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Minimally Invasive Video-Assisted Thyroidectomy for Benign Thyroid Disease: An Evidence-Based Review

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Abstract

Background A decade after nearly all surgical disciplines developed minimally invasive techniques, the first report of a single case of minimally invasive thyroidectomy was published. Minimally invasive video-assisted thyroidectomy (MIVAT) is now considered the most widely practiced and most easily reproducible minimally invasive procedure for thyroidectomy. The aim of this review was to analyze the treatment of benign thyroid diseases by MIVAT.

Methods A systematic evidence-based literature review focusing on three questions was carried out. Additional data were obtained on the basis of our personal experience. (1) Are minimally invasive procedures indicated in the treatment of thyroid diseases? (2) Is MIVAT a safe technique and what are the demonstrated advantages? (3) Since different thyroid diseases may be treated by MIVAT, is it of any value in the treatment of benign thyroid diseases?

Results MIVAT can be considered an appropriate treatment of some thyroid diseases; it represents a safe procedure with the same incidence of complications as traditional surgery, and also has advantages in terms of both cosmetic result and postoperative distress.

Conclusions In spite of an increasing trend toward performing more extensive procedures other than thyroidectomy alone during videoscopic procedures, the current literature seems to reaffirm that the main and safest indication for MIVAT is benign disease.

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Introduction

A decade after nearly all surgical disciplines developed minimally invasive techniques, leading to the fastest recovery of patients, reduced postoperative pain, and decreased hospitalization, the first report of a single case of minimally invasive thyroidectomy was published in 1997 [1]. The operative technique consisted of a totally endoscopic procedure, allowing a right lobectomy to be performed in a patient with single-lobe thyroid disease. Videoscopic surgery in the neck has evolved during the last 10 years [2–7], but its development has been limited by several factors, the most important of these being (1) the considerable number of different methods of access (neck, axilla, breast, chest), which has made it very difficult for surgeons inclined to perform this surgery to single out the procedure most suitable for them; and (2) the feeling by many, above all endocrine surgeons, that conventional parathyroidectomy and thyroidectomy have reached such a high standard of treatment in terms of both efficacy and safety as to render these new procedures not very useful [8].

A further concern has been that "endoscopic" does not always necessarily mean minimally invasive. Indeed, not only the visibility or the size of the scar, but also postoperative discomfort and length of hospitalization should be taken into account. We might simplify the description of the different techniques by dividing them into two categories: (1) totally endoscopic (needing neck insufflation) and (2) video-assisted (with no insufflation). Not all these techniques allow a total thyroidectomy; some of them allow only a single lobe dissection relying on a lateral approach.

A recent leading article by Henry [9] might be viewed as a benchmark to properly define a thyroidectomy as "minimally invasive." In fact, according to this author, breast and axilla approaches should not be considered minimally invasive because of the extensive dissection, long operative time, and complex postoperative course; furthermore, the use of an endoscope should be part of the definition itself. In this article we try to establish, on the basis of both the literature and our personal experience, the grade of recommendation for the treatment of benign thyroid diseases through a single videoscopic operation: minimally invasive video-assisted thyroidectomy (MIVAT) [10], generally considered the most widely practiced and most easily reproducible procedure in its class of operations [11].

Materials and methods

Study design

In this review some important questions are defined and chronologically developed to give an answer to the final issue: Is benign thyroid disease an indication for MIVAT? The questions considered are the following: (1) Are videoscopic procedures indicated in the treatment of thyroid diseases? (2) Is MIVAT a safe technique and what are the demonstrated advantages? (3) Is MIVAT of any value in the treatment of benign thyroid diseases? Finally, we decided to briefly describe our own most recent personal series of minimally invasive video-assisted thyroidectomies, with the goal of describing our current protocol of treatment in order to support the final conclusions on this specific topic.

Literature analysis

A literature search was performed through the MedLine database (www.ncbi.nlm.nih.gov), using different keywords covering the extremely wide field of thyroid surgery. The keywords were *minimally invasive* and *thyroid surgery*; all related articles of the papers selected were reviewed. Only articles discussing the topic of minimally invasive surgery of the thyroid were fully screened and analyzed. We decided to exclude from this analysis review articles and articles that were not written in the English language. The literature analyzed and discussed in this article are given in Table 1 following Sackett's evidence-based methodology [12] modified by Heinrich [13].

