

Minimally Invasive Video-Assisted Total Thyroidectomy (mi V.A.T.T.) - Case Series of 48 Patients

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ABSTRACT: Purpose: The first report of miVATT was published in 1998 by Miccoli, leading to a revolution in the field of thyroid surgery. This prospective study aims to evaluate the technique with regard to our department's experience over a four-year period. Material-Methods: Between September 2009 and October 2013, 48 adult patients (37 females, 11 males) with a mean age of 41.3 (\pm 11.6) years underwent scheduled miVATT for benign thyroid lesions. Selection criteria included thyroid volume <15 ml and nodules not exceeding 3.5 cm of diameter. Thyroiditis, previous neck surgery and previous irradiation, mediastinal goiter and involvement in another clinical study constituted the exclusion criteria. The procedure we performed was miVATT as described by Miccoli with the only additions being the use of the Harmonic Scalpel and the fixation of the endoscope on a holding device. Also, no drains were applied. Results: No conversions to open surgery were needed. Operation time for total thyroidectomy was 71.23 min (\pm 23.81) with a mean hospitalization of 1.14 days (\pm 0.4). Five patients (10.4%) exhibited transient hypocalcemia, whereas there were no recurrent laryngeal nerve palsies. Post-operative pain was mild and the final aesthetic result was considered excellent by the patients. Conclusion: miVATT is a safe and feasible alternative to the conventional thyroidectomy when performed in carefully selected patients by experienced surgeons.

KEYWORDS: total thyroidectomy, video-assisted surgery, endoscopic surgery, case series

Introduction

Even though the first thyroidectomy was described in 1850, the technique was quickly abandoned on account of unacceptably high mortality rates (40%) and crippling morbidity.[1] Notably, Theodore Kocher succeeded in reducing the incidence of post-operative complications whilst achieving minimal mortality (1%) through meticulous dissection and utilization of antisepsis. [2] Currently, thyroidectomy constitutes one of the most frequently performed operations in a global basis.[3] As a matter of fact, contemporary high-volume Thyroid Surgery Centers report morbidity and mortality rates below 1% even in elderly patients with massive goiters and upper airway obstruction.[4]

Having secured the feasibility of the thyroidectomy, surgeons shifted their attention towards the optimization of cosmetic results and diminishment of hospitalization duration as well as of postoperative pain. Gagner et al reported the first endoscopic parathyroidectomy in 1996.[5] Subsequently, several techniques on minimally invasive thyroidectomy were developed. Particularly, Miccoli et al performed the first minimally invasive Video-Assisted Total Thyroidectomy (mi VATT) via cervical or direct approach in 1998.[6] Since then, numerous other extra-cervical or indirect endoscopic approaches have been described such as the Anterior Chest Approach, Axillo

Bilateral Breast Approach (ABBA), Bilateral Axillo Breast Approach (BABA), Postauricular and Axillary Approach (PAA) as well as the Transoral approach.[7] In these extra-cervical techniques skin incisions for the insertion of trocars and specimen extraction are performed away from the neck, thus avoiding any visible cervical scars. However, they require extensive dissection, therefore cannot be considered minimally invasive and have not been widely accepted. [7, 8] Recently, promising preliminary results were reported on minimally invasive nonendoscopic thyroidectomy (MINET) and robotically-assisted procedures from specialized centers.[9, 10]

Initially the feasibility of mi VATT was treated with skepticism, as the technique demands mental visualization of three dimensional structures from a conventional two dimensional monitor as well as significant experience in thyroid surgery. Several studies were designed in order to assess the learning curve for the procedure. Indeed it was indicated that the plateau for a low complication rate is reached after 25-30 miVATTs for an experienced surgeon in both endocrine and laparoscopic procedures.[11-13] Even though mi VATT has been established as the predominant method of minimally invasive thyroidectomy in the majority of European and North American centers; there is still no unanimous consensus on the superiority of mi VATT over conventional open thyroidectomy.[14] This prospective study

was conducted in order to evaluate the implementation of mi VATT in terms of reproducibility and short-term outcomes.

