we found all inferior parathyroid glands to lie within the fossa in 78 of our cases.

C-shaped circle and recurrent laryngeal nerve

The RLN travels outside the false capsule and never enters the thyroid gland.[7,17] This nerve is located dorsolaterally to Berry's ligament, which it does not penetrate.[18,19]

It has been reported that the surgical capsule is occasionally defective infero-medially, and in these cases the RLN may actually pass through the thyroid tissue.[20] Another study has confirmed that there are cases in which the nerve may pass through the substance of the gland.[21] We have encountered one case in which, prior to dissection, the nerve appeared to pass through the thyroid gland; careful dissection revealed that the tubercle of Zuckerkandl overlay the RLN like a bridge.

Supporters of the capsular dissection technique believe that the false capsule on the posterior aspect should be completely preserved to protect the RLN.[1,2,4] In 87.4 per cent of our cases (132/151), the RLN was covered by the thin, translucent false capsule, prior to entering the larynx, and through this capsule the nerve could be seen ascending in the tracheoesophageal groove. The RLN is thus 'encountered', usually close to Berry's ligament, rather than dissected along its entire length.[2]

- **The false thyroid capsule is usually not well described**
- **This study describes the thyroid mesentery of the false thyroid capsule, in surgical cases**
- **The thyroid mesentery is distinctive and can guide thyroid dissection**

The RLN lies so close to the false capsule that it is at risk of nerve injury.[22,23] If the nerve branches at this level, as it does in up to 40 per cent of cases, it can be lifted upward during dissection and injured.[24] For this reason, excessive traction of the thyroid during dissection of the RLN from Berry's ligament should be avoided.[22] The nerve is best identified by the presence of the vasa nervorum on its surface. The RLN can also be injured by thermal or mechanical insults such as those caused by electrocautery and ultrasonic scalpels. Although the RLN ascends relatively far from the gland before reaching Berry's ligament, it sometimes travels between the branches of the inferior thyroid artery and can suffer traction injury due to this location. Ardito *et al.* reported that this anatomical variation may occur in up to 20.5 per cent of cases on the left side and 27 per cent of cases on the right side.[17] In our experience, division of the thyroid gland from the inferior pole upwards can help prevent such injuries. No temporary or permanent RLN palsy was seen in our series.

Conclusion

The findings in this study suggest that the false capsule, or thyroid mesentery, is a distinctive structure that can be used as a guide for surgical dissection. Dissection should proceed in the natural plane between the false and true capsules.

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Dr Y-G Xiao takes responsibility for the integrity of the content of the paper
Competing interests: None declared

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