6 Minimally Invasive Video-Assisted Thyroidectomy

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Introduction

The mid-1990s was a "golden" era for the development of endoscopic surgical techniques that followed the introduction of laparoscopic surgery. After first being used in minimally invasive parathyroid surgery, endoscopes were introduced into thyroid surgery. At first, endoscopes were used in the thyroid region to assess if their magnification might provide an advantage in a region where the identification of small structures was of paramount importance. Subsequently, a number of different, purely endoscopic operations were described. These procedures used gas insufflation and were completed in an entirely endoscopic manner. In 1998 the first minimally invasive video-assisted thyroidectomy (MIVAT) was performed in Pisa, Italy (Table 6.1). In this procedure the endoscope is held in position by an assistant, forgoing the need for gas insufflation. A year later the first series of MIVAT procedures was published. MIVAT was the only endoscopic technique that allowed performance of a total thyroidectomy through a single, minimal midline incision in the neck. This was perhaps the first example of a "single-port operation," well before this term was introduced.

While other complicated and often non-reproducible endoscopic techniques were abandoned, this operation has now become the most widespread technique for minimally invasive thyroidectomy. As a true minimally invasive approach, its popularity is partially attributable to the myriad advantages that it offers to patients over traditional thyroidectomy techniques. This procedure has been shown to result in less post-operative pain, faster recovery times, and greater patient satisfaction with their results while having a similar or better complication profile compared to conventional thyroidectomy. Further contributing to its attractiveness is MIVAT's standardization and thus reproducibility. As will be described, MIVAT largely recreates the steps of conventional thyroidectomy, making it relatively easy to learn and master.

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Table 6.1 Milestones in the development of the MIVAT technique

	Year	Ref.
First MIVAT performed in Pisa	1998	
First series reported in literature	1999	Miccoli et al.[1]
MIVAT and CT demonstrate similar surgical results	2001	Miccoli et al.[2]
MIVAT and CT demonstrate similar oncological results	2002	Miccoli et al.[3]
MIVAT and CT demonstrate a similar "manipulation" of the thyroid gland	2005	Lombardi et al.[4]
Central neck dissection is feasible with the MIVAT technique in selected cases	2007	Miccoli et al.[5]
MIVAT is demonstrated to be a safe and reproducible technique	2002, 2008	Miccoli et al.[6]; Terris et al.[7]
MIVAT and CT demonstrate similar oncological results after a 5-year follow-up	2009	Miccoli et al.[8]

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[3]Miccoli P, Elisei R, Materazzi G, Capezzone M, Galleri D, Pacini F, Berti P, Pinchera A. Minimally invasive video-assisted thyroidectomy for papillary carcinoma: a prospective study of its completeness. Surgery. 2002a;132(6):1070–3
[4]Lombardi CP, Raffaelli M, Princi P, Lulli P, Rossi ED, Fadda G, Bellantone R. Safety of video-assisted thyroidectomy versus conventional surgery. Head Neck. 2005;27(1):58–64
[5]Miccoli P, Elisei R, Donatini G, Materazzi G, Berti P. Video-assisted central compartment lymphadenectomy in a patient with a positive RET oncogene: initial experience. Surg Endosc. 2007;21(1):120–3
[6]Miccoli P, Bellantone R, Mourad M, Walz M, Raffaelli M, Berti P. Minimally invasive video-assisted thyroidectomy: multiinstitutional experience. World J Surg. 2002b;26:972–5
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Selection Criteria

The extent of the operation does not represent a limit of the technique as the surgeon can strictly adhere to the basic rules of a conventional thyroidectomy. As a result, when necessary, a near-total or an extracapsular total thyroidectomy can be achieved, according to the oncologic principles of thyroid surgery. A level VI (central neck) lymph node dissection can also be performed with the MIVAT technique. However, this should be limited to cases of prophylactic neck dissections.

The possibility of performing a thorough total thyroidectomy with the MIVAT technique was demonstrated during the years that followed its introduction. Its safety and efficacy documented, the indications for MIVAT expanded from benign disease to the treatment of low- and intermediate-risk papillary and follicular carcinomas. Subsequently, it has been shown to be appropriate for the treatment of medullary carcinoma in patients with a RET mutation, requiring not only a total thyroidectomy, but also a prophylactic central neck dissection.

