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ABSTRACT BOOK
ORAL PRESENTATIONS
Abstract number: 0005

COMPARISON OF PROPOFOL AND SEVOFLURANE ANESTHESIA DURING THYROID AND PARATHYROID SURGERY WITH ELECTROPHYSIOLOGIC RECURRENT LARYNGEAL NERVE MONITORING.

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Objectives
To avoid the injury of recurrent laryngeal nerve, intraoperative neural monitoring during thyroid and parathyroid surgery has gained widespread acceptance. During the surgery, muscle relaxant has great negative influence on electrophysiological activities in general anesthesia. We provide comparison of the effect of propofol and sevoflurane with less muscle relaxant during thyroid and parathyroid surgery with electrophysiologic recurrent laryngeal nerve monitoring.

Methods
A total of 60 cases that underwent thyroid and parathyroid surgery with intraoperative neural monitoring were performed general anesthesia with endotracheal intubation (NeverIntegrity Monitor tracheal cannula) and were divided into group propofol and sevoflurane randomly (n=30). The patients in group sevoflurane were inhaled the mixture of sevoflurane and oxygen after the induction of anethesia. We regulated the concentration of sevoflurane through the reaction of the patients (Anesthesia maintained with sevofluran). The patients in group propofol received infusion of propofol continually (Anesthesia maintained with propofol 1.0-1.5mg/(kg·h)). During the operation, SPO2, HR, BP, RR were monitored. The time of recovery of electrophysiological activities, the quantitative value of TOF, the amplitude of vibration of recurrent laryngeal nerve activities and the cases of throat reflection were all recorded.

Results
The time of recovery of electrophysiological activities in group propofol were longer than in group sevoflurane (P<0.05). The cases of throat reflection were less in group sevoflurane (P<0.05).

Conclusions
Both sevoflurane and propofol can provide satisfactory anesthesia during thyroid and parathyroid surgery with electrophysiologic recurrent laryngeal nerve monitoring. But anesthesia with sevoflurane maintained more stabilized maintenances of anesthesia for monitoring nerve electrophysiologic activities with less muscle relaxant.
Abstract number: 0006

CLINICAL APPLICATION OF THE RECURRENT LARYNGEAL NERVE MONITORING IN MICCOLI OPERATION.

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Objectives
Discuss the clinical application of the recurrent laryngeal nerve monitoring in Miccoli operation.

Methods
The study summarized 109 cases of Miccoli surgery patient data from the February 2013 to February 2014 treated in our hospital because of thyroid disease. Divided into conventional group and nerve monitoring group, we revealed comparative analysis between two groups of patients in the explored recurrent laryngeal time, total operation time, recurrent laryngeal nerve injury rate, incision extending rate, blood loss, postoperative drainage and hospitalization costs.

Results
In the recurrent laryngeal nerve monitoring group, explored time, total operation time, temporary recurrent laryngeal nerve injury rate, incision extending rate, permanent recurrent laryngeal nerve injury rate, average blood loss, postoperative drainage and hospital charges were: (4.7 ± 1.4) min, (94.5 ± 7.5) min, 1.39%, 0%, 2.44%, (32.6 ± 2.5) ml, (49.5 ± 6.7) ml and (20834.3 ± 189) yuan; while the conventional group are: (13.3 ± 3.1) min, (137.4 ± 9.3) min, 11.54%, 1.28%, 17.65%, (36.8 ± 5.7) ml, (52.1 ± 3.2) ml and (16937 ± 79) yuan. Temporary recurrent laryngeal nerve injury rate and hospital costs had a relatively significant difference (p <0.05) between the two groups. Explored recurrent laryngeal time, total operation time, temporary recurrent laryngeal nerve injury rate, incision extending rate, and hospitalization costs had a relatively significant difference (p <0.05) between the two groups.

Conclusions
In Miccoli operation, laryngeal nerve monitoring although expensive, but can reduce explored recurrent laryngeal time, total operation time, temporary recurrent laryngeal nerve injury rate and incision extending rate, and thus, in Miccoli operation, the recurrent laryngeal nerve monitoring should be promoted.
Abstract number: 0007

CLINICAL APPLICATION OF THE RECURRENT LARYNGEAL NERVE MONITORING IN THYROID REOPERATION.

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Objectives
Discuss the clinical application of the recurrent laryngeal nerve monitoring in thyroid reoperation.

Methods
The study summarized 82 cases of thyroid surgery patient data from the October 2011 to October 2013 treated in our hospital because of thyroid disease. Divided into conventional group and nerve monitoring group, we revealed comparative analysis between two groups of patients in the explored recurrent laryngeal time, total operation time, recurrent laryngeal nerve injury rate, blood loss, postoperative drainage and hospitalization costs. Discuss the clinical value of nerve monitoring in thyroid reoperation.

Results
In the recurrent laryngeal nerve monitoring group, explored time, total operation time, temporary recurrent laryngeal nerve injury rate, permanent recurrent laryngeal nerve injury rate, average blood loss, postoperative drainage and hospital charges were: \( (12.7 \pm 1.7) \) min, \( (129.5 \pm 4.3) \) min, \( 5.63\% \), \( 1.41\% \), \( (98.6 \pm 10.7) \) ml, \( (79.5 \pm 8.3) \) ml and \( (22725.3 \pm 143) \) yuan; while the conventional group are: \( (13.3 \pm 3.3) \) min, \( (137.4 \pm 9.3) \) min, \( 21.74\% \), \( 1.45\% \), \( (101.3 \pm 9.7) \) ml, \( (77.8 \pm 3.3) \) ml and \( (17307 \pm 114) \) yuan. Temporary recurrent laryngeal nerve injury rate and hospital costs had a relatively significant difference \( (p <0.05) \) between the two groups. In order to effectively evaluate the clinical value of recurrent laryngeal nerve injury monitoring, we calculated sensitivity, specificity, positive predictive value and negative predictive value which were 5%, 84%, 69.23% and 75%.

Conclusions
In thyroid reoperation, laryngeal nerve monitoring although expensive, but can reduce the rate of temporary recurrent laryngeal nerve injury, is a more reliable method of predicting postoperative nerve function, and thus, in thyroid reoperation, the recurrent laryngeal nerve monitoring should be promoted.
Abstract number: 0010

**BILEVEL POSITIVE AIR WAY PRESSURE FOR THE TREATMENT OF BILATERAL CORD PALSY AFTER THYROIDECTOMY.**

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**Objectives**
Bilateral cord palsy can happen in total thyroidectomy. Tracheotomy may be necessary in this potentially fatal outcome.

**Methods**
From Jan. 2011 to Dec. 2015, 12 patients who developed bilateral cord palsy after thyroidectomy were recruited in this study. There were 11 female patients and one male patient. Their ages ranged from 22 to 74 with an average of 46±16.5 (mean±SD) years. Total thyroidectomy was performed in all 12 patients, two with central lymph node dissection and one with modified radical neck dissection. Two patients had re-do surgery. IONM was selectively applied in 8 patients; among them 5 had losses of signals on both side and 3 had perfect signals. IONM was not applied in 4 patients. During surgery bilateral recurrent nerves were visually intact in all patients.

**Results**
All 12 patients had husky voice; 9 patients had choking and dysphagia; 4 patients had stridor. Dyspnea occurred in 3 of 4 patients with stridor at post operation day 0, 2 and 8. Patients were immediately applied bilevel positive air way pressure (BiPAP) if dyspnea occurred. The positive inspiratory pressure was kept around 10-15 cm H2O and the positive end expiratory pressure around 5 cm H2O with the monitoring of arterial oxyhemoglobin saturation (> 95%) and saturation of peripheral oxygen (> 95%). Dyspnea finally recovered at 5 to 9 days after applying BiPAP. Husky voice and choking in all 12 patients recovered within 15 weeks.

**Conclusions**
BiPAP can relieve dyspnea in patients who have bilateral cord palsy after total thyroidectomy. Tracheotomy seems not necessary. It is not necessary to change the surgical plan for the contralateral side in case of loss of signal on the first resection of bilateral goiter. All patients who have husky voice, choking, stridor and dyspnea due to bilateral cord palsy can recover within 15 weeks in this study.
Abstract number: 0011

RECURRENT LARYNGEAL NERVE SAFETY PARAMETERS OF THE HARMONIC FOCUS® DURING THYROID SURGERY: AN EXPERIMENTAL PORCINE MODEL USING CONTINUOUS ELECTROPHYSIOLOGIC VAGAL MONITORING.

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Objectives
Using Harmonic Focus (HF) in the thyroidectomy is known to be associated with better outcomes. In this study, we tested the safety of HF around the recurrent laryngeal nerve (RLN) in experimental porcine model using continuous electrophysiologic monitoring.

Methods
Ten piglets were used. HF was activated at a 5, 3, 1, and 0mm distance from the RLN (activation study). HF was directly touched the RLN after activation on the sternocleidomastoid muscle for 10 seconds with 10, 5, 4, and 1 second of cooling time (cooling study).

Results
In activation study, there was no adverse EMG event in all times of tests at more than1mm distance. In tests at 0mm, EMG was stable when the activation duration was 1 to 3 seconds. However, there were adverse EMG events when the activation duration was 4 seconds or longer. In cooling study, there was no adverse EMG event in tests with 10 second cooling time. When HF was cooled by touching sternocleidomastoid muscle after prior activation, there was no adverse EMG event in tests with 2 second or longer cooling time.
Conclusions

HF might be used safely at 1mm or longer distance from the RLN. In order to use HF around the RLN after prior activation, it should be cooled for more than 10 seconds or 2 seconds after cooling at muscle. HF should be used in a standardized manner to avoid the RLN injury.
Abstract number: 0012

**THERMAL INJURY OF RECURRENT LARYNGEAL NERVE BY THUNDERBEAT™ DURING THYROID SURGERY: PRELIMINARY RESULTS USING CONTINUOUS INTRAOPERATIVE NEUROMONITORING IN A PORCINE MODEL.**

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**Objectives**

Recurrent laryngeal nerve (RLN) palsy is the most common and serious complication after thyroid surgery. The use of energy based devices (EBD) has replaced hand-tying methods in many institutions. However, issues of EDB near RLN regarding the temperature and lateral thermal spread are still concerns. THUNDERBEAT (TB) is one of the most popular energy-based devices. The aim of this study was to test the safety parameters of TB during thyroidectomy.

**Methods**

Three piglets weighing 30 kg to 40 kg were used with the aid of continuous electrophysiologic monitoring prospectively. During the experiments, continuous IONM were performed using EMG endotracheal tube and NIM 3.0 response system. TB was activated at various distances from RLN. We determined the safe distance from the RLN and duration of activation time of TB.

**Results**

In the present study, there was no adverse EMG event at more than 3mm distance. Only amplitude decreased at 2mm distance after 8 seconds. However, immediate loss of signal (LOS) occurred at 1mm distance. This probably was due to immediate shrinkage of surrounding tissue after activation of TB.

**Conclusions**

Safe distance of TB was 3mm, and it should be used less than 8 seconds for distance closer than 3 mm. TB should be used at least more than 1mm in order to avoid RLN injury.
Abstract number: 0013

THE EFFICACY OF INTRAOPERATIVE NEUROMONITORING (IONM) DURING ROBOTIC THYROIDECTOMY: PROSPECTIVE, RANDOMIZED CASE-CONTROL EVALUATION.

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Objectives
This study evaluates the efficacy of intraoperative neuromonitoring (IONM) on voice performance after robotic thyroidectomy.

Methods
The study was based on a prospective randomized series. Between June 2011 to September 2012, 50 patients with thyroid cancer who underwent robotic thyroidectomy were enrolled. Both the IONM and non-IONM groups consisted of 25 patients each. Voice handicap index (VHI), voice range profile (VRP) and laryngoscopy were used to test the patients voice function. All voice evaluations were performed before surgery and at 2 weeks, 3 months, and 6 months after operation.

Results
The non-IONM and IOMN groups had similar VHI results. In laryngoscopic finding, there was no palsy observed in both groups. VRP minimum frequency and intensity were more rapidly recovered in IONM groups. VRP maximum frequency and intensity were not different between the two groups.

Conclusions
We found that IONM group could recover voice function more rapidly after a prospective randomized series of patients undergoing robotic thyroidectomy with the use of IOMN.
Abstract number: 0014

THERMAL INJURY OF RECURRENT LARYNGEAL NERVE BY ULTRASONIC DEVICES DURING THYROID SURGERY: RESULTS USING CONTINUOUS INTRAOPERATIVE NEUROMONITORING IN A PORCINE MODEL.

Kim H.1, Lee H.1, Kim H.1, Kwak H.1, Jung S.1, Woo S.1, Son G.1, Lee J.1, Bae J.1

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Objectives

Recurrent laryngeal nerve (RLN) palsy is the most common and serious complication after thyroid surgery. The use of energy based devices (EBD) has replaced hand-tying methods in many institutions. However, issues of EDB near RLN regarding the temperature and lateral thermal spread are still concerns. Harmonic scalpel ACE (HA) is one of the most popular EBD. The aim of this study was to test the safety parameters of HA during thyroidectomy.

Methods

Four piglets weighing 30kg to 40kg underwent thermal injury to the RLN. During the experiments, continuous IONM were performed using EMG endotracheal tube and NIM 3.0 response system. We examined the safety of using Harmonic Scalpel around RLN. We determined the limitation of safe distant and duration of using HA.

Results

In the present study, we found that the safe distant between the HA and RLN is over 3mm. Over 3mm, there was no limitation of duration of activation for safety. Within 3mm, we observed the LOS after 5 seconds. Within 1mm of distant between the HA and RLN, we observed LOS from starting of activation.

Conclusions

The safe distant of using HA is over 3mm. Within the distant of 3mm, the safe duration of activation is within 5 seconds.
Abstract number: 0015

INTRAOPERATIVE NERVE INTEGRITY MONITOR AS PART OF SAFETY DISSECTIONS OF RECURRENT LARYNGEAL NERVE AND SPINAL ACCESSORY NERVE.

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Objectives

Introduction. In thyroid cancer (TC) operations most frequently damaged vital structures are recurrent laryngeal nerve (RLN), spinal accessory nerve (SAN) and parathyroid glands.

Methods

27253 patients were operated on Thyroid (1973-2012). Unilateral RLN injury took place in 0.78%, bilateral - in 0.28%. In 2390 TC patients RLN injury took place in 0.31% despite or thanks to regular it dissection. That motivated us to perform RLN dissection in every thyroid operation. There are about 30 variations of RLN and inferior thyroid artery attitude and three most common points of RLN visualization: 1 – subclavial point, 2 – RLN “cross point” with the inferior thyroid artery, 3 – RLN entry point. Surgical anatomy we investigated on autopsy material (30 RLN, 20 SAN) and Surgery (1717 RLNs and 177 SANs). Intraoperative Nerve Integrity Monitor was used since 2001.

Results

It was found that RLNs in 3rd point were crossed by blood vessels in 94.9%. Vessels diameter depended on type of disease and varied of 1 to 3 mm. We preferred to find RLN and start it's dissection from below, because RLN and ITA crossing became visually controlled. Our technique allowed to find 15 nonrecurrent laryngeal nerves among 4070 patients. In 21 cases of RLN injury we performed RLN restoration under the IONIM control. During 1-2 years postoperatively 15 (71.4%) demonstrated vocal cord function improvement. For SAN protection during MRND we prefer the sternocleidomastoid muscle's upper third. In 85.18% SAN laid laterally, in 11.11% - behind and in 3.71% - medially to jugular vein. During the dissection the nerve continuity and serviceability was controlled with IONIM. We also use a zigzag shaped incision since 2001, Mac Fee or lateral approaches. It improves the functional and aesthetic results.

Conclusions

Regular using of suggested RLN, SAN dissection and IONIM technique, has decreased postoperative morbidity rates significantly.
Abstract number: 0018

RLN INJURY WITH INCOMPLETE LOSS OF EMG SIGNAL DURING MONITORED THYROIDECTOMY—EVALUATION AND OUTCOME.

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Objectives
During monitored thyroidectomy, a weaken or disrupted point of nerve conduction on the exposed RLN indicates electrophysiologic nerve injury. The correlation between vocal cord (VC) function and incomplete loss of signal (LOS) is unknown.

Methods
323 patients underwent standardized monitored thyroidectomy with 522 RLNs at risk were enrolled. After thyroid resection, the RLN was routinely stimulated at the most proximal (R2p) and distal (R2d signal) ends of exposure to determine if there was a substantial amplitude reduction (AR) and injured point on the nerve. VC mobility was routinely examined with pre- and post-operative video-fiberoptic laryngoscopy.

Results
29 RLNs were detected with substantial AR (R2p/2d <80%) and an injured point by neuromonitoring at the end of operations. 21(72%) nerves were caused by traction injury around the region of Berry’s ligament; another 8(28%) nerves were caused by mechanical trauma during dissecting RLN from cancer adhesion in 5 nerves, and from scar adhesion in 3 nerves. Injected and edematous change was found on the injured area in only 3 of the 29 RLNs (10%). Complete LOS (evoked potential <100µV) was found in 5 nerves and all showed postoperative VC palsy. Among the 24 nerves with incomplete LOS (>100µV, AR ranged from 22~79%), postoperative VC palsy was found in 4 (17%) nerves with AR from 62-79%, and final vagal (V2) signal from 181~490µV; while free VC mobility was found in the other 20 RLNs with AR from 22~53%, and V2 signal from 373~1,263µV.

Conclusions
Testing and comparing the R2p and R2d signal is a useful procedure to detect hidden injured point on the RLN, especially in nerves with incomplete LOS. When over 50% EMG AR is noted at the end of operation, the surgeon should consider the possibility of postoperative VC palsy and carefully evaluate the optimal contralateral surgery timing in patients with planned bilateral thyroid operation.
Abstract number: 0022

PERCUTANEOUS PROBE STIMULATION FOR INTRAOPERATIVE NEUROMONITORING IN TOTAL ENDOSCOPIC THYROIDECTOMY: A PRELIMINARY EXPERIENCE.

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Objectives

Intraoperative neuromonitoring (IONM) has gained increasing acceptance among surgeons during open thyroidectomy. The purpose of this study was to investigate the feasibility and value of IONM via percutaneous probe stimulation (PPS) during total endoscopic thyroidectomy (TET).

Methods

Consecutive series of 102 patients with 126 recurrent laryngeal nerves (RLNs) at risk undergoing both TET via bilateral breast approach and standardized IONM were prospectively enrolled. The stimulation probe was introduced into the working space by percutaneous puncture. During the lateral thyroid dissection, we periodically tested the proximal RLN via PPS to monitor any adverse EMG change. The vocal cord mobility was routinely examined with pre- and post-operative laryngofiberoscopy.

Results

All IONMs via PPS were performed successfully without any morbidity and scar in the neck. 12 nerves (9.5%) were detected with significant EMG change (amplitude reduction from baseline, AR, from 50% to 90%) during the lateral thyroid dissection. Compression around ITA (70%) and traction near berry ligament (30%) were the most common causative mechanisms, and modification of the surgical maneuver resulted in partial recovery of those EMG changes (AR, from 10% to 80% before closure of the wound). Temporary vocal cord palsy was noted in 8 of the 12 nerves with adverse EMG changes (final AR, from 65-80%), but all recovered within 3 months. No permanent palsy occurred in this series.

Conclusions

PPS is feasible and effective, rendering it a simple, safe, and surgeon-friendly procedure during IONM in TET with narrow operation space.
Abstract number: 0023

SURGEON-PERFORMED TRANSCUTANEOUS VOCAL CORD ULTRASONOGRAPHY IN VOCAL CORD EXAMINATION BEFORE AND AFTER THYROIDECTOMY.

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Objectives
Preoperative and early postoperative detection of vocal cord palsy is important in thyroid and parathyroid surgery. Routine direct laryngoscopy is not always possible in surgical units and besides may bring patients discomfort. Transcutaneous vocal cord ultrasonography (TVCUS) is a noninvasive alternative to direct laryngoscopy in assessing perioperative vocal cord function. The aim of this study was to evaluate the expediency of using surgeon-performed ultrasonography as a tool for perioperative assessment of vocal cord movement in comparison with direct laryngoscopy.

Methods
In the first phase of study the possibility to see by ultrasound vocal cords was successively investigated by three independent specially trained surgeons in 809 thyroid patients. Only coincident results were taken to account. In the second phase TVCUS and direct laryngoscopy was performed 561 patients before and after thyroidectomy.

Results
Vocal cords movement could be seen by ultrasound in 724 (89.5%) patients. Ultrasound was able to see vocal fold movement in 678 (90.6%) female patients but only in 17 (27.9%) male patients ($\chi^2 = 183.6; p<0.001$). Vocal cords were seen in 113 (97%) among patients up to 40 years and only in 12 (57.1%) in patients older 80 years ($\chi^2 = 6.3; p<0.05$). Postoperative TLUSG in patients with vocal cord palsy had a sensitivity 88.2%, specificity 98.5%.

Conclusions
Transcutaneous ultrasound represents an alternative tool to evaluate vocal cords movement for almost 90% of patients with thyroid disease. TLUSG is a promising, noninvasive method for replacing direct laryngoscopy before and after thyroidectomy.
Abstract number: 0024

INTRA-OPERATIVE VAGAL NEUROMONITORING PREDICTS NON-RECURRENT LARYNGEAL NERVES: TECHNICAL NOTES AND REVIEW OF THE RECENT LITERATURE.

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Objectives
During thyroid surgery, extreme caution must be taken not to harm the recurrent laryngeal nerve to avoid vocal cord palsy. A non-recurrent laryngeal nerve (NRLN) is a rare anatomical variation that is extremely vulnerable during thyroid surgery. The aberrant course is due to a congenital anomaly and is often associated with malformation of the primitive aortic arches. In this study we aimed to describe and evaluate our use of intra-operative vagal neuromonitoring.

Methods
Case representation of four NRLN during thyroid surgery in three female and one male patient of 37, 74, 40 and 51 years old, discovered early during surgery by using continuous intra-operative vagal nerve neuromonitoring. We performed a Pubmed search using following search terms: Non-recurrent laryngeal nerve; thyroidectomy; intraoperative vagal neuromonitoring; arteria lusoria; thyroid surgery.

Results
In 5 years of thyroid surgery, we encountered four NRLN out of 888 thyroid surgeries (0.45%). During thyroid surgery, we use continuous intra-operative vagal nerve neuromonitoring starting with checking vagal nerve signals. Thanks to this technique we were able to predict a NRLN during early dissection. It is essential to start stimulation in the most proximal portion of the carotid sheath. An absent pre-dissection signal on the right vagal nerve with a positive signal on the left vagal nerve indicates a non-recurrent course of the right nerve. Post-operatively CT-scan was performed in two cases and showed an associated extra-anatomical course of the subclavian artery also known as a lusorian artery.
Conclusions

The NRLN is an important surgical challenge because unilateral palsy can lead to permanent hoarseness. This anomaly, which is difficult to discover in the pre-operative setting, emphasizes the importance of a thorough surgical dissection and the use of intra-operative vagal nerve neuromonitoring. Our method of continuous intra-operative vagal nerve monitoring makes it possible to predict a non-recurrent laryngeal nerve in an early stage.
Abstract number: 0025

THERMAL INJURY OF RECURRENT LARYNGEAL NERVE BY SALINE IRRIGATION DURING THYROID SURGERY: RESULTS USING CONTINUOUS INTRAOPERATIVE NEUROMONITORING IN A PORCINE MODEL.

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Objectives
Recurrent laryngeal nerve (RLN) palsy is the most common and serious complication after thyroid surgery. Unexpected RLN palsy occurs, even though the visual integrity was assured and most nerve injuries were not recognized intraoperatively. Moreover, little is known about the thermal injury of RLN and limits of temperature which may induce the injury of RLN. The aim of this study is to evaluate threshold of imminent thermal RLN injury by cold and hot water irrigation.

Methods
Two piglets weighing 30kg to 40kg underwent RLN thermal injury. After identification of RLN, different temperature water was poured into operation field. During the experiments, we obtained EMG signals from continuous IONM using EMG endotracheal tube and NIM 3.0 response system. We have tested and measured the high and low points of water temperature that start to cause RLN injury.

Results
Below 10 degree temperature water, the latency of RLN prolonged 10% without change of amplitude. From 20 degree to 70 degree temperature water, there was no change of amplitude or latency. However, water with temperature above 80 degree temperature caused obvious loss of signal (LOS) and we could not observe recovery of signals for 30 minutes.

Conclusions
Permanent injury of RLNs (LOS) resulted from temperature of over 80 degree temperature. Under 10 degree temperature, latency increased transiently over 10%. However, it recovered eventually.
Abstract number: 0028

RELATIONSHIP BETWEEN THE ELECTROPHYSIOLOGICAL RESPONSE OF THE RECURRENT LARYNGEAL NERVE INVOLVED BY THYROID CANCER AND THE EXTENT OF NEURAL INVASION.