Material and methods

Study protocol

Our study recruited patients prospectively from September 2009 to October 2013. Eligibility criteria were: 1) adults (age > 18 years old), 2) scheduled total thyroidectomy, 3) benign goiter, 4) thyroid volume < 15 ml as estimated by ultrasound and 5) nodules not exceeding 3.5 cm of diameter. On the other hand patients with i) thyroiditis, ii) previous neck surgery, iii) previous irradiation to the neck, iv) cytological and clinical evidence of thyroid malignancy, v) mediastinal goiter and vi) participants in other clinical studies whose involvement could jeopardize our research, were excluded from this study. No discrimination was made on account of gender, race or Body Mass Index (B.M.I). The study was approved by the Ethics Committee of AHEPA University Hospital of Thessaloniki, Greece and all enrolled patients agreed to the terms of the study by signing an informed consent form.

Moreover, relevant clinical information were collected prospectively and recorded in a computer database. In particular, these data concerned patient demographics (age, sex), intraoperative data (duration of the procedure, conversion to open surgery: defined as extension of the cervical skin incision > 2.5 cm), pathology (histology, thyroid gland weight) and postoperative outcomes (ΔCa^{2+} : defined as postoperative minus preoperative concentration of plasma Ca^{2+} , ΔWBC : defined as postoperative minus preoperative White Blood Cell count, postoperative pain, hoarseness, complications, length of hospital stay and satisfaction with aesthetic results).

Patients self-evaluated postoperative pain, hoarseness and satisfaction with cosmetic results. In particular, postoperative pain was assessed by a Visual Analogue rating Scale [15] ranging from 1 (painless) to 10 (excruciating pain). Additionally, preoperative indirect laryngoscopy was performed in order to assess baseline vocal cord mobility and the examination was repeated postoperatively. Hoarseness was evaluated by VAS ranging from 1 (no voice alteration) to 10 (dramatic hoarseness). Satisfaction with cosmetic results was verbally described by each participating patient as poor, mediocre, good or excellent. Lastly, hypocalcemia was defined as plasma

Ca^{2+} concentration < 8.2 mg/dl in blood collected one day prior to hospital discharge.

Ultimately, Statistical Package for the Social Sciences (SPSS) for Windows (SPSS Inc., Chicago, IL) was utilized for the completion of statistical analysis of numerical data. All references were formed using EndNote X7 (by Thomson Reuters).

Description of our technique

We implemented a variation of the technique described by Miccoli et al.[6] In particular we used a holding device for the camera (Leyla retractor) and Harmonic Scalpel (Ethicon Endo-Surgery, Cincinnati OH, USA). Our approach comprises of three main stages: 1) early open stage, 2) endoscopic stage and 3) late open stage.

Early open stage

The patient is subjected to general endotracheal anesthesia and is placed in the supine position without neck hyperextension. The planned site of incision was marked upon the skin. Subsequently, a 2 cm horizontal incision is applied approximately 2 cm above the sternal notch. Subcutaneous adipose tissue and the platysma are meticulously dissected in order to avoid bleeding. Notably, superior and inferior platysmo-cutaneous flaps are not raised as in the conventional thyroidectomy. Retractors are placed at the sides of the incision and the midline is surgically divided about 3 cm using a diathermy. The strap muscles are vertically separated and Army-Navy retractors are gently placed in order to maintain the operating field during the procedure. Partial dissection of the sternothyroid muscle was planned to be performed in case of: difficult thyroid lobe mobilization or significantly large thyroid nodules. To continue, the middle thyroid vein is identified and ligated with the Harmonic Scalpel and either the right or the left thyroid lobe is delicately pulled towards the midline with Alice forceps.

Endoscopic stage

A 30-degree 5-mm endoscope is inserted through the skin incision without any gas infusion. The endoscope is firmly attached to the Leyla retractor which allows maneuvering of the camera in an upwards or downwards direction. Initially, the procedure is performed for the superior thyroid pedicle with the Leyla retractor sustained in an upwards direction. The spatula is used to separate the larynx from thyroid vessels and to retract them laterally. Then, the harmonic scalpel is utilized for the ligation of the ipsilateral superior thyroid artery and vein. It

also accomplishes sufficient hemostasis and ultimately decreases the overall duration of the operation.[16] However, disposable titanium clips were applied for vessel branches in close proximity to superior laryngeal nerves in order to avoid thermal injury.[17] Throughout this process the ipsilateral superior parathyroid gland is preserved and finally the upper thyroid pole of the same lobe is mobilized. The endoscope is repositioned with the holding device in downwards manner and the same procedure is repeated for the inferior lobe. The utmost caution is given in order to salvage the recurrent laryngeal nerve (RLN) which usually lies in the thyrotracheal groove.