In order to have successful outcomes, the following are broad inclusion and exclusion criteria:

- Benign thyroid nodules under 35 mm in their largest diameter or cytologically malignant (or suspicious) nodules under 20 mm, *together with*
- A thyroid volume (ultrasonographically estimated) under 25 ml
- No suspicion of metastatic lymph nodes in the central neck
- No evidence of metastatic or suspicious lymph nodes in the lateral neck
- No evidence of severe thyroiditis

As a suggestion, we always recommend to strictly adhere to the indications proposed, since every extension can cause unnecessary and undesired complications or conversions.

The Technique

The general principle behind the MIVAT technique is to perform a thorough thyroidectomy following the basic principles of the traditional thyroid surgery while gaining the advantages of endoscopic magnification. Critically, the endoscope is used only when it can improve the outcome of the procedure (thus the term "video-assisted" and not "endoscopic").

Instruments

The instruments specifically dedicated to MIVAT are a 30°, 7 or 5 mm, 29 cm long endoscope, a 21 cm long suction dissector (used to avoid the fogging of the endoscope resulting from the steam produced by the energy instrument), two 2 mm elevators of approximately the same length as the suction dissector, small grasping forceps (15 cm long), scissors (8 mm blades, 8 cm long), and two small retractors (16 cm long). Other instruments often utilized are an energy device of choice, titanium clips, and conventional forceps used for thyroid surgery. An insulated Bovie tip should be used to avoid skin burns and inadvertent injury to surrounding structures (given the limited working space).

Positioning

The operation can be conducted under general (either with orotracheal intubation or laryngeal mask airway) or locoregional anesthesia, following the surgeon's, anesthesiologist's, and patient's preferences.

The patient is placed in the supine position, with the neck only slightly hyperextended. Avoiding significant neck extension is one of the factors that explains the decreased pain associated with this procedure.

The primary surgeon will stand on the right side of the patient. Two assistants are employed. The camera assistant is positioned on the left side, across from the primary surgeon. The second assistant, who holds the retractors, stands at the head of the bed, facing the feet. The monitors are placed at both sides of the patient's head. The main monitor is in front of the primary surgeon. The second monitor is helpful but optional.

The camera assistant will always hold the endoscope looking toward the patient's head, positioned slightly away from the axis of the patient's midline, depending on the working side. The angled endoscope should always be used in one of two main positions: looking upside-down (30° lens looking inferiorly) and downside-up (30° angle looking upward), with no intermediate positions. This standardization allows the surgeon to always obtain the same visualization of the anatomy and orientation toward the neck. This is particularly crucial for non-experienced surgeons during all steps of the procedure.

Procedure Details

For teaching purposes we divide a MIVAT lobectomy into five steps:

Step 1: Incision and access to the thyroid region (performed under direct vision)

Step 2: Section of the upper pedicle (performed endoscopically)

Step 3: Identification of the critical structures: the recurrent nerve and the parathyroids (performed endoscopically)

Step 4: Extraction of the thyroid lobe outside the neck and completion of the near-total or total lobectomy (performed under direct vision)

Step 5: Suture of the access point

Step 1. Incision and Access to the Thyroid Region

The operation starts with a 2 cm, midline incision in a skin crease on the same line of the conventional Kocher's incision. This helps to maintain a satisfactory result in the case the operation needs a conversion to open surgery, when a short extension of the wound edges would convert the access to that of a conventional thyroidectomy.

Once the incision is made, the two smallest retractors should be positioned laterally. The "linea alba" should be carefully identified as in an open approach. The main challenge is

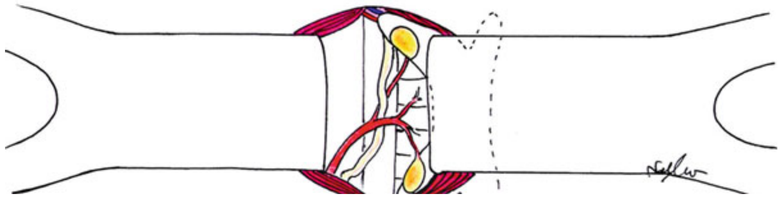

Fig. 6.1 The medial retractor is used to "hook" the thyroid lobe toward the trachea while also rotating it out of the trachea-esophageal groove

correctly identifying it in this limited space. We recommend palpating the tip of the thyroid cartilage to help find the midline.

Once identified, the midline should be opened by means of conventional electrocautery for a limited extent. The short aperture of the strap muscles will help avoid excessive retraction on the skin edges, focusing the majority of the tension on the muscles themselves. This allows the skin edges to remain vital and results in a good cosmetic outcome.