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Objectives
The recurrent laryngeal nerve (RLN) is often involved by thyroid cancer. In such cases, we try to preserve the nerve with sharp dissection or have to resect it with the cancer. Intraoperative neural monitoring (IONM) may support the surgeons in making the decision how to manage the nerve.

Methods
Among 3,024 patients with thyroid cancer who underwent their initial surgery in Kuma Hospital between May 2012 and February 2015, the RLNs in 230 patients (7.6%) were involved by the cancer. In 97 of the 230 patients with 101 involved RLNs, electrophysiological response to electrical stimuli of the RLN before dissection was recorded. The extent of involvement of the RLN was classified into three groups: RI-1; the nerve could be preserved with sharp dissection keeping its original thickness, RI-2; the nerve was preserved with partial layer resection of the nerve thinning its thickness, and RI-3; the nerve needed being resected with cancer.

Results
RI-1, RI-2, and RI-3 groups consisted of 52, 9, and 40 RLNs, respectively. Preoperative laryngoscopy revealed vocal cord paralysis or paresis in 4, 1, and 29 patients in each group, respectively. Electrophysiological response before dissection was positive in all patients in RI-1 and RI-2 groups, while only 17 of 40 RLNs in RI-3 group showed positive response. The average amplitude in patients with positive response before dissection was 806, 1057, and 348

Conclusions
Presence or absence and the amplitude of the electrophysiological responses to electrical stimuli before dissection may indicate the extent of involvement in RLNs involved by thyroid cancer, thus suggesting the extent of necessary dissection.
Abstract number: 0029

ANALYSIS OF EMG CHANGES IN CONTINUOUS INTRAOPERATIVE NEUROMONITORING: TRACTION INJURIES OF THE RECURRENT LARYNGEAL NERVE IN PIGS.

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Objectives
Traction injury of the RLN during neck-surgery seems to be a common reason for neuropraxia and postoperative vocal fold palsy. Implementation of continuous intraoperative neuromonitoring (CIONM) is based on the understanding that RLN-injury may evolve progressively with gradual decrease of EMG-amplitude. Detecting imminent nerve lesions before the moment of irreversible loss of function may contribute to decrease the occurrence of RLN-injury. An animal model has been established for more thorough studies on RLN traction injuries during CIONM. Incomplete reversible RLN-damages (neuropraxia) caused by traction were under controlled and reliable conditions induced and the effect on amplitude and latency analyzed.

Methods
Fifteen pigs (30 RLNs) underwent CIONM with simultaneous use of endotracheal tube surface-electrodes and translaryngeal needle-electrodes. The EMG’s were recorded during and following traction of the RLN. Samples for later electron-microscopic evaluation of nerve injuries were taken.

Results
In pilot experiments (n=8 RLN) traction injuries caused progressive reduction of amplitude and an increase of latency that finally resulted in loss of signal (LOS). The EMG-changes affected amplitude reduction more extensively that the latency and ended in Type1 LOS. In further experiments 22 RLNs were systematically analyzed with traction that resulted in 70-80% reduction of amplitude. In parallel with the amplitude reduction latency increased regularly, occasionally less than 10%. After reduction of signal (ROS) traction on RLN was relieved and time registered until amplitude recovery > 50%. There was no difference between needle and tube electrodes in percentage of ROS. The tube-electrodes showed more artefacts than needle-electrodes by manipulation.

Conclusions
Gradually evolving RLN-lesions occur by applying harmful energy to the nerve over time. Regarding CIONM, the imminent nerve damage can be detected by decrease of amplitude and/or increase of latency reflecting impaired nerve conduction velocity. Immediate relief of traction seems to be followed by signal recovery.
Abstract number: 0030

THE CHANGE OF EMG AMPLITUDE AND LATENCY DURING AND AFTER ACUTE RLN TRACTION STRESS WITH THE APPLICATION OF C-IONM IN A SWINE MODEL.

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Objectives
Traction injury has been reported to be the most common mechanism of recurrent laryngeal nerve (RLN) injury during thyroid surgery. This study aimed to investigate the change of EMG amplitude and latency during and after acute RLN traction stress with the application of C-IONM in a swine model.

Methods
12 pigs (n=24 RLNs) underwent C-IONM had their EMG tracings recorded with an acute RLN traction model and compare their EMG recovery after either 50% (n=12) or 70% (n=12) amplitude decrease.

Results
A progressive EMG amplitude decrease with a concordant latency increase occurred during RLN traction. The mean time to 50% and 70% amplitude decrease were 59±4 seconds and 75±6 seconds, and the correlated latency increase were 8±4% (3~18%) and 11±5% (5~21%) as amplitude decrease reached 50% and 70% respectively. When traction stress was relieved after 50% amplitude decrease, all the adverse EMG changes showed gradual recovery to baseline in 10 minutes. However, the EMG recovery were poorer and varied after 70% amplitude decrease with persistent amplitude decrease of 59±12% (35~70%) by 10 minutes and 43±23% (3~70%) by 20 minutes.

Conclusions
During C-IONM, EMG amplitude is a more sensitive and constant parameter than latency to reflect the acute RLN traction stress. Alarm threshold of 50% amplitude decrease has better EMG recovery than that of 70% amplitude decrease after releasing the acute traction stress.
Abstract number: 0031

LARYNGEAL NERVE MONITORING IN NON-THYROID/PARATHYROID OPERATIONS.

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Objectives

Intraoperative laryngeal nerve monitoring (IOLNM) has been frequently performed in thyroid and parathyroid surgery, in order to help nerve identification in reoperations. However, there are very few reports on its use in non-thyroid/parathyroid operations. The objective is to report the initial experience with the use of IOLNM in non-thyroid/parathyroid operations in which the laryngeal/vagus nerve may be at risk.

Methods

The charts of patients submitted to operations involving risk to the laryngeal/vagus nerves from 2001 to 2014 were retrospectively reviewed. The following data were collected: demographic distribution, type of operation, type of IOLNM and postoperative laryngeal nerve function.

Results

During this 15-year period, 10 patients underwent non-thyroid/parathyroid with IOLNM. There were 8 males and 2 females, with age ranging from 25 to 84 year-old (median age: 57.8 year-old). The type of operation was: robotic esophagectomy (4 cases), laparoscopic/thoracoscopic gastric pull-up (2 cases), open resection of recurrent Zenker’s diverticulum (2 cases), excision of carotid body tumor (1 case) and excision of recurrent radioinduced osteosarcoma of the neck with carotid artery resection (1 case). The nerves at risk were the inferior laryngeal nerve in 8 cases and the vagus nerve in 2 cases. All patients underwent intermittent nerve monitoring. Only 1 patient, submitted to a salvage robotic esophagectomy, experienced temporary nerve paralysis, which persisted for 4 months. No patient had permanent laryngeal nerve dysfunction.

Conclusions

In this preliminary study, including patients submitted to non-thyroid/parathyroid operations with potential risk of laryngeal paralysis, the use of IOLNM proved to be very effective to prevent the occurrence of permanent voice dysfunction. Evidently, a larger prospective multi-institutional study is necessary, but the Head and Neck Surgeon should keep in mind the possibility of using IOLNM whenever the laryngeal or vagus nerves are at risk, especially in the reoperative setting.
Abstract number: 0035

INTERMITTENT RLN MONITORING AS A PART OF POSTGRADUATE THYROID SURGERY TRAINING.

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Objectives
In the last decade IONM in thyroid surgery was widely applied. Due to thyroid surgeons need systematic training and standardization of the process. The aim of the presented study is to estimate the attitude and awareness of postgraduate course participants on routine use of i-IONM in thyroid surgery.

Methods
Six specialized individual training courses on thyroid surgery were conducted in 2012-2013 years in University Hospital “Kaspela”-Plovdiv, Bulgaria. Duration of each course was four weeks. One week was dedicated on i IONM. A qualitative research was done in 2014 year, using the method of focus group due to small number of participants /six people/. A list of eight questions were used by the moderator at the discussion. Duration of the meeting was thirty minutes.

Results
Data analysis showed that the most important step in routine implementation of i IONM is standardization of IONM technique. The method pushed the respondents to pay a greater attention in visualizing, identifying and dissecting the nerve and it's branches. Greatest confusion is related to loss of signal and it's interpretation.

Conclusions
Intermittent intraoperative RLN monitoring could be useful tool in postgraduate thyroid surgery programs, with proper standardization of the technique.
ADVANTAGES OF ROCURONIUM BROMIDE USAGE IN THYROID SURGERY WITH NEUROMONITORING.

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Objectives

The most serious complication of thyroidectomy is the recurrent laryngeal nerve palsy. The identification of recurrent laryngeal nerve by neuromonitoring is the most reliable way to prevent its damage. Specific consideration requires muscle relaxants. To achieve a good signal, it is necessary to restore proper neuromuscular conduction. That is why the choice of the muscle relaxant is so important. It should allow to achieve good conditions for intubation, have moderately long half-life and a specific antagonist. It guarantees a relaxant termination at any time. The aim of our study was to investigate the benefits of rocuronium bromide usage during neuromonitored thyroid surgery.

Methods

The study was conducted in a group of 93 patients scheduled for elective thyroidectomy. Induction phase of anesthesia was performed with fentanyl, propofol and rocuronium bromide. In each case the time from induction of anesthesia until the beginning of neurostimulation was measured. The relaxation was assessed with TOF (train of four) monitoring. Anesthesiologist consulted with the operator the quality of the signal. In doubtful cases a specific antagonist for rocuronium bromide was used.

Results

In all cases, the time to start the neurostimulation didn't differ significantly: 36.4±9.6 min (Kuskal-Wallis test). The dose of rocuronium had no statistically significant effect on the result of TOF by neurostimulation and on the necessity of neuromuscular blockade reversal (chi-square test). About sugammadex application decided the surgeon when inadequate nerve response occurred. In all analyzed cases we managed to obtain a signal during nerve stimulation.

Conclusions

Effect of administrated rocuronium bromide appears quickly, its half-life is moderately long, but depending on the dose. The mean time from induction phase of anesthesia to neurostimulation, is long enough to register proper signals. In cases where the results of neurostimulation are inadequate, it is possible to apply a specific antagonist for rocuronium bromide - sugammadex.
Abstract number: 0041

THE ANAESTHESIOLOGICAL APPROACH DURING NEUROMONITORING IN THYROID SURGERY; THE UNIVERSITY HOSPITAL VARESE (ITALY) EXPERIENCE.

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Objectives
Use of the neuromonitoring systems of the laryngeal nerves (IOMN) during surgery thyroidectomy is spreading more and more. It’s very important to conduct anesthesia in order to achieve the functionality and the effectiveness of the neuromonitoring and to cooperate with the surgeon. The aim is to provide an adequate anaesthesia plan that does not interfere with the electrophysiological monitoring.

Methods
In our University Hospital, we applied a protocol during thyroid surgery, described as Fig.1.

Results
In Varese from January 2009 to March 2015, 775 total thyroidectomy and 164 hemythyroidectomy interventions were performed. There were 2.9% of dislocations intraoperative tube (slipped toward the hull), 1.4% of rotations along the main axis of the tube and 0.21% of herniations headset for over-inflation.
Conclusions

In our experience the anaesthetic protocol is suitable to the needs of the neurophysiological monitoring, with optimal intraoperative conditions for the surgeon and good satisfaction for patients. Therefore, ensuring a good monitoring is necessary to make a proper anaesthesia plan that does not interfere with the electrophysiological monitoring.
Abstract number: 0042

EXPERIENCE WITH INTRAOPERATIVE NEUROMONITORING OF THE RECURRENT LARYNGEAL NERVE IMPROVES SURGICAL SKILLS AND OUTCOMES OF NON-MONITORED THYROIDECTOMY.

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Objectives
Intraoperative neuromonitoring (IONM) can serve as a tool to increase skills in recurrent laryngeal nerve (RLN) identification and safe complete removal of thyroid tissue. The aim of this study was to validate this hypothesis.

Methods
This prospective study comprised 775 patients (1161 RLNs at risk) who underwent thyroid surgery in 2011-2014. Solely visual identification of the RLN was undertaken in 2011. IONM was used as a training tool in 2012-2014 for the first three months of each year. In the following months thyroid operations were performed without IONM. IONM was carried out in keeping with the Recommendations of the International Neural Monitoring Study Group using NIM3.0 (Medtronic). Outcomes of non-monitored thyroid operations were compared in two time periods: before (01-12/2011) versus after (04-12/2012-2014) three-months exposure to IONM yearly (01-03/2012-2014). Primary endpoint was RLN identification, while secondary endpoints were prevalence of RLN injury and utilization of total thyroidectomy.

Results
In 2011, the rate of successful RLN visual identification was 27.2%. After introduction of IONM in 2012-2014, in the procedures performed without IONM, it was 78.7%, 89.4%, 91.3%, respectively. Prevalence of RLN injury in 2011 was 6.8%, while in the years following the introduction of IONM it was gradually decreasing: 3.61%, 2.66%, 1.4%, respectively. Utilization of total thyroidectomy increased from 47.9% in 2011 to 100% in 2014.

Conclusions
Three months of experience with IONM in each of the years 2012-2014 allowed for increase of RLN identification (p < 0.05), decrease in prevalence of RLN injury (p<0.05), and safe increase in utilization of total thyroidectomy (p < 0.0001) in non-monitored thyroid operations. Thus, IONM is a valuable tool for the surgical training.
Abstract number: 0043

MECHANISMS OF RECURRENT LARYNGEAL NERVE INJURY.

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Objectives
Intraoperative nerve monitoring (IONM) during thyroidectomy, parathyroidectomy and related central neck procedures can help determine actual mechanisms of recurrent laryngeal nerve (RLN) injury. This is especially true of visually intact nerves, which without nerve monitoring, would assume to be functionally intact. This study examines mechanisms of RLN injury at a high volume center.

Methods
Between March 2004 and December 2013 a total of 2,726 patients underwent 2,733 procedures by two surgeons for thyroidectomy, parathyroidectomy, and/or neck dissection with IONM involving 4,650 nerves-at-risk. Prospective data were collected concerning demographics, diagnosis, procedure, surgeon, and temporary versus permanent RLN injury. The visual and functional identification of the RLN were recorded, including loss of function, the mechanism and location of injury, noting anatomy of the RLN. Preoperative and postoperative laryngoscopy were done according to surgeons’ practice. This data was analyzed retrospectively.

Results
4650 nerves were at risk, 3834 for bilateral, 816 for unilateral risk. Overall incidence of RLN injury was 2.5% (n=115), permanent injury is 0.34%. The RLN was identified visually and/or functionally in 99.3% of nerves-at-risk. Intraoperative injury was found to occur more often in visually intact RLN (2.2%), than a transected RLN (n=12; 0.26%) p< 0.0001. Traction was the most common cause of injury (n=55; 48%), with 12 (10.5%) involving a bifurcated nerve. Among permanent injuries, 38% (n=6) involved a bifurcated RLN. Compression by clamp accounted for 8.7% of all injuries; ligature (7%), compression by vessel (8%) and forceps (2.6%). There were two thermal injuries (1.75%). 67% (n=77) of all RLN injury and 84% (n=46) of traction injuries occurred.

Conclusions
RLN injury occurs principally to a visually intact nerve. The most common mechanism of RLN injury is traction, with 20 percent of these involving a bifurcated nerve, underscoring the importance of IONM to assess the RLN for injury intraoperatively.
THE LEARNING CURVE FOR INTRAOPERATIVE RECURRENT LARYNGEAL NERVE NEUROMONITORING IN THYROID SURGERY.

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Objectives
Intraoperative neuromonitoring (IONM) of the recurrent laryngeal nerve (RLN) is used to minimize the risk of nerve injury in thyroid surgery. However, this procedure requires a learning period to master the technique and learn how to apply the algorithm of problem solving in case of loss of signal. The aim of the study was to evaluate the learning curve for IONM.

Methods
Three-year period (2012-2014) of working with IONM (NIM3.0, Medtronic) was prospectively analyzed with special emphasis on the comparison of the implementation phase in 2012 (101 patients, 190 RLNs at risk) with subsequent years of IONM utilization in 2013 (75 patients, 129 RLNs at risk) and 2014 (65 patients, 120 RLNs at risk).

Results
The rate of successful IONM-assisted identification of the RLN increased gradually in 2012-2014 (92.1% vs 95.2% vs 99.0%, respectively; p=0.022) with a corresponding decreased rate of technical problems (12.9%, 4.3%, 4.6%, respectively; p=0.039). Prevalence of RLN injury tended to decrease over time: 3.7%, 1.5%, 0.8%. Increase in sensitivity (71% vs 100%), specificity (98% vs 99%), positive predictive value (62% vs. 75%), negative predictive value (98% vs. 100%) and overall accuracy of IONM (97% vs 99%) was observed (p=0.049). Increasing experience with IONM resulted in shift towards more often utilization of total thyroidectomy (92%, 100%, 100%, respectively; p=0.004).

Conclusions
Mastering the technique of IONM requires about 100 thyroid procedures in order to minimize prevalence of technical problems and achieve high accuracy of the method.
Abstract number: 0055

ESTIMATION OF EXTRALARYNGEAL BRANCING OF THE RECURRENT LARYNGEAL NERVE AND FUNCTION CONTROL OF ITS BRANCHES USING THE INTRAOPERATIVE NEUROMONITORING.

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Objectives
Extralaryngeal bifurcation of the recurrent laryngeal nerve (RLN) is a known anatomical variation. The aim of this study is to estimate the rate of the extralaryngeal branching of the RLN and to show which branches have motor function.

Methods
Between 4/2013 and 3/2015 428 patients (99 male/329 female) underwent thyroidectomy with or without neck dissection and had full exposure of the RLNs. All of the above operations were performed with the use of intraoperative neuromonitoring that gave information about the motor function of the branches.

Results
In all, 852 RLNs were fully dissected, 427 left and 425 right. Extralaryngeal branching was present in 243 patients (243/428): 33 bilateral, 114 right and 96 left. 39/243(16%) patients were male and 204/243(84%) were female. From the 427 left RLNs extralaryngeal bifurcation was present in 129 (129/427, 30.21%) and from the 425 right RLNs extralaryngeal bifurcation was present in 147 (147/425, 34.58%). 5 RLNs had more than two branches, all in the left side: 4 of the left RLNs had 3 branches and 1 had four branches. Using the intraoperative neuromonitoring we concluded that motor function to the vocal cord had only one branch, the most anterior. During the stimulation of the anterior branch we had a typical signal and we watched the muscle contraction in the area of the larynx.

Conclusions
In about 1/3 of the cases the variation of extralaryngeal branching of the RLN is present. Motor function that can move the vocal cord is had only by the anterior branch while the function of the inferior branches, it seems, cannot effect total movement of the vocal cord or has mixed sensory and weak motor function. The full dissection of the RLN is very important in order to recognize its branches and thus avoid damage to the anterior branch that gives motor innervation to the vocal cord.
Abstract number: 0057

PROGNOSTIC VALUE OF INTRAOPERATIVE NEURAL MONITORING OF THE RECURRENT LARYNGEAL NERVE IN THYROID SURGERY.

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Objectives
Intraoperative recurrent laryngeal nerve (RLN) neural monitoring (IONM) has gained increasing acceptance in thyroid surgery. Nevertheless, the diagnostic accuracy of this method in prognostication of postoperative nerve function remains controversial. The aim of this study was to evaluate the diagnostic accuracy of IONM in thyroid surgery.

Methods
This prospective study was conducted at our institution in 2011–2013. Five hundred consenting patients qualified for total thyroidectomy with IONM (1000 nerves at risk) using NIM 3.0 Response (Medtronic, US) equipment were included. Laryngoscopy was used to evaluate and follow-up the RLN injury. The primary outcome was diagnostic accuracy of IONM. The Receiver Operating Characteristics (ROC) was used for evaluation of diagnostic accuracy of IONM.

Results
Loss of signal (LOS) occurred in 31 cases, of which 25 patients with LOS had corresponding vocal fold paresis found in postoperative laryngoscopy (2.5%) including 20 (2.0%) temporary and 5 (0.5%) permanent nerve lesions. The following diagnostic accuracy values were calculated for the criterion recommended by INMSG (V2 amplitude ≤ 100 µV): sensitivity 92.0%, specificity 99.3%, positive predictive value 76.7%, and negative predictive value 99.8%. The ROC curve analysis allowed for calculation of the most optimal criterion in prognostication of postoperative vocal fold paresis, which was V2 amplitude ≤ 189 µV. For this criterion, positive predictive value was 77.4%, while negative predictive value was 99.9%. Concurrently, the analysis of relative values of V2 / V1 quotient revealed that a decrease of the V2 amplitude below 18.4% of the initial V1 amplitude value (below 81.6%) had a comparably high prognostic accuracy. For this criterion, positive predictive value was 76.6%, and negative predictive value was 99.8%.

Conclusions
Adherence to the standardized protocol recommended by INMSG allows for optimizing predictive values of intraoperative neural monitoring in prognostication of postoperative RLN function.
Abstract number: 0059

INTRAOPERATIVE NEUROMONITORING IN THYROID AND PARATHYROID SURGERY. RESULTS AND ANALYSES BY RECURRENT NERVE INJURY INDEX (IRI).

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Objectives
Intraoperative neural monitoring (IONM) during thyroid and parathyroid surgery is accepted as the gold standard like as visual identification of the recurrent laryngeal nerve (RLN). Routine dissection of the RLN during thyroidectomy or parathyroidectomy was described in the literature. IONM might contribute methods to voice preservation following thyroidectomy or parathyroidectomy.

Methods
We analyzed the results of total thyroidectomy in one year interval. The surgery was done in one institution by more surgeons. Some used the neuromonitoring during the procedure, the second group did not use this method for preserving of the recurrent laryngeal nerves (RLN). The voice function was observed before and after the surgery. The lost function were observed next seven month after. The recovery of the function was analyzed by voice analyses procedure. We used the recurrent nerve injury index (described by ASTL) for results analyse.

Results
We analyzed 382 thyroid surgery in one year interval. For the cohort analysis we selected the total thyroidectomy only. In this group we added all procedures. The malfunction of recurrent laryngeal nerves after the surgery was analyzed in both groups. Temporary palsy of the nerves we observed in 24% and 19% respectively. The permanent palsy we observed in 1% of exposed nerves. The results for experts and experienced surgeons are similar, but the indication for using of IONM are the same. We used Index of recurrent nerve injury index IRI for results analysis.

Conclusions
The IONM can we used for function of the nerves fibers but never for mapping of presence of nerves. The IONM is necessary for the patient with the pals of RLN before the surgery, than we were done procedure on the side of rest function of RLN. We used the index of recurrent nerve injury for the objective analyses of the results in thyroid and parathyroid surgery.
Abstract number: 0063

INTRAOPERATIVE NEUROMONITORING IN PELVIC SURGERY - FIRST USING IN POLAND.

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Objectives
Surgical procedures in pelvis are associated with a risk of autonomic nerve damage. Fecal incontinence, urinary disorders, sexual dysfunction have been reported as a frequent postoperative complication. The purpose of this report is to present the results of the pelvic intraoperative neuromonitoring (pION), used – for the first time in Poland – in the 3rd Department of General Surgery Jagiellonian University in Cracow.

Methods
Four patients (2 female, 2 male) underwent procedures involving dissection deep in the pelvis: three of them low anterior resection of the rectum and one proctocolectomy. Intraoperative identification of pelvic autonomic nerves was carried out successfully. Neurostimulation was performed bilaterally during posterior dissection, after complete mesorectal dissection and after rectal resection to confirm that the neural connection of pelvic structures was left intact.

Results
Stimulation resulted in significantly increased amplitudes of the time-based electromyographic signal of the IAS. In three patients pION enabled detection of hypogastric plexus’ fibers and confirmed functional nerve integrity to the internal anal sphincter and the bladder after complete resection. In one patient there was no signal from left hypogastric plexus after wide resection.

Conclusions
Based on our results we may conclude that pION in pelvic surgery may reduce the risk of low anterior resection syndrome and other complications. Nevertheless, this is a fairly new procedure. We suppose that in future, neuromonitoring will become a gold-standard procedure, although it elevates costs and extends time of operation. Further studies with neurophysiological pION signal analysis and long term functional follow-up are needed.
Abstract number: 0066

EVALUATION OF VAGAL NERVE SIZE IN STANDARDIZED MONITORED THYROIDECTOMY.

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Objectives
Vagus nerve (VN) stimulation is mandatory in standardized intraoperative nerve monitoring (IONM) in thyroid surgery. This study evaluated prospectively the diameter of the VN.

Methods
100 consecutive patients underwent thyroidectomy, providing 191 intraoperative VN measurement. The tips of a caliper were adjusted to fit laterally the VN to be measured. 70 VN underwent electrode placement for continuous IONM (CIONM). VN measurement was performed before (V1) and after thyroid resection (V2) to document changes in the size.

