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Advancements and Controversies in Thyroid Surgery: Indications, Techniques, and Complications and Pain Management

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Abstract

Introduction: Thyroid surgery has evolved significantly, with ongoing debates surrounding indications, techniques, and postoperative outcomes. Historically, total thyroidectomy was the standard approach for both benign and malignant thyroid diseases. However, more conservative methods, like thyroid lobectomy, have gained traction, especially for well-differentiated thyroid cancer (WDTC). Additionally, minimally invasive and transoral techniques are emerging as potential alternatives to improve patient outcomes and reduce scarring. This review explores these developments and examines the challenges associated with thyroid surgery, particularly postoperative complications. **Methods:** This narrative review synthesizes recent literature on thyroid surgery, focusing on total thyroidectomy, thyroid lobectomy, and hemi-thyroidectomy for benign and malignant thyroid conditions. It also evaluates the impact of minimally invasive and transoral approaches, along with common postoperative complications such as recurrent nerve palsy, hypocalcemia, and hematoma, and their management strategies. **Results:** Thyroid lobectomy has shown to be a safe and effective alternative to total thyroidectomy for low-risk WDTC, offering similar outcomes. Minimally invasive and transoral techniques have improved cosmetic results and reduced recovery times, though they require specialized skills. Postoperative complications, including recurrent nerve injury and hypocalcemia, remain significant but manageable with proper monitoring and early intervention. **Conclusion:** Thyroid surgery has shifted toward more conservative approaches, such as thyroid lobectomy, and newer minimally invasive techniques. While these advancements offer improved patient outcomes, the management of complications remains crucial. Continued research and collaboration are key to refining surgical practices and enhancing patient care.

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Introduction:

Since late nineteenth century thyroid surgery has changed in many ways .On the other hand, the surgical indications for benign and malignant disease have also continued to develope and caused some controversies.(1)

For example, the 2015 ATA (American Thyroid Association) guidelines recommended thyroid lobectomy for the management of WDTC (Well-Differentiated Thyroid Cancer)(2) Previously, thyroid lobectomy wasn't performed often. Some studies have shown that the extent of surgery may effect recurrence and survival in PTC (3). Therefore, there was hesitation to move towards more conservative treatment. Since then, satisfying evidence has shown that thyroid lobectomy can be a good replacement for total thyroidectomy in particular situations.(4-7)

Hemithyroidectomy and thyroidectomy

Hemithyroidectomy and thyroidectomy are often performed for benign thyroid disease in practice. The surveys show that we have increasing risks with the extent of the resection. Therefore, the risks and indications should be weighed-up and evaluations must be done on both sides.(8) For example Selective morphology- and function-related resection is generally used as the surgical treatment of choice for benign goiter causing iodine deficiency. In this operation all nodules are removed in order to prevent reoperations for recurrency. This option is often declined because of the anticipation of more complications. In a study, a number of patients who underwent total thyroidectomy were checked. A comparison between them and data collected from patient undergoing hemithyroidectomy or subtotal resection showed that the rate of complications associated with total thyroidectomy, specifically, recurrent nerve palsy, hypocalcemia, wound infection, and secondary hemorrhage, did not differ significantly from that associated with subtotal resections/hemithyroidectomies. These findings shows that total thyroidectomy is an satisfying surgical replacement for benign multinodular goiters.(9)

However generally speaking the risks and post-operative sequela of total thyroidectomy are greater than that of lobectomy.(7, 10) Furthermore, thyroid for example lobectomy expunges the rare but severe complication of bilateral RLN injury. Total thyroidectomy needs life-long TSH replacement.(7) Malignancy is known to be the most obvious indication for thyroid surgery, but other indications are also not rare..(11)