Results

Is MIVAT indicated in the treatment of thyroid diseases? Several techniques are summarized and described in Table 2, together with their main indications and the level of evidence of the single study. From the summary table we can easily observe that the years immediately following the first case description were characterized by simple technical descriptions of the feasibility of the different techniques, without any grade of recommendation for any one of these techniques. The first prospective and randomized study comparing the MIVAT technique to the conventional operation and proving its feasibility and efficacy was proposed by Miccoli et al. in 2001 [14]. The same group produced another prospective and randomized study on treating malignant thyroid disease (and specifically low-risk papillary cancer) by this technique [15]. Both studies demonstrate a high level of evidence and grade of recommendation. To our knowledge, the only other study comparing conventional thyroidectomy to a minimally invasive technique other than MIVAT was performed by Terris et al. in 2005 [16]. The authors compare conventional open thyroidectomy to minimally invasive thyroidectomy (MITh) performed through a significantly smaller incision using the Sofferman technique (transection of the straps muscles), demonstrating not only the feasibility of the technique but also the better cosmetic

Table 1 Sackett's classification, modified by Heinrich, of the level of evidence

Level of evidence	Type of trial	Criteria for classification	Grade of recommendation
I	Large randomized trials with clear-cut results (and low risk of errors)	Sample size calculation provided and fulfilled, study endpoint provided	A
II	Small randomized trials with uncertain results (and moderate to high risk of errors)	Matched analysis, sample size calculation not given or not fulfilled; study endpoints not provided, convincing comparative studies	B
III	Nonrandomized, contemporaneous controls	Noncomparative, prospective	C
IV	Nonrandomized, historical controls	Retrospective analysis, cohort studies	–
V	No control, case series only; opinion of experts	Small series, review articles	–

Table 2 Different techniques for minimally invasive thyroidectomy and relative indications

Authors	Journal, Year	Technique	No. cases	Indications	Operations performed	Level of evidence
Huscher et al.	Surg Endosc, 1997 (letter)	TE, with CO_2 insufflation	1	Papillary cancer (3 mm)	Lobectomy	V
Miccoli et al.	J Endocrinol Invest, 1999	MIVAT	12	Microfollicular nodules	Lobectomy	IV
Shimizu et al	J Am Coll Surg, 1999	TE with skin lifting	5	Benign and malignant diseases	Lobectomy, nodule resection, central nodes dissection	IV
Ohgami et al.	Surg Laparosc Endosc Percutan Tech, 2000	TE, breast approach, with CO_2 insufflation	5	Benign disease	Lobectomy, partial resection of one lobe	IV
Ikeda et al.	Surg Endosc, 2001	TE, axilla approach, CO_2 insufflation	19	Adenoma, 1 microcarcinoma	Lobectomy	IV
Miccoli et al.	Surgery, 2001	MIVAT	25 (MIVAT) vs. 24 (conventional)	Benign and malignant diseases	Lobectomy, total thyroidectomy	II, grade of recommendation: B
Gagner et al.	Thyroid, 2001	TE, with CO_2 insufflation	18	Benign disease	Lobectomy	IV
Miccoli et al.	Surgery, 2002	MIVAT	16 (MIVAT) vs 17 (conventional)	Low-risk papillary carcinoma	Total thyroidectomy	II, grade of recommendation: B
Bellantone et al.	J Am Coll Surg, 2002	MIVAT	53	Benign and malignant diseases	Lobectomy, total thyroidectomy	IV
Inabnet et al.	Surg Endosc, 2003	TE, with CO_2 insufflation	38	Benign & malignant diseases	Lobectomy	IV
Schabram et al.	World J Surg, 2004	MIVAT	196	Benign disease	Nodule excision, partial and total lobectomy	IV
Terris et al.	Laryngoscope, 2005	MITh	31 (MITh) vs. 17 (conventional)	Benign and malignant diseases	Lobectomy, total thyroidectomy	II, grade of recommendation: B
Terris and Chin	Laryngoscope, 2006	MIVAT	36	Benign and malignant diseases	Lobectomy, total thyroidectomy	IV
Henry et al.	World J Surg, 2006	TE, with CO_2 insufflation	38	Benign disease	Lobectomy	IV

TE = totally endoscopic; MIVAT = minimally invasive video-assisted thyroidectomy; MITh = minimally invasive thyroidectomy using the Sofferman technique

outcome. This latter advantage leads to the following question about the outcome of minimally invasive procedures.

Is MIVAT a safe technique and what are its demonstrated advantages? The safety and advantages of the minimally invasive techniques can be demonstrated with high levels of evidence only through prospective and randomized studies that compare the outcomes of the conventional and minimally invasive procedures in terms of complication rates and the evaluation of other parameters.