Results
36% VN measured less than 2 mm diameter, 64% more than 2 mm. Correlation tests did not demonstrate significant relationships between VN diameter and gender, age, weight, side, thyroid pathology, VN distribution within the carotid sheath, recurrent laryngeal nerve (RLN) anatomy and neurophysiologic data. We observed increase in VN diameter between V1 and V2. Temporary RLN palsy rate was 4.7%.

Conclusions
The study describes precise VN measurement. The information is useful for appropriate CIONM electrode selection to overcome electrode VN compression. VN size increased between V1 and V2, probably due to edema. Therefore, important feature of a CIONM electrode design is that they have to adapt over the time of the surgical procedure.
Abstract number: 0070

VESSEL SEALING SYSTEM (VSS) SAFETY AROUND THE RECURRENT LARYNGEAL NERVE (RLN).

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Objectives
VSS safety around RLN is still not understood. (1) What is the safe distance and duration that VSS can be used close to RLN? (2) Is it safe to dissect RLN immediately after using VSS?

Methods
The protocol was approved by Animal-Care-Kaohsiung-University (Taiwan). Duroc–Landrace-piglets were intubated with EMG endotracheal tube. To investigate EMG changes we used continuous neuromonitoring. Safety was evaluated in different conditions: (1) VSS (N=4, power 2) distance to nerve: 2 and 5mm; duration: 1st 5 sec (f/u 3 min), if no EMG change 2nd 10 sec (f/u 3 min); if no EMG change 3rd 15 sec; if EMG change, f/u 20min to observe the recovery. (2) How long before use VSS to dissect the nerve? (N=2) test VSS on muscle, then touch RLN immediately. Duration: 1st 5 sec (f/u 3 min), if no EMG change 2nd 10 sec (f/u 3 min), if no EMG change 3rd 15 sec if EMG change, f/u 20min to observe the recovery.

Results
Do not directly touch the RLN with VSS immediately after the latter has been used. Safe margin and duration is 2mm for less than 5sec.

Conclusions
We propose a standardized use for VSS near the RLN.
RECURRENT LARYNGEAL NERVE INJURY FOLLOWING THYROID SURGERY, INCIDENCE AND RISK FACTORS.

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Objectives

Recurrent laryngeal nerve (RLN) injury is a recognized possible complication following thyroid surgery. Although many intraoperative procedures have been introduced to prevent the nerve injury, still the average incidence of transient and permanent recurrent laryngeal nerve palsy is 9.8% and 2.3%, respectively. The aim of the present study was to evaluate prevalence and risk factors of RLN injury after thyroid surgery.

Methods

We retrospectively analyzed the records of 428 patients who underwent thyroid surgery at the National Guard Hospital, King Abdul-Aziz Medical City, Jeddah, Saudi Arabia between 2008 and 2015. Risk factors for RLN injury were evaluated in detail. Preoperative and postoperative indirect laryngoscopic examinations with or without video-stroboscopy were performed for all patients. Routine visual identification of the RLN and intermittent neurostimulation to evaluate the contraction of cricoarytenoid muscle (laryngeal twitch) were performed during all operative procedures.

Results

428 patients were included in this study. Female to male ratio was 8:2. Transient versus permanent unilateral vocal cord problems occurred in 19 (4.4%) versus 4 (0.9%) cases. Complete recovery of vocal cord function was documented in all unilateral transient vocal cord palsy in a period less than 6 months. Bilateral vocal cord problems occurred in 2 cases (0.5%), all necessitated a tracheotomy at the beginning but one was weaned of tracheotomy after improvement. There was increase in the incidence of RLN injury in redo-surgery and in malignant thyroid diseases. However, there was no significant difference in the incidence of RLN injury with regards to gender.

Conclusions

Thyroid carcinoma and re-do thyroid surgery were associated with increased risk of operative RLN injury. We can minimize the risk of RLN injury during thyroid surgery by visual identifying the nerve and following its course carefully and with use of intermittent nerve stimulator. Most of our patients with unilateral vocal cord palsy recovered vocal cord function postoperatively.
Abstract number: 0079

C-IONM IN THYROID SURGERY: SAFETY ANALYSIS OF 400 CONSECUTIVE ELECTRODE PROBE PLACEMENTS.

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Objectives
Considering the promising results of continuous intraoperative neuromonitoring (C-IONM), it is appropriate to analyze its safety.

Methods
IONM was performed according to standards of equipment set up, induction and maintenance anesthesia and correct tube positioning verification tests and EMG definitions. A detail schema for the C-IONM standardized procedure was used to control any adverse event in the dissection of VN and subsequent C-IONM electrode positioning.

Results
400 VN dissections were analyzed. Anterior approach to the carotid sheath was performed in 55% cases, while modified anterior in 45%. The P location of the VN was the most common configuration observed on either side (65%). VN measured less than 2 mm in diameter in 46% of cases, whereas in 54% VN > 2 mm. C-IONM probe position was achieved in every case. Mean time effort for C-IONM probe positioning was 15

Conclusions
We analyze technical issues to achieve more critical view of safety of vagal nerve (VN) dissection, stimulation and C-IONM probe placement.
Abstract number: 0080

RECURRENT LARYNGEAL NERVE INJURY IN THYROID SURGERY: CLINICAL PATHWAYS AND RESOURCES CONSUMPTION.

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Objectives
To assess resources consumption in the management of patients with injured versus non-injured RLN (Recurrent Laryngeal Nerve). RLN palsy represents one of the most frequent complications after thyroid surgery. The impact of RLN injury management seems to be relevant to patient, National Healthcare System (NHS) and society.

Methods
Direct and indirect costs in RLN injury management were estimated. The study was based on five standardized clinical pathways (vocal folds function recovery within one, three and six months and vocal fold permanent paralysis after six months until one year without and with phono-surgery) and on the analysis of injured patient care process. Direct costs were valued from the NHS and patient perspectives. From the societal perspective, indirect costs were valued in terms of productivity losses. A comparison analysis was performed considering the no-RLN injury clinical pathway as the baseline.

Results
Direct medical costs supported by NHS range from a minimum of € 79.46 to a maximum of € 3,261.95. From patient perspective, the direct medical costs supported by the patient increase from a minimum of € 3,60 to a maximum of € 499.45. Productivity losses were accounted in € 156 per day per patient. From NHS perspective, the percentage increase ranging from 43.25% to 98.14%. From patient perspective, it ranges from 51.52% to 80.60%.

Conclusions
The analysis shows a significant economic impact of RLN injury management, which varies depending on the damage duration and severity. This involves considerable additional costs supported by NHS and by the patient.
INTRAOPERATIVE NERVE MONITORING (IONM)
OF RECURRENT LARYNGEAL NERVE. COMPARISON
BETWEEN THYROIDECTOMY WITHOUT IONM,
WITH INTERMITTENT (I-IONM) AND WITH
CONTINUOUS NEUROMONITORING (C-IONM).

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Objectives
To compare the intermittent neuromonitoring (i-IONM) and the continuous (c-IONM) for
the protection of the recurrent laryngeal nerve during thyroidectomy.

Methods
Since 2006 the i-IONM has been regularly applied in thyroid surgery; in 2009 it has been used
in a standardized way (V1, R1, V2, R2) and in 2013 the c-IONM was introduced as additional
support for the thyroidectomy. Rates of vocal cord paralysis (VCP) and the corresponding
IONM signals of both methods were compared. IONM has not been applied in 870 nerves at
risk (NAR). IONM without standardization has been used in 198 NAR, in 1176 nerves was
used in a standardized way and the c-IONM on 386 nerves.

Results
A VCP was diagnosed in 5.9% using the non-IONM (4.9% transient, permanent 1%); 5.7%
in non-standardized IONM (5.1% transient, permanent 0.6%); 4.7% in standardized IONM
(3.9% transient, 0.8% permanent) and 3.1% in the c-IONM (0% permanent). The c-IONM has
allowed us to highlight the most dangerous moments for the loss of signal, that were identified
in: medial traction of the thyroid gland, dissection of the lower pole, of the ligament of Berry,
or of the inferior thyroid artery’s branches. The intraoperative modification of the surgical
act has resulted in the recovery of the EMG signal in the 63% of the cases with the c-IONM
(19/30 NAR). The recognition of the surgical maneuver is significantly higher for c-IONM vs.
i-IONM (63 vs. 24%, p=0.0008).
Conclusions

The c-IONM method reduces the rates of VCP. Continuous control of the signals during the various stages of the dissection reduces irreversible damage of the nerve and allows the surgeon to pay more attention to the functioning of the nerve.
Abstract number: 0082

PREDICTORS OF FAILURE OF PLANNED TOTAL THYROIDECTOMY. THE ROLE OF IONM.

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Objectives
To determine the rate and predictors of failure of planned total thyroidectomy.

Methods
Retrospective analysis, prospective collection of 988 patients with benign bilateral thyroid disease admitted for surgery between 1999-2012. Main outcome measure was failure of total thyroidectomy (f-TT).

Results
Of the 988 patient who were offered a TT, the treatment failed in 71 patients (7.2%). Multivariate analysis identified as pre-operative independent predictors of f-TT: age>75 years. Intra-operative predictors of f-TT: non identification of recurrent laryngeal nerve, no use of neuromonitoring. Post-operative predictors: gland volume >85ml. The likelihood of f-TT was 10% if no predictor was present, 32% if 1 was present, and 56% if >2 were present. The percentage distribution curve of f-TT is correlated with time period. Overall morbidity of f-TT patients was almost 6-fold higher than those with successful TT (s-TT) (8.7% vs 4.7%; P<.05). During the study period, 18% of patients (13/71) need for completion thyroidectomy.

Conclusions
7% of patients underwent less than total thyroidectomy. We identify pre-, intra- and post-operative factors predict failure of TT. This data must be taken into account when generalizations are made about the overall high success rates of TT.
Abstract number: 0083

INTRAOPERATIVE NEUROMONITORING IN THYROID SURGERY: A POINT PREVALENCE SURVEY ON UTILIZATION, MANAGEMENT AND DOCUMENTATION IN ITALY.


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Objectives
The frequency of neuromonitoring during thyroid surgery is under-reported in Italy. Our survey depicts the patterns of use, management and documentation for IONM devices in Italy.

Methods
A point prevalence survey was undertaken from Italian surgeons attending the 2014 International Neuromonitoring Study Group (INMSG) meeting. Qualitative and quantitative data were used for the analysis. Questions probed IONM prevalence, surgeon background, hospital geographic practice locations, type of hospital, rationale for IONM use, sources of initial capital investment for IONM acquisition, type of equipment, use of continuous IONM, monitoring management, use of distinctive standards and IONM documentation.
Results

IONM is currently delivered through 48 units in Italy. In 2013, the distribution of IONM by specialties included: general (50%), ENT (46%), thoracic surgery (4%). Overall, 12,853 IONM procedures were performed between 2006 and 2013. In 2007 we counted 253 procedures, in 2013 about 5,100. The distribution is: public hospital 48%, academic setting 37%, private maintenance 15%. The use category of high volume thyroid hospitals represented 33%. Initial capital investment for the acquisition of the monitoring equipment was 67% public and 33% with charitable/private funding. Audio plus graphic and EMG electrodes surface endotracheal tube-based monitoring systems accounted for the majority. Continuous IONM was introduced in 5 Academic Centers. Overall motivations expressed are legal (30%), RLN confirmation (20%), RLN identification (20%), prognosis (10%), helpful in difficult cases (10%), decrease surgical time (5%), educational (5%). The survey revealed that participants had few experience with the standardized approach of IONM technique (28%). General IONM information to patients and/or subsequent specific IONM informed consent was initiated in 8% of Centers. EMG determinations included in medical chart in 20%. There were no significant associations found between all parameters considered.

Conclusions

There is increased utilization of IONM in Italy: we highlighted areas for improvement in management and documentation.
Objectives
Voice disturbance is one of the important problems after thyroid surgery. The injury of superior and recurrent laryngeal nerves may induce these phonatory changes. The aim of the present study is to evaluate the efficiency of intraoperative neuromonitoring by comparing voice outcomes based on the use of neuromonitoring.

Methods
Two-hundred patient undergoing thyroid surgery were divided into two groups: 98 patients underwent thyroid surgery with intraoperative neuromonitoring (EMG group) and 102 patients underwent thyroid surgery without intraoperative neuromonitoring (no EMG group). Acoustic voice analysis was performed preoperatively, 1 week, and 1 month postoperatively. Voice outcomes between EMG group and no EMG group were compared in patients who underwent thyroid surgery.

Results
Fundamental frequency (F0) was significantly decreased in No EMG group more than EMG group irrespective of the extent of thyroid surgery: hemithyroidectomy (p = 0.04) and total thyroidectomy (p = 0.02). In addition, maximal voice pitch of no EMG group showed significant decrease at 1 week (p<0.01) and 1 month (p<0.01) after hemithyroidectomy and at 1 month (p=0.03) after total thyroidectomy. However, GRBAS grade, VHI score, Jitter, Shimmer, NHR, and voice pitch showed no statistical difference between two groups.

Conclusions
Although large-scale cohort study including long-term evaluation of voice outcome is needed, our study suggests that intraoperative neuromonitoring may be beneficial for preserving fundamental frequency and high pitched voice outcome.
LOSS OF SIGNAL DURING THYROID SURGERY: PRELIMINARY RESULTS OF AN ON-GOING PROSPECTIVE STUDY.

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Objectives
Herein, we aimed to evaluate the outcomes of vocal cord function in cases with Type 1 and 2 ‘loss of signal’ after thyroid surgery and investigate false and true positive reasons for ‘loss of signal (LOS)’ to reach a modality for intraoperative LOS evaluation and management.

Methods
This is a prospective evaluation study, based on International IONM Study Group’s ‘POLT Study’, conducted by the Turkish IONM Study Group. Members of the study group were asked to collect data of cases with LOS after thyroidectomy ± central node dissection, having an intact vocal cord, preoperatively. Intermittent or continuous monitoring had been carried out. Loss of signal was defined as amplitude reduction <100µV, and signal delay >10%. The protocol was stressed on demographics, preoperative EMG amplitudes of the vagus and recurrent nerves, LOS Type 1&2, reasons for LOS and postoperative vocal cord examination outcomes. The study started in October 2014.

Results
Until now, 21 patients with LOS were recruited. The mean age was 39±10 (18-71) and 90% of cases were female. Operation due to cancer was carried out in 66% of cases. Five (23%) underwent a completion thyroidectomy, 14 (66%) a total or near-total thyroidectomy. Three (14%) received an additional central node dissection. One operation resulted in a bilateral palsy (both Type 2). There were 7 (32%) Type 1 and 15 (68%) Type 2 lesions. Postoperative assessment of vocal cords was normal in 6 (28%) cases, while incomplete palsy was reported in 5 (23%) cases. Traction, coagulation and compression were the reasons for LOS in 62%, 19% and 9% in cases, respectively. Other reasons (10%) will be discussed.

Conclusions
LOS resulted with 72% vocal cord paralysis. Stronger data is warranted for late postoperative outcomes and recovery rates of segmental and global loss of signal during thyroidectomy.
Abstract number: 0104

PROSPECTIVE VALIDATION STUDY OF CERNEA CLASSIFICATION IN PREDICTING EMG ALTERATIONS OF EXTERNAL BRANCH OF THE SUPERIOR LARYNGEAL NERVE DURING SUPERIOR THYROID ARTERY DISSECTION AND LIGATION.

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Objectives
Cernea classification is commonly applied in clinical research and practice. We evaluate by means of IONM the hypothesis whether this scheme is useful for predicting which EBSLN subtype has increased risk of injury.

Methods
Prospective analysis of 400 consecutive EBSLN. Nerve monitoring was performed according to standards. Positive identification of EBSLN was achieved with both CTM twitch and glottic evoked EMG response. We defined S1 the first EBSLN stimulation at identification and S2 final nerve stimulation achieved in the most cranial aspect of nerve exposed above the area of surgical dissection after STA ligation and definitive hemostasis.
Results
The mean S1 EMG amplitude acquired was 259+/67(180-421), 321+/79(192-391), 371+/38 (200-551)μV respectively for type 1, 2A and 2B (p=0.08). S1 and S2 amplitudes were similar in type 1 (p=0.3). S1 and S2 determinations changed significantly in type 2A and 2B (p=0.04 and 0.03). The number of EBSLN that experienced at >25% decreased amplitude in S2 increased significantly from Type 1 (4.9%) to Type 2A (11.2%) and 2B (18%) (p=0.01). None of type 1, 2.8% type 2A and 3% type 2B experienced loss of EBSLN conductivity with disappearance of both CTM twitch and EMG response (p<0.05). Latency determinations did not vary significantly for any parameter compared.

Conclusions
Cernea classification predicts intraoperative risk of EBSLN stress. We identified amplitude differences between S1 and S2 determinations in type 2A and 2B, confirming that surgical dissection in these subtypes are more demanding.
Abstract number: 0105

STAGE-THYROIDECTOMY: SINGLE INSTITUTION PERSPECTIVE.

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Objectives
Neuromonitoring (NM) in thyroid surgery improves the intraoperative assessment of RLN function. We describe our patient management after loss of EMG signal at the end of the first lobectomy.

Methods
Standard NM technique was applied with both vagal and RLN stimulation (V1,R1,R2,V2). Patients underwent pre-and postoperative laryngoscopy. Patient were informed of the possibility of stage thyroidectomy preoperatively.

Results
In 23 patients over 803 consecutive thyroid procedure (2.8%), V2 signal after first lobe resection was missing (loss of signal LOS <150mcV). In 20/23 of cases we stopped the surgical procedure (stage-thyroidectomy). In the 3 cases with malignancy and severe co-morbidities (ASA3-4score) total thyroidectomy was performed at once. In this cases, such strategy was discussed preoperatively with patients, in none of these cases bilateral RLN occurred (only unilateral transient). Postoperative laryngoscopy confirmed RLN palsy in 21/23 cases. All true positive patients were supported by speech therapy. False positive (N.2), malignant (N.8) and symptomatic goiters (N.7) underwent completion thyroidectomy within 6 months. One case underwent RAI for hyperthyroidism. Two patients underwent only follow-up.

Conclusions
NM changes surgical decision-making process in a multidisciplinary manner. A reduced EMG signal at the first side, may induce the surgeon not to complete total thyroidectomy thus avoiding a risk of bilateral RLN injury. We stress the importance of a dedicated informed consent with emphasis on shared decision making with patient, anesthesiologist and endocrinologist.
Abstract number: 0106

AMPLITUDE AND LATENCY PROFILE DURING NIM TRIVANTAGE EMG TUBE POSITION MODIFICATION.


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Objectives
The NIM TriVantage EMG tube was developed to improve the IONM sensitivity of EMG response recording from RLN. Aim of this experimental study is to evaluate EMG profiles during tube malpositioning.

Methods
The protocol was approved by Korea University College of Medicine, Seoul, Korea. Duroc–Landrace-piglets were intubated with the NIM TriVantage EMG Tube which includes an electrode surface area and active electrode length differentiated above and below vocal folds (VF). Each EMG channel has an electrode placed anterior above the VF and posterior below the VF. The 7mm EMG tube measures an overall electrode length of 49mm constructed by a 25.4mm anterior and 38.1mm posterior pads. To investigate EMG changes we used continuous neuromonitoring. A window on the front portion of the trachea (2-4 ring) was used to monitor exact tube position. The protocol included upward and downward malposition (10-20mm), tube rotation (45-90°).
Results
The NIM TriVantage EMG tube is positional sensitive from the RLN and VN nerves with amplitude of ≥ 250 uV within a wide operating positional range of placement of ±90 degrees rotation and ±19 mm depth relative to optimal position. To the contrary EMG latency is minimally affected by tube position with the exception of errors in automatic latency measuring.

Conclusions
Amplitude from EMG endotracheal tube surface electrodes is dependent on position with respect muscles of the larynx. The Amplitude change effect can be seen readily with CIOM monitoring whenever EMG tube position with respect to the larynx. Latency is independent variable of tube position. Using the combination of amplitude and latency to monitor the status of a nerve helps overcome the limitations of each parameter identifying true nerve changes.
Abstract number: 0109

BENIGN GOITER SURGERY IN NORWAY: ANALYSIS OF ELECTROMYOGRAPHIC SIGNAL CHANGES AND VOICE QUALITY IN HEMITHYREOIDECTOMIES.

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Objectives
In Norway, about 70% of goiter surgery is performed as unilateral surgery. Our study aimed for a better understanding of electromyographic (EMG) signals and voice quality after hemithyroidectomy for benign goiter. We wanted to investigate potential EMG changes in patients with no recurrent nerve palsy (RLNP), correlating EMG signals and voice quality.

Methods
We prospectively evaluated possible associations between EMG signals and change in voice quality. Between January 2012 and November 2014, we included 42 patients operated with hemithyroidectomy (primary surgery) at Haukeland University Hospital. Reason for surgery was unilateral goiter with symptoms, or diagnostic surgery. Patients with RLNP after surgery were excluded. Voice assessment included preoperative and 1 week postoperative videostroboscopic examination of the larynx, and voice recording, VHI (Voice Handicap Index) and VAS (Visual Analogue Scale) questionnaires. Hirano-Bless was scored by one laryngologist. Surgery were performed by two surgeons, using intermittent intraoperative neuromonitoring (NIM Medtronic 3.0). EMG measures were amplitude and latency.

Results
The changes in values from V1->V2, R1-R2 (amplitude, latency) were compared to subsequent changes in VHI, VAS, Hirano-Bless score, maximum phonation time (MPT), fundamental frequency (Fo). We observed amplitude reduction>50% for 11 of 42 patients. VHI>19 after surgery was observed for 6 of 42 patients, of which 3 had an amplitude reduction of >50%. Hirano Bless score 17,2 (mean) / 17 (median), indicating normal vocal cord function after surgery. MFT was 16,5 (mean) /15,5(median). Fo was 195 (mean)/ 200 (median). Thyroid volume was 44,5 ml (mean) /34 ml (median), range 9-196 ml. Operation time 107 min(median/110 (mean), range 65-230 min. Age 53 years(mean)/ 51 years (median). Gender: females 34, males 8.
Conclusions
After unilateral thyreoidectomy (with no RLNP) we did not observe abnormal voice changes. The possible relationship between change in amplitude and voice function can’t be concluded based on this study.
Standard and Continuous Nerve Stimulation of Intraoperative Neuromonitoring in Thyroid Surgery.

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Objectives
Standard intraoperative neuromonitoring (sIONM) allow the surgeon to assess the recurrent laryngeal nerve (RLN) function intermittently. Continuous intraoperative neuromonitoring (cIONM) provides real-time RLN evaluation during surgical maneuvers. In this study, we aimed to compare the effects of sIONM with cIONM on vocal cord paralysis rates.

Methods
Prospectively recorded data of the patients, whom underwent thyroid surgery, with IONM between March 2014 and March 2015 were evaluated retrospectively. RLNs under the risk were divided into two groups of “sIONM applied” (group 1) and “cIONM applied” (group 2). High-risk thyroidectomy and vocal cord paralysis (VCP) rates were compared between the groups. High-risk interventions were identified as; Basedow-Graves’ disease, substernal goiter, secondary surgical intervention and central neck dissection.

Results
276 RLNs of 152 patients (126F, 26M) were evaluated. 154 RLNs in group 1 and 122 RLNs in group 2 were evaluated. High-risk surgical intervention rate was significantly higher in group 2 [66 (54.1%) vs 51 (33.1%), p=0.001]. VCP rates in groups 1 and 2 were; 9 (7.4%), 5 (3.3%) (5 complete) temporary and 1 (0.9%), 1 (0.7%) permanent respectively. There was no significant difference in the aspect of temporary and permanent VCP rates between the groups. Temporary and permanent VCP rates of high-risk thyroidectomies in group 1 and 2 were 3 (6%), 6 (9.2%) and 1 (1.9), 0 respectively; difference was not significant. Temporary VCP were 6 complete, 3 incomplete in group 1 and 5 complete in group 2.

Conclusions
The probability of the occurrence of surgical maneuvers that may effect in RLN dysfunction is higher in high-risk thyroidectomies. Although the high-risk thyroidectomy rates were higher in cIONM applied patients than sIONM applied patients; temporary and permanent VCP rates are similar to sIONM. cIONM should be preferred in high-risk thyroidectomies.
Abstract number: 0115

INNERVATION OF THE HUMAN CRICOPHARYNGEAL MUSCLE BY THE RECURRENT LARYNGEAL NERVE AND THE EXTERNAL BRANCH OF THE SUPERIOR LARYNGEAL NERVE.

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Objectives
The major component of the upper esophageal sphincter is the cricopharyngeal muscle (CFM). Innervation of this muscle remains controversial. We aimed to assess the contribution of the laryngeal nerves to the motor activity of the cricopharyngeal muscle.

Methods
We performed intraoperative electromyographic study of 27 patients during thyroidectomy. The recurrent laryngeal nerve (RLN), vagus nerve, external branch of the superior laryngeal nerve (EBSLN) and pharyngeal plexus were stimulated intraoperatively. Responses were evaluated by visual observation of the CFM and electromyographies via needle electrodes inserted into the CFM. A positive electric evoked response was accepted to be greater than 100mV.

