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What is the Ideal Approach for Thyroidectomy in a Given Patient? Algorithmic Approach Based on Institutional Experience

Bhargav RP* and Sabaretnam M

Department of Endocrine Surgery, India

***Corresponding author:**

Ramakanth Bhargav Panchangam, Department of Endocrine Surgery, Senior Consultant Endocrine Surgeon, India, E-mail: endoanswers@gmail.com

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Thyroidectomy; Endoscopy; Algorithm; Surgery; Technique

1. Abstract

1.1. Introduction: Thyroidectomy can be performed by open or wide array of endoscopic techniques. But, the availability of plethora of options led to confusion amongst patients and surgeons in selecting appropriate technique. In this context, we analysed our experience with specific emphasis on deducing an algorithm on ideal technique for a given patient.

1.2. Material and Methods: This is a retrospective study conducted at a tertiary care endocrine surgery department in South India over a period of ten years from July 2009 to June 2019. All clinical, operative and followup data are analysed in detail. We categorized all the clinico-investigative, logistic and patient factors influencing the choice of thyroidectomy technique in to four types A, B, C and D. Type A included disease related factors; Type B included logistics related factors; Type C factors based on comorbidities; Type D based on patient and their family.

1.3. Results: Open thyroidectomy was performed in 1794/ 2075 (86.5 %) cases. Endoscopic thyroidectomy was employed in 281 subjects. Type A to C factors, bifurcated the choice of technique to OT and ET without the need for Type D factors. Type D factors primarily dictated the choice amongst the available ET techniques. Further, DI, II and VII factors converted some of the ET feasible subjects to OT. DIII, IV, V, VI factors dictated the choice of a particular ET technique.

1.4. Conclusions: 1) The ideal technique of thyroidectomy for a given patient depended on logistics, expertise and patient choice rather than disease (goiter) related factors

2. Introduction

Goiter is a very common endocrine disease requiring surgical thyroidectomy for various indications [1, 2]. Open thyroidectomy through lower anterior neck incision is the most common approach employed till date. Various endoscopic thyroidectomy techniques through novel routes such as trans-axillary, post auricular, robotic, trans chest wall and transoral have been attempted in the past two decades [3-9]. But, the availability of plethora of options led to confusion amongst patients, young consultant surgeons in selecting appropriate technique for a particular disease. Most of the ET studies in literature emphasize on feasibility, safety and cosmetic aspects of their reporting technique. Very few studies reported comparision of different techniques [10, 11]. Lack of uniform consensus and specific indications for each technique, furthers this conundrum of appropriate choice of a procedure. This lacuna in literature prompted us to analyse our experience with specific emphasis on deducing an algorithm on ideal thyroidectomy.

3. Material and Methods

This is a retrospective study conducted at a tertiary care endocrine surgery department in Southern India over the period of 10 years from July 2009 to June 2019. All the clinical, investigative, operative, pathological and follow-up data were collected from our prospectively filled database. Our experience with standard techniques of thyroidectomy – open, gasless trans-axillary, trans-axillary (gas) and trans-oral routes were chosen as templates. Above techniques were analysed with the specific emphasis on choice of technique based on disease related, non-disease related, patient factors. Specific questionnaire on choice of thyroidectomy technique was employed in each subject (through one or more of communication modes – physical followup, email, telephonic enquiry) to supplement the documented information. All the cases, who underwent surgical thyroidectomy during the study period with

complete information and follow up data were included. Exclusion criteria were cases with incomplete data, operated elsewhere and lost to follow up cases.