The first two prospective studies already reported demonstrated the feasibility of MIVAT in the treatment of both benign and low-risk malignant disease, with the significant advantages of a better postoperative course and cosmetic result. The only disadvantage of MIVAT found in the first study was a longer operative time, which disappeared in the latter studies performed by the same team once a proper learning curve has been obtained. A multicenter study published in 2002 [17] further demonstrated the reproducibility of MIVAT in different surgical settings; however, it did not reach high levels of evidence due to the retrospective though large series analyzed.

Ikeda et al. in 2004 [18] published a prospective but nonrandomized study comparing the two techniques for minimally invasive thyroidectomy performed in his department (level of evidence III and grade of recommendation C). The authors conclude that both techniques are safe and feasible and have different advantages as summarized in Table 3. After the first prospective studies already cited, Lombardi et al. [19] also reported that MIVAT and conventional thyroidectomy demonstrated the same gland manipulation in a prospective and randomized study on a small series of patients.

Ujiki et al. [20] demonstrated the advantages of the MIVAT technique over conventional thyroidectomy, but the study design was a retrospective review of their personal series (level of evidence IV, no grade of recommendation).

Very recently, Hegazy et al. [21], Perigli et al. [22], and Terris et al. [23] compared in larger prospective studies two or three different techniques for thyroidectomy, obtaining different outcomes from every different approach, as summarized in Table 3. The first study [21] obtained a high level of evidence (II) and grade of recommendation (B), while the series published by both Perigli et al. and Terris et al. were larger but nonrandomized and therefore obtained a lower level of evidence (III) and grade of recommendation (C).

Finally, Del Rio et al. [24] published a prospective but nonrandomized large series of patients that compared MIVAT and conventional thyroidectomy with the goal of demonstrating a better postoperative course and cosmetic outcome of the minimally invasive procedure over the conventional technique. The results obtained confirmed the authors' hypothesis with a level of evidence III and grade of recommendation C.

Is MIVAT of any value in the treatment of benign thyroid diseases? To our knowledge, no article found in the PubMed database specifically addressed this topic, except for two articles that specifically dealt with the treatment of Graves' disease [25, 26]. We then decided to analyze the larger and more recent series reported in the literature that report on the incidence of benign disease treated with the MIVAT technique and, in addition, analyze our most recent global series of patients. The results obtained are summarized in Table 4.

The first two articles analyzed the feasibility of MIVAT in the treatment of Graves' disease, the most difficult benign thyroid disease in terms of intraoperative bleeding control. Both studies pointed out the validity of the use of the technique in treating this disease when the preoperative indications are strictly followed. The level of evidence and grade of recommendation are III and C, respectively, due to the prospective but nonrandomized evaluation performed on contemporaneous controls.

The other articles considered in this analysis represent the most recent and largest series reported in the literature, but they simply evaluate large experiences of surgeons performing MIVAT. From those studies we can point out the incidence of benign disease compared to the total number of cases and also analyze the incidence of uninodular versus multinodular disease.

In the largest series reported to date [27], we describe an overall percentage of benign disease treated by MIVAT of 68%. When analyzing more specifically the incidence of the different benign diseases, we can see that 290 patients were treated because of an undetermined cytologic diagnosis, whereas the remaining cases were operated on with a more certain diagnosis of benign disease.

If we analyze the series reported by Lombardi et al. [28], we see that their incidence of benign disease treated by MIVAT is 86%, consisting mainly of suspicious or microfollicular single nodules (64% of the overall 409 benign diagnoses). The numbers reported are similar to those described in their earlier publication [29], where the incidence of undetermined nodules operated on was 63.5% of cases. The smallest series reported by Terris and Chin [30] describes an 88.9% incidence of benign thyroid disease treated with MIVAT, and in patients with a benign diagnosis, the incidence of a microfollicular nodule was 56.2%. If we further analyze the incidence of patients treated by MIVAT compared to the entire number of thyroidectomies performed by every single center, we find that our earlier publications describe a 9.7% use of MIVAT compared to the whole series of thyroidectomies performed