After visualization of the thyroid gland, the operative space of one side should be entered with blunt dissection utilizing the spatulas. As in open surgery, the virtual space between the strap muscles and the thyroid lobe should be entered with the small retractors at first and then with the conventional army-navy after the posterior aspect of the thyroid lobe and the carotid sheath are visualized.

The correct positioning of the retractors is one of the key points of this operation. The lateral retractor should be retracting the carotid sheath and all its contents laterally (preventing an undesired thermal injury to those structures when the energy devices are used in the small operative space). The medial retractor should "hook" the thyroid lobe medially, while at the same time trying to slightly rotate it on the tracheal axis. The retractor should almost hide the lobe from the view of the endoscope (Fig. 6.1). The medial retractor mimics the role of the hand of the assistant during a conventional thyroidectomy. Be aware that, in this phase, the two retractors should always be placed in a symmetrical position, at the two edges of the incision.

Step 2. Section of the Upper Pedicle

This is the most challenging part of the endoscopic operation, and the only one step that is significantly different from the way it is performed in traditional surgery.

The largest retractors are still positioned on both sides of the incision. This positioning will be maintained throughout this entire step.

The endoscopic portion of the operation starts by introducing the tip of the endoscope through the incision to allow visualization of the operative field. The endoscope is a 30°, 7 mm in caliber scope that will initially be oriented caudally to allow division of the middle thyroid vein when present (Fig. 6.2a). Ligation can be achieved using either the energy instrument or a double clip (Fig. 6.2b).

Once this step is done, the endoscope can be rotated downside-up and, looking upward, the upper pedicle will be visualized at the top of the screen (Fig. 6.3).

The upper pedicle is then sectioned in one step. Alternatively, based on the surgeon's preference, the superior pedicle vessels can be divided individually. It is important to remember that for MIVAT, thyroid glands are of limited size, and consequently these vessels can be very small. Before sectioning the vessels of the upper pedicle, it is highly advised to carefully check for the presence of the branches of the superior laryngeal (or Galli-Curci's) nerve. The superior nerve creates a loop at various heights of the upper pedicle or higher, heading medially to enter the lateral side of the cricothyroid muscle (Fig. 6.4a–c). The magnification provided by the endoscope, together with the view it allows of the cephalic aspect of the surgical field, permits this nerve to be seen when it is in its lowest positions (which is often not recognized during conventional thyroidectomy). Once the branches of the nerve have been visualized, their safety should be guaranteed by avoiding excessive heat exposure from using an energy device too close to them.

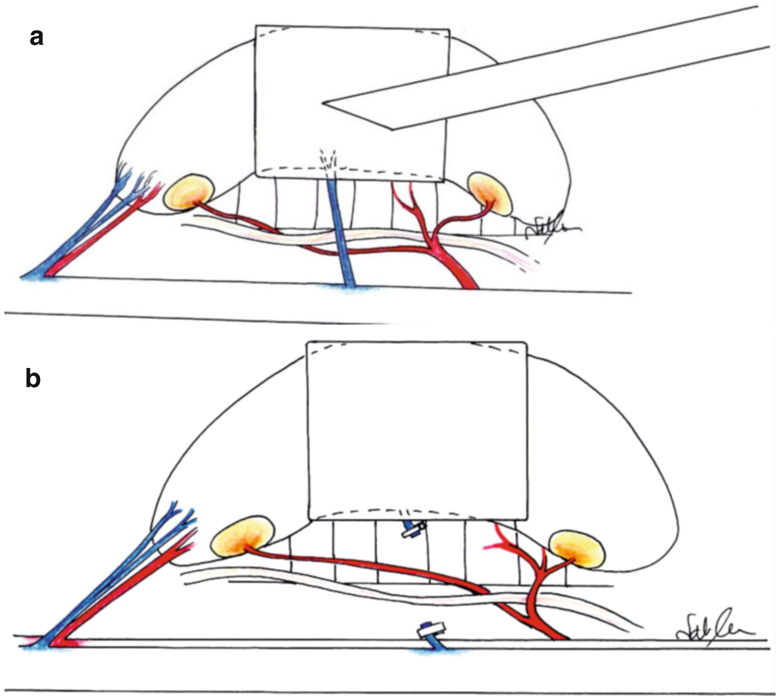

Fig. 6.2 The endoscope, oriented caudally, allows direct vision of the middle thyroid vein (**a**). This vein is then divided (**b**)