The surgery of thyroid for patients with low- and intermediate-risk differentiated thyroid carcinoma (DTC), with a primary tumour <4 cm and no extrathyroidal extension (ETE) or lymph node (LN) metastases is controversial whether patients with these risk factors should have complete thyroidectomy and/or radioactive iodine remnant ablation or should be checked without further treatments. Notably, the recurrence rate in patients who underwent thyroid lobectomy is low and the. These findings offers a more conservative approach for management strategy over immediate completion surgery, eventhough the recurrence risk may be higher.(12)

As for neoplastic lesion despite total thyroidectomy (TT) is the mostly practiced, according to the ATA guidelines, many surgeons perform completion thyroidectomy (CT) after hemithyroidectomy .As expected CT has a higher complication rate than the primary procedure .CT following hemithyroidectomy can be performed .(13).

One of the most frequent malignancies is differentiated thyroid carcinoma (DTC). Unfortunately, surgical treatment of thyroid diseases is still controversial. Total thyroidectomy (TT) has been considered the best treatment for DTC since it eliminates the potential residual risks (14).There is an increasing trend in performing TL(Thyroid Lobectomy) over TT regarding thyroid cancer. (15) (12) The lobectomy is sufficiently performed for sub centimeter and unifocal cancer, low-risk cancer in the absence of pathological lymph nodes. However the choice still remains controversial.(16) Pediatric thyroid diseases requiring surgery is uncommon and causes more complications in adults. Thyroid disorders requiring surgery in the pediatric population include Grave's disease (GD), thyroid cancer and non-cancerous nodules. When surgery is performed for patients for GD, near-total or total thyroidectomy is normally suggested. When surgery is performed for patients with thyroid cancer, total thyroidectomy is recommended. The treatment for Isolated nodules without preoperative evidence of cancer may be lobectomy or near-total thyroidectomy. As expected, complication rates for thyroidectomy are higher in children than adults. (17-20)

As for Grave's disease near-total or total thyroidectomy is suggested, since subtotal thyroidectomy is associated with a higher relapse rate. (20, 21) Surgical options for DTC include total thyroidectomy, near-total thyroidectomy, subtotal thyroidectomy, or lobectomy and as claimed earlier the option still stays controversial.(20, 22)

At the end considering diseases like Grave's disease, cold thyroid nodules and head, neck, and thorax irradiation during childhood, cold dominant nodule of the thyroid, papillary follicular carcinoma, four medullary carcinoma, anaplastic or small cell carcinoma, and reticulum cell sarcoma options for thyroid surgery should be chosen. However, the multifold risk of

complications in a second neck exploration, plus the anesthetic risk and the time delay when further surgery was then needed after a subtotal procedure, are completely prevented by performing total thyroidectomy primarily. Thus, when surgery is indicated for the management of Grave's disease, thyroid nodules and childhood irradiation, and cold dominant nodules of the thyroid suspected of carcinoma, it is highly recommended that total thyroidectomy be performed.(23)

Approach and methods for thyroid surgery

In thyroid surgery multiple different cervical minimally invasive (partly endoscopically assisted) and extracervical endoscopic (partly robot-assisted) approaches have been developed in the last 20 years. The indications for the use of alternative and conventional approaches are principally the same. The alternative approaches to the thyroid gland can be divided in cervical minimally invasive, extra cervical endoscopic (robot-assisted) and transoral operations (natural orifice transluminal endoscopic surgery, NOTES). Conventional thyroid operations are standardized procedures with low complication. The request for a perfect cosmetic result should not overweigh patients' safety. Only a few alternative approaches (e. g. MIVAT, RAT) can yet be considered as a safe addition in experienced hands in highly selected patients.(24)

There are many described endoscopic approaches for thyroid surgery. The most common cervical approach is the minimally invasive gasless video-assisted cervical technique. The robotic trans axillary, retro auricular, and axillary breast approaches avoid a neck scar and are becoming popular. Thyroid surgery has evolved throughout the years, from being one of the riskiest surgeries into one of the safest surgical procedures performed today. Recent technologic innovations have allowed surgeons to remove the thyroid gland from a remote site while avoiding visible neck scars.(25)

Transoral thyroidectomy

Transoral thyroidectomy is a kind of “natural orifice transluminal endoscopic surgery (NOTES)” which is now being performed in increasing frequency. However, the safety and feasibility have not been concluded yet.(26) Wilhelm and Metzig(27) was considered to be the first surgeon to perform transoral endoscopic thyroid surgery in clinical practice.

