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Original article

Minimally Invasive Thyroidectomy and Intraoperative Neuromonitoring (IONM): is MIVAT the better surgical option?

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Abstract. *Background:* In the last two decades, many new techniques have been introduced in thyroid surgery. Minimally invasive video-assisted thyroidectomy (MIVAT) has benefited from technological advances and the use of intraoperative neuromonitoring (IONM) has improved surgical outcomes, with a small cervical incision. *Methods:* We retrospectively analyzed the use of IONM in patients undergoing MIVAT, from 2015 to 2020, at the Operative Unit of the General Surgical Clinic of the University Hospital of Parma, Italy. We compared our data with a control group from 2011 to 2014 treated with the same minimally invasive technique but without using IONM. The aim of our study was to evaluate the use of IONM in patients undergoing MIVAT, and we compared data of the two groups, routinary use or non-use of the IONM, to assess if there was a different incidence of postoperative complications and a significant difference in surgical operative time. *Results:* We collected data on 328 cases, divided into two groups according to the routinary use or non-use of the IONM. The incidence of serological hypocalcemia was lower in group 2 ($p < 0.0001$). We did not register differences in the incidence of wound infection, postoperative seroma, or hemorrhage. We did not register statistically significant differences in the surgical procedure time between the groups and the incidence of dysphonia was higher in group 1 but without statistical significance (p=ns). *Conclusions:* MIVAT is a feasible and safe technique with good esthetic outcomes and the combined use of IONM presents a better outcome in terms of postoperative dysphonia. (www.actabiomedica.it)

Key words: IONM, MIVAT, thyroidectomy, lobectomy, minimally invasive thyroid surgery

Introduction

In the last two decades, many new techniques have been introduced in thyroid surgery also due to the increased diagnosis of suspicious thyroid nodules. The spread of these techniques has resulted in a better cosmetic outcome for the patient but not always in a lower impact in terms of surgical trauma. In comparison with traditional surgery, not all these surgical approaches have shown similar results in terms of incidence of associated adverse events or oncological radicality.

In the field of endocrine surgery, in particular thyroid surgery, various minimally invasive techniques have been developed but the one that has had the greatest worldwide spread is the minimally invasive video-assisted thyroidectomy, defined as MIVAT (1).

MIVAT is a minimally invasive technique that uses cervical access with a small incision and, unlike the others, does not use other anatomical pathways as in the case of endoscopic or robotic trans axillary thyroidectomy, trans areolar mammary thyroidectomy, transoral thyroid surgery.

Table 1. Indication and contraindication to MIVAT.

Indications	Contraindications	Relative contraindications
Thyroid nodules <35 mm	Prior neck surgery	Prior neck irradiation
Thyroid volume <30 ml	Locally advanced thyroid carcinoma	Thyroiditis or Graves disease
Low and intermediate risk papillary thyroid carcinoma	Preoperative evidence of lymphnode metastases	
Patients with RET gene mutation		

The concept of minimally invasive surgery must be identified with the surgery that determines the least anatomical dissection to treat the target organ.

Over the years, technology has come to the aid of surgery and has allowed the development of these new techniques. Also, MIVAT has benefited from technological advances through better image magnification, the safety of dissection, and better hemostasis given by the energy devices (2-4). Furthermore, the possibility of combining the anatomical identification of the inferior laryngeal nerve with the possibility of analyzing and controlling its function, with consequent modification of the intraoperative surgical strategy, through the use of intraoperative neuromonitoring (IONM) has improved surgical outcomes.

Table 2. IONM Standard steps.

L1: vocal cord examination with preoperative laryngoscopy
V1: stimulation of the ipsilateral vagus before RLN dissection
R1: stimulation of the RLN at the first point where it is found in the tracheoesophageal groove
S1: stimulation of the EBSLN with the probe after it has been detected
S2: stimulation of the EBSLN proximal to the point where superior thyroid vessels are separated, following separation of the vessels and successful bleeding control
R2: stimulation of the RLN at its most proximal point after the dissection is complete
V2: vagus stimulation after bleeding control is complete at the surgical field
L2: vocal cord examination with postoperative laryngoscopy

Methods

We retrospectively analyzed the use of the IONM in patients undergoing minimally invasive video-assisted thyroidectomy (MIVAT), for both lobectomy and total thyroidectomy, from 2015 to 2020, at the Operative Unit of the General Surgical Clinic of the University Hospital of Parma, Italy. We compared our data with a control group from 2011 to 2014, that also underwent surgery at the Operative Unit of the General Surgical Clinic of the University Hospital of Parma, treated with the same minimally invasive technique but without using intraoperative neuromonitoring (IONM).