Based on the available data, we categorized all the clinico-investigative, logistic and patient factors influencing the choice of thyroidectomy technique in to four types A, B, C and D. Type A included disease related factors – goiter size, vascularity, local invasiveness, need for lymph node dissection ; Type B included logistics related factors – surgeon's preference, expertise of surgical team, availability of equipment, financial affordability of patients, provision of health insurance ; Type C factors included comorbidities – severe renal, cardiac, pulmonary, cerebrovascular or hepatic disease; Type D included patient and their family choice related factors. Goiter was graded based on WHO criteria in to grade 0, 1 and 2 [12]. Small goiter was defined as grade 0 or 1 goiter or largest size of nodule more than 4 cm. Large goiter was defined as grade 2 and nodule size more than 4 cm. Early malignancy was defined as locally non-invasive malignancy. High grade malignancy was defined as locally invasive goiter with invasion of surrounding visceral structures in neck. Based on our observations, a sequential four tier algorithm was developed to determine an ideal choice of thyroidectomy technique for a given patient (Figures 1-4).

The study complied with the international ethical norms of the Helsinki Declaration – Ethical Principles for Medical Research Involving Human Subjects, 2004 [13]. Statistical analysis was done with SPSS 20.0 version. Descriptive analysis was done.

Figure 1: Tier I (Disease related factors) influencing choice of thyroidectomy technique

Figure 2: Tier II (Logistics related factors) influencing choice of thyroidectomy technique