One of the advantages of such surgical methods is that they leave no visible scar on the neck, compared to the conventional open thyroidectomy. However, accessing the thyroid from a different site resulted in a longer incision on other sites, wider flap dissection range, and longer operation time. In the transaxillary and the retro auricular approaches, a 5~6 cm, or more, incision scar can be seen in axilla or hairline behind the ear. These approaches have a major drawback; that is, operating on the contralateral thyroid is challenging because the incision is only made on one side.(28)

History

For more than 100 years, thyroid surgery has been safely performed via an anterior neck incision (29). This scar heals well in the majority of patients, with generally acceptable cosmetic outcomes. Despite this, nearly 20% of patients will experience some feelings of self-consciousness years after thyroid surgery, while more than 10% will consider further treatments such as plastic surgery to improve the appearance of their scars(30). The impact of a cervical incision on the health-related quality of life (HRQOL) was found to be similar to the impact of vitiligo, psoriasis, or severe atopic dermatitis in one series(31). Because excellent cosmesis cannot be guaranteed, remote-access thyroid surgery has evolved to address the potential morbidity of an anterior cervical incision(32). Unfortunately, the perception of a scar can vary between patients and surgeons, further impairing the ability of patients to achieve optimal cosmesis (33-36)

Transoral endoscopic parathyroidectomy vestibular approach (TOEPVA)

TOEPVA can also be performed for select patients with localized primary hyperparathyroidism (HPT). Those without parathyroid adenoma localization, recurrent or persistent primary HPT, suspected multigland disease, secondary or tertiary HPT, family history of MEN, suspected parathyroid carcinoma, or previous central neck surgery or neck irradiation therapy should be excluded from consideration. Similar to TOETVA, the patient should also be highly motivated for a “scarless” approach. The authors recommend two imaging modalities with concordant findings, usually surgeon performed ultrasound and sestamibi with multi-phase CT, for localization prior to offering TOEPVA. This has shown to have a positive predictive value of up to 99% for localization.(35, 37)

Pain management

Pain management in thyroid surgery is an integral component of the recovery process and directly influences patient outcomes, including satisfaction, recovery time, and the risk of complications. While advancements in surgical techniques—such as minimally invasive, robotic-assisted, and transoral thyroidectomy—have significantly reduced the physical trauma associated with traditional thyroid surgeries, pain management remains a critical focus. These

modern approaches often lead to smaller incisions, reduced scarring, and lower postoperative pain, but the need for effective pain control continues to be an essential part of patient care.

The key to effective pain management in thyroid surgery lies in a multimodal approach, combining local anesthetics, non-opioid analgesics, and, in some cases, nerve blocks to control pain while minimizing opioid use. By reducing reliance on opioids, which are associated with adverse effects such as delayed recovery, nausea, and potential long-term dependence, a comprehensive pain management plan can help improve the patient's overall surgical experience. Several studies have shown that the combination of local anesthesia and non-opioid analgesics, such as acetaminophen or NSAIDs, provides sufficient pain relief, especially in the immediate postoperative period.

Additionally, complications like hematoma, recurrent laryngeal nerve (RLN) palsy, and hypocalcemia can exacerbate postoperative pain and lead to further discomfort, complicating recovery. For example, a hematoma in the neck, if not managed promptly, can cause significant pain and airway compression, requiring additional surgical intervention. Therefore, careful postoperative monitoring is essential for identifying such complications early and implementing timely interventions. In cases of RLN injury, patients may experience pain due to vocal cord dysfunction and difficulty swallowing, which can significantly impact their recovery experience.