Table 3 Safety and advantages/disadvantages

Authors	Journal, Year	Technique, No. cases	Study design	Complication rate	Conclusion of the study; Adv/Disadv	Level/ grade
Miccoli et al.	Surgery, 2001	25 (MIVAT) vs. 24 (conventional)	Prospective, randomized	2 transient RNP (MIVAT); 1 RNP, 1 hypopara (conventional)	Adv: Better cosmetic result ($p = 0.01$), less postoperative pain ($p = 0.003$) Disadv: Longer operative time ($p = 0.001$)	II/B
Miccoli et al.	World J Surg, 2002	336 MIVAT	Multicenter study, retrospective	7 transient and 1 permanent RNP (0.3%); 9 transient and 2 permanent hypopara (0.67%)	Conclusion: reproducibility of MIVAT in different settings Adv: smaller scars Disadv: longer operative time	IV
Miccoli et al.	Surgery, 2002	16 (MIVAT) vs 17 (conventional)	Prospective, randomized	3 transient RNP (MIVAT); 1 hypopara (conventional)	Conclusion: Same oncologic completeness Adv: smaller incision	II/B
Ikeda et al.	World J Surg, 2004	20 MIVAT vs. 20 axillary TE	Prospective, nonrandomized	No permanent complications in either group	MIVAT: less operative time (<0.01) and less pain (<0.01) TE: higher cosmetic satisfaction (<0.01)	III/C
Lombardi et al.	Head Neck, 2005	10 MIVAT vs. 10 conventional	Prospective, randomized	No permanent complications in either group	Conclusion: same gland manipulation Adv: better cosmetic result, less postoperative pain.	II/B
Ujiki et al.	Ann Surg Oncol, 2006	22 (MIVAT) vs 26 (conventional)	Retrospective	No permanent complications in either group	Conclusion: MIVAT is safe and effective as conventional surgery Adv: smaller incision Disadv: longer operative time	IV
Hegazy et al.	World J Surg, 2007	35 (MIVAT) vs. 33 (ST)	Prospective, randomized	No permanent complications in either group	Conclusions: ST needed shorter operative time (<0.05) MIVAT offers better postoperative course (<0.05) and smaller incisions (<0.05) Same cosmetic outcome	II/B
Terris et al.	Laryngoscope, 2007	51 (MIVAT) vs. 120 (MINET) vs. 77 (conventional)	Prospective, nonrandomized	Not reported	Conclusions : MIVAT and MINET produced significantly smaller incisions than the conventional technique	III/C
Del Rio et al.	Langenbecks Arch Surg, 2007	52 (MIVAT) vs 61 (conventional)	Prospective, nonrandomized	Not reported	Conclusions: less postoperative pain and better cosmetic result for MIVAT	III/C
Perigli et al.	World J Surg, 2007	56 (MIVAT) vs. 214 (MIT) vs. 687 (conventional)	Prospective, nonrandomized	0 vs. 2 vs. 9 RNP (not significant), 0 vs. 0 vs. 1 hypopara (not significant)	Conclusions: less postoperative pain and better cosmetic result for MIVAT	III/C

Adv = advantage; Disadv = disadvantage; Level/grade = level of evidence/grade of recommendation; MIVAT = minimally invasive video-assisted thyroidectomy; RNP = recurrent nerve palsy; ST = minimally invasive open thyroidectomy using the Sofferman technique (strap muscle transection); TE = totally endoscopic; MINET = minimally invasive nonendoscopic thyroidectomy; MIT = minimally invasive thyroidectomy (open approach)

Table 4 Minimally invasive thyroid surgery in the treatment of benign thyroid disease

Authors	Journal, Year	Technique	No. of benign diseases treated/ total cases (%)	Level of evidence/Grade of recommendation
Berti et al.[a]	Surg Endosc, 2004	MIVAT	31/31 (100%)	III/C
Maeda et al.[a]	Br J Surg, 2006	MIVAT	63/63 (100%)	III/C
Miccoli et al.	Langenbecks Arch Surg, 2006	MIVAT	563/839 (67.6%)	IV
Lombardi et al.	World J Surg, 2006	MIVAT	409/473 (86.5%)	IV
Lombardi et al.	Langenbecks Arch Surg, 2006	MIVAT	452/521 (86.7%)	IV
Terris and Chin	Laryngoscope, 2006	MIVAT	32/36 (89%)	IV

[a] These series deal exclusively with the treatment of Graves' disease

in the same period, with 16.1% and 28.8% incidences reported by Lombardi et al. and Terris and Chin, respectively.

Personal series

The preoperative diagnoses of patients from our personal series was as follows: oxyphilic/follicular nodule ($n = 462$), low-risk papillary carcinoma ($n = 403$), multinodular goiter ($n = 342$), Graves' disease ($n = 64$), toxic adenoma ($n = 33$), RET mutation without evidence of medullary thyroid cancer ($n = 27$), completion thyroidectomy after diagnosis of papillary carcinoma in the contralateral lobe ($n = 16$), toxic multinodular goiter ($n = 10$), completion thyroidectomy after diagnosis of thyroglossal duct carcinoma ($n = 1$). The diagnosis and overall incidence of benign/malignant diseases are given in Figure 1.

