SCARLESS NECK SURGERY FOR BENIGN THYROID & PARATHYROID PATHOLOGY

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***Abstract**: Endoscopic surgery in the neck was attempted in 1996 for performing parathyroidectomy. A similar surgical technique was used for performing thyroidectomy the following year.*
Most commonly reported endoscopic neck surgery studies in literature have been on thyroid and parathyroid glands. The approaches are divided into two types i.e. the total endoscopic approach using CO_2 insufflation and the video assisted approach without CO_2 insufflation. The latter approach has been reported more often. The surgical access (port placements) may vary – the common sites are the neck, anterior chest wall, axilla and periareolar region. The limiting factors are the size of the gland and malignancy. Few reports are available on endoscopic resection for early thyroid malignancy and cervical lymph node dissection. Endoscopic neck surgery has primarily evolved due to its cosmetic benefits and it has proved to be safe and feasible in suitable patients with thyroid and parathyroid pathologies.

INTRODUCTION

The cervical region comprises a plethora of well-defined anatomical structures systematically arranged in layers with minimal or negligible vascular overlap. These well-defined layers form the vascular anatomical planes, which have been exploited by the endoscopic surgeon to create a working space for surgical manipulation. Reported initially in 1996[1], endoscopic neck surgery has evolved in its application especially due to cosmetic benefits. The other advantages include better tissue identification due to the magnified image thus decreasing the chances of injury to vital structures such as the recurrent laryngeal nerve.

The primary *target organs* have been the parathyroid and the thyroid glands[2,3,4,5,7,8,9], although few studies have reported on its application to other cervical structures, such as the submandibular gland and cervical spine[9,10,11]. Furthermore the *approaches* may be classified into total (pure) endoscopic (CO_2 insufflation)[3,4,5,6], video assisted endoscopic[12,13,14,15] and minimally invasive mini incision approaches[16,17,18,19]. The total endoscopic approach has been further sub classified into a supraclavicular, anterior chest wall, axillary and periareolar breast approach. The latter three have also been attempted in the video assisted endoscopic approach.

Video-endoscopic neck surgery remains restricted to specialized centres of minimal access surgery.

Indications for a minimal access approach for thyroid or parathyroid pathology are essentially the same as for open surgery.

A thyroid swelling can present as a multinodular goitre, a solitary thyroid nodule (toxic / asymptomatic) or as Grave's disease, indication for removal include:

- Doubt of malignancy
- Toxic adenoma
- Pressure symptoms
- Cosmesis
- Grave's disease

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Table 1 **Exclusion criteria for Endothyroidectomy**

1) Family history of Ca thyroid
2) History of neck irradiation
3) Significant thyroiditis
4) Multinodular Goitre (MNG)
5)Thyroid nodule > 35mm (Relative)[20,21,22,23,24,25,26,27]

VIDEO ENDOSCOPY ASSISTED THYROID SURGERY

Endoscopic thyroidectomy has progressed towards more remote sites of access to improve cosmesis and provide patients with a scar less neck. This has been more on patient demand as thyroid disease predominantly affects women. The patient must be apprised of the difference in the technique and surgical approaches. Investigations are performed to assess the fitness of the patient for anesthesia and to evaluate the existing pathology. These specialized investigations help in defining the nature of the thyroid lesion and include:

- Thyroid function tests
- Ultrasonography
- Fine needle aspiration cytology (FNAC)
- Indirect laryngoscopy

Method

The procedure requires general anesthesia with endotracheal intubation.

Patient position and operation theatre layout

The patient lies supine with the neck in neutral position, a sandbag under the shoulders and head stabilized (extension should not be done as in open surgery because it stretches the neck muscles and hinders the development of the pretracheal space). The operating surgeon and the camera man stand on the side opposite to the pathology site, the

scrub nurse on the side opposite to the operating surgeon and the monitor is placed above and behind the patient's head.

Port Placement

- The primary access port is a 1.5cm long incision and made along the periareolar margin of the breast opposite to the site of pathology. The two working ports are 2mm / 3mm or 5mm in size. One is placed in the anterior axillary fold on the same side as the primary port and the second port is placed on the peri-areolar margin of the opposite breast.(Fig.1)
- The primary port is made under direct vision up to the pectoral fascia. Thereafter a glove finger balloon mounted on a suction cannula is introduced into this tunnel and the balloon inflated to create the working space.