The emergence of transoral thyroidectomy, which aims to avoid visible neck scars, has introduced new challenges in pain management. While the aesthetic advantages of this approach are clear, it may result in increased operating time, a more complex dissection area, and longer recovery periods compared to traditional methods. However, for patients seeking "scarless" surgery, managing the pain associated with these alternative approaches becomes even more crucial. Moreover, the learning curve associated with these newer techniques means that proper pain control during the procedure and in the postoperative phase is vital to ensure a smooth recovery process.

Furthermore, patient education and personalized pain management plans are vital in addressing individual pain thresholds and expectations. For instance, patients undergoing total thyroidectomy or more extensive resections may experience more intense postoperative discomfort than those undergoing lobectomy, and pain management strategies must be adjusted accordingly. Providing clear communication about what to expect after surgery, discussing options for pain relief, and ensuring adequate follow-up care can also improve patient outcomes.

Overall, while modern thyroid surgery techniques have greatly minimized the invasiveness and physical impact of the procedure, managing postoperative pain remains a priority to enhance recovery and patient satisfaction. Tailoring pain management protocols to the specific surgical technique used, the patient's medical history, and the presence of any complications is essential. A well-coordinated approach that combines the expertise of surgeons, anesthesiologists, and pain specialists can significantly improve the postoperative experience, reducing both pain and the risk of long-term discomfort or complications. Effective pain management not only aids in physical recovery but also contributes to the overall success of thyroid surgery by improving the patient's quality of life and promoting faster return to normal activities.

Limitations

Similar to other novel surgical techniques, transoral vestibular approach surgery is limited by increased operating time, a notable but reasonable learning curve, unique complications (generally minor, as above), and rigid patient selection criteria. (TOET/PVA) has significantly longer operative times than the conventional transcervical technique in all described case series, perhaps due to port placement and flap dissection(38). The largest series by Anuwong et al.(39) reported significant differences in mean operative times of 78.6 versus 64.2 minutes for lobectomy via TOETVA and the open approach, respectively, and 135.1 versus 103.3 minutes for total thyroidectomy via TOETVA than the open approach, respectively. The experience with TOEPVA has been more limited than TOETVA thus far. Sasanakietkul et al.'s 12-patient series from Thailand demonstrated the safety of the procedure while achieving biochemical cure of primary hyperparathyroidism without major complications (40). One temporary recurrent laryngeal neve palsy was reported. This experience has presented more than 20 cases(35, 41).