Results
Forty six (24 right, 22 left) cricopharyngeal muscles were evaluated. The pharyngeal plexus stimulation yielded both positive visual contractions and EMG responses in the 42 CFMs (2080+1583 µV (101-8041)). EBSLN stimulation resulted in contractions visually from the 28 CFMs and positive EMG responses from the 35 CFMs (686+630(100-2923 µV). The visible contractions from the 37 CFMs and positive EMG activity from the 41 CFMs (337+280 µV (100-1556)) were achieved by stimulating 45 RLNs. It resulted in visible contractions from the 36 CFMs and positive EMG responses from the 37 CFMs (292+229 µV (101-1077)) by stimulating the 42 vagal nerves. Motor activity is achieved from the 32 CFMs by both RLN and EBSLN stimulation, 9 CFMs by RLN stimulation, 3 CFMs by EBSLN stimulation and 2 CFMs resulted in no response by any of them.

Conclusions
This is the first report which provides evidence that the EBSLN functionally contributes to the motor innervation of the human CFM. The main nerve of the CFM is the pharyngeal plexus. Both EBSLN and RLN usually contributes to the motor innervation of the CFM. The effects of the nerve injuries may alter in the aspect of swallowing function, depending on the complex motor innervation of the CFM.
Abstract number: 0116

RECURRENT LARYNGEAL NERVE’S MOTOR FUNCTION: SOMETIMES MOTOR FIBERS MAY ALSO BE LOCATED IN THE POSTERIOR BRANCH.

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Objectives
In some of the studies performed by using intraoperative neuromonitoring (IONM), recurrent laryngeal nerve (RLN) is reported to have motor fibers located in the anterior branch. We hypothesized that, sometimes the posterior branch of the RLN may also have motor function. We aimed to evaluate motor function of the branches in the branching RLNs in this study.

Methods
Our study group consisted of 337(281 F, 56 M) (Age: 49.4±13.5/years) consecutive patients, having 200(±34.1) branching nerves out of 587 RLNs, undergoing thyroid surgery with IONM. Both anterior and posterior branches of the RLN were assessed separately by both EMG endotracheal tube for adduction and finger palpation for detection of laryngeal twitch due to posterior cricoarytenoid abduction. The RLNs having motor function only in the anterior branches were defined as group 1, whereas the nerves having motor function both in the anterior and posterior branches were as group 2.

Results
There were 185 RLNs in group 1 and 15 RLNs in group 2, assessed by IONM. The median branching distance was greater in group 2 compared to group 1 (p=0.045, 24.13±13.60mm, 17.30±8.47mm respectively). The laryngeal twitch assessed by finger palpation, was detected in all 95 PCA muscles by the anterior branch stimulation. The laryngeal twitch of 10 PCA muscles in group 2, was detected in 3 RLNs by anterior branch, 4 RLNs by posterior branch, 3 RLNs by both anterior and posterior branch stimulation.

Conclusions
The anterior branch of RLN always have the motor fibers for adduction. Sometimes, the anterior and posterior branches may both have motor function, especially the nerves having greater branching diameter. The motor fibers for abduction may be located in either the anterior or posterior branches or in both of them. All the extralaryngeal branches of RLN must be preserved to ensure the motor functions of it.
Abstract number: 0119

THE INNERVATION PATTERN OF THE CRICOThYROID MUSCLE.

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Objectives
The cricothyroid muscle is active during phonation and respiration. Traditionally, the cricothyroid muscle (CTM) is supplied by the external branch of the superior laryngeal nerve (EBSLN). The intralaryngeal connections are defined between the laryngeal nerves in some of the anatomic studies. The different EMG patterns may be seen due to these connections. We aimed to evaluate the effects of the different nerves to the motor function of the cricothyroid muscle.

Methods
We performed electromyographic study on 45 CTMs of 27 patients during thyroidectomy performed by using IONM. Both ipsilateral and contralateral recurrent laryngeal nerves (RLN), vagus nerves, external branch of the superior laryngeal nerves (EBSLN) and pharyngeal plexus were stimulated during the surgery, using standard monopolar stimulator probe with the current value of 1mA. Responses were evaluated by visual observation of CTMs and electromyographies via needle electrodes inserted into the pars recta of CTMs. A positive EMG response was accepted to be greater than 100mV.

Results
The EBSLNs of 45 CTMs resulted in both positive visible contractions and EMG responses (7501+6939 (755-28766) µV). The RLN and vagal nerve stimulations of 45 CTMs yielded in both positive visible contractions and EMG responses in 24, 22 CTMs and 22, 29 CTMs (498+785 (100-36131) µV, 643+920 (104-2950) µV) respectively. The visible contractions from 4 CTMs and positive EMG responses from 12 CTMs were achieved by stimulation of contralateral 26 EBSLNs (160+49 (106-237) mV). Not any visible responses were achieved by stimulating 43 pharyngeal plexus neither ipsilaterally nor contralaterally. Not any visual responses or EMG responses were determined by stimulation of contralateral RLS and vagus.

Conclusions
The ipsilateral RLN supply of the CTM is not rare. Anatomic variability of the connections between the laryngeal nerves is correlated with the variability in the EMG pattern. This may be a finding explaining variant positions of the vocal folds after laryngeal nerve lesions.
IS INTRAOPERATIVE NEURAL MONITORING NECESSARY FOR THE EXPLORATION OF THE SUPERIOR LARYNGEAL NERVE.

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Objectives
Intraoperative neuromonitoring (IONM) has gained widespread acceptance as an adjunct to the gold standard of visual identification of recurrent laryngeal nerve (RLN), during thyroid surgery. Adversely to routine dissection of RLN, many surgeons tend to avoid exposing and identifying the external branch of the superior laryngeal nerve (EBSLN) routinely. However, the use of IONM for the exploration of EBSLN is becoming widespread. We aimed to evaluate the contribution of IONM to visual and functional identification of EBSLN, in this study.

Methods
The prospective data of 221 (183F, 38M) patients, who underwent thyroid surgery with IONM for the exploration of EBSLN between July 2012-March 2015, were evaluated retrospectively. In this study, surface endotracheal tube-based Medtronic NIM3 (Medtronic, Jacksonwille, FL) IONM device was used. EBSLN was tried to be identified visually after dissection of sternothyroid-laryngeal triangle during superior pole dissection. If it was not identified visually, it was tried to be explored with probe. If it was not identified with probe, the fibers of inferior pharyngeal constrictor muscle wasn’t dissected to identify nerve visually. The function of SLSE was evaluated by cricothyroid muscle twitch. Additionally, the contribution of the SLSE to adduction of vocal cord was evaluated by the electromyography (EMG) records.

Results
The intervention was performed on 49 patients unilaterally and 172 patients bilaterally of 221 patients. 374 (95.2%) of 393 EBSLN were identified. 145 (36.9%) EBSLN were identified visually before stimulated with probe. 130 (33.1%) EBSLN were identified visually after being identified with probe. Although 99 (25.2%) EBSLN were identified with probe, they weren’t visualized. The IONM provided meaningful contribution to visual (p=0.001) and functional (p=0.001) identification of EBSLN. Additionally, positive EMG responses were recorded from 257 EBSLN (68.7%).

Conclusions
IONM provides an important contribution to visual and functional identification of EBSLN. IONM must be used for the exploration of EBSLN routinely. IONM is the strongest candidate to be gold standard for the exploration of EBSLN.
Abstract number: 0121

DIFFERENT VULNERABILITY OF LEFT AND RIGHT RECURRENT LARYNGEAL NERVE UNDER TENSILE STRESS IN A PORCINE MODEL.

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Objectives
Paralysis of recurrent laryngeal nerve (RLNP) in thyroid surgery is still a threatening complication. Our aim was to analyze the impact of prolonged mild tensile stress on the RLN in an animal model using continuous neuromonitoring (c-IONM) with the Saxophone Electrode.

Methods
Constant tensile stress was applied to left and right recurrent laryngeal nerves in pigs (n=14). In group I (n=18 RLN) tensile stress of 1.2 N was applied until the signal amplitude was reduced to 15% of baseline. In group II (n=10 RLN) 0.34 N were maintained for 10 minutes.

Results
In group I we found a great variation of the duration to attain 85% change of signal (COS) inter- and intra-individually, median 22 min (range 2-116 min). Left and right side do not differ significantly (3-68 min respectively 2-116 min p=0.18). However in each individual animal there appear to be a vulnerable (2-14 min), and a less vulnerable nerve (30-116 min). These differences become highly significant at 85% COS (p

Conclusions
In our study each individual animal appears to have one RLN that was 4.9 times more vulnerable than the contralateral side (range 1.5-51 times). The differences became more prominent at higher COS and were highly significant at 85% COS (p<0.001). The more vulnerable nerve does not seem to have a side preference.
Abstract number: 0123

THYROID CARTILAGE ELECTRODES VS TUBE ELECTRODES IN INTRA-OPERATIVE NEUROMONITORING: PROSPECTIVE EVALUATION OF 25 CASES.

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Objectives
During thyroid surgery, extreme caution must be taken not to harm the recurrent laryngeal nerve to avoid vocal cord palsy. In our center we routinely use intra-operative neuromonitoring, consisting of an S-shaped probe for continuous vagal stimulation and a hand-held bipolar stimulator with receptor electrodes placed on the endotracheal tube. Absence or distortion of the detection signal often is due to a dislocation of the tube, rotation or traction during thyroid surgery. We developed electrodes that can be placed directly on the thyroid cartilage to avoid external factors that cause this distortion.

Methods
A prospective observational analysis was performed, during 5 years from January 1, 2010 to January 5, 2015. We constructed a large database of 850 consecutive thyroid operations. Of this 850 cases, 25 were performed under general anesthesia with a laryngeal mask and with acquisition electrodes placed during surgery directly on the thyroid cartilage instead of fixed on the endotracheal tube.

Results
We compared and evaluated data from 25 thyroid surgery cases where we used our electrodes. There was no significant difference in duration of surgery, complication rates or re-interventions. Placement of acquisition electrodes on the thyroid cartilage provides a more stable detection signal with higher amplitude compared with signals detected with the electrodes on the endotracheal tube.

Conclusions
With acquisition electrodes on the thyroid cartilage, there is no influence of the positioning of the electrodes on the quality of the detection signal. External factors such as rotation, traction and dislocation of the endotracheal tube that disturb a stable, clear nerve signal can be avoided. In addition, the use of a laryngeal mask instead of an endotracheal tube is possible when placing the electrodes directly on the thyroid cartilage.
Abstract number: 0128

COMPARISON OF PERIOPERATIVE STRESS IN PATIENTS UNDERGOING THYROID SURGERY WITH AND WITHOUT NEUROMONITORING – A PILOT STUDY.

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Objectives
Utilization of intraoperative neuromonitoring (IONM) of the laryngeal nerves during thyroidectomy has a potential to improve patient safety. However, a systematic psychological comparison of preoperative stress in patients qualified for thyroidectomy with versus without IONM has never been undertaken. The aim of this study was find out whether planned utilization of IONM has any influence on reduction of the level of stress and anxiety before and after surgery.

Methods
The was a prospective, comparative study. A standardized questionnaire was used at 1 - 7 days before surgery and at 1 - 7 days after the operation. Outcomes were compared in two groups: in 15 thyroidectomies with IONM and in 15 thyroidectomies without IONM. Both groups consisted of patients with benign nodular goiter, euthyroid, aged 18 - 55. Both groups were comparable with respect to gender, age, BMI and indications for surgery, size of the will, and extent of planned thyroid resection (total thyroidectomy). The following psychological tools were used: 1) DASS - Manual for the Depression Anxiety Stress Scales, 2) STAI - Anxiety Inventory, 3) GHQ-12 -General Health Questionnaires, 4) FACT H&N- Functional Assessment of Cancer Therapy - Head and Neck Scale 5) Visual Analogue VAS to measure the subjective evaluation of the patient in pain, mood, stress, fear and satisfaction from the treatment.

Results
Patients operated on with IONM showed significantly lower level of anxiety preoperatively when compared to patients operated without IONM. However, no correlation was found between level of education and the stress level.

Conclusions
The results of this pilot study suggest that planned utilization of IONM during thyroidectomy may reduce patient anxiety before surgery. However, further research in this area is needed to confirm this preliminary finding in a larger population of patients.
Abstract number: 0131

**NM-C2 GROUP – THE FIRST STEP – ANALYSIS OF THE PRESENT STATUS OF IONM PROCEDURES.**


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**Objectives**

Intraoperative neurophysiological neuromonitoring in thyroid surgery has been quickly developing in recent two decades. In spite of the very good scientific background, technological progress and subjective positive impression about its application, the number of published evidence-based medicine data confirming IONM’s clinical value is limited. This may be due to the lack of standardization of the technique irrespective of the published international recommendations.

**Methods**

The aim of the study was to analyze data from 16 surgery departments in Poland using the same IONM system – C2 (Inomed, Germany). Retrospective clinical data were collected for the period from July 2014 till December 2014. Data registered during the procedures intraoperatively (raw data) were collected and independently analyzed, estimating its technical accuracy, using program C2-Analysis Tool 0.9.4.2 (Inomed, Germany). The analyzed group comprised 2337 thyroid operations with 1291 performed with IONM.
Results
The independent analysis of data recorded during operation revealed that 22% procedures were performed according to the algorithm V1R1R2V2, 30% procedures with algorithm R1R2V2, the rest of the procedures were performed according to the algorithm R1R2. CIONM was performed in 0.4% of cases. Medium time of IONM (from the first to the last stimulation in the same patient) was 37’44” ranging from 10’ to 4h08’59”. Four percent of the procedures were recognized as inadequate from technical point of view.

Conclusions
IONM was performed in majority of thyroid operations, however the percentage of IONM performed with V1R1R2V2 algorithm is not satisfactory. Technical inadequacy of the procedures remains a problem even in experienced hands. Further effort of the group should concentrate on: 1) Standardisation of the IONM algorithm – increase the number of procedures with V1R1R2V2 algorithm, 2) improve and standardize the procedures from the „technical“ point of view, 3) prospective analysis of clinical value of the technique including the number of complications and LOS.
Abstract number: 0137

HOW MUCH CONTINUOUS INTRAOPERATIVE NEUROMONITORING IN THYROID SURGERY REDUCE THE RISK OF RECURRENT LARYNGEAL NERVE INJURY?

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Objectives
Continuous intraoperative neural monitoring (CIONM) in thyroid surgery, as the intermittent (IONM), has gained acceptance as an adjunct to the gold standard of visual nerve identification. Despite the increasing use of CIONM, it remains unclear how much it minimize nerve injury comparing to IONM. The aim of this study is to describe the experience with CIONM and to compare the risk of laryngeal nerve injury between patients that underwent thyroid surgery with and without CIONM.

Methods
Retrospective analysis involving 115 consecutive thyroidectomies and/or central neck dissection performed from April 2012 to March 2015. They were compared with 185 other patients that underwent surgery without CIONM in the same period. Patients were then compared concerning the vocal cord motion in the systematic postoperative rigid transoral laryngoscopy.

Results
The incidence of nerve injury in CIONM group was 1.7% while patients without CIONM developed 7% (P=0.03). By calculating the relative risk of nerve injury we found that patients submitted to CIONM presented risk of nerve injury four times less than those operated without CIONM. Cases submitted to CIONM didn’t presented definitive vocal cord palsy compared to 1.10% in the other group. The only two cases with CIONM that presented temporary nerve injury underwent to central neck dissection due to recurrent lymph node metastasis of papillary carcinoma.

Conclusions
We found that CIONM for thyroid surgery could minimize recurrent nerve injury four times less comparing to surgery without CIONM and was capable to prevent definitive palsy in all cases.
Abstract number: 0138

POST-CRICOID ELECTROPHYSIOLOGIC CHANGES PREDICTING VOCAL CORD PARALYSIS ASSOCIATED WITH RECURRENT LARYNGEAL NERVE COMPRESSIVE INJURY IN A CANINE MODEL.

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Objectives
Recurrent laryngeal nerve (RLN) injury is a feared complication of thyroid/parathyroid surgery. Neural monitoring (IONM) is applied routinely to gain more information regarding the functional status of the RLN intraoperatively. Use of post cricoid surface electrodes for IONM for RLN identification though well-established in the literature, limited information is available. The cricothyroid muscle is one of the key muscles innervated by the RLN. While the normative post-cricoid electrophysiologic parameters of RLN have been reported, the post-cricoid electro-physiologic parameters of RLN after non-transection neuropraxic compressive injury remain unknown. We aim to present post-cricoid electrophysiologic normative parameters as well as changes predicting vocal cord paralysis (VCP) associated with RLN Compressive Injury in a Canine Model.

Methods
We developed a canine model to identify IONM post-cricoid EMG correlates of postoperative VCP. Post-cricoid and endotracheal tube (ETT) EMG electrodes were placed using standard techniques and recordings were obtained before and after compressive RLN injury, sufficient to cause VCP. EMG characteristics from post-cricoid and ETT electrodes were recorded and compared.
Results
Normative post-cricoid electrode recordings revealed a mean amplitude of $1288 \pm 509.2 \mu V$ and a mean latency of 8.20 ms with maximal (1 mA) vagal stimulation, and mean amplitude of $1807 \pm 1065.4 \mu V$ and mean latency of 3.50 ms for maximal (1 mA) RLN stimulation. Threshold stimulation in the canine was 0.43 mA for the vagus (mean EMG amplitude of $627 \pm 496.9 \mu V$ and latency of 8.38 ms) and was 0.18 mA for the RLN (mean EMG amplitude of $1162 \pm 782.3 \mu V$ and latency of 3.86 ms). After injury, there was a 62.1% decrement in post-cricoid EMG amplitude from $1288.2 \mu V$ to 488.8 $\mu V$ with maximal stimulation of the vagus and $1807.0 \mu V$ to 371.5 $\mu V$ with maximal stimulation of the RLN. Threshold stimulation of the vagus increased by 23% (from 0.43 mA to 0.53 mA) and there was a corresponding 42% decrease in amplitude from 626.7 $\mu V$ to 364.17 $\mu V$. In the case of RLN stimulation, latency consistently increased following injury with a 17.3% increase in latency to a mean latency increase from 3.5 ms to 4.1 ms. Threshold stimulation of the RLN after injury increased from 0.18 to 0.29 mA with a decrease in EMG amplitude from 1161.6 $\mu V$ to 413.3 $\mu V$. Thus, compression nerve injury decreased post-cricoid EMG amplitude and increased EMG latency, with a 60% increase in RLN threshold stimulation compared to pre-injury values. If RLN amplitude decreases by 80% with an absolute amplitude of 300 $\mu V$ or less in combination with a latency increase of 10% or more, then RLN injury and associated VCP is likely. These values were similar to values obtained with ETT EMG recordings before and after injury.

Conclusions
Our results may help surgeons predict post-operative vocal fold function based on post-cricoid electrophysiologic parameters and thereby guide intra-operative decision making.
Abstract number: 0139

NEURAL MONITORED STAGED SURGICAL MANAGEMENT FOR ADVANCED THYROID CANCERS: SAFETY AND ONCOLOGIC OUTCOMES.

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Objectives
Total thyroidectomy, with extensive bilateral neck dissections performed to manage advanced thyroid cancer with wide-spread nodal metastasis, may lead to increased risk of complications including bilateral recurrent laryngeal nerve (RLN) paralysis and permanent hypoparathyroidism. A planned staged approach to reduce the risk of such complications can be designed after delineating disease extent through radiographic mapping. We evaluate oncologic results and safety of neural monitored staged thyroid and neck surgery for management of thyroid cancer with extensive neck metastasis.

Methods
Thirty-five patients with thyroid cancer and extensive nodal disease undergoing staged neck surgery by the senior author (GWR) in thyroid and parathyroid division at Massachusetts Eye and Ear Infirmary between January 2004 and May 2013 were retrospectively identified and the oncologic and surgical outcomes were reviewed.

Results
34% patients had more than 5 nodal compartments with positive lymph nodes, average number of excised lymph nodes was 51, and average positive lymph node yield was 17. Extranodal extension was present in 51%, extrathyroidal extension in 73%, vascular invasion in 53% and RLN invasion in 17% of patients. Neural monitored two-stage neck surgeries with 2.5 months mean interval were associated with no RLN palsy; permanent hypoparathyroidism and chyle leak occurred in one patient each. Loco-regional recurrence occurred in 5.7%, at a median follow-up of 28 months. Median postoperative non-stimulated and stimulated thyroglobulin in PTC patients were 0.2 ng/mL and 0.75 ng/mL, respectively.

Conclusions
Neural monitored two-stage surgical approach represents a safe and effective alternative strategy option to simultaneous bilateral surgery in the management of thyroid cancer with extensive neck metastasis.
Abstract number: 0140

IMPLEMENTATION OF INTRAOPERATIVE NERVE MONITORING TRAINING IN A PORCINE MODEL IN LATINAMERICA.

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Objectives
The use of intraoperative nerve monitoring (IONM) in thyroid, parathyroid and other head and neck applications has increased worldwide. The vast majority of surgeons who have adopted this technology have not received formal training, in fact, some are not aware of the standardized application of the technique while monitoring the laryngeal nerves. The need for a more personal doctor to doctor training in IONM was identified and a solution was implemented.

Methods
A two-day course was designed for surgeons and anesthesiologists, including lectures, live surgery with IONM at third level hospitals and a pig-lab surgical practice (thyroidectomy and parotidectomy) in a certified veterinary clinic following the guidelines of the International Neural Monitoring Study Group. Two experienced surgeons (JPD-CSD) and an anesthesiologist are in charge of the course, besides an experienced veterinary anesthesiologist use total intravenous anesthesia (TIVA) in the animal model.

Results
Sixty-one participants attended the animal model training course. Trainees included 20 Head & Neck surgeons (33%), 20 General Surgeons (33%), 12 Endocrine Surgeons (19%), 6 residents of general surgery and ENT (10%) and 3 anesthesiologists (5%). The majority of them came from Colombia (42%), Mexico (20%), Panama (10%), Argentina (8%) and other Latin American countries. All the participants perform intermittent and continuous IONM in the animal model with the standardized approach, models of nerve injury in various fashions and algorithms for perioperative IONM problem solving.

Conclusions
The incorporation of an animal model during IONM training courses, provides the participant with a better understanding of the physiology of nerve injury, and without doubt, the possibility of using what they learned during the course as a tool for in-vivo early detection of adverse electromyographic changes during thyroid operations that may alert surgeons to correct certain maneuvers to prevent irreversible nerve injury.
Abstract number: 0143

LARYNGEAL ELECTROMYOGRAPHIC REALITIES IN POSTTHYROIDECTOMY PATIENTS WITH NORMAL VOCAL CORD MOBILITY.

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Objectives
Permanent vocal cord paralysis causing dysphonia is a rare complication of thyroid surgery with an incidence of 1-5%. It is well-known that there are some voice complaints in patients with thyroid pathology before and after the surgery even with normal vocal cord mobility and mucosal fold anatomy. The aim of this study is to investigate the partial nerve injury of laryngeal nerves after surgery in patients with normal vocal cord motional and mucosal functions.

Methods
A total of 32 patients who had undergone primary total thyroidectomy ± neck dissection in tertiary referral center were enrolled in this prospective clinical study. Preoperative larengeal electromyographic (LEMG) analysis was performed to all patients with normal laryngoscopic vocal cord examination. LEMG analysis was repeated after the first and the third months of surgery in the patients with normal vocal cord mobility. LEMG analysis was performed via examining thyroarytenoid (TA) and cricothyroid (CT) muscles to evaluate the bilateral inferior and external branch of superior laryngeal nerves respectively. Laryngeal nerve partial paresis was defined according to LEMG findings of each muscles on both side.

Results
Four of the 32 patients had mild to moderate degrees of partial nerve paresis during preoperative LEMG analysis of TA and CT muscles on each side. After 3 months of surgery there was a statistically significant worsening of LEMG findings in right and left external branch of superior laryngeal nerves respectively. Laryngeal nerve partial paresis was defined according to LEMG findings of each muscles on both side.

Conclusions
This is the first study which support the risk of progression of laryngeal nerve paresis in patients with normal laryngoscopic examination after thyroid surgery with respect to LEMG analysis.
Abstract number: 0144

EVALUATION OF OUTCOMES AND PROGNOSIS OF THE LOSS OF SIGNAL IN THYROID AND PARATHYROID REOPERATIONS WITH INTRAOPERATIVE NERVE MONITORING.

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Objectives
The prevalence of recurrent laryngeal nerve (RLN) injury is higher in reoperative surgery. The use of intraoperative nerve monitoring (IONM) is believed to minimize the risk of nerve injury in reoperations. The aim of this study was to evaluate the prevalence of RLN injury in patients under reoperative surgery with IONM and the prognosis of the loss of signal (LOS) in this group of patients.