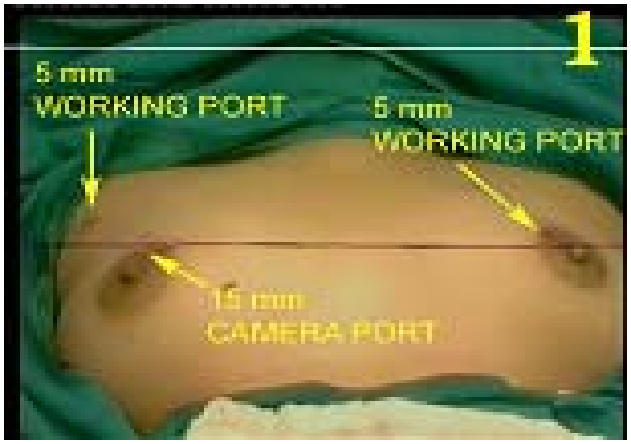

Fig. 1 Port placement : camera port 15mm rt. peri-areolar margin, 5 mm working port, anterior axillary fold same side, 5mm working port left peri-areolar margin.

- A 10mm Hassan's trocar is then placed in this region and a purse string suture is taken subcutaneously all around the trocar and tied for creating an air tight seal before beginning insufflation.
- A 10mm 30° telescope is then introduced into the trocar and the space inspected.
- The two lateral ports are now made under direct vision.
- It is preferable to use plastic ringed trocar cannulas for the two working ports. These trocars do not slip out of the port site during dissection in the limited space thus avoiding loss of CO2 and vision. Plastic cannulas have the added advantage of not interfering with cautery.
- The working space is expanded using ultrasonic shears (almost the entire surgery is performed using this energy source) into the area of the neck. Bilateral sternocleidomastoid muscles form the first anatomical landmark for spatial orientation. The space between these two is occupied by the strap muscles (Fig. 2).
- The strap muscles are split in the midline using ultrasonic shears to expose the thyroid gland (Fig. 3).

Identification of the inferior thyroid pedicle

Fig. 2 Large working space with Left and Right sternocleidomastoid forming the anatomical landmark for orientation

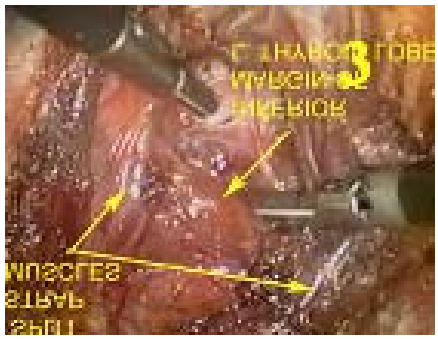

Fig. 3 Dissection begins at inferior margin of thyroid after splitting the strap muscles

- The important landmarks for identification and maintaining anatomical orientation include the tracheal rings in the midline and the carotid sheath laterally on either side.
- The isthmus overlies the second and third tracheal rings. It is traced laterally to the lateral thyroid lobe. The dissection begins along the lower thyroid margin, which is lifted up to expose the inferior thyroid pedicle
- The thyroid lobe is lifted at the infero lateral border to approach the tracheo thyroid groove. The inferior thyroid artery can be seen entering the glandular substance after emerging from below the carotid sheath (Fig. 4).

Position and identification of recurrent laryngeal nerve

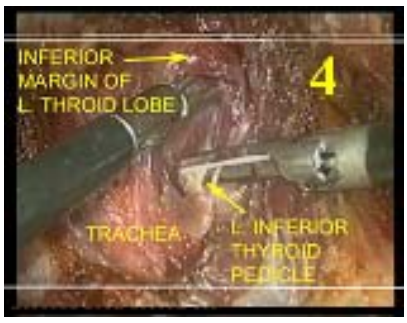

Fig. 4 Inferior thyroid pedicle divided with ultrasonic shears

- The recurrent laryngeal nerve is the next structure to be identified, traced and preserved before proceeding with the division of the inferior thyroid vessels. Being

embryologically related to the fourth aortic arch, the nerve descends down to hook around the subclavian artery on the right and the aortic arch on the left. It then moves along a variable course in the tracheo esophageal groove. The nerve may traverse through a vascular fork of the terminal arterial branches before entering the larynx. On endoscopy it is visualized as a glistening white cord like structure distinct from the inferior thyroid artery. The magnification makes identification and preservation of this structure easier. Once the nerve is clearly defined and traced, the inferior thyroid artery is divided (Fig. 5).