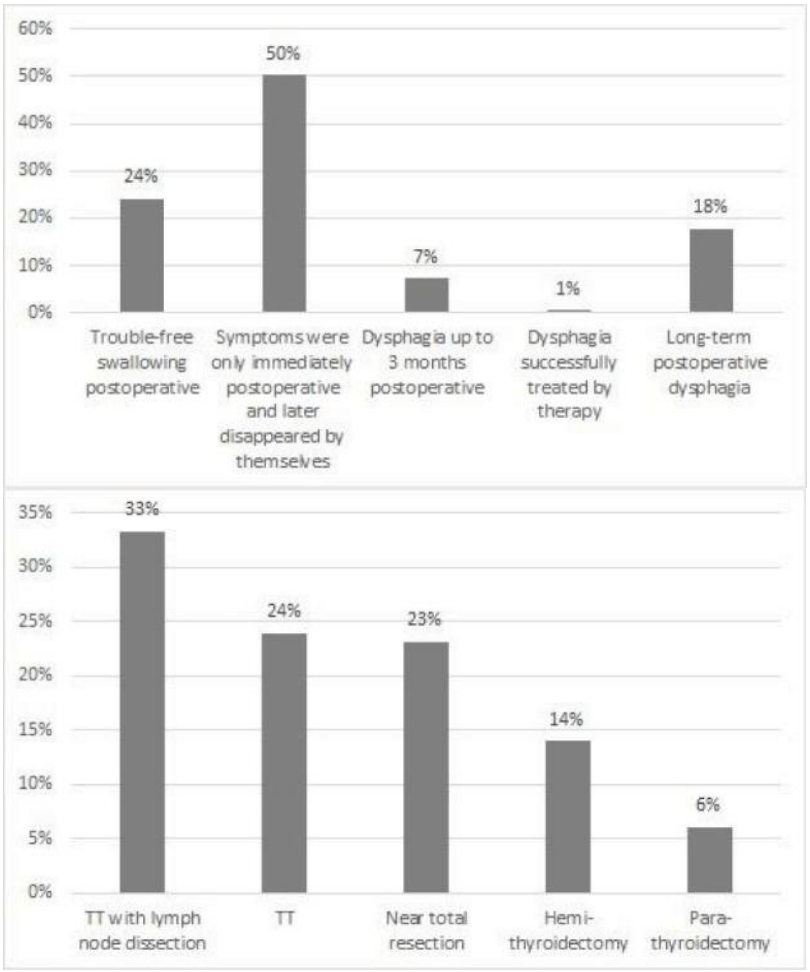
Potential complications

Novel complications associated with transoral vestibular approach surgery include mental nerve injury, chin flap perforation, and oral commissure or inferior labial frenulum tear. Revised positions of vestibular incisions to decrease the incidence of nerve injury have been implemented in some series. Previous reports of the transoral vestibular approach documented a high complication rate (15.6–100%) for mental nerve injury with the use of the robotic-assisted technique due to the 5 mm incisions in close proximity to the center incisions(27, 42, 43). Since then, both 5 mm incisions have been relocated, allowing for greater

mobility of the lip and decreasing tension on the mental nerve where it exits the mental foramen.(35)

Outcomes

Medical records were reviewed for patient characteristics and outcomes, including operative time (incision to closure time), estimated intraoperative blood loss, and pain as measured by the visual analog scale (VAS). Mean values and values for the first 3 days postoperatively were reported. Complications were identified. An RLN injury was defined as impaired movement of one or both vocal cords on laryngoscopy. A permanent RLN injury was defined as an injury that did not recover within 6 months. Seroma that required aspiration was recorded. Hypoparathyroidism was defined as a parathyroid hormone level less than 13 pg/mL (to convert to nanograms per liter, multiply by 1) 24 hours postoperatively. Permanent hypoparathyroidism was defined as no recovery within 6 months.(44, 45)Mental nerve injury was characterized as lower lip paresthesia after surgery. Hematoma was defined as obvious postoperative bleeding that caused neck swelling and required a subsequent operation. Infection was defined as postoperative local abscess or high-grade fever with evidence of systemic bacterial spread that required treatment.(39)



hematoma – dysphagia and edema in thyroid surgery

Hemodynamic shock and even death occur as a result of intraoperative bleeding during thyroidectomy. Efforts to control bleeding can increase the running time of the operation and may put other organs near thyroid at risk. Postoperative bleeding on the other hand sometimes requires reoperation, and may prolong the hospitalization and the recovery duration.(46)

Bleeding after thyroid surgery is a very sensitive emergency(47) Age, gender, or surgeon weren't effective on reoperation for bleeding. Patients who undergo total thyroidectomy tend to need reoperation for bleeding more often compared to others who undergo hemithyroidectomy(47)

Postoperative hemorrhage can cause airway compression and respiratory distress. Almost all postoperative hematoma cases occur in the first 6 h after

surgery and several surgeon or patient factors can be effective .(48)

Even though most hematomas need to be evacuated and reexplored, only anprogressively worsening hematoma in a patient necessitates immediate evacuation at the bedside..(49)