Methods
We evaluated in a retrospective way the patients that underwent reoperative thyroid or parathyroid surgery with IONM between 2011 and 2015 for benign or malignant disease. The exclusion criteria were contralateral recurrent/persistent disease (Goiter or cancer) in patients with previous lobectomy, recurrence in the pyramidal lobe or incomplete clinical data or follow-up information.

Results
132 patients were included (111 women, 21 men), mean age (SD) 53.1 ± 14.9 years, patients operated for completion thyroidectomy for cancer or recurrent thyroid cancer 109 (83%), recurrent goiter 5 (3.9%) and hyperparathyroidism 18 (13.1%), including 45 bilateral and 87 unilateral reoperations with 177 nerves at risk (NAR). 8 (6%) patients required nerve resection for tumoral involvement. Excluding these nerves, 7 (4.1%) showed a true loss of signal without transection (2 global and 5 segmental) and one recovered the signal during the procedure; underwent laryngoscopy within the first 2 days after surgery three patients had a non-fully mobile cord and three had a paralyzed vocal cord. Transient and permanent RLN injuries were found respectively in four (2.4%) and two (1.2 %) nerves. The PPV of IONM was 86%, NPV 100%, S 100%, E 99%.

Conclusions
The prevalence of RLN injury is low in reoperative surgery with IONM. The PPV of IONM during reoperations is higher than other situations and accurately indicated postoperative ipsilateral vocal cord dysfunction with high reliability. IONM is a useful tool during thyroid or parathyroid reoperations.
Abstract number: 0148

USE OF ULTRASOUND DOPPLEROGRAPHY IN VISUALIZATION OF VOCAL CORDS PARESES.


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Objectives

Ultrasound is convenient and effective method of visualization of vocal cords mobility in patients before and after thyroid and parathyroid surgery. Though today it is difficult to assess a degree of vocal cords mobility dysfunction due to subjective estimation and different qualification of specialists. The goal of this study was evaluation of vocal cords mobility by power and color dopplerography in addition to B-mode ultrasound.

Methods

Material and methods. We performed ultrasound examination of vocal cords mobility with power and color Doppler in 443 patients before and after thyroid and parathyroid surgery. Endoscopic laryngoscopy was performed as a control method to all of these patients.

Results

Vocal cords pareses were diagnosed in 34 patients (7.6 %) in postoperative period by endoscopic laryngoscopy. According to ultrasound power and color Doppler vocal cords pareses were revealed in 30 patients (6.7 %). Sensitivity of the latter method was 88.2 %, specificity – 98.5 %.

Conclusions

Ultrasound examination allows to visualize vocal cords dysfunction in a vast majority of patients before and after thyroid and parathyroid surgery. Power and color Doppler allows to objectify examination results.
Abstract number: 0149

TWO-STAGE THYROIDECTOMY – THE CLINICAL VALUE OF INTRAOPERATIVE NEUROMONITORING DURING BILATERAL THYROID SURGERY.

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Objectives
Bilateral paralysis of the recurrent laryngeal nerve is associated with a very high risk of respiratory complications. A two-stage thyroidectomy should be considered in each case of signal loss following unilateral stimulation. The objective of the present study was to assess the value of intraoperative neuromonitoring in the strategy of surgical treatment of total thyroidectomy.

Methods
A retrospective study included a group of 500 patients qualified for total thyroidectomies with intraoperative neuromonitoring of the recurrent laryngeal nerves. In keeping with the recommendations formulated by the International Neural Monitoring Study Group, a true signal loss was defined as a drop in the amplitude below 100µV and/or absence of laryngeal twitch response. In each case, the procedure started on the dominant side or/and at the site of a suspected neoplastic process. The assessment of vocal cord function was based on a laryngological examination, which was performed in each case prior to and following surgery and during a 6-month follow-up.

Results
In the analyzed group, an intraoperative loss of signal was observed in 25 patients. Of the patients in the study group, in eight cases, the procedure was discontinued. Depending on the character loss of signal, the mean time of improvement of vocal cord mobility ranged from 2 to 6 months. The reoperations was performed within 4-6 months following the primary treatment in five patients after their vocal cord function returned to normal, in one subject after confirming vocal cords mobility postoperatively and in two patients with permanent vocal cord paralysis.

Conclusions
Intraoperative neuromonitoring allows for changing the operative strategy and avoiding bilateral paralysis of the recurrent laryngeal nerves. It is, therefore, an effective method in limiting the risk of unnecessary tracheostomy.
VIDEO PRESENTATIONS
Abstract number: 0058

UTILIZATION OF NEUROMONITORING IN SECONDARY SURGICAL PROCEDURES ON THYROID GLAND.

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Objectives
Secondary surgical procedures on the thyroid gland have significantly higher risk of complications and recurrent laryngeal nerve (RLN) injury. Altered neck anatomy after the initial surgery interferes the identification and safety of removal of thyroid tissue, hence the use of neuromonitoring in this type of procedures can be particularly helpful. The aim of the study is to present in the visual form, difficult, non-anatomical, recurrent laryngeal nerve courses in secondary surgery on the thyroid gland, where the utilization of intraoperative neuromonitoring (IONM) prevented the RLN injury.

Methods
37 (15.6%) of the 236 surgeries with IONM on thyroid gland in 2011-2014 were secondary procedures. In this group, 26 (71%) were due to recurrent goiter, 11 (29%) - radicalization surgery due to postoperatively diagnosed thyroid cancer. RLN monitoring was carried out in keeping with the Recommendations of the International Neural Monitoring Study Group using NIM -3, Medtronic. Video and photographic documentation made with SONY Cybershot camera was analyzed.

Results
Identification rate of the RLN in secondary surgery with IONM was 94%. Four non-anatomical RLN courses in recurrent goiter were presented: 1) RLN completely attached to the lateral surface of the capsule of enlarged goiter, 2) branched RLN ingrown into postoperative scar, 3) RLN attached to the thyroid’s inferior pole in the recurrent retrosternal goiter, 4) RLN running in numerous adhesions in recurrent goiter.

Conclusions
Visual identification of RLN in recurrent goiter procedures is difficult even for an experienced endocrine surgeon, thus the utilization of IONM in these types of surgeries should be particularly recommended to increase both the accuracy of the identification and radicalness of removal of thyroid tissue.
Abstract number: 0060

RECURRENT LARYNGEAL NERVE BRANCING IN THE THYROID SURGERY WITH INTRAOPERATIVE NEUROMONITORING.

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Objectives
Recurrent laryngeal nerve (RLN) branching is quite common. There are a variety of branching types in terms of quantity, as well as the location of branch-point, and their relation to other structures in the neck. It is crucial for the safety of thyroid surgery to distinguish sensory and motor branches. The aim of study is a presentation of the images and videos of different types of RLN branches and the value of intraoperative neuromonitoring (IONM) in the identification of sensory and motor branches.

Methods
In 2012-2014, 236 thyroid surgical procedures were performed with intraoperative neuromonitoring. RLN monitoring was carried out in keeping with the Recommendations of the International Neural Monitoring Study Group using NIM -3, Medtronic. Video and photographic documentation of RLN branches, made with SONY Cybershot camera, was investigated.

Results
Approximately 30% of the branches were identified in thyroid surgery with IONM. Four examples of the branches of the RLN were presented: 1) RLN giving off two main branches: the anterior (sensory) and posterior (motor), 2) RLN dividing into many small branches, 3) RLN branch, in which the two branches - anterior and posterior run parallel mimicking one thick trunk of the nerve 4) RLN branches intertwine with inferior thyroid artery branches. The videos presents utilization of the IONM in the localization of the RLN branches and identification of its anterior (correct signal after nerve stimulation) and posterior (no stimulation) branch.

Conclusions
IONM facilitates identification of the RLN branches, which are characterized by great diversity, and allows to investigate the physiology of nerve, by differentiation of sensory and motor branches.
Abstract number: 0061

LARYNGEAL ENTRY POINT OF RECURRENT LARYNGEAL NERVE - POTENTIAL LOCATION OF INJURY.

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Objectives
Laryngeal entry point of the recurrent laryngeal nerve (RLN) is the most constant localization of its course and identification. However, the RLN in this position is often displaced by nodularly altered thyroid or scar tissue. The relation of the RLN to the ligament of Berry variates, it can be closely connected, affecting the safety of its radical removal.

Methods
In 2012-2014, 236 thyroid surgical procedures were performed with intraoperative neuromonitoring. RLN monitoring was carried out in keeping with the Recommendations of the International Neural Monitoring Study Group using NIM -3, Medtronic. Video and photographic documentation of distal section of RLN, made with SONY Cybershot camera, was investigated.

Results
There was a large volatility of the anatomical variants of the RLN distal section. Pathological lesions in this location have great impact on its course. Four variations of RLN laryngeal entry point during thyroid surgery with IONM are presented: 1) RLN enters the larynx at 90 degrees angle and is closely connected to the ligament of Berry, 2) RLN overlaps the lateral capsule of goiter before entering the larynx, 3) distal part of the RLN is displaced by the scar after initial operation, creating a sharp flexure at the entrance to the larynx, 4) RLN in the distance of less than 5mm before laryngeal entry point splits into two branches.

Conclusions
Intraoperative neuromonitoring facilitates the correct identification of the RLN at the laryngeal entry point protecting it against accidental injury, while allowing a safe total removal of the thyroid tissue in this location.
Abstract number: 0062

TRANSIENT LOSS OF SIGNAL IN THYROID SURGERY WITH INTRAOPERATIVE NEUROMONITORING.

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Objectives
Preserved integrity of the nerve anatomy does not always correspond to its proper function. Intraoperative neuromonitoring (IONM) introduction to thyroid surgery enabled functional assessment of recurrent laryngeal nerve (RLN). During monitored thyroid operation, in addition to typical loss of signal as defined by the International Group for Neuromonitoring, transient loss of RLN signal with full return of its function before completing the surgery can be observed. Such a loss of signal usually do not result in postoperative RLN paresis.

Methods
During 01.01.2012- 02.28.2015, 257 thyroid procedures with IONM were performed. In four cases, transient loss of signal with subsequent return of the RLN function by the end of redder was reported. RLN monitoring was carried out in keeping with the Recommendations of the International Neural Monitoring Study Group using NIM -3, Medtronic. Photographic and video documentation was made camera with SONY Cybershot.

Results
We present two cases of transient RLN’s loss of signal and return of its function, with normal vocal cord function after surgery.

1) 52 years old, woman, operated on due to Graves’ disease with giant goiter- the traction mechanism causes RLN injury, which results in a loss of signal from both the R1 and V1, injury location was found (segmental type), after 40 min return of the function (R2, V2) was observed.

2) 42 years old, woman, radicalization surgery due to diagnosed papillary thyroid cancer-injury induced by pressure on the RLN with the retractor. Transient loss of signal was observed with full recovery after 15 minutes.

Conclusions
IONM in thyroid surgery facilities identification of even transitory, subtle RLN dysfunctions, thus enabling to accurately understand the injury mechanisms.
Abstract number: 0067

IMPACT OF INTRAOPERATIVE NERVE MONITORING ON TOTAL THYROIDECTOMY AND CENTRAL COMPARTMENT DISSECTION IN NODE-POSITIVE, ORGAN CAPSULE INVASIVE PAPILLARY THYROID CANCER.

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Objectives
Lymph node metastasis of papillary thyroid cancer (PTC) are of prognostic value as well concerning risk of local recurrence as systemic disease. For node-positive PTC total thyroidectomy including central compartment dissection represents treatment of choice.

Methods
The video is demonstrating surgical technique with impact of nerve monitoring in a patient with node-positive, organ capsule invading PTC.

Results
The recurrent laryngeal and superior laryngeal nerve can be safely separated from the attached lymph node metastases by means of intraoperative nerve monitoring which enables bilateral procedure in one stage.

Conclusions
The recurrent laryngeal and superior laryngeal nerve can be safely separated from the attached lymph node metastases by means of intraoperative nerve monitoring which enables bilateral procedure in one stage.
Abstract number: 0068

STIMULATING DISSECTING INSTRUMENTS DURING NEUROMONITORING.

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Objectives
During intraoperative neuromonitoring (IONM) of recurrent laryngeal nerve (RLN) in thyroid surgery, the need for frequent shifting between the dissecting instruments and stimulating probe is troublesome and time-consuming. Therefore, use of these two instruments in combination would be a noticeable future direction.

Methods
One hundred consecutive patients with 168 RLNs at risk were enrolled. We developed prototypes of SDIs and applied them to early detect adverse EMG changes during the risky phase of RLN dissection. In the case of substantial EMG change (amplitude decrease > 50%) during dissection, the surgical maneuver was paused and thyroid traction was released immediately.

Results
The application of SDIs was feasible in all cases and did not result in any morbidity. Nineteen RLNs were detected with substantial EMG change that was caused by traction stress during dissection with SDIs and that featured progressive gradual EMG recovery after releasing thyroid traction. After thyroid resection, 10 RLNs had a weak point of nerve conduction detected at region of Berry’s ligament, but only one nerve with 79% amplitude reduction developed postoperative temporary vocal palsy.

Conclusions
Conclusion: The application of SDIs is a simple and effective way to monitor the nerve’s function instantly during the risky phase of RLN injury in thyroid surgery. It provides surgeons with real-time feedback of EMG response and can be applied as a tool for the early detection of adverse EMG change caused by traction distress.
Abstract number: 0073

AUTOMATIC PERIODIC STIMULATING (APS) ACCESSORY INSTALLATION: SCHEMA TECHNIQUE INTENDED TO CONTROL ANY ADVERSE EVENT IN THE DISSECTION OF VAGAL NERVE AND SUBSEQUENT ELECTRODE POSITIONING.


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Objectives
There are several commercially available C-IONM probes with differences regarding the design, geometry, size, adaptability, versatility, hindrance and mode of stimulation (tripolar vs bipolar vs monopolar). Most used C-IONM probes have a closed design and geometry. This is essential to prevent any dislocation of the C-IONM probes and for a constant EMG signal stability of amplitude and latency. The video present the Automatic Periodic Stimulating (APS, Medtronic, Jacksonville, Florida, USA) device installation which is a closed design probe.

Methods
A detail schema for the C-IONM standardized procedure was fallowed. This schema was intended to control any adverse event in the dissection of VN and subsequent C-IONM electrode positioning. Circumferential dissection of the VN is required. Therefore, for optimal placement, the VN is dissected 360° at the carotid sheath for approximately 10 mm along the length of the nerve. VN dissection is carried out meticulously with fine tip anatomical instruments as shannessy. Subsequent the C-IONM probe is gently positioned. Efforts were made to avoid dissecting arterial and venous blood supply of the VN while preparing its course

Results
The APS Electrode is hold on a 45° angle to the VN and gently slide open tabs over nerve. When nerve is between the electrode enclosure tabs, electrode is rotate back parallel position on the nerve and forceps are released. It is important to consider the possibility of neuro-anatomical variation that could prevent desired innervation of APS monitored distal anatomy. The electrode is visually inspect the electrode to ensure that it is attached completely around the nerve, without pinching the nerve.
Conclusions

Finally, attempts were to keep the surgical field dry with a swab to avoid any artifacts and/or signal shunting. APS is available in two sizes: 2 and 3mm. Initial baseline (V1) responses should be greater than 500.
Abstract number: 0074

EXTERNAL BRANCH OF THE SUPERIOR LARYNGEAL NERVE MONITORING

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Keywords: Monitoring of the RLN, Monitoring of the EBSLN, Education and training

Objectives
The video presents the technique of EBSLN identification by means of IONM. EBSLN identification is border into the sternothyroid-laryngeal triangle. IONM was performed according to standards. IONM equipment with an audio and graphic (threshold, amplitude, latency and waveform shape) monitor documentation was used for the current study

Methods
Monitor was set with a reduced response threshold to identified small response at 100µV, stimulation rejection artifact at 2,6ms, pulsatile stimulus 100 µs duration at 4Hz. Endotracheal tube-based surface electrodes system was applied (Trivantage EMG tube, Medtronic, Jacksonville, Florida, USA). Size 6 to 8 internal diameter (ID) endotracheal EMG tubes were used. EBSLN function was acquired by intermitted monopolar atraumatic ball tip simulator probe set at 1 to 3 mA

Results
Positive identification of EBSLN was achieved by both CTM twich and glottis evoked EMG response with a clear biphasic waveform with recognizable amplitude. For the current study we add new determinations defined as S1 and S2. The early identification and first EBSLN stimulation prior to STA dissection and ligation is defined S1. The final EBSLN stimulation at the end of the surgical procedure, after complete haemostasis and STA ligation was recorded as S2. It is important to test the EBSLN the most cranial portion of the nerve.

Conclusions
In order to get a true negative it is important to check for the absence of neural tissue in the pedicle that is to be divided (i.e., no CTM visual twitch or endotracheal glottic waveform). Los of signal (LOS) of the EBSLN was defined as an absence of CTM twitch combined with the previous obtained EMG signal and biphasic waveform. LOS can be diagnosed only when preoperative VC function was intact, and the presence of the CTM twitch and amplitude was >100.
Abstract number: 0075

NORMATIVE V1 AND RLN EMG QUANTITATIVE PARAMETERS: OPTIMIZING EMG SIGNAL.

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Objectives
The present video present tips for optimizing EMG signal in monitored thyroidectomy. An unequivocal definition of normative EMG data is mandatory.

Methods
The surgeon together with the anesthesiologist should optimize EMG signal, and in particular the V1 signal, by means of appropriate verification of electrode materials and stimulation protocols, correct EMG tube position and proper use of induction and maintenance anesthesia drugs. INMSG have proposed a proper definition/level for V1 amplitude of > 500μV.

Results
The V1 signal is the prerequisite for the correct interpretation, diagnosis and verification of a functional intact RLN, for definition of a “significant” reduction of signal, “re-entry” signal, loss of signal (LOS) and again for the correct evaluation of the results.

Conclusions
All efforts should be directed by the Surgeon and Anesthesiologist to achieve and optimize V1 EMG signal amplitude (> 500μV) before beginning thyroid resection and any RLN dissection.
Abstract number: 0076

EARLY AND DEFINITE IDENTIFICATION OF THE RECURRENT LARYNGEAL NERVE (RLN) BY MEANS OF IONM.


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Objectives

Early and definite identification of the recurrent laryngeal nerve (RLN) is an important step to avoid inadvertent nerve injury during complicated thyroid operations. IONM can locate the RLN before visual confirmation.

Methods

The rate of RLN identification without IONM is 90%, with IONM 99.3%. The video present the technique for early and definitive identification of the RLN in monitored thyroid surgery. The RLN is mapped out in the paratracheal region through probe stimulation and then visually identified through directed dissection provided by the previous neural mapping. RLN is identified and confirmed both visually and electrically by means of IONM.

Results

Once the nerve is identified, additional intermittent stimulation of adjacent non-neural tissue versus nerve can help in tracing the nerve and all its branches throughout the dissected field. In particular, we use the stimulator continually both prior (identification) and during (monitoring) the neural dissection of the tracheoesophageal groove. IONM can locate the RLN before visual confirmation: this concept is important in particular for difficult cases as Graves's and recurrent thyroid disease. Treating hyperthyroidism and scarred tissue could have more problems with hemostasis due to the high degree of vascularisation.

Conclusions

To prevent oozing and bleeding, the new device is useful to indicate the correct position of RLN by passing the probe at the overlying tissue of tracheoesophageal groove before visual confirmation at the beginning of the case. IONM distinguish between vessel and nerve. For identification of the RLN we suggest to deliver an electric current of 3-2mA to map and search for the nerve. Once the nerve is identified, to confirm RLN identification and intraoperative monitoring we suggest to deliver an electric current of 0.5-1mA.
Abstract number: 0077

TECHNICAL NOTES FOR VAGUS NERVE STIMULATION FOR STANDARDIZED MONITORING.

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Objectives
Standardization of the intraoperative neuromonitoring (IONM) technique is an essential aspect of modern monitored thyroid surgery.

Methods
The standardized technique involves vagal nerve stimulation monitored thyroid surgery.

Results
VN stimulation is useful for technical problem solving, detecting non-recurrent laryngeal nerve (non-RLN), recognizing any recurrent laryngeal nerve (RLN) lesions, and precisely predicting RLN postoperative function.

Conclusions
Herein, the video present technical notes for carotid sheath access and VN identification to achieve the critical view of safety of the VN stimulation with or without dissection.
Abstract number: 0078

TROUBLESHOOTING ALGORITHMS FOR IONM.


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Objectives
The adoption of IONM technique is hampered by a steep learning curve. Equipment malfunction or improper endotracheal tube position can result in unsuccessful monitoring which could potentially give rise to misleading information that might increase the risk of RLN injury.

Methods
Few specialist surgeons and anesthesiologist are trained in most common IONM pitfalls.

Results
A remarkable guideline recently focused on standards of IONM equipment set up and standards of loss of signal evaluation and intraoperative problem solving algorithm.

Conclusions
The present video reviews intraoperative problem solving algorithm in monitored thyroidectomy.
Abstract number: 0088

**INNERVATION OF THE CRICOTHYROID MUSCLE BY EXTRALARYNGEAL BRANCHES OF THE RECURRENT LARYNGEAL NERVE.**

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**Objectives**

The laryngeal muscles are innervated by the recurrent laryngeal nerve (RLN) and the external branch of the superior laryngeal nerve (EBSLN). It is generally thought that the RLN innervates the endolaryngeal muscles and the EBSLN innervates the cricothyroid muscle (CTM). Meticulous anatomical studies found communication between these nerves. Recent neurophysiological studies revealed the activation of the endolaryngeal muscles when the EBSLN was electrically stimulated in 70%–80% of the patients. Recently, we found and reported that at least 39% of 70 RLNs examined electrophysiologically during thyroid surgery showed the inverse innervation to the CTM by the RLN. Here, we show innervation of the CTM by extralaryngeal branches of the RLN.

**Methods**

During thyroid cancer surgeries, we encountered five patients who had an extralaryngeal branch of the RLN, electrical stimulation of which showed contraction of the CTM. The EBSLN and RLN were electrically stimulated. Responses were evaluated by visual observation of contraction of the CTM and palpable laryngeal twitch of the endolaryngeal muscles. Electromyographic studies were also performed in two patients.

**Results**

Six of the eight RLNs examined showed contraction of the CTM on stimulation. Five of these six RLNs had an extralaryngeal branch that showed contraction of the CTM on stimulation. Stimulation of the RLN central to the branch yielded contraction of the CTM and laryngeal twitch, whereas stimulation of the RLN peripheral to the branch yielded only laryngeal twitch. These phenomena were also confirmed with electromyographic studies obtained with the electrodes inserted in the CTM and surface electrodes of the endotracheal tube following the electrical stimulation. In the video session, we will demonstrate some of these interesting cases.

**Conclusions**

Extralaryngeal branches of the RLN innervated the CTM in five patients. This phenomenon might have an influence on voice changes following thyroid surgery.
Abstract number: 0093

CONTINUOUS INTRAOPERATIVE NERVE MONITORING IN A PATIENT WITH RECURRENT/PERSISTENT DIFFERENTIATED THYROID CANCER AND PREOPERATIVE VOCAL CORD PARALYSIS.

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Objectives
The decision on how best to treat recurrent/persistent nodal disease is challenging and requires the evaluation of the risk and benefits by a multidisciplinary team.

Methods
We present the case of a patient with recurrent/persistent nodal disease in the central and lateral neck and preoperative vocal cord paralysis. In 2007 a 44 year old woman was treated in another Institution for a differentiated thyroid carcinoma. She underwent a total thyroidectomy that was complicated by a left vocal cord paralysis. After surgery she received radioiodine ablation. A macroscopic recurrence in the right thyroid bed was detected in 2009, that was treated, over the following years, with five cycles of radioiodine therapy (cumulative doses 509.05 mCi 131I). In 2014 she presented to our Unit because of the progression of the right central neck disease. After an accurate preoperative workup that revealed a recurrence also in the right lateral neck, a right central neck dissection and selective right lateral neck dissection with Continuous Intraoperative Neuromonitoring (C-IONM) was performed.

Results
The postoperative course was complicated by a chylous fistula and a chylothorax that were successful managed conservatively with total parenteral nutrition. No vocal cord dysfunction occurred. The patient was discharged on twentieth postoperative day in well condition. At 1-year follow-up, she is disease free.

Conclusions
Management of recurrent/persistent differentiated thyroid cancer requires a decision making process that includes the patient and the physicians. Decision on the timing of the intervention is the crucial step in the management of recurrent thyroid carcinoma. Preventing local disease progression and invasion of vital structures is the main reason for surgery. The use of C-IONM is an effective help in redo surgery especially in patients with preoperative vocal cord paralysis.
Abstract number: 0098

TROUBLESHOOTING DURING INTRAOPERATIVE NEUROMONITORING - A VIDEO PRESENTATION.