We divided patients into 2 groups: group 1 MIVAT without using IONM, and group 2 MIVAT with IONM.

We analyzed: surgical indication, type of surgical procedure, surgical timing, patient age, gender, serum calcium values at 24 h, postoperative dysphonia, postoperative hemorrhage, the incidence of seroma/wound infection, and nodules size.

The inclusion criteria for the MIVAT technique are shown in Table 1.

The exclusion criteria in our study were: age<18 years, no response to follow-up, conversion from video-assisted surgery to traditional surgery.

All patients enrolled in our work were contacted at least one year after surgery.

The MIVAT technique was performed after an adequate learning curve and the collected data refer to patients treated subsequently. We used a 30-degree optic, 5 mm in diameter, multipurpose clips, and energy devices dedicated to thyroid surgery. The neuromonitoring used was the NIM-3.0 equipment system (Medtronic, Jacksonville, FL, USA).

The patients of the IONM-MIVAT group underwent surgery with the search for the nerve signal with a standardized intermittent technique (5). (Table 2)

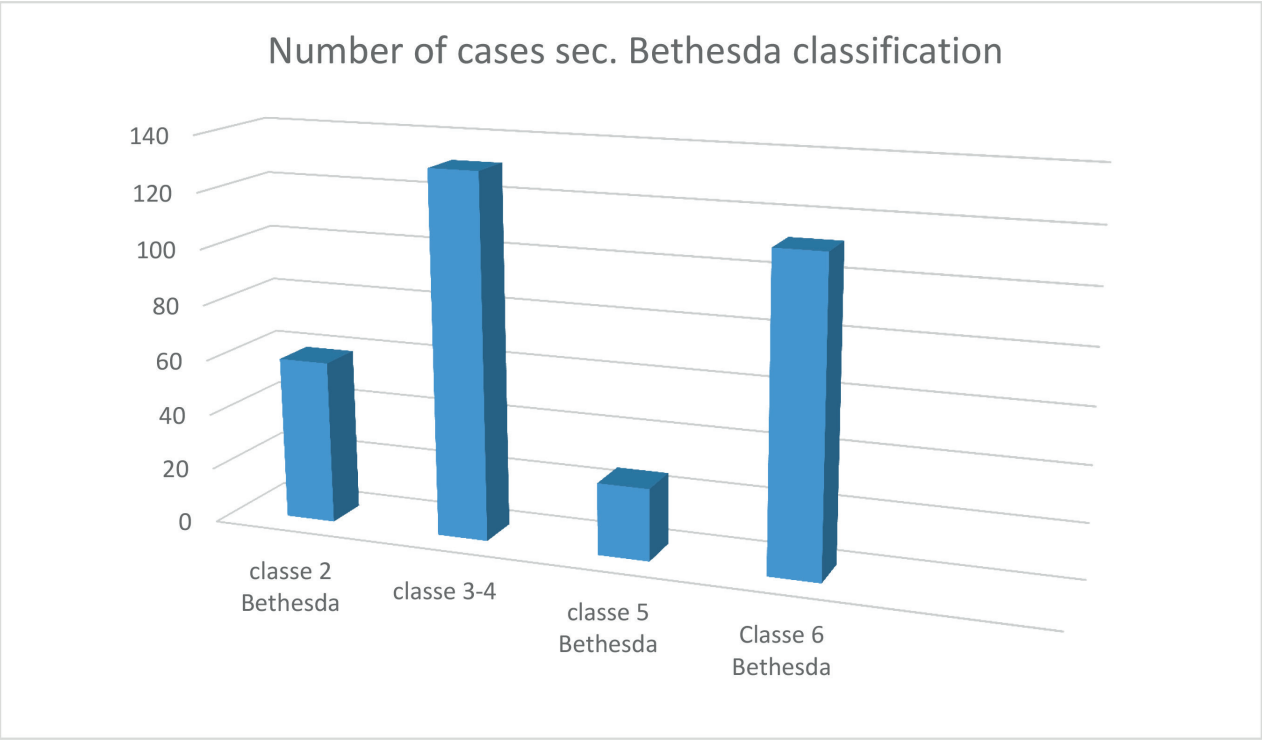

Figure 1. Preoperative FNAC.

The aim of our study was to evaluate the use of IONM in patients undergoing thyroid surgery with MIVAT, and we compared the data of the two groups, routinary use or non-use of the IONM, to assess if there is a different incidence of postoperative complications and a significant difference in surgical operative time.