A study showed that thyroid bed and strap muscles/sternocleidomastoid were the most common origination for hematoma within 24 h after thyroid surgery.(50)

Some analytic data suggests that the change in surgical technique over the past three decades did not lower the risk of postoperative bleeding. On the contrary, the risk of postoperative bleeding increased, reflecting more extensive thyroid resection(51, 52)

On the other hand the harmonic scalpel and LigaSure systems have been shown to notably decrease operative times without increasing costs or complications(48)

Although the use of a hemostatic agent and drain are suggested in some special cases ,normally postoperative drain use isn't common in routine thyroid surgery because it increases hospital stay and pain but doesn't affect patient outcomes (48)

In the past several decades economic pressures have increasingly driven the evolution of medical practice. Ambitious goals have been set for same-day discharge or 1-day surgery. But postoperative complications like hematoma or dysphagia can be an obstacle here.(51, 53, 54)

Dysphagia is frequently reported after thyroidectomy. Factors like post-operative scarring, modification in the vascular supply, or damage to tiny branches of the recurrent laryngeal nerve going to the cricopharyngeal muscle can cause dysphagia (55, 56). As claimed in a study there is no association between dysphagia and patients' age or gender, the specimen volume, and patients' body mass index. But the rate of incisively of operation was effective on dysphagia. According to analytic data the frequency of dysphagia regarding to different diagnoses, a significant risk of postoperative dysphagia was found in patients with Graves' disease and carcinoma. Patients who underwent operation for hyperparathyroidism were at a very lower risk for dysphagia.

The results of one study confirm that patients frequently go through postoperative swallowing problems.(56)

In the early postoperative weeks after thyroidectomy, swallowing impairment is self-explanatory and is reported by most patients.(55)

It is often overseen in patients who had uncomplicated thyroid surgery without nerve palsy, and those patients therefore do not receive the appropriate follow-up and cares. Acoording to the the large number of patients who may experience subjective thyroidectomy-related dysphagia, patients should be preoperatively and postoperatively questioned and followed-up about swallowing symptoms(57)

As shown in a study of four hundred patients undergoing thyroid surgery for benign thyroid disease, 13.5 percent laryngeal edema was noted laryngoscopically.

The occurrence of edema increases in younger patients, in patients with toxic goiters, and in those undergoing more radical procedures. In this study edema developed in the majority of patients on the first and second postoperative day, was mainly supraglottic.(58-60)

Laryngeal edema is mostly the outcome of major operative trauma to the neck and occasionally of intubation problems.(59)

Conclusion

Thyroid surgery has undergone significant transformations over the years, marked by advancements in techniques, evolving indications, and ongoing controversies. The journey from total thyroidectomy as the gold standard to the acceptance of more conservative approaches like thyroid lobectomy underscores the importance of evidence-based practice and personalized medicine. As our understanding of thyroid diseases continues to deepen, clinicians must navigate the complexities of surgical decision-making, weighing the risks and benefits for each individual patient.

While total thyroidectomy remains indispensable in certain scenarios, particularly in the management of aggressive thyroid cancers, the emergence of alternative surgical approaches offers new possibilities for minimizing morbidity and optimizing cosmetic outcomes. However, these novel techniques come with their own set of challenges and limitations, necessitating careful patient selection and surgeon expertise.

Moreover, the management of postoperative complications such as recurrent nerve palsy, hypocalcemia, and hematoma requires vigilant monitoring and timely intervention to ensure optimal patient recovery. Collaborative efforts among internists, surgeons, and allied healthcare professionals are paramount in delivering comprehensive care and improving patient outcomes.

As we navigate the dynamic landscape of thyroid surgery, continued research, education, and interdisciplinary collaboration will play pivotal roles in advancing the field and enhancing the quality of care for individuals with thyroid disorders. By staying abreast of the latest evidence and embracing a patient-centered approach, we can strive towards achieving the best possible outcomes and improving the overall well-being of our patients.

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