Late open stage

The endoscope and retractors are removed. The ipsilateral lobe is released from the trachea by ligating small vessels and transecting Berry’s ligament. Then, the isthmus is dissected from the trachea and divided. The lobe is finally resected by the conventional open technique.

The aforementioned stages are repeated for the contralateral lobe in order to complete the total thyroidectomy. The midline is closed with a single suture and the skin with either glue or running subcuticular suture. In our experience a thyroidectomy with adequate hemostasis does not require drains and with that in mind no drains were applied.[15]

Results

In total 48 patients underwent mi VATT in our study. There were 37 (77%) females and 11 (23%) males with a mean age of 41.3 ± 11.6 years. The operation duration was 71.23 ± 23.81 min and thyroid gland weight 52.68 ± 21.14 gr. It should be highlighted that no conversion to the open procedure was necessary. Moreover, with respect to the VAS scale, postoperative pain was characterized as 1.67 ± 0.89 (max: 10), which is quite mild. In addition, the index Δ WBC was applied in order to evaluate the acute inflammatory response of patients’ immune systems towards trauma inflicted from the operation. Indeed, increased Δ WBC could indicate tissue destruction by novice surgeons in mi VATT. The final result for Δ WBC was a mean of 5608 cells/ μ L with $SD=2347$ cells/ μ L.

Furthermore, Δ Ca²⁺ was calculated as -1.14 ± 0.52 mg/dL, with only 5 (10.4%) cases of transient clinical hypoparathyroidism. The former was either associated with positive Chovstek’s and/or Trousseau’s signs or with complaints of new onset paresthesia expressed by the patients. Oral calcium carbonate and

vitamin D3 supplementation was offered to treat the clinical manifestations of hypocalcemia in those five patients. In addition, hoarseness was self-evaluated with the VAS scale and described as 2.30 ± 1.11 (max: 10), which does not interfere significantly with verbal communication in the immediate post-operative period. Postoperative indirect laryngoscopy of all patients revealed that none of them had reduced vocal cord mobility compared to baseline status and 0 (0%) recurrent laryngeal nerve palsies were noted. Ultimately, hospitalization lasted for a mean of 1.14 ± 0.4 days. Last but not least, the cosmetic result was considered excellent by all patients who were treated with mi VATT. A brief summary of our results is depicted in Table 1.

Table 1. Intraoperative and Postoperative results

Operation duration [SD] (min)	71.23 [23.81]
Thyroid gland weight[SD] (gr)	52.68 [21.14]
Conversion to conventional thyroidectomy	0 (0%)
Post-operative pain [SD]	1.67 [0.89]
Δ WBC [SD] (cells/ μ L)	5608 [2347]
Δ Ca ²⁺ [SD] (mg/dl)	-1.14 [0.52]
Hoarseness [SD]	2.30 [1.11]
Complications	
<i>Transient hypocalcemia</i>	5(10.4%)
<i>RLN Palsy</i>	0 (0%)
Hoarseness [SD]	2.30 [1.11]
Hospitalization [SD] (days)	1.14 [0.4]

Discussion

Admittedly, mi VATT is currently considered a safe and reproducible minimally invasive technique for the resection of small-volume pathology of the thyroid gland.[18] A major drawback of the procedure constitutes its relatively long duration. Indeed, in our series the length of the operation was 71.23 ± 23.81 min. Other authors have described significantly longer surgical times for total thyroidectomy within the range of 100-200 min.[19, 20] Interestingly enough, De Napoli et al reported on a population of 99 pediatric patients (<18 years) that mi VATT (40 ± 6.57 min) was associated with significantly shorter OR time versus its conventional open counterpart (49.3 ± 12.9 min), $p=0.0007$. Complication rates did not differ statistically between the two groups.[21]

On another note, Barczyński et al in their Randomized Clinical Trial also utilized the Harmonic Scalpel as did we. Even though acquiring this instrument increases the cost of the operation about 20-30 euros, its application was linked to a briefer operation (31.4 ± 7.7 vs 47.5 ± 13.2 min; $p < 0.001$), reduced mean intraoperative bleeding (12.9 ± 5.7 vs 32.8 ± 13.0 ml; $p < 0.001$) and shorter mean scar length at one month postoperatively (15.6 ± 1.4 vs 21.5 ± 1.9 mm; $p < 0.001$). [17]

Additionally, only five patients developed transient hypoparathyroidism and no other complication was noted in our study. Miscellaneous thyroid surgery centers have published similar morbidity rates in mi VATT and conventional thyroidectomy (Table 2).[22-24] Indisputably, the incidence of postoperative morbidity is directly associated with the surgeon's experience in the procedure. However, as our previous clinical trial demonstrated, mi VATT seems to be an easy technique to master even for last-year general surgery residents.[25] What is more, in our study no conversion to open surgery was performed. In literature, conversion rates vary from 0.2% to 1.4%. [13, 26, 27] The most common causes for extending the surgical incision are in decreasing order: difficult dissection due to thyroiditis, esophageal perforation, infiltrated lymph nodes in thyroid carcinoma and rarely uncontrollable intraoperative bleeding [21].