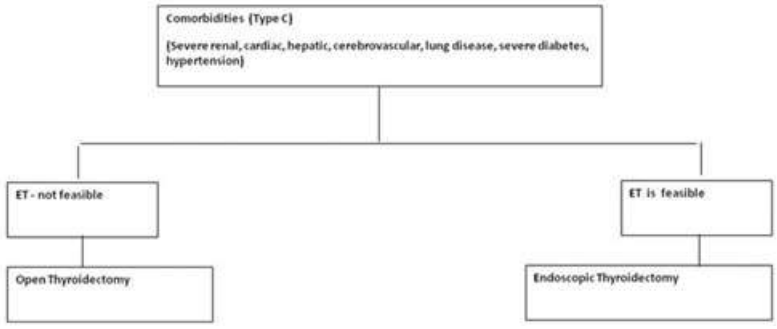

Figure 3: Tier III (Comordities) influencing choice of thyroidectomy technique

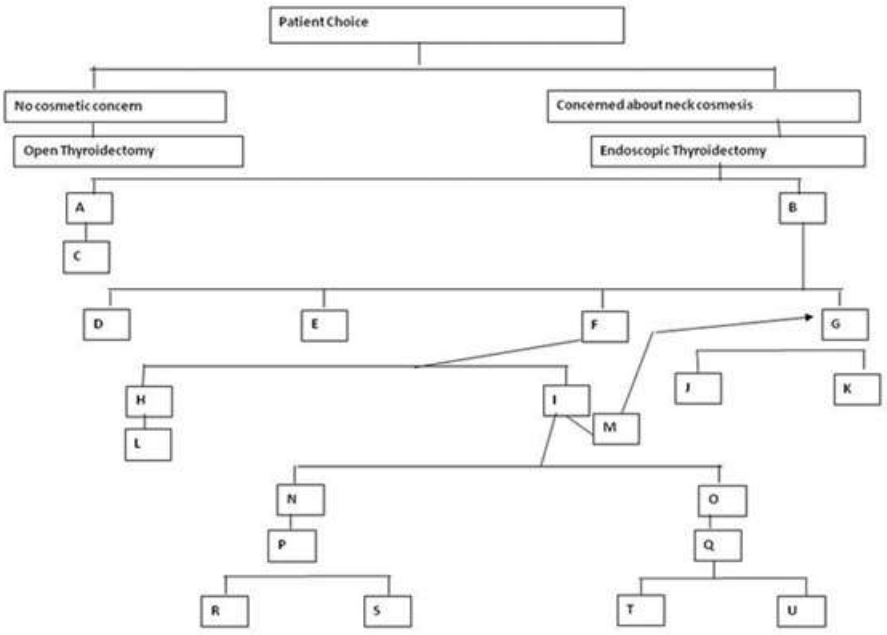

Figure 4: Tier IV, Patient and family Choice factors - A) wants minimal scar in neck; B) wants no neck scar; C) MIVAT; D) Post-auricular ET; E) Chest wall; F) Axillary route; G) Trans-oral ET; H) Affordability is not an issue; I) Affordability is an issue/ unavailable robotic facility; J) Robotic (available and affordable); K) Manual (less affordable and unavailable robotic facility; L) Robotic approach; M) No axillary scar; N) No risk factors for hypercarbia; O) Presence of risk factors for hypercarbia; P) Gas based ET; Q) Gasless ET; R) Bilateral approach; S) Unilateral; T) Bilateral; U) Unilateral

3.1. Validation of the Algorithm

We employed this sequential four tier algorithm in a prospective pilot study on patients undergoing thyroidectomy over a period of 6 months from July 2019 to December 2019. For the purpose of validation, four tier algorithm was used for deciding ideal choice of thyroidectomy technique in 154 patients. Results of validation are detailed in Table 3. Type A, B, C factors ruled out the feasibility of ET and favoured the choice of OT in 108/ 154 subjects. 24/ 46 remaining subjects had no cosmetic concerns and left the choice to surgeon. Based on this DI factor, 20/ 24 underwent OT and remaining four subjects underwent ET. The remaining 22 subjects underwent endoscopic thyroidectomy based on various DII to DVII factors. Patients were more convinced and gained clarity on chosen thyroidectomy technique, with this algorithm.

3.2. Brief Notes on our Operative Techniques

All the cases were performed by the operative team - the primary Operating Surgeon (OS) and two Assisting Surgeons (AS). In all the patients, procedure was performed under General inhalational anesthesia, except in 3 cases (nerve block and local anaesthesia were used)

3.2.1. Open thyroidectomy (OT): This was conventional technique of thyroidectomy through a 4-10 cm transverse skin crease incision in front of neck overlying the goiter based on its size and morphology. Extended incision and/ or additional incision was employed in cases of lymph node dissection. The rest of the operative steps were sequential dissection in anatomical planes to complete the excision of goiter. Wound was closed in layers after hemostasis.

3.2.2. Gasless Trans-axillary thyroidectomy [TAT (GL)]: Patient was placed in 20° reverse Trendelenberg position with neck extended. The ipsilateral arm was abducted to 90° and elbow flexed such that hand stays besides the head. The surface markings of relevant anatomical landmarks such as clavicle, Anterior Axillary Line (AAL), Sternocleidomastoid (SCM) and jugular notch were made. A 4-5 cm long skin incision was used 1 cm posterior and parallel to AAL. Skin incision was deepened up to pectoral fascia. Endoscopic dissection was performed underneath pectoral fascia. Thyroid bed was entered through the avascular area between the two heads of SCM. The sternal head of SCM and strap muscles are retracted by AS to the opposite side. For total thyroidectomy similar procedure was repeated on contralateral side. For hemithyroidectomy, ipsilateral goitre was resected after incising the isthmus. The resected specimen was delivered through axilla. More technical details are available in our previous publication [14].

3.2.3. Trans-chest wall thyroidectomy (TCT): Operative steps similar to TAT (except for site of access) were used for Trans-chest wall endoscopic thyroidectomy. A 4-6 cm infraclavicular, anterior chest wall incision was used in gasless TCT and 3 ports for TCT with CO2 gas technique, for accessing the goiter.

3.2.4. Trans-axillary thyroidectomy with Gas [TAT (G)]: The position and surgical markings of patient is similar to TAT (GL). After elevating the flaps subpectorally, three ports are used in triangulated manner. Two 10 mm and one 5 mm ports were used. Harmonic shears was used for dissection and hemostasis. This technique was used both for total and hemi thyroidectomy.