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Objectives
Herein, we aim to overlook the steps of intraoperative troubleshooting after loss of signal during intraoperative neuromonitoring.

Methods
A 54 year-old female, undergoing thyroidectomy for a suspicious thyroid nodule, is presented via a video.

Results
During surgery, Type 2 'loss of signal' occurred and all steps of the troubleshooting algorithm were reviewed.

Conclusions
Well-designed troubleshooting protocols, in case of loss of signal during thyroid surgery, are of utmost importance.
Abstract number: 0101

ROBOTIC THYROIDECTOMY WITH CONTINUOUS INTRAOPERATIVE NEUROMONITORING (C-IONM).

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Objectives
This study examined the utility and technical feasibility of continuous intraoperative neuromonitoring (C-IONM) of the recurrent laryngeal nerve (RLN) during robotic thyroidectomy to identify and preserve this nerve.

Methods
The bilateral axillo-breast approach (BABA) was chosen for the method of robotic thyroidectomy. Under general anesthesia with an electromyographic endotracheal tube (EMG tube) (NIM Standard Reinforced EMG Endotracheal Tube), bilateral axillary 8 mm incisions and bilateral circumareolar 12 mm incisions were made for trochars insertion. A neuromonitoring probe was inserted from the right axilla. After the robot systems were docked to the patient’s trocars, a midline division of the strap muscles was performed from the level of the thyroid cartilage to the sternal notch, and the isthmus of the thyroid gland was divided using ultrasonic shears. After the strap muscles were retracted laterally, vagus nerve was found and automatic periodic stimulating (APS) lead was applied. The inferolateral side of the thyroid gland was carefully dissected to identify the RLN and the functional integrity of the RLN using C-IONM. After identification of the RLN using C-IONM, Berry’s ligament was divided using ultrasonic shears or electric cautery. After meticulous hemostasis and bleeding control were performed, the functional integrity of the RLN was again confirmed at the end of the thyroidectomy by testing the most proximally and distally exposed portions of the nerve.

Results
All the RLNs were visualized and identified by IONM during robotic thyroidectomy. C-IONM was successfully applied to all nerves deemed to be at risk and no RLNs had experienced severe combined events.

Conclusions
We found that C-IONM can be feasible and effective for identifying RLN during robotic thyroidectomy.
Abstract number: 0102

ROBOTIC THYROIDECTOMY WITH INTERMITTENT INTRAOPERATIVE NEUROMONITORING (I-IONM).

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Objectives
This study examined the utility and technical feasibility of intermittent intraoperative neuromonitoring (I-IONM) of the recurrent laryngeal nerve (RLN) during robotic thyroidectomy to identify and preserve this nerve.

Methods
The bilateral axillo-breast approach (BABA) was chosen for the method of robotic thyroidectomy. Under general anesthesia with an electromyographic endotracheal tube (EMG tube) (NIM Standard Reinforced EMG Endotracheal Tube), bilateral axillary 8 mm incisions and bilateral circumareolar 12 mm incisions were made for trochars insertion. A neuromonitoring probe was inserted from the right axilla. After the robot systems were docked to the patient’s trocars, a midline division of the strap muscles was performed from the level of the thyroid cartilage to the sternal notch, and the isthmus of the thyroid gland was divided using ultrasonic shears. After the strap muscles were retracted laterally, the inferolateral side of the thyroid gland was carefully dissected to identify the RLN and the functional integrity of the RLN using I-IONM. After identification of the RLN using I-IONM, Berry’s ligament was divided using ultrasonic shears or electric cautery. After meticulous hemostasis and bleeding control were performed, the functional integrity of the RLN was again confirmed at the end of the thyroidectomy by testing the most proximally and distally exposed portions of the nerve.

Results
All the RLNs were visualized and identified by IONM during robotic thyroidectomy. I-IONM was successfully applied to all nerves deemed to be at risk and no RLNs had experienced severe combined events.

Conclusions
We found that I-IONM can be feasible and effective for identifying RLN during robotic thyroidectomy.
Abstract number: 0107

INITIAL EXPERIENCE WITH NEUROMONITORING IN ROBOTIC THYROIDECTOMY USING A GASLESS TRANSAXILLARY APPROACH.

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Objectives

Recurrent laryngeal nerve (RLN) palsy is an intrinsic complication of thyroid surgery. Anatomical variations of the RLN can be a potential cause of nerve injury due to visual misidentification. Patients undergoing reoperations or extensive resections of malignancies carry an increased risk of nerve damage. In addition, the functional integrity of the RLN can be threatened by direct nerve injury resulting from accidental transection, clipping or ligation. The gold standard for preventing RLN injury is neuromonitoring of the RLN. This technique facilitates RLN identification in altered anatomy as is found at reoperation and can prevent bilateral vocal cord palsy. Additionally the prognosis of patients with postoperative voice symptoms can be supported by the objective intraoperative measurements.

Methods

We experienced the technical feasibility and efficacy of intraoperative neuromonitoring (IONM) of the RLN to aid its identification and preservation during robotic thyroidectomy (RT) using a gasless transaxillary approach.

Results

Herein, we present how to identify and handle the RLN with the application of IONM in RT using a gasless transaxillary approach.
Abstract number: 0117

VALUE OF INTRAOPERATIVE RECURRENT LARYNGEAL NERVE MONITOR DURING REPEATED THYROID AND PARATHYROID SURGERIES.

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Objectives

Intraoperative monitoring of recurrent laryngeal nerves (IOMRLN) at the end of the thyroid and parathyroid operations is becoming standard practice for the protection of those important structures in 21st century. The possible reasons for laryngeal muscles paresis and paralysis after thyroid and parathyroid surgery were: the cancer invasion before the operations; RLN surgical liberation from the tumors and scars; accidental damage of RLN during the operation; an unexpected postoperative that complication in cases with apparent macroscopically intact RLN. Every patient needs an observation of the larynx before the operation on TG or PTG and, preferably by using fiberoptic laryngoscope. An MRI scan allows one to estimate the stage of spread of primary or recurrent tumors on the surrounding tissues, organs and lymph nodes. A thorough preoperative observation of the patient allows one to determine the volume of the operation - the full and radical removal of the tumors, regional metastases or palliative citoreductive operations.

Methods

During 1974 – 2012 period in Saint Petersburg Center of Endocrine Surgery and Oncology 1368 patients with recurrent goiter (RG) were operated on. That made 5.2% of the total number (26468) of thyroid and parathyroid patients treated in the Center. We have been using IORLNM in our Center since 2001. Here represented comparative estimations of the unilateral and bilateral RLNs damages dynamics during the 1974-1991 period before regular visualization (368 RG patient) and after (1992-2010) with permanent RLN dissection and IOMRLN (596 RG patients) starting with 2001.

Results

During the first period of our practice the rates of unilateral damage of RLN made 7.6%, bilateral - 1.63%. During the next period - 0.5% and 0.34% respectively. The difference is statistically reliable.

Conclusions

Thyroid and parathyroid Surgery under visual and IOMRLN control has proved its efficiency and usefulness. Videopresentation.
Abstract number: 0124

VIDEO: HOW DETECT A NON-RECURRENT LARYNGEAL NERVE DURING THYROID SURGERY WITH THE USE OF INTRAOPERATIVE NEUROMONITORING.

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3 Head and Neck Surgery, University Hospital Ghent

Objectives
During thyroid surgery, extreme caution must be taken not to harm the recurrent laryngeal nerve to avoid vocal cord palsy. A non-recurrent laryngeal nerve (NRLN) is a rare anatomical variation that is extremely vulnerable during thyroid surgery. The aberrant course is due to a congenital anomaly and is often associated with malformation of the primitive aortic arches. In our video we aimed to describe and show our use of intra-operative vagal neuromonitoring.

Methods
In our center we routinely use intra-operative neuromonitoring, consisting of an S-shaped probe for continuous vagal stimulation and a hand-held bipolar stimulator with receptor electrodes placed on the endotracheal tube. In our video we demonstrate through a case representation how an NRLN can be discovered early during surgery by using continuous intra-operative vagal nerve neuromonitoring.

Results
In 5 years of thyroid surgery, we encountered four NRLN out of 888 thyroid surgeries (0,45%). During thyroid surgery, we use continuous intra-operative vagal nerve neuromonitoring starting with checking vagal nerve signals. Thanks to this technique we were able to predict a NRLN during early dissection. It is essential to start stimulation in the most proximal portion of the carotid sheath. An absent pre-dissection signal on the right vagal nerve with a positive signal on the left vagal nerve indicates a non-recurrent course of the right nerve.

Conclusions
The NRLN is an important surgical challenge because unilateral palsy can lead to permanent hoarseness. This anomaly, which is difficult to discover in the pre-operative setting, emphasizes the importance of a thorough surgical dissection and the use of intra-operative vagal nerve neuromonitoring. Our method of continuous intra-operative vagal nerve monitoring makes it possible to predict a non-recurrent laryngeal nerve in an early stage.
Abstract number: 0125

VIDEO: NEW PLACEMENT OF ACQUISITION ELECTRODES ON THE THYROID CARTILAGE IN INTRAOPERATIVE NEUROMONITORING DURING THYROID SURGERY.

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3 Head and Neck Surgery, University Hospital Ghent

Objectives
During thyroid surgery, extreme caution must be taken not to harm the recurrent laryngeal nerve to avoid vocal cord palsy. In our center we routinely use intra-operative neuromonitoring, consisting of an S-shaped probe for continuous vagal stimulation and a hand-held bipolar stimulator with receptor electrodes placed on the endotracheal tube. Absence or distortion of the detection signal often is due to a dislocation of the tube, rotation or traction during thyroid surgery.

Methods
We developed electrodes that can be placed directly on the thyroid cartilage to avoid external factors that cause this distortion. We performed already 25 thyroid surgery cases under general anesthesia with a laryngeal mask and with acquisition electrodes placed during surgery directly on the thyroid cartilage instead of fixed on the endotracheal tube.

Results
In our video we present our technique of electrode placement directly on the thyroid cartilage. There was no significant difference in duration of surgery, complication rates or re-interventions. Placement of acquisition electrodes on the thyroid cartilage provides a more stable detection signal with higher amplitude compared with signals detected with the electrodes on the endotracheal tube.

Conclusions
With acquisition electrodes on the thyroid cartilage, there is no influence of the positioning of the electrodes on the quality of the detection signal. External factors such as rotation, traction and dislocation of the endotracheal tube that disturb a stable, clear nerve signal can be avoided. In addition, the use of a laryngeal mask instead of an endotracheal tube is possible when placing the electrodes directly on the thyroid cartilage.
Abstract number: 0150

HOW TO AVOID INJURY OF THE EBSLN?

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Objectives
The film presents the most important principles of the EBSLN identification by IONM based on the management standards developed by the International Neural Monitoring Study Group. The most common problems are presented along with practical hints pertaining to nerve identification. The amplitude, latency period and the waveform shape were characterized by the EBSLN signal.

Methods
The authors of the film employed an IONM system and a NIM FLEX EMG (Medtronic, Jacksonville, Florida, USA) endotracheal tube with a 7.0-8.0 internal diameter and a surface electrode. The monitor was configured to an excitability threshold of 100 µV (or lower) and stimulation current delivered through a monopolar electrode within the range of 1-2 mA. A stimulus up to 2 mA was employed for the purpose of mapping, and 1 mA for confirming the identification of the EBSLN. The standard of preoperative management addressed the principles of anesthesia induction, configuration of the equipment and verification of the endotracheal tube positioning.

Results
A positive identification of the EBSLN was assessed based on the cricothyroid muscle (CTM) spasm, which was present in all the patients, and on the electromyography recording obtained by means of surface electrodes situated within the vocal folds. Such a reaction was present in approximately 70-80% of the patients and constituted additional confirmation of the appropriate identification of the EBSLN. The factors that affected nerve identification included the goiter size, the length of the neck and the side where the procedure was performed. A loss of signal (LOS) was defined as absence of the cricothyroid muscle twitch in a situation where the preoperative vocal fold function had been intact, while the presence of the CTM spasm and its amplitude > 100µV.

Conclusions
The knowledge of principles of preparing and managing the patient based on the standards of general anesthesia, anatomical variants of the nerve course, special situations and the course of the very surgery allow for an appropriate identification of the EBSLN, thus preventing its injury and improving the quality of life of the patients following the surgical treatment.
POSTER PRESENTATIONS
Abstract number: 0008

COMPARISON OF SHORT-TERM POSTOPERATIVE COMPLICATIONS OF THYROIDECTOMY USING LIGATURE AND SUTURE LIGATION.

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Objectives
Thyroidectomy is one of the most common forms of operations in general surgery. Regarding the status and importance of thyroidectomy and protective measures for avoiding the surgical complications, we aimed at investigating the short-term postoperative complications of thyroidectomy by applying the two methods of ligature use and suture ligation of vessels. We used a nerve monitoring in all patients.

Methods
We design a double-blind randomized clinical trial. This study conducted on 140 candidates of thyroidectomy. In all patients we use a monitoring nerve system. The patients were randomly equally allocated assigned to two groups of 70. In the ligature group, thyroidectomy was performed via ligature use, and in the suture ligation group, it was done with suture ligation. Using a specific questionnaire, the required demographic information, type of surgical operation, duration of surgery, rate of bleeding, the preoperative and postoperative serum calcium concentration, hypocalcemia symptoms, hoarseness, and laryngoscopic findings were collected and analyzed.

Results
The findings revealed that the average time of total and subtotal thyroidectomy lasted 93.94 min.

Conclusions
Regarding the fact that on the whole, nerve detection and monitoring is a very useful and safe technique of operation and duration of thyroidectomy was shorter in ligature approach compared to the suture ligation, it can be considered as a suitable method to substitute suture ligation. However, meticulous precautions should be taken specifically with regard to the efferent laryngeal nerve and hoarseness.
Abstract number: 0016

IN SEARCH OF FUNCTIONAL AND AESTHETIC APPROACH FOR LATERAL NECK METASTASES OF THYROID CANCER.

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Objectives
Nowadays surgeons should try to save functionally important neck organs, achieve aesthetic adequacy of neck lymphadenectomy in thyroid cancer patients.

Methods
According to the rules of cosmetic surgery incisions should be made along the skin folds. During the last 19 years the patented transverse - skew incision, Mac Fee and lateral incisions were applied for neck dissections in our clinic. After preparing of skin flap and mobilization of the sternocleidomastoid muscle's (SCMM) anterior edge surgeon could found the spinal accessory nerve (SAN). Dissection performed downwards was more preferable because it allowed to recognize and save every branch of the SAN, resected lymphatic nodules carefully. IONIM helped to ensure that trapezius and SCMM constricted in reply to the electric impulses. Branches of SAN were taken on holders. N. vagus, n. hypoglossus, n. frenicus and RLN were similarly found, mobilized and taken on holders. The IONIM control was performed. Since 2001 we know that often electric irritation of nerves resulted in inhibition of conduction and muscular answer. The safety of the listed neck nerves and brachial plexus we controlled after the dissection. At worst, in case of nerve damage, neurorraphy (12 observations) can be applied. Edges of skin wound were sutured with continuous or regular method.

Results
No cases of sharp or rounded wound edges necrosis were observed using the presented incision in 177 TC patients with lateral neck metastases. Hypertrophic scar changes were observed in 17 (9.6%) patients. The scar on the lateral surface of neck was undistinguished and the upper limb function - unlimited in follow up period.

Conclusions
SAN dissection downwards from mastoid process facilitates recognizing and saving of the nerve branches and resecting of lymph nodes metastases. The lateral transverse and Mac Fee incisions were suitable for the long and sin necks. Photo, Video IOINM presentations.
Abstract number: 0017

HISTORY OF RECURRENT LARYNGEAL NERVE RESEARCH.

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Objectives
The history of thyroid surgery demonstrates the evolution of modern surgical techniques.

Methods
Early development of thyroid surgery in Europe came from the School of Salerno, Italy, in the 12-13 centuries. It includes using of a hot iron, setons, ligatures with often patients death. The anatomy of the normal thyroid gland was understood through the work of Leonardo da Vinci.

Results
The recurrent laryngeal nerve (RLN) was found as a branch of the vagus nerve witch descends into the thorax before rising up to reach the neck. Galen at first described the RLN in detail during the second century. He recognized in studies on the living pig that “if one compresses the nerve with the fingers or a ligature or …cuts the nerve, the pig stopped squealing”. Arabic medical literature also contains references to the RLN (Albucassis, 1000 A.D.). During the Renaissance, in 1503, Leonardo Da Vinci drew the first anatomical representation of the RLN. Vesalius, in 1543, produced excellent anatomical drawings of the RLN. J. Berry described the thyroid suspending ligament. G. W. Crile called the area near the nerve “no man’s land.” In 1903, V.I. Razumovskii described medullary thyroid cancer, preoperative laryngoscopy for prevention bilateral RLN palsy. In 1904, A. A. Bobrov and his pupil A. A. Lezhnev reported on 106 thyroid operations under RLN visual control. Since 1938, F. H. Lahey and his staff have performed every thyroidectomies with RLN dissection and decreased the rate of it injuries to 0.3%.

Conclusions
A. A. Bobrov’s, Lahey’s, Razumovkii’s works with its emphasis on anatomy set the course and direction for modern thyroid surgery.
Abstract number: 0019

MECHANISM OF RECURRENT LARYNGEAL NERVE INJURY AND THE APPLICATION OF INTRAOPERATIVE NEUROMONITORING IN THYROID SURGERY.

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2 Department of Otolaryngology- Head and Neck Surgery, Kaohsiung Medical University

Objectives
To detect adverse amplitude of electromyogram(EMG) change by applying the intraoperative(IONM) in thyroid surgery to avoid recurrent laryngeal nerve (RLN) injury and explore the mechanism of RLN injury.

Methods
From April 2013 to September 2013, 120 patients (208 nerves at risk) underwent complex thyroidectomy with the application of IONM. Stimulated the proximal point of RLNs with a probe continuously during the surgery. When a more than 50% decrease of the EMG amplitude experienced, we paused all the operation steps and waited for EMG recovery until 10 minutes. Recorded the data every 2 minutes during the waiting. Analyzed the effects of EMG amplitudes and vocal cords movement by different injury mechanisms.

Results
The EMG amplitude which decreased more than 50% experienced on 19 RLNs. There were 15 RLNs’ EMG amplitude surpass the degree of the 70%R1 in 10 minutes recovery. The mechanism of nerve injury: Thermal, Compression, Suture experienced 1 case respectively, 3 cases came from Clamping and 13 cases were caused by Traction. No permanent vocal cord palsy happened.

Conclusions
Traction was more common in the thyroid surgery. The decrease of EMG amplitude caused by the temporary RLN injury is recoverable in a certain time. 50% decrease of EMG amplitude can be used as a warning criterion that alerts surgeon to correct the surgical maneuver immediately to prevent irreversible nerve damage.
THE RELEVANCY BETWEEN THE CHANGE OF AMPLITUDE ON DIFFERENT SITES OF RECURRENT LARYNGEAL NERVE AND THE MOVEMENT OF VOCAL CORDS IN THYROID SURGERY.

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Objectives
Research the relevancy between the function of recurrent laryngeal nerve (RLN) during thyroid surgery with the movement of vocal cords post operation by applying the intraoperative neuromonitoring (IONM) and verify the proper warning criterion.

Methods
From April 2013 to October 2013, 130 patients (214 nerves at risk) underwent complex thyroidectomy with the application of IONM. According to the degree of amplitude changing on different sites of RLN (proximal site and distal site) before closing incision, we divided all the patients into 10 groups. Compared against every patient’s vocal cords movement post operation by laryngoscopy, and simulated the neural function in real time.

Results
7 patients got abnormal movement of vocal cords, the corresponding nerves’ amplitudes were in the range between 0 to 50%, 1 case from Group 6 (Rp/Rd belongs to 40-50%), 1 case from Group 8 (Rp/Rd belongs to 20-30%), 1 case from Group 9 (Rp/Rd belongs to 10-20%), 4 case from Group 10 (Rp/Rd belongs to 0-10%), and there’s no permanent RLN palsy.

Conclusions
The final amplitude of RLN decreased below 50% R1 would probably lead to vocal cords’ abnormal movement, and when it decreased below 30%, the possibility of abnormal movement would increase; 50% decrease of EMG amplitude can be used as a warning criterion to prevent nerve function damage.
Abstract number: 0021

THE EMG PARAMETERS OF SUPERIOR LARYNGEAL NERVE RECORD WITH NIM TRIVANTAGE™ EMG ENDOTRACHEAL TUBE: A PORCINE MODEL.

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2 Otorhinolaryngology–Head and Neck Surgery, Faculty of Medicine, College of Medicine, Kaohsiung Medical University

Objectives
Recording and analyzing the EMG parameters of external branch of superior laryngeal nerve (EBSLN).

Methods
Revealed 8 EBSLNs and 8 homolateral recurrent laryngeal nerves (RLNs) from 6 swine. Stimulated each EBSLN with 4 different kinds of probes (Prass mini, Prass large, ball tip 1mm, ball tip 2.3mm, as Group #1 to #4) respectively. Applying NIM 3.0 and TriVantage™ EMG endotracheal tube to record the EMG parameters, including amplitude, latency, threshold current, refractory phase current, waveform characters, etc.

Results
The data was from 4 different probes groups. The medians of amplitudes from EBSLNs were 198~405.5μV, the corresponding medians from RLNs were 868.5~907μV; the mean values from EBSLNs latencies were 2.49 to 2.67ms, which from RLNs were 2.50 to 2.42ms. The average threshold current from EBSLNs were 0.41 to 0.58mA, which from RLNs were 0.22 to 0.51mA; the EBSLNs average refractory phase current were 0.71 to 1.18mA, which RLNs were 0.44 to 1.10mA. The EBSLNs’ waveforms had smaller artifacts or no artifact compared to RLNs’. There’re the same number of crest and trough in waveforms of EBSLNs and RLNs.

Conclusions
The application of NIM3.0 with TriVantage™ EMG endotracheal tube is conductive for EBSLN identification. Compared to RLN, EBSLN has obviously lower amplitude on EMG. The latency of EBSLN is longer, and the threshold and the refractory phase current are higher than RLN, but insignificantly. The waveform of EBSLN is similar to RLN, but EBSLN has smaller artifacts or no artifact compared to RLN. It is helpful to avoid intraoperative EBSLN injury, when we know the EMG parameters of EBSLN.
Abstract number: 0026

SUCCESSFUL MANAGEMENT OF ECTOPIC MEDIASTINAL THYROID TISSUE ACCOMPANYING MULTINODULAR GOITER UNDER INTRAOPERATIVE NEURAL MONITORING.

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Objectives
Ectopic mediastinal thyroid tissue is very rare. It is often mistaken for a malignant tumor or metastasis from a neighboring malignancy.

Methods
We report a case of ectopic mediastinal thyroid tissue accompanying bilateral multinodular goiter.

Results
This 36 year-old woman with no major systemic disease was admitted due to a mediastinal mass with trachea compression noted by chest radiography at a routine health examination. She denied of body weight loss, poor appetite, fatigue, dysphagia or dyspnea. CT of chest showed the presence of bilateral thyroid goiter, a mediastinal mass, and a tiny nodular lesion at right middle lobe of the lung. Ultrasonography confirmed the presence of multinodular goiter in bilateral thyroid, and fine needle aspiration cytology was done which revealed atypical cells. Lab data showed TSH: 0.561 (normal range), free T4: 1.133 (normal range), and thyroglobulin: 397 (above normal range). Subsequently, the patient received bilateral total thyroidectomy via a collar incision using intraoperative neural monitoring of the recurrent laryngeal nerve, and thoracoscopic resection of the mediastinal mass and right middle lobe lung nodule. Except for transient hypocalcemia, the postoperative hospital course was uneventful. No transient or permanent vocal palsy was noted after the surgery. Pathologic results showed bilateral thyroid goiter, an ectopic mediastinal thyroid tissue, and atelectasis of lung with focal fibrosis and hemorrhage.

Conclusions
Via a combined cervical and thoracoscopic approach with the use of intraoperative recurrent laryngeal nerve monitoring, this uncommon case of simultaneous bilateral thyroid goiter, an ectopic mediastinal thyroid tissue, and a lung inflammatory lesion was successfully treated.
Abstract number: 0032

NOT TOO COMMON FINDINGS IN INTRAOPERATIVE NERVE MONITORING

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Objectives
To show some strange findings during intraoperative monitoring surgery besides showing a Naso/tracheal intubation with an electrode inserted tube in a patient with sever trismus that needed Thyroid surgery under neuromonitorization Intraoperative Nerve Monitoring use has been spreading throughout the world, and its use and applications are getting day by day more acceptance by the surgical community. As this is happening surgeons are continuously making new improvements to the technique in order to make it each time more reliable. However, thought our practice we have come along weird situations regarding the use of the electrode inserted tube and with some strange findings in some of the patients operated on. We wish to present a series of pictures of videos and pictures to discuss with the audience.