- The inferior parathyroid gland is encountered here lying caudal to the inferior thyroid artery and ventral to the recurrent laryngeal nerve.
- The superior parathyroid gland lies cephalad to the inferior thyroid artery and dorsal to the recurrent laryngeal nerve and should be identified and preserved.

Middle thyroid vein

- The lateral thyroid lobe is now lifted off the thyroid cartilage and the middle thyroid vein is encountered which is defined and divided (Fig. 6).

Superior thyroid artery

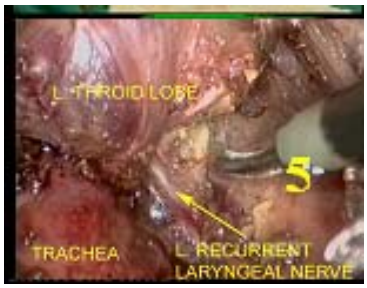

Fig. 5 The thyroid lobe lifted up to expose the recurrent laryngeal nerve

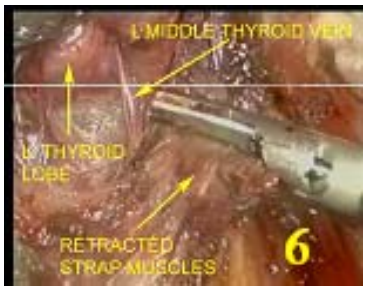

Fig. 6 The left middle thyroid vein defined

- The laterally mobilized thyroid lobe is lifted up to the trachea and the isthmus is dissected off the trachea. The isthmus is then divided using cautery or the harmonic scalpel (Fig 7).
- The mobilized thyroid lobe is retracted caudally and inferiorly to expose the superior thyroid pedicle. This vessel is divided close to the superior thyroid pole to avoid injury to the superior laryngeal nerve (Fig. 8 & 8.1).
- The specimen is retrieved through the periareolar incision (Fig. 9).
- Having excised and removed the specimen the operated area is inspected for hemostasis (Fig. 10).
- Maintaining hemostasis is of paramount importance due to the limited operating space.
- A 12 Fr suction drain is placed in the area through the axillary port.
- The strap muscles are sutured in the midline with 2'O'

Fig. 7 Division of isthmus

Fig. 8 Division of superior thyroid pedicle while retracting the mobilized thyroid lobe inferiorly

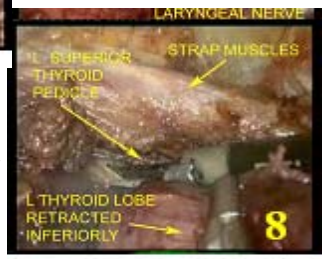

Fig. 8.1 Completing division of superior thyroid pedicle posteriorly by lifting the mobilized thyroid lobe superiorly

Fig. 9 Complete hemostasis after left hemithyroidectomy

Fig. 10 Extracting the specimen from the 15mm peri-areolar incision

vicryl suture.
- CO2 is desufflated and the incision is closed in layers for ensuring a good cosmetic scar. Skin is approximated using subcuticular sutures for both the periareolar and the remaining 5 mm port.
- The drain is removed after 24 hours and patient discharged.

The aim of most studies apart from being cosmetically superior has been to be minimally invasive offering all associated advantages such as minimal postoperative pain, rapid recovery and low analgesic requirement[28,29,30].

In terms of invasiveness none of the distant sites of access prove to be truly minimally invasive as extent of invasion is much more compared to a focused, direct approach. The popularity has however persisted and increased due to improvement in cosmesis.

The supraclavicular approach has certain advantages such as rapid access to thyroid (in the event of a vascular mishap), the advantage of applying external pressure for hemostasis[31]. The video assisted focused approach using conventional instruments has a shorter learning curve[32,33,34,35].