3.2.5. Trans-oral thyroidectomy (TOT): The decubitus of patient

is supine with 30° reverse Trendelenburg position and extension of neck with arms placed by the side of chest. After draping, neck and oral cavity (lips, lower vestibule and chin) are prepared. A 10 mm frenulotomy incision was placed and dissected through orbicularis oris muscle up to chin with diathermy. Two 5 mm lateral incisions were placed in lower vestibule over lower lip, 2 cm away on either side of frenulotomy site. Hydrodissection was used to create adequate operative space. Rest of the procedure was similar to endoscopic thyroidectomy. The detailed operative steps are available in our previous publication [15]. After removing the trocars, interrupted stitches with 3-0 monocryl were applied to the oral mucosa of port sites.

4. Results

During the study period of 120 months, 2075 eligible subjects constituted our study cohort. OT was performed in 1794/ 2075 (86.5 %) cases. ET was employed in 281 subjects. TAT (GL), TAT (G), TCT, TOT was employed in 66, 15, 48 and 152 subjects respectively. The mean age of the OT group was 41.5 ± 11.5 years (14-79) and the mean age of ET group was 28 ± 9.2 years (16-49) . Mean operative time for TAT (GL), TAT (G), TCT and TOT was 123.4 ± 12.3 (82-206) minutes, 115 ± 9.5 (94-232) minutes, 135 ± 15.4 (102-184) minutes and 103.7 ± 15 (115-196) minutes. Mean operative time for OT was 97.5 ± 43.4 (42-323) minutes. Total thyroidectomy was performed in 1422/ 1794 (79.3 %) and hemithyoidectomy in 372/ 1794 (20.7 %) in OT group. Hemithyroidectomy was performed in 255/ 281 (90.7 %) and total thyroidectomy in 26/ 281 (9.3 %) subjects in ET group. Two cases undergoing ET had to be converted to OT due to hypercarbia related cardiac arrhythmia. Two cases undergoing ET were converted to OT due to intraoperative bleeding. The overall incidence of temporary hypocalcemia was 18 % and permanent hypocalcemia in 2 cases. The incidence of recurrent laryngeal neuropraxia was 0.3 %. In OT group, histopathology was colloid nodules (859), nodular hyperplasia (274), Graves' disease (111), Hashimoto's thyroiditis (72), follicular adenoma (168), papillary thyroid cancer (229), follicular cancer (47), medullary cancer (34). In ET group, histopathology was colloid nodules (92), nodular hyperplasia 8), follicular adenoma (137)), Graves' disease (4), Hashimoto's thyroiditis (9), papillary thyroid cancer (25), minimally invasive follicular cancer (6). Follow up duration for the entire cohort was 45 ± 11.2 months (12 – 120).

The frequency of thyroidectomy techniques based on Type D factors are detailed in Table 1. Type A to C factors, bifurcated the choice of technique to OT and ET without the need for Type D factors. A to C factors bifurcated the entire cohort in to ET non-feasible and ET feasible groups, which included 538 and 1537 subjects respectively. Type D factors primarily dictated the choice of various available ET techniques in these latter 1537 subjects. Further, DI,II and VII factors directed 95 %, 86 % and 92 % of the ET feasible subjects respectively to OT. DIII, IV, V, VI factors dictated the choice of a particular ET technique as shown in Table 2. Type DVI factor (presence of cardiac disease or chronic pulmonary disease) specifically deemed to be a risk factor for CO2 insufflation related complications, dictated the use of gasless ET technique in eleven patients.

Table 1: Type D factors influencing final choice of thyroidectomy technique

Parameter *	OT (N =)	MIVAT ** (N =)	Chest ET (N =)	TAT	TAT-G	TOT	Robotic **
I (886)	862	-	3	3	4	14	-
II (103)	89	-	-	2	4	8	--
III (54)	-	-	12	15	13	16	-
IV (78)	-	-	-	26	22	30	-
V (75)	-	-	-	2	5	68	-
VI (11)	-	-	-	11	-	-	-
VII (330)	305	-	-	9	-	16	-

*Number of patients befitting this each particular parameter as shown in parenthesis ** Not applicable as either we do not perform or unavailable facility

I – No cosmetic concern; II – favoured only a minimal scar in neck; III – wanted no neck scar; IV – wanted only axillary approach; V – wanted only oral approach; VI – presence of comorbidites precluding CO2 insufflation; VII – patient's family choice.