Methods
A retrospective case review is presented.

Results
Throughout the presentation of three cases, the authors wish to show weird situation in neuromonitorization.

Conclusions
Even though Intraoperative Neuromonitorization is today a straight forward technique, there are some rare instances that a surgeon must be aware.
Abstract number: 0033

NON-THYROIDAL OR PARATHYROIDAL / RECURRENT NERVE APPLICATIONS OF INTRAOPERATIVE NEUROMONITORING IN HEAD AND NECK SURGERY.

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**Objectives**

To review an discuss other applications of intraoperative nerve monitoring (IONM) in head and neck. Although the Recurrent Laryngeal nerve neuromonitoring is the most commonly nerve monitorized in head and neck surgery, there are however other potential applications and nerves to monitor offering similar benefits to the patients with tumors in other anatomical areas different from the thyroid or parathyroid. It should be kept in mind that the experience gained and learned through the use of Intraoperative Neuromonitoring in thyroid and parathyroid surgery can be applied to nerves such as the Trigeminal, Facial, Hypoglossal, Spinal accessory, Vagus as well as the Phrenic nerve.

**Methods**

A retrospective review of a series of cases on which IONM was used in surgical operations different from Thyroid and Parathyroid surgery.

**Results**

A total of forty two cases were operated over the past five years, facial nerve monitoring during Parotidectomy (benign or malignant) was the most common surgery followed by Hypoglossal nerve monitoring. Illustrative videos showing this applications will be shown.

**Conclusions**

Even though today’s IONM is more used in surgeries of the Thyroid and Parathyroid trying to avoid damage to the Laryngeal nerves, there are other applications of neuromonitoring that can be applied to different surgeries in head and neck.
Abstract number: 0034

NEUROMONITORIZATION FINDINGS IN RECURRENT NERVES INVOLVED BY WELL DIFFERENTIATED THYROID CANCER.

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3 Otorrinolaringologia, Hospital Militar
4 Medicina/Endocrinologia, Universidad Pontificia Bolivariana

Objectives

Even though Well Differentiated Thyroid Cancer (WDTC) has regularly a very good, prognosis, there are however cases on which the tumor might show patterns like extra thyroidal extension compromising nearby structures. “Normal” preoperative vocal function might be seen in patients on whom an involvement of the nerve is not suspected, regardless of what the surgeon will find when performing the thyroidectomy. Even more, when a patient is operated under Intraoperative Neuromonitorization (IONM) the vagus nerve as well as the recurrent nerve itself might show normal conducting nerve even though that recurrent nerve will be found to be involved by tumor. We want to present a series of patients with WDTC on whom the recurrent nerve was found to involved grossly by tumor conserving its conducting properties, even under macroscopic involvement of almost the entire nerve. It is suspected that regardless of gross tumor involvement the nerve continues to work, prove of it is obtaining a waveform in the monitor and contraction of the laryngeal muscles. On the other hand, preoperative vocal cord paralysis correlated with lack of signal on those patients undergoing total thyroidectomy under IONM.

Methods

A retrospective study of two thyroid surgeons using intraoperative nerve neuromonitoring was conducted.

Results

Out of sixteen patients operated under IONM, twelve of them were found to have functional, conducting recurrent nerves, that were finally sacrificed as they had macroscopic tumor involvement. Four patients with preoperative vocal cord paralysis showed no activity during stimulation correlating with their original status.

Conclusions

Even though a patient might have a normal voice and a normal laryngeal exam preoperatively, the surgeon might find a recurrent nerve involved by tumor that still conducts when stimulated while operating under neuromonitorization.
Abstract number: 0036

CAN SUBJECTIVE VOICE ASSESSMENT AFTER THYROIDECTOMY BE ASSOCIATED TO LARYNGOSCOPY? WHICH IS THE ROLE OF INTRAOPERATIVE NEUROMONITORING?

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Objectives
The aim of this study is to analyze voice function after thyroidectomy for patients with normal preoperative voice in relation with postoperative laryngoscopy. We also tried to determine whether intraoperative neuromonitoring helped to avoid recurrent laryngeal nerve injury.

Methods
Between November 2014 and March 2015, 61 patients underwent total thyroidectomy for both benign and malignant thyroid diseases. Preoperative and postoperative laryngoscopy was conducted. On discharge, patients were asked to assess their voice to a scale from 0 to 10. Data was analyzed using chi square test (Pearson chi square test, Fisher’s exact test) and logistic regression.

Results
In our series, 30 (49.2%) patients noticed voice alteration after thyroidectomy but only 11 (18%) of all the patients had pathologic postoperative laryngoscopy. After statistical analysis of the results, was found that unchanged voice was 6,214 times more possible to be subjectively detected, when postoperative laryngoscopy was normal. This association was found statistically significant (P=0.028). There was not statistically significant result comparing postoperative laryngoscopy to the use of neuromonitoring(p=0.747). The same result occurred when neuromonitoring was compared to subjective voice assessment (p=0.605). When using logistic regression, it was found that patients have higher possibility to present pathological postoperative laryngoscopy (odds ratio=1,250) when neuromonitoring was not used. However, this association was not statistically significant (p=0.739>0.05).

Conclusions
Early vocal symptoms are common following thyroidectomy, but usually transient. Patients must be informed about the risk of voice impairment postoperatively. Objective voice assessment can help monitoring voice disorders. Intraoperative neuromonitoring should be used under certain recommendations.
Abstract number: 0037

PHRENIC NERVE STIMULATION DURING NECK DISSECTION FOR ADVANCED THYROID CANCER INVOLVING LEVEL IV, IS IT WORTH DOING IT

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Objectives
To review our experience with neck dissections in patients with advanced macroscopic metastatic disease due to Thyroid Cancer involving level IV of the neck and potentially affecting the area surrounding the phrenic nerve. To describe the technique to stimulate the phrenic nerve in order to assure its integrity. To discuss the safety of phrenic nerve stimulation based in other indications of its use. Metastatic thyroid cancer to the neck imposes on the surgeon a challenge to remove only the disease but alto to preserve many structures that may be involved by extension of the tumor out of the lymph nodes. The careful surgeon dissecting level IV should be careful not to injure the lymphatic system, especially the Thoracic duct in the left, but also should be gentle dissecting diseases nearby the Phrenic nerve, if there is gross macroscopic disease near the scalene

Methods
A retrospective review of patients with advanced metastatic thyroid cancer with involvement of level IV of the neck.

Results
Eighteen patients with various Thyroid Cancer types were identified in five year period. All of them underwent surgery under IONM and had grossly metastatic disease on top of the scalene muscle near by the phrenic nerve requiring its manipulation to remove the disease. Stimulation after the end of the dissection showed a functional nerve, none of the patients developed paralysis of the phrenic nerve post-operative.

Conclusions
Even though, Phrenic nerve stimulation is not an usual indication, a surgeon operating on patients with advanced neck metastatic disease and confident using neuromonitorizacion should keep in mind this potential indication to stimulate the phrenic nerve if during the dissection feels that the nerve could have been injured.
Abstract number: 0038

RECURRENT LARYNGEAL NERVES INVOLVED BY LOCALLY ADVANCED THYROID TUMORS—WHAT SHOULD BE PERFORMED?

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Objectives
The question of whether an tumor involved recurrent laryngeal nerve (RLN) should be shaved or resected remains controversial. The aim of the present retrospective study was to compare the outcomes between patients who underwent shaving or resection and to identify patient benefits.

Methods
The cohort comprised 11 patients, 3 males and 8 females, aged 23 to 69 years (median 47 years). Type and extent of involvement of each RLN was reported in the protocol. In 10 cases - RLN were involved by Thyroid cancer (9 PTC, 1 ATC), and in one case by Riedel Thyroiditis. Preoperatively 4 patients showed signs of RLN palsy. In 4 patients RLN were disengaged from tumor tissue by shaving. One patient underwent RLN preservation, while 5 underwent RLN resection. Vocal cord function and patients status were compared pre- and postoperatively in all cases.

Results
After surgery 9 patients suffered vocal cord palsy, with one requiring a tracheostomy. After follow-up of 12 months, 6 patients suffered permanent vocal cord paralysis, and the other 3 showed full recovery.

Conclusions
Our data suggested that shaving could not preserve normal functionality of the involved RLNs in early postoperative period.
Abstract number: 0039

**APPLICATION OF SUGAMMADEX IN NEUROMONITORED THYROID SURGERY.**

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**Objectives**

Neuromonitoring used in thyroid surgery is becoming more available and an increasingly common method. Specific consideration in the anesthesiology proceedings requires muscle relaxants. It comes to the possibility of the signal misinterpretation. The reliable withdrawal of the relaxation during the recurrent laryngeal nerve stimulation can be achieved by applying the sugammadex, a specific antagonist for vecuronium bromide. The aim of our study was to determine the influence of the rocuronium bromide usage on the application of sugammadex in neuromonitored thyroid surgery.

**Methods**

The study included 93 patients scheduled for the elective thyroidectomy. To provide suitable conditions for intubation we applied a muscle relaxant: rocuronium bromide in dosage of about 0.6 mg per kg. Essential moment of the surgery is the time when it comes to the nerve stimulation: time to neurostimulation. In doubtful cases, on the surgeons’ request, we used sugammadex.

**Results**

In all analyzed cases we managed to get a signal during nerve stimulation. In all cases, the time to start the neurostimulation didn’t differ significantly: 36.4min.

**Conclusions**

Signal attenuation is an acceptable and known surgeons situation. That may be mainly a nerve paresis or residual muscle relaxants effect. Sugammadex is a good solution in cases where particular type of surgery needs perfect conditions for intubation at its short duration in combination with application of neuromonitoring.
CASE REPORT OF CARDIAC ARREST WITH INTRAOPERATIVE VAGAL STIMULATION

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Objectives
Intraoperative neuromonitoring (IONM) is a useful tool to increase the rate of detection of the recurrent laryngeal nerve and the external branch of the superior laryngeal nerve during thyroid and parathyroid surgery. Nerve stimulation, including stimulation of the vagal nerve, is reported to be safe. At Lund University Hospital, IONM has been used for more than four years. Currently, we use the Medtronic 3.0 NIM with a default stimulation voltage of 1 mA. During fall 2014, we had two cases with severe cardiac complications seemingly attributable to vagal nerve stimulation during surgery.

Methods
A 81-year old woman, cardiopulmonally healthy, with a previous hospitalization for severe hypercalcemia that was treated with biphosphonates and vigorous hydration, was admitted for parathyroid surgery. Scintigraphy and ultrasound were concordant for a lower left adenoma. At surgery, the patient was thin and the vagal nerve easily accessible. After stimulation of the vagal nerve, the patient becomes increasingly bradycard which goes over into cardiac arrest. Atropine, ephedrine and external cardiac compression is given and sinus rhythm recurs. Postoperatively, telemetry and echocardiography reveal no abnormalities.

A 76 year old man, without previous known heart disease, was admitted for biopsy-proven metastatic follicular cancer in the right neck. He had had a total thyroidectomy 2006 and the pathology report stated follicular tumor of borderline malignant potential. We performed a modified radical neck dissection. During stimulation of the vagal nerve, the patient experienced a long sinus arrest/asystole, which however prompt responded to intravenous ephedrine. Postoperative examinations revealed no signs of cardiac disease.

Results
No relevance in a case report.

Conclusions
Intraoperative vagal stimulation might be associated with profound bradycardia or even asystole in elderly patients. The surgeon and anesthesiologist should be aware of this potential complication and take appropriate precautions. A survey of users of IONM might be useful to investigate the frequency of this complication.
Abstract number: 0046

INTRAOPERATIVE NEUROMONITORING OF THE EXTERNAL BRANCH OF THE SUPERIOR LARYNGEAL NERVE DURING ROBOTIC THYROID SURGERY: A PRELIMINARY PROSPECTIVE STUDY.

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Objectives
Changes to the voice caused by injury of the external branch of the superior laryngeal nerve (EBSLN) during thyroid surgery diminished quality of life. The aim of the present study was to evaluate the feasibility of monitoring EBSLNs during robotic thyroid surgery.

Methods
A total of 10 patients undergoing bilateral axillo-breast approach (BABA) robotic thyroid surgery were enrolled in the present study. The Nerve Integrity Monitor (NIM Response 2.0 System, Medtronic Xomed, Jacksonville, FL, USA) was used for EBSLN monitoring. We performed voice assessments preoperatively and at 1 and 3 months postoperatively using the Voice Handicap Index-10 (VHI-10), maximal phonation time (MPT), phonation efficient index (PEI), and laryngeal electromyography (EMG).

Results
A total of 19 EBSLNs were at risk and 14 EBSLNs (73.7%) were identified using neuromonitoring. The VHI-10 showed a change of voice over time (0.1 vs. 3.6 vs. 1.3); however, this was not statistically significant (P = 0.056). VHI-10 scores normalized at 3 months postoperatively compared to the preoperative scores. MPT (a) (16.0 vs. 15.6 vs. 15.4) (P = 0.889), and MPT (e) (20.1 vs. 15.4 vs. 18.5) (P = 0.174) showed no significant differences preoperatively compared to the values obtained 1 and 3 months postoperatively. There was a significant change of PEI over time (4.8 vs. 1.1 vs. 4.6) (P = 0.036); however, the values normalized at 3 months postoperatively. Laryngeal EMG results showed four cases (21.2%) of neuropathy of the EBSLNs at 1 month postoperatively, and electrodiagnostic studies revealed nearly complete recovery of the function of the EBSLNs in these four patients at 3 months postoperatively.

Conclusions
It is suggested that neuromonitoring of the EBSLNs during BABA robotic thyroid surgery is feasible and might be helpful to preserve voice quality. Future studies will be required to ascertain the efficacy of neuromonitoring of the EBSLNs.
Abstract number: 0047

AN EXPERIENCE AFTER FIRST 1000 THYROID OPERATIONS WITH NEUROMONITORING.

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Objectives
Since 2013 we have started thyroid surgery routinely with neuromonitoring. We performed now more than 1200 procedures for goiters, Graves’ disease and cancers.

Methods
We have estimated the time of the operation, progress in learning new method, troubles and surgeon’s satisfaction rate of recurrent nerve palsy was noted.

Results
We did not improve significantly our rate of palsy due to good results in the former period (0.4 % vs. 0.3 %) After two-hundred operation neuromonitoring did not sustain the time of surgery. Thus procedure gives us calm in the time of operation and ensure good result after.

Conclusions
Neuromonitoring for thyroid surgery is very helpful, save and cheap instrument. Very important for thyroid reoperations.
Abstract number: 0048

DETECTION OF 42 NON-RECURRENT LARYNGEAL NERVES WITH INTRAOPERATIVE NEUROMONITORING.

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Objectives
42 cases of non-recurrent laryngeal nerves (NRLN) were detected by IONM. We analyzed the anatomical and neurophysiological characteristics of all NRLN cases.

Methods
All patients were applied with IONM. With a standardized IONM procedure, all NRLN were detected at the stage of V1 stimulation before lobe dissection. All cases were photographed and EMG signals were recorded.

Results
All NRLNs were found at the right side, with 22 cases of type I (47.6%) and 20 of type IIA (52.4%). The total incidence of NRLN is 0.38%. All NRLNs were detected by a positive EMG response proximally but negative response distally of the vagus. The median latency of V1 EMG waveform is 2.25ms compared to 3.78ms of control group. Only 8 cases (19%) were found to have an anatomic variation of arch aortic preoperatively with CT examination. All NRLNs were totally dissected, fully exposed and successfully protected by IONM. No vocal cord palsy were found in postoperative laryngoscope.

Conclusions
NRLN can be detected by IONM before lobe dissection easily, a positive EMG response at the proximal vagus but negative response at distal vagus, or a significant shortened EMG latency of V1 signal both indicates an NRLN. Compared to finding an arch aortic variation via preoperative CT scan, IONM is more sensitive. Nerve injury of NRLN cases can be easily avoided by IONM.
Abstract number: 0050

**ELECTROPHYSIOLOGIC MONITORING CORRELATES OF RECURRENT LARYNGEAL NERVE HEAT THERMAL INJURY IN A PORCINE MODEL.**

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**Objectives**

Thermal injury to the recurrent laryngeal nerve (RLN) may not be visually apparent and may go unrecognized intraoperatively. This study aimed to investigate the heat thermal tolerance of RLN and evaluate the electrophysiologic correlates of electromyographic (EMG) signal change during an acute RLN heat damage.

**Methods**

Ten pigs (20 RLNs) undergoing continuous intraoperative neuromonitoring (CIONM) had their EMG tracings recorded and correlated with heated normal saline (NS) irrigation of varying temperature and duration.

**Results**

In the initial pilot study, the EMG was without change during incremental heated NS irrigation (40/45/50/55°C for 60secs) but adverse EMG combined events (CE, amplitude decrease with a concordant latency increase) occurred and degraded to loss of signal (LOS, by 17.5±1.3s) when the temperature was elevated to 60°C (n=4). Another 16 RLNs were evaluated to further compare the EMG pattern after various degrees of thermal stress (60/70°C for 30/20s). EMG recordings showed CEs and LOS in all, and only 6 of 8 RLNs with 60°C exposure showing slight EMG amplitude recovery (16-35%) after 20 minutes. None of the injured nerve segments were visually apparent but all were detectable by IONM.

**Conclusions**

60°C is a critical temperature to cause RLN thermal injury. CIONM can be used as a tool for the early detection of acute thermal stress and may guide use of energy-based devices during thyroid procedures.
Abstract number: 0051

FEASIBILITY OF INTRAOPERATIVE NEUROMONITORING DURING TOTAL ENDOSCOPIC THYROIDECTOMY FOR THYROID CANCER AND ITS INFLUENCE ON SURGERY TIME AND RLN PARESIS.

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Objectives
The aim of this study was to test the hypothesis that the application of intraoperative nerve monitoring (IONM) could reduce the time needed for operation, and may be of additional benefit in protecting recurrent laryngeal nerve (RLN) during total endoscopic thyroidectomy for high-risk thyroid cancer patients.

Methods
123 patients underwent TET with or without IONM were included in the study. Each group was divided into two subgroups according to whether accompanied by autoimmune thyroiditis (AT). The primary outcome measures was the time used on related surgery procedure and the prevalence of RLN injury.

Results
IONM could reduce the time used to identify a RLN (10.58±2.53 min versus 16.48±2.50 min, P<0.01).

Conclusions
IONM reduce the time needed for RLN localization and then for lobectomy, but not for CCD in TET for thyroid cancer. IONM also could decrease the incidence of the RLN paresis compared with visualization alone, especially temporary RLN paresis.
Abstract number: 0053

EVALUATION OF ANATOMICAL VARIANTS OF THE RECURRENT LARYNGEAL NERVE IN THYROID SURGERY WITH INTRAOPERATIVE NEUROMONITORING.

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Objectives
Use of intraoperative neuromonitoring (IONM) in thyroid surgery may improve surgical orientation in the operating field. The aim of this study was to assess the anatomical variants of the recurrent laryngeal nerve (RLN) in thyroid surgery with IONM.

Methods
This prospective study comprised 242 RLNs exposed to risk of injury in 128 patients operated on with IONM (NIM3.0, Medtronic). One hundred twenty right RLNs and 122 left RLNs were assessed. Course of the RLN on both sides of the neck in relation to the inferior thyroid artery (ITA) and the presence of branching, its type and branch-point of the nerve were analyzed.

Results
One (0.8%) non-recurrent RLN on the right side of the neck was identified. RLN branched in 33% on the right side and in 20% on the left side of the neck (p=0.001). Presence of a single branch was noticed in 68%, while multiple branches of RLN were found in 32%. Branching in the distance up to one centimeter from the laryngeal entry point was found in 39%, while 61% of RLN branched at the level of the junction with ITA. There were no statistical significant differences in the distance between the entrance to the larynx on the right and left side. There was no correlation between the number of branches, the type of branching and gender. In 15% of patients concurrent branches on both sides of the neck were identified, in 20.2% on the right side only, and in 6.1% solely on the left. RLN more often was located over than underneath the ITA, on the right side (78% vs. 22%) and on the left side (75.8% vs. 24.2%), respectively.

Conclusions
Right RLN may be exposed to a greater risk of injury due to the higher prevalence of its branching than on the left nerve.
Abstract number: 0054

ASSSESSMENT OF THE TUBERCLE OF ZUCKERKANDL IN THYROID SURGERY WITH INTRAOPERATIVE NEUROMONITORING.

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Objectives

Tubercle of Zuckerkandl (TZ) is the most posteriorly and laterally located part of thyroid gland. The aim of the study was to assess the size of the TZ in the thyroid surgery and to analyze factors of its suspected enlargement.

Methods

128 patients operated on with IONM (NIM3.0, Medtronic) were analyzed for presence of TZ using Pelizzo’s classification system (0 - unrecognizable, 1 - being only thickening, 2 - smaller than 1 cm, 3 - larger than 1 cm). Age, sex, BMI, volume of the thyroid, displacement of trachea, presence of retrosternal goiter, type of goiter, were analyzed as factors for prediction of the TZ enlargement. In addition, course of the RLN in relation to the TZ was investigated.

Results

On the right side the presence of the TZ was more frequent and it was larger than on the left side (Pelizzo’s classification grade 0: 18% vs. 31%, grade 1: 10% vs. 19%, grade 2: 42% vs. 27%, grade 3: 31% vs. 23%; p = 0.002). Increased prevalence of TZ larger than 1 cm was observed in cases of surgery for recurrent goiter when compared to primary thyroid operations (53% vs. 22%, respectively; p = 0.001). Age, sex, and BMI did not correlate to the size of TZ. There was no correlation between the X-ray image of the trachea (displacement, stricture), volume of the thyroid gland, presence or size of the TZ. TZ was more found frequently in the retrosternal goiter (p = 0.001). However, RLN was located in all cases posterior to the TZ, if present.

Conclusions

The enlarged TZ can be expected in recurrent and retrosternal goiter. Preoperative imaging is inadequate for predicting presence and size of TZ. If TZ is identified intraoperatively it can serve as a landmark for the RLN localization which can be further facilitated by IONM.
INTRAOPERATIVE NEUROMONITORING IN THYROID AND PARATHYROID SURGERY: A NATIONAL SURVEY ON UTILIZATION, MANAGEMENT AND DOCUMENTATION IN SPAIN IN 2014


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Abstract number: 0056

Objectives
Intraoperative neuromonitoring (IONM) of the recurrent laryngeal nerve (RLN) incorporates a new vision to surgical practice. Frequency of IONM during thyroid and parathyroid surgery is underreported in Spain.

Methods
To know the initial experience and learning curve, patterns of use, use of standards guidelines and documentation for IONM during thyroid and parathyroid surgery, a national survey among endocrine surgeons was undertaken under the supervision of the Spanish Endocrine Surgery Section. A web-based survey for 2014 activity regarding IONM was developed with input from members of the Spanish Association of Surgeons. A 75-question survey was developed. Questions were focused on clinical-related issues, surgeon background, hospital geographic practice locations, type of hospital, IONM prevalence, rationale for IONM use, type of equipment, use of intermittent/continuous IONM, monitoring management, use of standards guidelines and documentation.

Results
27 surgical units answered the survey. The type of hospital is: public 95 % (almost academic) and private maintenance 5 %. 80% of respondents were below 56 years of age and 77% had more than 11 years of surgical experience. 80% of hospitals had an endocrine surgical unit. High volume thyroid hospitals represented 73 % (48% performed 100-200 thyroidectomies(t)/year;48% 11-30 parathyroids (p)/year; 14% 200-300 t/year; 26% 31-50 p/year;11% more than 300t/year; 18.5% 51-100p/year). Audio plus graphic and EMG electrodes surface
endotracheal tube-based monitoring systems accounted for the majority (Medtronic NIM 3.0® 52%; Avalanche® Dr. Langer Medical 22%). Intermittent IONM was prevailing. Motivations expressed for the use of IONM were RLN identification-confirmation, adjunct in difficult cases prognosis, educational, research and legal.

**Conclusions**

IONM is increasingly used in Spain. Learning curve is steep especially with continuous monitoring. Standardized approach technique needs to be fully established.
Abstract number: 0065

THYROID CANCER RECURRENCE IN RIGHT PARAESOPHAGEAL LYMPH NODE - THE MOST COMMON OVERLOOK LN DURING CENTRAL LN DISSECTION.