The data were analyzed using "GraphPad software" with the t-student method and the chi-square test.

This work is approved by the Institutional Ethics Committee to collect the data.

Results

In the period from 2011 to 2020, 401 patients were operated with the MIVAT technique at the Operative Unit of the General Surgical Clinic of the University Hospital of Parma, Italy. 73 patients were excluded due to incomplete data or loss to follow-up.

2020 was characterized by the impact of the Sars Covid-19 pandemic which led to a decrease in the surgical response to endocrine surgery waiting lists (6-13).

We collected complete data on 328 cases, divided into two groups according to the routinary use or non-use of the IONM.

The results of the preoperative cytological examination (FNAC) of the patients that underwent surgery are reported in Figure 1.

The incidence of serological hypocalcemia considering serum calcium values < 8 mg/dL was lower in percentage terms in group 2 with p <0.0001.

We did not register differences in the incidence of wound infection, postoperative seroma, or hemorrhage.

The size of the nodules treated had no statistically significant differences in the two groups (p=n.s.).

Comparing the type of surgical treatment between the two groups, in the first group we found 81 total thyroidectomies out of 86 cases, while in the second group, an incidence of 154 total thyroidectomies out of 242 cases treated with p = 0.0001.

In group 2 the size of the nodules of patients undergoing thyroidectomy versus patients in whom lobectomy was performed were different with p=0.01.

Table 3. Cases characteristics and adverse events.

	Group 1*	Group 2**	p
Age years	46,52 +/-11,69	45,07+/-12,14	n.s.
Sex (male/female)	12/74	49/193	n.s.
Calcium level <8 mg/dL at 24 h. postop.	41/86 (47,7%)	31/139 (22,3%)	<0,0001
Vocal cord palsy at 6 months	1/86 (1,2%)	2/242 (0,8%)	n.s.
Sieroma/infection, haematoma	-	-	
Surgical procedure time (min.)	59,38+/-9,42	55,20+/-13,44	n.s.
Nodule size (mm)	15,58+/-8,1	13,96+/-6,72	n.s.

Abbreviations: *Group 1: no IONM; ** Group 2: with IONM.

We did not register statistically significant differences in the surgical procedure time between the groups with values of 59.38+/-9.42 min vs 55.20+/-13.44 min.

The incidence of dysphonia was higher in percentage terms in group 1 but without statistical significance (p=ns). No bilateral dysphonia was found in both groups (Table 3).

Discussion

Thyroid surgery has seen surgical options change in terms of indications and technical innovation (14-16). The choice of our Operative Unit to perform minimally invasive thyroid surgery, in the cases selectable according to the inclusion criteria, deposes for the use of MIVAT which still today allows a minimal anatomical dissection with low surgical trauma for the patient, less postoperative pain, compared to traditional open surgery, and with better cosmetic results (17).

Furthermore, MIVAT associates minimally invasiveness with safety, also in the oncological field (18), and allows intraoperative neuromonitoring to be used with a standardized technique (19,20).

The "remote" accesses defined as endoscopic or robotic are associated with difficulties related to the creation of the anatomical pathway with the consequent not easy possibility of using the IONM according to the standardized technique (19-21).

The difference in terms of the type of surgical procedure performed in the two reference groups is due to the publication of the 2015 guidelines of the American Thyroid Association which modified the indications for the treatment of nodular thyroid diseases, in particular for indeterminate nodules after cytological examination (22,23).

Few studies have been published on the use of IONM in remote-access thyroidectomy. Its use is relatively difficult, in remote access, due to the limited working space and the difficulty in identifying the vagus nerve.

The latest innovations in the MIVAT technique are associated with marked vision improvement through the use of high-resolution video columns, now commonly spread in most operating theatres, allowing minimally invasive surgery to be performed at costs similar to those of traditional surgery.

It is known that among the adverse events correlated to thyroid surgery, we must highlight postoperative dysphonia, due to chordal hypomotility, as the event that can most affect the postoperative course and patient satisfaction. The development of devices that allow for the monitoring of extra cervical nerve function remains the real frontier for being able to use the IONM in all thyroidectomy techniques, even remotely.

In the future, new methods for stimulation with continuous IONM will also help remote techniques (24) in the use of different devices.

The large number of cases that should be performed to statistically determine the efficacy of IONM in minimally invasive thyroid surgery must include a prospective randomized multicenter study with a subsequent control group.