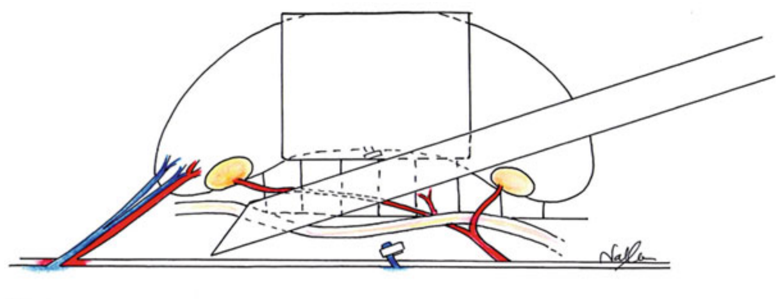

Fig. 6.3 In order to visualize the superior pedicle vessels, after division of the middle thyroid vein, the endoscope is faced cranially

Once the pedicle has been divided, hemostasis should be carefully verified. Any area of uncertain ligation should be immediately addressed for two reasons. Any acute bleeding can be very hard to manage endoscopically and can lead to undesired conversions. On the other hand, delayed bleeding can result in highly dangerous situations. As no drain will be left in the neck and the incision will be sealed, a spontaneous evacuation of the hematoma cannot be readily achieved.

Step 3. Identification of the Recurrent Nerve and the Parathyroid Glands

The great benefit of endoscopic magnification is the reason why this step is the easiest of the whole procedure. From conventional thyroid surgery, an experienced thyroid surgeon knows exactly where to search for the recurrent laryngeal nerve and the parathyroid glands. During MIVAT, having 20x magnification of these areas facilitates quick identification of these structures.

Proper positioning of all of the instruments is a key point during this step of the procedure. The retractors, in their lateral positions, should expose the space where the recurrent nerve and the parathyroid glands are located. The medial retractor is essential to "load" the thyroid lobe, also lifting it in order to visualize the area between the trachea and the esophagus

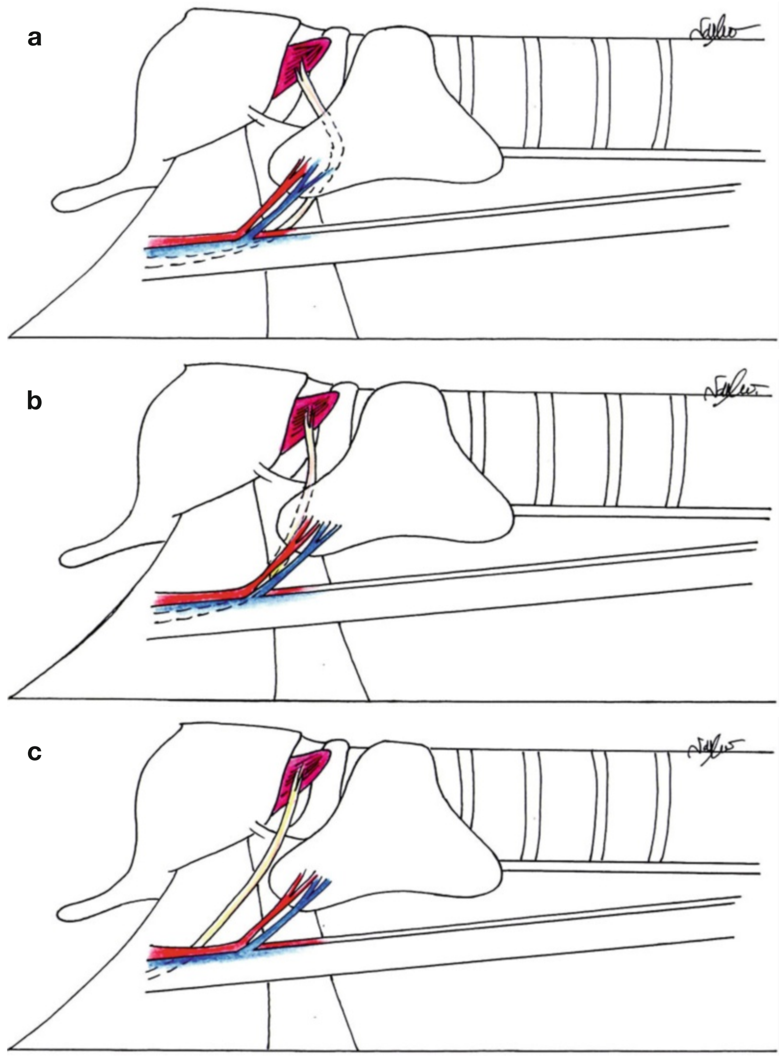

Fig. 6.4 The external branch of the superior laryngeal nerve can be visualized. This nerve can loop inferiorly to varying degrees (**a**–**c**)