Table 2. Postoperative complication rates in mi VATT

Transient unilateral RLN palsy	2.4%
Permanent unilateral RLN palsy	1.2%
Transient bilateral RLN palsy	0.1%
Transient clinical hypoparathyroidism	5.1%
Permanent clinical hypoparathyroidism	0.4%
Postoperative bleeding	0.2%
Surgical site infection	0.1%

Moreover, the aesthetic results in our patients who underwent mi VATT were self-evaluated as excellent. On account of a recent trend for the implementation of Robotic technology in all aspects of Surgery, Materazzi et al performed a prospective randomized clinical trial to compare mi VATT versus robot-assisted transaxillary thyroidectomy (RATT) in terms of aesthetic outcomes and overall satisfaction. They

documented that mi VATT is not only performed faster (71.6 min) than RATT (120.4 min), but is also accompanied by less postoperative pain and superior patient satisfaction with the cosmetic results.[28] Despite objectively superior aesthetic results in favor of mi VATT, it has been stressed that patients are not primarily concerned with the length of the scar as long as they are afforded radical treatment for their disease.[29]

Accurate answers on the benefits of mi VATT were offered by a 2013 meta-analysis which involved 9 prospective randomized studies comparing mi VATT to conventional thyroidectomy (CT). Overall, 581 patients were randomly assigned to either mi VATT (n=289) or CT (n=292). Indeed, patients who were treated with mi VATT experienced significantly less postoperative pain. Moreover, mi VATT was associated with more satisfactory aesthetic results than CT (9.0 vs. 6.8, SMD = -3.388, 95 % CI = -5.720 to -1.057). As expected, operative time was significantly longer in mi VATT (75.2 vs. 59.2 min, SMD = 1.246, 95 % CI = 0.227-2.266).[30]

Indisputably, worldwide experience with mi VATT is anything but extensive. For instance, even though in our case series study patients with thyroiditis were not offered the procedure, Miccoli et al reported that among 1946 individuals treated with this particular technique, thyroiditis was observed histologically in 17.9% of those with benign thyroid lesions and in 30.9% with thyroid malignancies.¹⁸ Truly the implementation of mi VATT in the treatment of thyroid carcinomas has received contradicting reactions. Currently, mi VATT can be applied for curative intent in cases of low and intermediate risk papillary carcinomas without lymph node metastasis.[31] A relative indication of mi VATT has been advocated for prophylactic total thyroidectomy in carriers of the RET oncogene.[32] Encouraging preliminary results have also been reported for follicular carcinomas, in which mi VATT seems to offer similar five year survival rates to open thyroidectomy.[33] Moreover, descriptions of central compartment lymph node dissection and even total cervical lymphadenectomy do exist in published papers. [34, 35] However, there is still no hard evidence on long-term results of mi VATT for malignant lesions and should by no means be considered a viable alternative to open surgery which remains the gold standard for thyroid carcinomas.

With increased experience implementing mi VATT, novel approaches are attempted in order to surmount restrictions imposed by two-dimensional endoscopic technology. Specifically, Mercante et al described in 2013 the first short series in which a Three-dimensional (3D) minimally invasive video-assisted thyroidectomy (MIVAT) was carried out with a 4-mm, 3D 0-degree stereoscopic endoscope. Three patients who underwent total thyroidectomy and data were gathered prospectively. Operation length for the 3D mi VATT ranged from 72 to 90 minutes. No complications were reported.[36]

Conclusion

This prospective case series study reveals that mi VATT constitutes a safe and feasible procedure when performed by experienced and skillful endocrine surgeons. However, there is still ambivalence around the exact limitations of the technique; especially in the management of thyroid carcinomas. The authors estimate that large, multi-institutional randomized controlled clinical trials are required in order to evaluate mi VATT with the utmost effectiveness.

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Author contributions

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