Today our personal experience testifies that the percentage of patients treated with the use of

the IONM presents a better outcome regarding the hoarseness indicator even if not statistically significant, it eliminates bilateral hoarseness by applying the two-stage thyroidectomy protocol and allows better and faster learning of the surgical procedures to less experienced surgeons, which is extremely important in a teaching hospital.

The surgical procedure time in the two groups is superimposable once the initial learning phase has passed, just as the incidence of adverse events does not differ in percentage; there is a less incidence of postoperative serological hypocalcemia in the group in which the IONM was used, probably for a minor dissection conducted for the control of the inferior laryngeal nerve with consequent lower risk of devascularization of the parathyroid glands (25).

However, there remains a higher level of safety perceived during surgery and in the event of any medical litigation, proof that in the case of the onset of chordal paresis, after correctly informing the patient preoperatively, this adverse event was predictable but not preventable.

Conclusions

In our experience MIVAT can be considered a feasible and safe technique with good esthetic outcomes and the combined use of IONM presents a better outcome regarding the hoarseness indicator and eliminates bilateral hoarseness by applying the two-stage thyroidectomy.

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Ethic Committee: This work is approved by the Institutional Ethics Committee to collect the data. with the protocol number 17740 of 27/04/2022.

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References

1. Dionigi G, Dralle H, Materazzi G, Kim HY, Miccoli P. Happy 20th birthday to minimally invasive video-assisted thyroidectomy! J Endocrinol Invest. 2020 Mar;43(3): 385-388. doi: 10.1007/s40618-019-01119-1.
2. Applewhite MK, White MG, James BC, et al. Ultrasonic, bipolar, and integrated energy devices: comparing heat spread in collateral tissues. J Surg Res. 2017 Jan;207: 249-254. doi: 10.1016/j.jss.2016.06.077.
3. Canu GL, Medas F, Podda F, Tatti A, Pisano G, Erdas E, Calò PG. Thyroidectomy with energy-based devices: surgical outcomes and complications-comparison between Harmonic Focus, LigaSure Small Jaw and Thunderbeat Open Fine Jaw. Gland Surg. 2020 Jun;9(3):721-726. doi: 10.21037/gs.2020.03.31.
4. Yu X, Liu C, Yan M, Gong W, Wang Y. Hyperthermal liquid, spray, and smog may be potential risk factors for recurrent laryngeal nerve thermal injury during thyroid surgeries. Endocrine. 2021 Apr;72(1):198-207. doi: 10.1007 /s12020-020-02451-w.
5. Del Rio P, Bonati E, Loderer T, Rossini M, Cozzani F. Can we routinely identify the external branch of the superior laryngeal nerves with neural monitoring?: a prospective report on 176 consecutive nerves at risk. Updates Surg. 2021 Dec;73(6):2275-2281. doi: 10.1007/s13304-021-01084-6.
6. Medas F, Ansaldo GL, Avenia N, et al. The THYCOVIT (Thyroid Surgery during COVID-19 pandemic in Italy) study: results from a nationwide, multicentric, case-controlled study. Updates Surg. 2021 Aug;73(4):1467-1475. doi: 10.1007/s13304-021-01051-1.
7. Zhang D, Fu Y, Liang N, et al. Thyroid surgery during coronavirus-19 pandemic phases I, II and III: lessons learned in China, South Korea, Iran and Italy. J Endocrinol Invest. 2021 May;44(5):1065-1073. doi: 10.1007/s40618-020-01407-1.
8. Giuffrida M, Cozzani F, Rossini M, Bonati E, Del Rio P. How COVID-19 pandemic has changed elective surgery: the experience in a general surgery unit at a COVID-hospital. Acta Biomed. 2021 Nov 5;92(5):e2021304. doi: 10.23750 /abm.v92i5.10296.
9. Rottoli M, Gori A, Pellino G, et al. Colorectal Cancer Stage at Diagnosis Before vs During the COVID-19 Pandemic in Italy. JAMA Netw Open. 2022 Nov 1;5(11):e2243119. doi: 10.1001/jamanetworkopen.2022.43119.
10. Giuliani G, Guerra F, Messinese S, et al. The COVID - AGICT study: COVID-19 and advanced gastro-intestinal cancer surgical treatment. A multicentric Italian study on the SARS-CoV-2 pandemic impact on gastro-intestinal cancers surgical treatment during the 2020. Analysis of perioperative and short-term oncological outcomes. Surg Oncol. 2023 Apr;47:101907. doi: 10.1016/j.suronc.2023.101907.