5. Discussion

Goitrous thyroid disease due to goiter, autoimmune Graves' disease, malignancy and nodules is the commonest endocrine disease. Incidence of nodular goitres of the thyroid is as high as 5-12% in large population studies both in the developing world and the Western world [1, 2]. Goitrous thyroid disease often needs thyroidectomy in the form of hemithyroidectomy, subtotal or total thyroidectomy. Traditional approach through horizontal skin crease neck incision for thyroid exploration was done for the most part of the 20th century and continues to be the most common technique for thyroidectomy.

A study of the historical journey of thyroidectomy reveals how it was evolved by passionate endocrine and neck surgeons through various phases to the present era of minimal access surgery [16]. Increasing confidence and experience in laparoscopic surgical skills have permeated into endocrine surgery after demonstration of endoscopic parathyroidectomy and thyroidectomy in 1996 by Gagner [3]. Later, Husher reported first ET in 1997 [4]. Later, Miccoli developed and reported the technique of minimally in-

vasive video-assisted thyroidectomy (MIVAT) in 1999, which is performed through a 1.5–2 cm transverse incision in lower anterior neck [5]. Although open conventional neck approach is still the most common approach worldwide, a plethora of ET techniques ranging from totally endoscopic, video-assisted, transaxillary, robotic, post-auricular, lateral neck and chest-wall approaches have been already attempted [3-9] Likewise, both gas dependent and gasless techniques have been attempted. Although none of them are validated universally, focussed mini thyroidectomy and minimally invasive neck thyroidectomy approaches are favoured alternatives by the majority [17, 18]. Efficacy wise, conventional cervicotomy, lateral and MIVAT techniques are comparable, but there is no gold standard alternative ET to conventional OT through the neck.

One of the main objective of any ET technique is best cosmesis with an indistinct scar. The real need for an extracervical ET emerges, when cosmesis is the major concern for young and unmarried men/ women. Furthermore, it avoids the wound/scar-related morbidities such as hypertrophic scar/keloid formation (in dark skinned) and ugly scar, especially in fair-skinned individuals. The gasless axillary approach makes it difficult to visualize the opposite lobe. To counterbalance this situation, we employed a similar procedure on contralateral side through its corresponding axilla for total thyroidectomy. This bilateral axillary approach for total thyroidectomy was not associated with any extra morbidity compared to unilateral approach and ensures better identification of RLN and PTG on both sides. Gasless trans-axillary techniques have been reported in the past [19-22]. Kang et al., described a similar technique, but employed a subcutaneous route with an additional 5 mm chest wall port. We found that dissection in the subfascial plane was easier and associated with lesser subcutaneous bruising. Robotic transaxillary technique with similar approach is reported, but is feasible in very few centers [23]. We also showed that total thyroidectomy with gas dependent single axilla approach is feasible, though ergonomically challenging to the surgeon. Transoral thyroidectomy circumvents all the above cosmetic and ergonomic concerns, as the healing of oral mucosa is brisk and complete, without visible anywhere on the body. Our results justify these observations and details on this technique are reported in our earlier paper [15].