Table 2[32,36,37] Post – Operative Complications with Endothyroidectomy

1) Rec. laryngeal n palsy
2) Hypocalcemia
3) Seroma
4) Hematoma
5) Wound infection
6) Subcutaneous emphysema (with CO_2 insufflation)

Our experience comprises 25 patients operated since 1997. Twenty one patients had a solitary thyroid nodule and 4 patients had small multinodular goiter. In 3 patients a supraclavicular approach was adopted and 22 patients were operated by a peri-areolar approach. The surgery in one of the 3 patients of the supraclavicular approach was converted to a conventional exploration due to abnormally high vascularity of the gland, which turned out to be a multicentric papillary carcinoma on histopathology. The patient subsequently underwent a completion thyroidectomy. Three patients developed subcutaneous emphysema which resolved over 24 hours and 5 patients showed bruising in the presternal region which resolved in 2 weeks. There were no other complications. It was easier operating from the periareolar approach as a larger working space was available. In 21 patients of solitary thyroid nodule a hemi thyroidectomy was performed and in 3 patients of multinodular goiter the excision extended to a little more than half the opposite lobe. The size of the resected specimen varied from 2 x 2.4cm^2 to 5 x 4.1cm^2 (the specimen were not weighed).

ENDOSCOPIC PARATHYROIDECTOMY

Indications for parathyroidectomy are:

- Hyper-functioning parathyroid adenoma
- Parathyroid hyperplasia

The benign nature of the disease and small size of the specimen make it an ideal organ for access and dissection using the minimal access technique.

What follows is description of video-endoscopic thyroid surgery using the periareolar approach with CO_2 insufflation

Preoperative Evaluation

In case of hyperparathyroidism with hypercalcemia, the specialised investigations required are:

- USG/ CT Scan / MRI Scan of the neck.
- Technetium 99m Sestamibi scan / Thallium technetium subtraction scan depending on which is available for localisation. A combination of the sestamibi scan along with a radiological investigation has been described as equivalent to an open conventional bilateral exploration of the neck for localizing the parathyroid lesion. High-resolution cervical ultrasonography alone has reported a high success rate of 94% for preoperative specific side localization of the parathyroid lesion[(38)]. The sensitivity was reported as 89% with a 98% positive predictive value.

Perioperative Evaluation

- Techniques to ensure complete removal of the hyper functioning parathyroid tissue in MIP reported are intra-operative rapid parathormone assays[(39,40,41,42,43)], frozen section and good clinical judgment followed by postoperative S.Ca^{++} and PTH level monitoring. Several studies have also reported day care minimally invasive parathyroidectomy (MIP) using local /regional anesthesia[(44)]. Such centers apply techniques such as chemilumescent assay for intact PTH level (quick PTH) giving a success rate of 95% to 98% to ensure a cure for the patient before discharge[(45,46,47,)]. However these results are best observed in patients with uniglandular disease. Provided a careful preoperative patient selection is performed, an MIP will cure the patient whether or not an intra operative QPTH assay is done[(48)].

Method

The patient position and operation theatre layout remains the same as described for thyroidectomy.

Localization of the parathyroid gland

- Before embarking on the procedure of parathyroidectomy for parathyroid hyperplasia a thorough knowledge of the embryology and surgical anatomy of the parathyroid glands is a must.
- The approach is along the inferolateral margin of the thyroid lobe. On lifting the lobe the inferior thyroid artery and recurrent laryngeal nerve can be seen in the tracheo

thyroid groove.

- Majority of parathyroid glands are located within 1-2 cm of the intersection between the inferior thyroid artery and the recurrent laryngeal nerve.
- Remember the rule of symmetry i.e. glands situated on one side are placed similarly to the ones on the other side.
- A superior gland not in its usual position is likely to lie more posteriorly and caudally behind the esophagus and anterior to the vertebral column. The endoscopic advantage lies in being able to trace its blood supply arising from the inferior thyroid artery to site of the gland. The dissection may extend up to the anterior mediastinum. The lower parathyroid may be similarly traced as it may be displaced to lie in the thyro-thymic ligament or anterior mediastinum. The other sites which need to be explored include the upper thyroid pole, the retroesophageal or the retropharyngeal space[18]. A gland may be situated here in about 1% of cases.
- Lastly if the gland is still not found one may recall the embryological development of the superior and inferior thyroid gland which arise from the fourth and the third pharyngeal pouch respectively. Rarely the inferior thyroid gland may not descend to its normal position and may come to lie as high as the submandibular gland[19]. In such a situation conversion to a conventional approach may be required.
- In case of parathyroid adenoma pre-operative localizing studies such as CT Scan/ MRI Scan / 99 Technetium sestamibi scan facilitates a more direct approach with limited dissection of the concerned area.
- The dissection proceeds by isolating and cauterizing vessel supplying the gland.
- The gland is now excised and extracted through the primary port to prevent any trauma and spillage of cells.
- Hemostasis must be ensured and a suction drain placed through one of the 5mm ports for about 24 hrs.
- The facility of frozen section histopathology report is advisable especially in cases of parathyroid hyperplasia and where intra-operative rapid parathormone assays are not available.