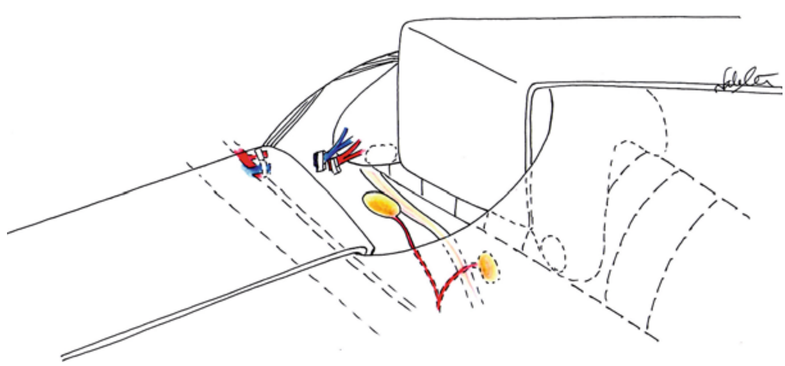

Fig. 6.5 The region where the recurrent laryngeal nerve and the superior parathyroid gland are located is exposed with medial retraction of the thyroid lobe

(Fig. 6.5). The endoscope should always be facing downward, with only a slight medial orientation.

During this step there is generally no need to divide anything, and the entire phase is performed with blunt dissection achieved with the two spatulas. First, the recurrent laryngeal nerve is identified and then dissected until its point of entry in the laryngeal muscles. There is no need, in our opinion, to dissect the nerve too extensively in the caudal direction (farther from its entry point), since the purpose of this dissection is to avoid any traction on the nerve during the step of the mobilization of the lobe. Adequately releasing the nerve allows it to lie on the posterior fascia of the neck when extracting the lobe. The same principle is applied to the parathyroid glands: once identified, they should be only minimally dissected to avoid injury to their vascular pedicles, which might limit their viability and function.

The main branch of the recurrent nerve lies on the anterior surface of the vertebral muscles covered by the deep cervical fascia on the right side and on the esophagus on the left side. On both sides the nerve can be easily visualized at the point it crosses the inferior thyroid artery. This exposure can be achieved with the two spatulas using blunt dissection. An additional anatomical clue to the location of the nerve is the many small lymph nodes that are almost always present in the area surrounding the recurrent nerve. These can be easily dissected, uncovering the nerve itself.

The most frequent position of the superior parathyroid gland is at the upper pole of the thyroid lobe, laterally to the lobe itself, or adherent to it. Familiarity with the typical shape and color of parathyroid glands is essential for their recognition. These characteristics are greatly enhanced by the endoscopic vision. Once identified the parathyroid gland can be gently dissected, always taking care to preserve its small pedicle, and delicately moved away from the thyroid gland. It is important to release the parathyroid glands adequately from the thyroid lobe to avoid any damage to their vascular supply during the mobilization and extraction of the lobe.

In regard to the inferior parathyroid gland, it can often be in a position where it can be hidden behind the blade of the retractor. In the case when an inferior parathyroid gland cannot be identified during the endoscopic exploration, the surgeon can move to the next step of the surgery and search for the inferior parathyroid gland once the lobe has been rotated outside the wound.

Step 4. Mobilization and Extraction of the Thyroid Lobe and Completion of the Lobectomy

This portion of the operation is performed under direct vision, basically following the rules of conventional open surgery.