The other objectives of any ET technique are curative resection, lower morbidity and feasibility. Though most of the available ET techniques have been proved to be safe, they occasionally cause complications. While the morbidities in OT and ET are similar, the only unique and documented complication of gas-dependent ET was related to hypercarbia – subcutaneous emphysema, mediastinal emphysema and cardiac arrhythmias [24, 25]. Especially, patients with comorbid conditions such as hypertension, diabetes and chronic obstructive airway disease are susceptible to the complications. These complications are related to CO2 insufflation pressures, length of surgery, susceptibility and comorbid conditions of the patient. Lower CO2 insufflation pressures, intensive end tidal CO2 monitoring (EtCO2), intra-operative Arterial Blood Gas analysis (ABG), intermittent desufflation, shorter operative times, proper patient selection have been recommended to counter these gas related complications [26]. On the contrary, gasless techniques are very safe as it nullifies the whole gamut of gas related morbidity. The only practical disadvantage of gasless over gas dependent technique is inadequate operative space compared to gas based techniques.

Open cervicotomy technique proven to be feasible for thyroidectomy irrespective of goiter size, pathology, functional status or age of patient. ET is comparatively more difficult than open technique, due to ergonomic, expertise, experience, equipment constraints and morbidity concerns. ET has been successfully performed for solitary thyroid nodule, Graves' disease, multinodular goiter, low-risk differentiated thyroid cancer, central compartment neck dissections as demonstrated by many studies [27-30]. Large and invasive thyroid cancers, cases with extensive lymphadenopathy and highly vascular goiters precluded ET visavis OT, due to inadequate operative space and concern of incomplete tissue clearance.

As women are predominantly affected with thyroid disease, endoscopic procedures with minimal or no scar in the neck are in demand. According to anatomical access, ET can be performed through cervical, extracervical (chest wall, transaxillary, transoral, transauricular), or combined or robotic approaches [9, 20, 29]. Irrespective of different approaches for access, the operative steps around the thyroid gland are similar to open thyroidectomy. Thorough knowledge of thyroid surgical anatomy and extensive experience in standard thyroidectomy were mandatory to achieve optimal results with ET. Choice of laparoscopic instruments for dissection and hemostasis depends on surgeon's experience.

Another practical aspect in making ideal choice of thyroidectomy technique is surgeon's experience factor. This choice conundrum is less pronounced with a senior surgeon, as they tend to be more dogmatic and patients tend to accept his choice based on reputation. Moreover, it is known that very few senior surgeons are ready to learn the newer ET techniques and tend to offer OT to patients. While OT is a time tested and safe technique, a deserving patient may miss ET advantages, because of this bias. Though a younger surgeon is more skilled and updated, he is less experienced in thyroidectomy. To circumvent this bias, we need a mature decision based on factual discussion between surgeon (based on his skills and experience) and patient (choice and specific concerns) for the best thyroidectomy technique in that given patient.

The availability of wide range of options leads to confusion amongst young surgeons in selecting appropriate technique for a particular goiter. This dilemma affects the patient, who is in search of the best hospital and best thyroidectomy technique for his/ her goiter. Lack of uniform consensus and specific indications for

each technique, furthers this conundrum of appropriate choice of a procedure. Moreover, we learnt that every technique has its own unique set of advantages and disadvantages. Most of the ET studies in literature emphasized on feasibility, safety and cosmetic aspects of their reporting technique. There is a dearth of information on the ideal technique for an individual patient. In this context, we propose an algorithm based on most of disease related, non-disease related, social and patient factors, which we opine is the most contemporary one as it is based on available experience (both ours and published literature). Further, we opine that each institute can develop their own algorithm based on above and other local factors. Our proposed algorithm offers a representative model to make ready-made choice of ideal thyroidectomy technique for patients and young surgeons in the absence of universal consensus.

6. Conclusions

Based on this study, we opine that:

1) Disease (goiter) related factors guided in performing open versus endoscopic thyroidectomy

2) The ideal technique of endoscopic thyroidectomy for a given patient depended more on logistics, expertise and patient choice rather than disease (goiter) related factors

3) Though, we are far from developing an ideal algorithm for choosing a particular technique, the ideal technique depends on local logistics, institutional protocol, surgeon choice and patient concerns.

4) Our proposed algorithm appears to be a contemporary, all inclusive chart to make decision on the ideal choice of thyroidectomy technique for patients and surgeons.

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