11. Medas F, Dobrinja C, Al-Suhaimi EA et al. Effect of the COVID-19 pandemic on surgery for indeterminate thyroid nodules (THYCOVID): a retrospective, international, multicentre, cross-sectional study. Lancet Diabetes Endocrinol. 2023 Apr 28:S2213-8587(23)00094-3. doi: 10.1016/S2213-8587(23)00094-3.
12. Giuliani G, Coletta D, Guerra F, et al. The MIS-COVID-AGICT Study: Trend of Minimally Invasive Surgery for Gastrointestinal Cancer Treatment During the First Waves of the COVID-19 Pandemic in Italy. Subgroup Analysis from the COVID-AGICT Study: COVID-19 and Advanced Gastrointestinal Cancer Surgical Treatment. J Laparoendosc Adv Surg Tech A. 2023 May 2. doi: 10.1089/lap.2023.0058.
13. Miccoli P, Berti P, Conte M, Bendinelli C, Marcocci C. Minimally invasive surgery for thyroid small nodules: preliminary report. J Endocrinol Invest. 1999 Dec;22(11):849-51. doi: 10.1007/BF03343657.
14. Del Rio P, Arcuri MF, Pisani P, De Simone B, Sianesi M. Minimally invasive video-assisted thyroidectomy (MIVAT): what is the real advantage? Langenbecks Arch Surg. 2010 Apr;395(4):323-6. doi: 10.1007/s00423-009-0589-2.
15. Bellotti C, Capponi MG, Cinquepalmi M, et al. MIVAT: the last 2 years experience, tips and techniques after more than 10 years. Surg Endosc. 2018 May;32(5):2340-2344. doi: 10.1007/s00464-017-5929-7.
16. Chen WH, Chen CY. Postoperative quality of life and cosmetic outcome between minimally invasive video-assisted thyroidectomy and bilateral axillo-breast approach robotic thyroidectomy: a single center retrospective cohort study. Updates Surg. 2021 Aug;73(4):1459-1465. doi: 10.1007/s13304-021-01035-1.
17. Randolph GW, Dralle H. Electrophysiologic recurrent laryngeal nerve monitoring during thyroid and parathyroid surgery: international standards guideline statement. Laryngoscope. 2011 Jan;121 Suppl 1:S1-16. doi: 10.1002/lary.21119.
18. Del Rio P, Maestroni U, Sianesi M, et al. Minimally invasive video-assisted thyroidectomy for papillary thyroid cancer: a prospective 5-year follow-up study. Tumori. 2015 Mar-Apr;101(2):144-7. doi: 10.5301/tj.5000223.
19. Rossini M, Cozzani F, Loderer T, Bonati E, Giuffrida M, Del Rio P. Intraoperative Neuromonitoring, Nerves at Risk and Staged Thyroidectomy, our Experience on 377 Consecutive Cases. Acta Biomed. 2022 May 11;93(2):e2022040. doi: 10.23750/abm.v93i2.11178.
20. Ji YB, Ko SH, Song CM, et al. Feasibility and efficacy of intraoperative neural monitoring in remote access robotic and endoscopic thyroidectomy. Oral Oncol. 2020 Apr;103:104617. doi: 10.1016/j.oraloncology.2020.104617.
21. Munshi R, Mankowski N, Souza S, et al. The Effect of Patient Positioning on Intraoperative Neuromonitoring During Thyroid and Parathyroid Surgery. Am Surg. 2021 Dec 3:31348211061103. doi: 10.1177/00031348211061103.
22. Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid. 2016 Jan;26(1):1-133. doi: 10.1089/thy.2015.0020.
23. Pacini F, Basolo F, Bellantone R, et al. Italian consensus on diagnosis and treatment of differentiated thyroid cancer: joint statements of six Italian societies. J Endocrinol Invest. 2018 Jul;41(7):849-876. doi: 10.1007/s40618-018-0884-2.
24. Zhang D, Wang C, Wang T, et al. Clinical Experience of Use of Percutaneous Continuous Nervemonitoring in Robotic Bilateral Axillo-Breast Thyroid Surgery. Front Endocrinol (Lausanne). 2022 Feb 8;12:817026. doi: 10.3389/fendo.2021.817026.
25. Melfa G, Siragusa G, Cocorullo G, et al. Effects of Intraoperative Nerve Monitoring Techniques on Voice and Swallowing Disorders after Uncomplicated Thyroidectomy: Preliminary Report of a Bi-Institutional Prospective Study. J Clin Med. 2022 Dec 30;12(1):305. doi: 10.3390/jcm12010305.

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