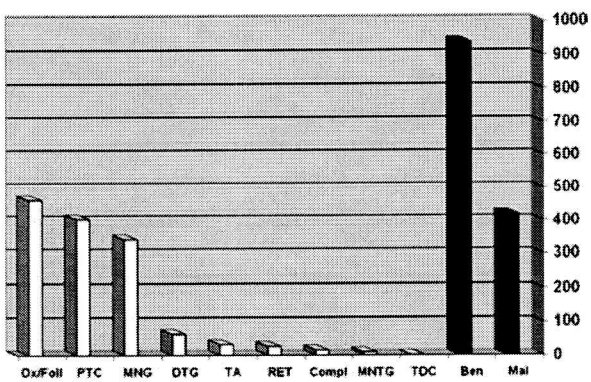

Fig. 1 Preoperative indications for MIVAT: personal series 1998–2007. Ox/Foll: oxyphilic/follicular nodule; PTC: papillary thyroid carcinoma; MNG: multinodular goiter; DTG: diffuse toxic goiter (Graves' disease); TA: toxic adenoma; RET: ret gene positive; Compl: completion thyroidectomy after lobectomy; MNTG: multinodular toxic goiter; TDC: total thyroidectomy after diagnosis of thyroglossal duct carcinoma; Ben: overall benign disease; Mal: overall malignant disease

Discussion

Even though the use of thyroid videoscopic procedures have been limited in the past to treating only benign diseases, this no longer seems to be true. Most reports actually describe their use in treating both benign and malignant pathologies. There is wide agreement, however, that the latter should be limited to only "low-risk" malignancies. In spite of this, the main indications in the literature are still represented by small goiters with undetermined cytology, follicular tumors, and toxic adenomas, and this is also confirmed by our experience (Fig. 2). This might lead to the conclusion that lateral approaches aiming to remove a single lobe might be widely accepted and followed by most surgeons treating benign thyroid diseases. On the contrary, it should be stressed that a single-sided technique cannot be indicated in the treatment of bilateral thyroid gland diseases, which form the majority of the indications in relatively iodine-deficient areas such as Italy and many other European, Asian, and even American countries [31]. It is very common, in fact, for patients with suspicious or undetermined cytology [32], and many patients with follicular adenoma also have bilateral nodularity. For this reason, it would be advisable to favor videoscopic procedures that rely on central access that can easily treat both sides of the thyroid.

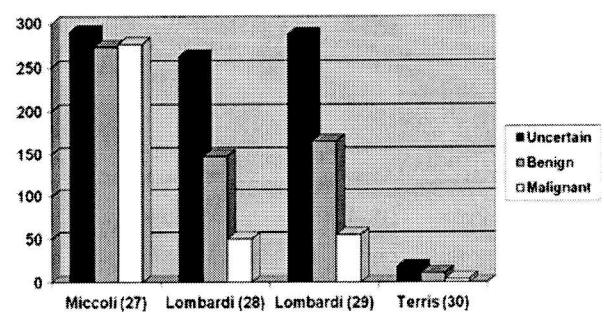

Fig. 2 Incidence of different indications in the most recent MIVAT series described in literature

As long as strict selection criteria that have been well-established in the literature are followed, then it can be concluded that (1) MIVAT is the appropriate indication in the treatment of some thyroid diseases. (2) MIVAT is a safe procedure with the same level of complications as traditional surgery; it also offers a few significant advantages in terms of both cosmetic result and postoperative distress. (3) Its main and safest indication is still benign thyroid diseases.

New fields of application for MIVAT might be "low-risk" malignancies such as small papillary thyroid carcinomas and RET gene mutation carriers with normal pentagastrin-stimulated levels of calcitonin [33] where no central compartment lymphadenectomy is required. For the first indication, there is only one article that compares MIVAT to traditional surgery. It showed that the same radicality was reached at the thyroid bed level by both procedures, with MIVAT displaying an advantage in terms of cosmetic result and postoperative pain. One of the major criticisms, however, was that the trial was "underpowered and there was no evaluation of oncologic outcome" [34]. On the other hand, although the main guidelines of scientific societies [35, 36] do not consider central compartment lymphadenectomy necessary in the treatment of any thyroid malignancy, more and more recommendations about performing this step together with thyroidectomy appear in the literature [37]. Thus, in spite of a few reports claiming that both a central [38–41] and a lateral compartment clearance can be performed during videoscopic procedures, the literature seems to reaffirm that the main indication for MIVAT should be benign disease.

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