Our own experience spans 8 years with 18 patients of primary hyperparathyroidism (PHPT) subjected to total endoscopic parathyroidectomy. Seventeen of these patients were diagnosed with a single parathyroid adenoma on 99^{TC} sestamibi scan corroborated by an USG neck or an MRI scan. One patient was diagnosed to have parathyroid hyperplasia. Ten procedures (7 procedures with CO_2 insufflation and 3 procedures video assisted) were performed by a supraclavicular approach, 4 by an anterior chest wall approach and 4 by a periareolar breast approach. Carbon dioxide insufflation was maintained at 10mm of Hg. Post operative monitoring of S Ca^{++} and S PTH levels were done to confirm complete removal of all hyper functioning parathyroid tissue. There was one conversion due to non-localization of the parathyroid adenoma. The tumor was identified in the tracheo-esophageal groove. Although the number of patients in our experience is small, the results conform to those reported in literature in terms of safety and feasibility.

Table3[49] Complications reported in Endoparathyroidectomy are -

1) Recurrent laryngeal nerve palsy
2) Failed surgery (persistent – hyper calcemia / increasePTH)
3) Hemorrhage
4) Seroma
5) Hypocalcemia

Carbon dioxide embolization, a potential life threatening complication has so far not been reported.

Our progress from a supraclavicular approach to a periareolar approach is strongly driven by superior cosmetic results, as the dissection involved in this approach is much more than a focused mini-incision approach.

Gasless Endosurgery for thyroid & parathyroid

Alternative approach

There is one line of thought which objects to the potential of intraoperative hyper carbia and subcutaneous emphysema while undergoing endoscopic neck dissection. As an alternative to avoid this problem innovators have come up with the gasless approach.

- The 2 cm primary port is made in the suprasternal notch under direct vision and extended up to the investing layer of the deep cervical fascia.
- This is followed by a short infusion of CO_2 for 3-4 minutes to facilitate creation of the pretracheal space under endo vision.
- The trocar is then removed and the insufflated CO_2 released.
- A 30° 5mm endoscope is inserted through the same incision. Two conventional skin retractors are inserted for retracting the thyroid lobe medially and the muscles laterally. All dissection takes place through this incision using special spatulated instruments.

Advantages

- The anatomy of the neck comprises delicate and important structures, the identification of which is tremendously enhanced by bright light and the magnification offered on endoscopy.
- Improved cosmesis is one of the major potential benefits of endoscopic neck exploration.
- The minimally invasive approach may lead to less post-operative pain and a faster functional recovery.

- Direct palpation of the structures can be done in neck surgery which is a great advantage. This can also be used to apply direct pressure on bleeding vessels.

Disadvantages

- Requires high degree of technical expertise of the surgical team and good quality equipment and instruments.
- Results in prolongation of operative time which may shorten as experience of dissecting in this area increases. However surgeons quickly adapt and the operative time reduces dramatically after a few cases only.
- The cost of the procedure may be slightly more due to disposable laparoscopic instruments and prolonged operating time.
- It is also important to bear in mind that since most thyroidectomies are performed for a potentially malignant nodule, it becomes imperative that the clinical outcome of the same being performed endoscopically be similar, if not better than its open counter part.

CONCLUSION

Endoscopic neck surgery offers a definite cosmetic advantage over its conventional counterpart. With increasing skill and patient demand, this surgery is going to be performed in more centers. However careful patient selection is advocated. Though few centers are reporting good results in thyroid malignancy, the role of endoscopic approach in thyroid malignancy is as yet controversial.

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