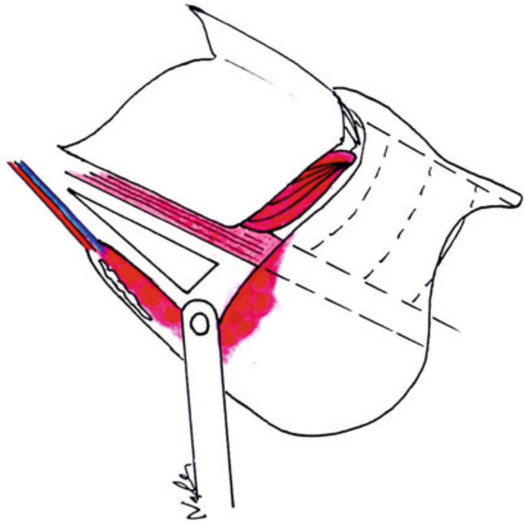

Fig. 6.6 The "triangle of Miccoli-Berti" is demonstrated. The *triangle* is bordered by the upper pedicle laterally, the pyramidal lobe or isthmus medially, and the prethyroidal muscles

This step starts by grasping the superior pole of the thyroid lobe (which has already been dissected) with a conventional forceps. It is then gently extracted through the incision by rotating the entire lobe on his longest axis, paying attention to avoid any damage to the vessels of the inferior pole, from where the vascular feeding of the inferior parathyroid gland may arise. If the upper pedicle has been properly and completely dissected, the surgeon will encounter no resistance in delivering the superior pole of the lobe. Once the upper pole is through the incision, it is necessary to increase the mobility of the lobe itself. This can be achieved by a step-by-step dissection, starting from the areas that are safer (with a minimal risk of creating any morbidity).

With this basic principle in mind, better mobility can be obtained by starting to dissect the lobe from the upper pole and descending toward the isthmus, ultimately dividing it. The critical point of this maneuver, in our experience, is to open the space between the posterior aspect of the upper pedicle (the origin of the ligament of Berry) and the isthmus itself. This area is known among those who perform the MIVAT procedure as the "triangle of Miccoli-Berti," after the surgeons who identified this point as an essential step for the correct extraction of the thyroid lobe (Fig. 6.6). The "triangle" is oriented downward, composed of the posterior aspect of the upper pedicle laterally, the pyramidal lobe medially, and the prethyroidal muscles forming the base. This area can be safely dissected prior to exposing the recurrent nerve and the parathyroid glands once again. It is necessary, once all the elements are identified, to cut the isthmus in a downward direction, completely dividing it and exposing the tracheal surface. The lobe is now free from its superior and medial attachments. The next step is to cut the vessels of the inferior pole, taking care to not damage the vessels supporting the inferior parathyroid gland. Once this step is complete, the lobe can be completely and delicately delivered through the incision. The surgeon can now expose the lateral side of the lobe, following, once again, the previously identified recurrent nerve and both the parathyroid glands in the traditional way.

If a problem is encountered while delivering the lobe (generally because of an underestimation of its size), the surgeon can use these two "tricks" to allow a tension-free extraction avoiding any rupture of the capsule. If there is an evident cystic component, aspirating the liquid with a syringe can significantly decrease the size of the lobe. If there is excessive tension on the strap muscles, these can act "like a curtain," hampering delivery of the lobe. This can often be solved by asking the anesthesiologist to provide a paralyzing agent. This will allow the strap muscles to relax and the entire trachea-larynx-thyroid lobe block to be more easily mobilized.

A total thyroidectomy can be performed by repeating the same steps on the opposite side. If the surgeon has started on the side with the largest lobe, as we always suggest, the opposite lobectomy will typically take less time to complete.

Step 5. Suture of the Access

Once the lobectomy/total thyroidectomy is finished and the hemostasis is carefully obtained, the surgeon should inspect the critical structures on both sides for the last time. The integrity of the recurrent nerve(s) should be verified as well as the viability of the parathyroid glands. When their vitality is uncertain, they should be autotransplanted. No drain is placed in MIVAT cases.

The strap muscles can then be reapproximated with one or two single stitch(es). Three single subcutaneous stitches are used to approach the skin edges. In our institution surgical glue is used to seal the skin.

Outcomes

Since its development, MIVAT has consistently been shown to result in extensive advantages for patients. These results have been exhibited in studies both from the group that developed MIVAT and subsequent groups who have adopted the technique.

The most commonly demonstrated advantages of MIVAT compared with other thyroidectomy techniques are decreased postoperative pain and improved cosmetic outcome. Other significant benefits of the technique include less frequent and less severe dysphonia and dysphagia, shorter recovery periods, and greater overall patient satisfaction with their surgical experience. The rates of complications, including laryngeal nerve injury and hypoparathyroidism, have been demonstrated to be as low as with conventional thyroidectomy.

Conclusion

MIVAT currently represents the most widespread minimally invasive technique for thyroidectomy, for reasons including its reproducibility, excellent clinical and oncological results, and the clear advantages it provides to patients.

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