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Objectives

Central compartment dissection (CLND) typically involves removal of level VI lymph nodes, including the pretracheal, paratracheal and prelaryngeal nodes on both sides. Right paraesophageal lymph node (RPLN) may be overlooked generally during CLND due to its unique anatomy. Recent studies showed RPLN metastasis ranges from 12 to 20%. We applying the intraoperative nerve monitoring for 8 patients with thyroid cancer who received reoperation for recurrent RPLN metastasis and analyzed the clinical data

Methods

A total of 8 patients with 7 papillary and one medullary cancer who underwent total thyroidectomy with CLND in the initial operation were enrolled in this study. Intraoperative nerve monitoring was routinely used, and 4 of them were added with APS. The operation time, additional cost, and operative mobility were compared with 30 papillary cancer patients who underwent RPLN dissection during CLND

Results

Eight but one (with medullary cancer) patients received radioiodine treatment before recurrent RPLN found. Initial pathological staging is: 3 cases with stage III, 3 with stage II, and 2 with stage I. The typical operative finding is that adhesion between nerve and surrounding tissue or recurrent L/N which is usually just below the nerve. Four cases with tightly adhesion had transient loss of signal of nerve monitor during operation. One case needed microscope dissection due to severe adhesion between nerve and RPLN. Four patients had transient hypocalcemia, but no permanent hypoparathyroidism or nerve damage. The cost of reoperation is 1.5 times of first operation, and the operative time for RPLN dissection is 82

Conclusions

RPLN dissection should be emphasized on the education of CLND. Missing or overlooking those RPLN will cause not only incomplete treatment but also increasing surgical mobility and medical cost during reoperation. Intraoperative nerve monitoring is useful for protecting nerve injury during reoperation.
Abstract number: 0069

REVERSAL OF DEEP ROCURONIUM-INDUCED NEUROMUSCULAR BLOCK BY SUGAMMADEX DURING INTRAOPERATIVE NEUROMONITORING IN THYROID SURGERY-ANIMAL EXPERIMENT AND CLINICAL STUDY.

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Objectives
The use of neuromuscular blocking agent interferes with the function of intraoperative neuromonitoring (IONM) in thyroid surgery. An enhanced neuromuscular-blockade recovery (ENBR) protocol was investigated in animal experiment and clinical study.

Methods
In animal experiment, 12 piglets were injected with rocuronium 0.6mg/kg and randomly allocated to receive normal saline, sugammadex 2 mg/kg or sugammadex 4mg/kg to compare the recovery of laryngeal EMG. In clinical study, 50 patients who underwent thyroidectomy with IONM followed ENBR protocol- rocuronium 0.6 mg/kg at anesthesia induction and 2 mg/kg of sugammadex at operation start. Accelerometry was used for continuous quantitative monitoring of neuromuscular transmission.

Results
In animal experiment, it took 49±15 min, 13±6 min and 4.2±1.5 min for the 80% recovery of laryngeal EMG after injection of saline, sugammadex 2 mg/kg and sugammadex 4mg/kg, respectively. In clinical study, TOF ratio recovered from 0 to >0.9 within 10 minutes. All patients had high EMG amplitude at early stage of operation and excellent intubation showed in 96% patients.

Conclusions
The animal experiment and clinical study proved that sugammadex 2 mg/kg allows effective and rapid restoration of neuromuscular function deeply suppressed by rocuronium. Implementation of the ENBR protocol assures optimal conditions for tracheal intubation and IONM of RLN in thyroid surgery.
Objectives

Injury to the recurrent laryngeal nerve (RLN) remains a significant morbidity during thyroid surgery. The aim of this study was to elucidate normative recurrent laryngeal nerve electromyographic (EMG) parameters during intraoperative nerve monitoring (IONM).

Methods

From February 2014 to March 2015, IONM was routinely used in thyroid, parathyroid and neck exploration operations. The Inomed C2 Nerve Monitor was used. We recorded the stimulation current, amplitude and latency of the recurrent laryngeal nerve before and after nerve dissection.

Results

46 patients with a mean age of 51 years old (range, 20-77 years) were analyzed in this study. The most commonly performed surgical procedure was total thyroidectomy (25/46, 53.2%). No patients had hoarseness after surgery. The median stimulation current for both the right and left RLN was 0.500mA. The median amplitude for the right RLN was 0.930mV and that for the left RLN was greater (1.060mV). The difference was not significant (right RLN vs left RLN, p= 0.304). The median latency for the right RLN and left RLN was 2.40. The difference was not significant (right RLN vs left RLN, p= 0.581). After neck dissection, there was an increase in amplitude but decrease in latency in both RLNs although this was not statistically significant. Nature of pathology and site of surgery appeared to have no significant difference on both RLN latency and amplitude.

Conclusions

This study highlights the normative electromyographic parameters for bilateral RLN nerve stimulation in an Asian population. No significant difference was noted in both pre- and post-dissection RLN electromyographic parameters.
Abstract number: 0087

VAGUS NERVE TRACTION INJURY DETECTED BY IONM IN THYROID CANCER SURGERY: 4 CASE REPORTS.

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Objectives
Intraoperative neural monitoring (IONM) has increasingly garnered the attention of the surgeons performing thyroid cancer surgery around the world. IONM can aid to correctly and easily find recurrent laryngeal nerve (RLN) beside visual identification, also reduce and detect RLN injury. However, traction injury to vagus nerve, detected by IONM, has been seldom reported.

Methods
We aim to present traction injury to vagus nerve, detected by IONM during lateral cervical lymph dissection in our 700 thyroid cancer surgery.

Results
One male patient, 22 years old, suffered from bilateral thyroid cancer with bilateral lymph node metastases, was transmitted to our hospital for staged left lobectomy and lymph dissection after right RLN injury in first-time right lobectomy and lymph dissection. After completing lateral cervical dissection, vagal nerve was intact, and right V2 EMG signal was normal. When right lobectomy and central dissection finished, right RLN was intact, and right R2 EMG signal was normal. But, V2 EMG signal was lost at middle of vagus nerve where it was tracted with cervical vessels by the retractor. So, due to cord paralysis tracheotomy must be performed for over 6 months. Similarly, another patient acquired vagus nerve traction injury, fortunately resumed cord motion. The other two case, vagus nerve traction injury occurred during minimally invasive video-assisted selective lateral lymph dissection, resulting in temporary cord paralysis.

Conclusions
During thyroid cancer surgery, IONM helps to detect vagal nerve traction injury, which should not be ignored.
Abstract number: 0089

EVALUATION OF THE NEUROMAPPING TECHNIQUE IN THE IDENTIFICATION OF THE RECURRENT LARYNGEAL NERVE DURING THYROIDECTOMY.

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Objectives
Intraoperative recurrent laryngeal nerve (RLN) neural monitoring (IONM) has gained increasing acceptance in thyroid surgery. Nevertheless, the value of this method in improving identification rate and time from skin incision to nerve identification remains controversial. The aim of this study was to assess the usefulness of the neuromapping technique in intraoperative localization of the RLN.

Methods
This prospective study was conducted at our institution in 2011–2013. Five hundred consenting patients qualified for total thyroidectomy with IONM (1000 nerves at risk) using NIM 3.0 Response (Medtronic, US) equipment were included. The primary outcome was percentage of the RLNs identified with the neuromapping technique prior to visual nerve identification.

Results
The application of the neuromapping technique allowed for localization of 921 (92.1%) RLNs before their visual identification. Branched RLNs were found in 245 (24.5%) cases.

Conclusions
Utilization of the neuromapping technique during thyroidectomy allows for efficient localization of the RLNs including ramified nerves.
Abstract number: 0090

CLINICAL VALUE OF INTRAOPERATIVE NEURAL MONITORING OF THE RECURRENT LARYNGEAL NERVE IN DIFFERENTIAL DIAGNOSIS OF SEGMENTAL VERSUS GLOBAL NERVE INJURY.

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Objectives
Intraoperative neural monitoring (IONM) can be used for diagnosis of nerve injury and prognostication of postoperative nerve function. The aim of this study was to assess the usefulness of the neuromapping technique in intraoperative establishing the differential diagnosis of both the type and site of nerve lesion in case of loss of signal (LOS).

Methods
A prospective study was conducted in 2011 – 2013 and comprised of 500 patients qualified for total thyroidectomy with IONM of the RLNs (1000 nerves at risk). The surface electromyography of the vocalis muscles was used according to guidelines formulated by the International Neural Monitoring Study Group (INMSG). The primary endpoint was descriptive characteristics of the type and site of the RLN lesion in case of intraoperative LOS. All patients had pre- and postoperative vocal folds assessment during 6 months follow-up.

Results
Among 25 patients with LOS and corresponding vocal fold paresis found in postoperative laryngoscopy (2.5%), intraoperative RLN neural mapping allowed for identification of the segmental type of nerve injury (type I) in 11 cases and the global type of injury (type II) in 14 cases. All the permanent injuries (100%) were segmental (type I), whereas 14/20 (70%) temporary injuries were global (type II). Median time for improvement of the ipsilateral vocal fold mobility was 2 months (range: 2 – 4) for global injuries (type II), and 6 months (range: 4 - 6) for segmental injuries (type I); p<0.001.

Conclusions
In case of LOS, the use of the neuromapping technique is helpful in differentiation of the type of nerve lesion, in clarification of the exact mechanisms leading to nerve injury, and in prognostication of regenerative potential of the nerve.
Abstract number: 0092

ROUTINE USE OF INTRAOPERATIVE NEUROMONITORING CHANGES THE OPERATIVE STRATEGY DURING BILATERAL THYROID SURGERY

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Objectives
Intraoperative neuromonitoring (IONM) is gaining acceptance during thyroid surgery as an adjunct to the routine visual identification of the recurrent laryngeal nerve (RLN). Two-stage thyroidectomy has been recommended in patients with true loss of signal, to avoid the risk of bilateral vocal cord palsy.

Methods
All patients receiving bilateral thyroid surgery between March 2011 and December 2014 were reviewed. IONM was routinely used to test vagus nerve and RLN before, during and after complete dissection. Loss of signal was defined as electromyographic change from initial satisfactory signal. In all planned bilateral operation, we begin with the largest side or with the malignant/suspicious side. If the intraoperative neuromonitoring (IONM) signal was lost after stimulation of the vagus nerve at the end of the first side, or if there was a significant signal drop, we stopped the procedure. Postoperative laryngoscopies were performed in all cases to evaluate postoperative vocal cord function.

Results
The procedure has been staged in 7 out of 350 operations. Six cases had a complete loss of signal, in one case there was a signal drop of 60%. In six cases, the nerve was visually intact during operation. Six of the seven patients had a postoperative vocal cord dysfunction that recovered within six months. In one case, postoperative laryngoscopy showed normal vocal cord function. This patient received the completion of thyroidectomy one week after the initial operation. In the six patients with postoperative vocal cord dysfunction, completion of thyroidectomy was performed after six months.

Conclusions
Our findings confirm that a visual intact nerve is not necessarily a functional nerve. Intraoperative neuromonitoring provides information on the functional status of the nerve and allows to change the operative strategy. The routine use of IONM is an effective help in limiting morbidity in all patients undergoing bilateral thyroid procedures.
Abstract number: 0094

EVALUATION OF THE IMPLEMENTATION PHASE OF INTRAOPERATIVE NEUROMONITORING (IONM) IN PATIENTS WITH THYROID CANCER TREATED IN A CENTER ROUTINELY USING VISUALIZATION OF RECURRENT LARYNGEAL NERVES (RLNS)

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Objectives
In Poland IONM has become a more common procedure in thyroid surgery. The aim of the study was to assess the initial phase of IONM implementation in the center routinely using visualization of RLNs.

Methods
We analyzed a pilot group of 25 patients operated on due to thyroid cancer using IONM (May - July 2014). Procedure was performed in accordance with the guidelines of International Neural Monitoring Study Group. Total thyroidectomy (TT) with central lymphadenectomy (CND) was performed in 10 cases, in 7 additionally with unilateral neck dissection (UND). 8 patients underwent secondary TT.

Results
Early paresis of RLN with real intraoperative loss of signal (LOS) was observed in 1 patient (4%; 1/50 nerves – 2%) after secondary TT. The false LOS was noted in 2 patients due to equipment-related problems (damage to the head and improperly attached electrode). We compared time of surgery in groups of patients undergoing TT with CND (10 patients- Group 1) or TT with UND (7 patients- Group 3) using IONM to a retrospective groups of patients operated on between 2004-2006 with similar cancer stage and similar extent of surgery (Group 2:TT with CND-160 patients and Group 4: TT with UND -35 patients). Mean time of surgery in Group 1 was 98 min (range 75-135) and 103 min in Group 2 (range 65-140), respectively;(p=0.178; Mann-Whitney). In Group 3 mean time was 192 min (145-240 min) and in Group 4 - 175 min (145-200 min); (p=0.56 Mann Whitney). Unilateral paresis of the RLN was observed in 9 cases (5.6%; 9/320 nerves – 2.8%) in Group 2 and in 3 patients in Group 4 (8.5%; 3/70 nerves – 4.3%).
Conclusions

In a specialized center the stage of implementing IONM was not related to significant technical problems. A significant prolongation of surgery with the use of IONM was not observed.
Abstract number: 0095

TRANSIENT LOSS OF SIGNAL (LOS) IN TWO SURGICAL PROCEDURES DUE TO ADVANCED LOW-DIFFERENTIATED PAPILLARY THYROID CANCER (PTC) USING INTRAOPERATIVE NEUROMONITORING – CASE STUDY

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Objectives
Two cases of advanced low-differentiated PTC are presented.

Methods
We analyzed two surgical procedures with transient intraoperative LOS using IONM.

Results
An 11-year-old boy was primarily non-radically operated on at the other surgical centre due to low-differentiated PTC with metastases to cervical lymph nodes. Postoperative fine needle aspiration biopsy confirmed the presence of cancer in the remnant of the right lobe and bilateral cervical lymph node metastases. The patient was reoperated on at our Institute. The removal of thyroid remnants with strap muscles, the central neck dissection and bilateral cervical lymphadenectomy was performed under neuromonitoring control. Proper functioning of the right recurrent laryngeal nerve (RRLN) was identified entering cicatricial and cancer infiltration site. Revision of the left side was performed first. IONM confirmed the preservation of the left nerve function. LOS was detected after separating the RRLN. The return of RRLN function was observed following bilateral neck dissection (after 150 min), which was confirmed by neuromonitoring and by post-operative laryngological examination. A 63-year-old female with advanced low-differentiated PTC of the right lobe with metastases to the right lateral neck compartment, mediastinum and with the suspicion of pulmonary metastases was operated on. Total thyroidectomy with central neck dissection and right lymphadenectomy were performed using neuromonitoring. The surgical procedure was started on the left side due to cancer advancement and a high risk of injury to the RRLN. The maintenance of the left nerve function was confirmed by IONM. During preparation on the right side, LOS was noticed. After cervical lymphadenectomy (90 min), the return of the RRLN function was observed. Post-operative laryngological examination confirmed a proper function of the vocal cords.
Conclusions

The application of IONM allows the modification of surgical procedure. The certainty concerning continuity and function of one of the nerves facilitates radical surgery on the opposite side.
Abstract number: 0096

EXPERIENCE IN PANAMA OF INTRAOPERATIVE NEUROMONITORING OF THE RECURRENT LARYNGEAL NERVE IN PATIENTS WITH NERVES AT RISK

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Objectives

1-Perform neuromonitoring of the recurrent laryngeal nerve during thyroidectomy procedure in patients with nerves at risk
2-Measure latency, duration and magnitude of the record obtained by stimulating the vagus and laryngeal recurrent nerve.
3-Establish the electrophysiological characteristics of an adequate record.

Methods

The same surgeon operated on 88 patients (7 men and 81 women) aged 23-74 years diagnosed with papillary thyroid cancer (46%), multinodular goiter (38%), follicular adenoma (9%) and nodular hyperplasia (7%). Standardized technique and intraoperative RLN monitoring protocol was used. Pre and postoperative laryngoscopy was performed. Anesthetic technique short-acting depolarizing agents were used. The recording electrode (endothracheal tube) was connected to a Monitor Medtronic NIM-Response® 3.0. Electromyographic responses (EMG) were obtained by stimulating with a monopolar electrode, with stimuli of 1 to 2 mA according to the technique in 4 steps in a sequential order V1-R1-R2-V2. The response threshold was set to 100

Results

The morphology of the record (EMG) was consistent. The magnitude, latency and duration of responses were determined. The averages of the amplitudes were higher for the vagus and RLN on the left compared to the right side, (Left side: V1: 540 µV and V2: 432 µV) (Left side R1: 784µV, R2: 706 µV)(Right side: V1: 467µV and V2: 407) (Right side: R1: 628 µV and R2: 558 µV)The highest mean response magnitude were obtained in the left recurrent laryngeal nerve of patients between 40-60 years.

Conclusions

1-The intraoperative neuromonitoring of the recurrent laryngeal nerve during thyroidectomy in patients at risk nerves prevents nerve injury.
2-Preliminary electrophysiological results shown are similar to those reported in the literature.
Abstract number: 0100

INTRAOPERATIVE RECURRENT LARYNGEAL NERVE MONITORING DURING PARATHYROIDECTOMY.

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Objectives
The recurrent laryngeal nerve (RLN) injury can occur during parathyroidectomy, in particular in reoperative cases or during dissection of the superior parathyroid adenoma. The aim of this study was to sum up our experience with utilization of intraoperative neuromonitoring (IONM) during parathyroidectomy for primary hyperparathyroidism (pHPT).

Methods
This is a retrospective study. Records of all patients undergoing parathyroid surgery for pHPT at our institution in 2004-2014 were searched for eligible patients. Indications for utilization of IONM during parathyroidectomy and the RLN morbidity were analyzed. All patients underwent vocal cord evaluation pre- and postoperatively.

Results
Thirty eight patients with pHPT underwent parathyroidectomy with IONM including 25 open minimally invasive parathyroidectomies for a solitary superior parathyroid adenoma in secondary ectopic localization identified on the preoperative imaging (including 12 reoperations for persistent pHPT initially operated outside our institution), and 13 bilateral neck exploration for suspected multiglandular disease. The early RLN injury occurred in 1 (1.9%) of 51 nerves at risk.

Conclusions
IONM was utilized at our institution on select patients operated on for pHPT. Surgeon's preferences for utilization for IONM during parathyroidectomy included reoperative cases, surgery for presumably superior parathyroid adenoma localized in the secondary ectopic position on preoperative imaging, and planned bilateral neck exploration.
CONSEQUENCES OF IONM ON VOCAL CORD FUNCTION AND PHONIATRIC PARAMETERS: CONTINUOUS VS. INTERMITTANT MONITORING.

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Objectives
The aim was to investigate whether there was a difference in vocal cord function and phoniatric parameters between continuous and intermittent monitoring protocols.

Methods
Between May - November 2014, thyroidectomized patients were included prospectively and were assigned randomly into three groups. Group A received “continuous vagus monitoring”, Group B received “intermittent neuromonitoring via a bipolar probe”, and Group C received “no neuromonitoring”. All patients were evaluated preoperatively, postoperatively 1st day, and 1st week; both for vocal cord mobility via direct laryngoscopy and phoniatric tests.

Results
A total of 37 patients were included. Demographics distributed homogeneously between groups. Amplitude and latency values did not differ between age and gender, irrespective of above mentioned groups. According pre-resection vs. post-resection results, a significant increase in the amplitude of the left vagus was found (0,24-0,33%µV; p=0,042). In Group B, amplitude and latency values of the right recurrent nerve increased significantly after resection (amplitude 0,52-0,62µV and latency 1,73-1,63ms; p=0,04). No statistically significant differences were found between groups according direct laryngoscopic examinations, as well as phoniatric test results. Four patients suffered from abnormal vocal cord findings in the early period. A comparison of these with patients having normal findings, resulted in a difference of the better value during the 1st week (1,61% vs. 2,45%; p=0,005).

Conclusions
No superiority of either of the techniques could be shown in terms of vocal cord function and phoniatric parameters. Nevertheless, larger studies are warranted.
Abstract number: 0110

THE EFFECT OF AGE AND GENDER ON NORMATIVE VAGAL AND RECURRENT LARYNGEAL NERVE ELECTROPHYSIOLOGICAL DATA

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Objectives
To demonstrate the normative vagal and recurrent laryngeal nerve (RLN) electromyographic parameters during intraoperative nerve monitoring and to investigate the effect of age and gender on the electromyographic parameters of vagal and RLN.

Methods
Seventy-nine consecutive patients with 151 nerves at risk were included. All patients underwent preoperative and postoperative vocal cord examination. Any patient with abnormal findings on preoperative vocal cord examination was excluded. Intraoperative nerve monitoring (IONM) was applied by a standardized IONM set up using the noninvasive surface electrode endotracheal tube and the Dr. Langer Avalanche SI NIM monitor with a hand hold stimulating probe. The amplitude and the latency of the evoked response for vagal and RLN were recorded initially at the beginning of surgery.

Results
The mean amplitude and latency on the left versus right RLN, and the mean amplitude on left versus right vagal nerve showed no significant difference. The latency was significantly longer on the left (5.8±1.2 ms) versus right vagal nerve (4.2±0.9 ms)(P=0.0001). The mean amplitude was significantly higher on left RLN (896±515µV) compared to left vagal nerve (618±372µV). The left vagus mean latency was longer compared to left RLN (5.8±1.2 vs 2.1±1ms; P=0.0001). The mean amplitude of right RLN and right vagal nerve was similar (P=0.7). The right vagus mean latency was significantly longer compared to right RLN (4.2±0.9ms vs 2.1±0.6ms P=0.0001). Gender had no significant effect on latency and amplitude measurements. Age had no significant correlation with latency of RLN and vagal nerve. The amplitude was significantly lower on RLN and vagal nerve in patients with an age above 60 years compared to younger patients (for RLN: 653±271µV vs. 845±526µV; P=0.01)(for vagal nerve: 490±206µV vs. 692±458µV; P=0.001).

Conclusions
Gender had no significant effect on the latency and amplitude measurements. The amplitude on RLN and vagal nerve was significantly lower in older patients (age above 60 years) compared to younger patients.
Abstract number: 0113

CLINICAL INSIGNIFICANCE OF CONTRALATERAL LARYNGEAL RESPONSE IN EMG TRACING DURING CONTINUOUS NEUROMONITORING GUIDED THYROID SURGERY

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Objectives
Continuous neuromonitoring (CNM) reliably predicts postoperative ipsilateral vocal fold function during thyroid surgery. However, there are no data available in the pertinent literature regarding the significance of recorded EMG waveforms of the contralateral vocal fold when bilateral channel recording tube electrodes are used. This prospective study was undertaken to evaluate the clinical significance of EMG waveforms recorded from the contralateral larynx during ipsilateral intraoperative vagal stimulation CNM guided thyroid surgery.

Methods
Twenty five consecutive patients scheduled for bilateral thyroid surgery were enrolled in this trial. All continuously stimulated ipsilateral vagus nerves had their EMG tracings recorded and correlated with contralateral surgical maneuvers and contralateral postoperative vocal fold function after usage of intermittent neuromonitoring only.

Results
The majority of cases were primary surgery (24/25 patients; 92%) for benign thyroid diseases (22/25 patients; 88%). There were 2 contralateral loss of signals with one corresponding contralateral transient vocal fold palsy. As in almost all cases (20/25 patients including both cases with loss of signals; 80%), the ipsilateral continuous EMG tracings did not correlate with contralateral surgical maneuvers. The median baseline amplitude was 1105 µV (interquartile range: 883; 1446). Isolated decrease of amplitude to <50% of baseline was most frequent (18/20; 72%), followed by uneventful courses (5/25; 20%), and isolated increase of latency to >110% of baseline (2/25; 8%). The median final amplitude after resection was 890 µV (interquartile range: 628; 1471).

Conclusions
Laryngeal response from contralateral vocal fold seems not to result in reliable information in ipsilateral continuously EMG tracing. Showing the clinical insignificance of contralateral EMG waveforms, online registration of action potentials is only reliably caused by ipsilateral real time vagus nerve stimulation offering prediction of only the ipsilateral vocal fold function.
Abstract number: 0114

ADVANCED CARDIAC AV BLOCK IS NOT A CONTRAINDICATION FOR THE SUCCESSFUL USE OF CONTINUOUS VAGUS NERVE STIMULATION DURING THYROID SURGERY

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Objectives
Continuous neuromonitoring (CNM) improves RLN protection by reliable signalling impending nerve injury that it has the opportunity to immediately correct surgical action. However, real time stimulation of vagus nerve might result in increased, but subclinical parasympathetic cardiac activity. This investigation was conducted to evaluate the feasibility and safety of CIONM in patients with advanced AV block.

Methods
All patients with pre-existing Mobitz type II or complete AV block and CNM guided thyroid surgery were included in this study. Peri- and intra-operative cardiac parameters were analysed to assess effects of CNM on the parasympathetic system.

Results
3 out of 1288 patients (6/2162 nerves at risk) with advanced AV block were enrolled in this study. 2 of them had cardiac pacemaker using VDD mode, which were temporary switched into V00 mode only during CNM surgery. No clinical relevant cardiac arrhythmias or hemodynamic events occurred during surgery; no changes in median heart rate or in median blood pressure were detected.

Conclusions
Accounting principles and intraoperative handling of cardiac pacemaker CNM appears feasible and safe in thyroid surgery even in cardiac patient with advanced AV block.
Abstract number: 0118

SIMULTANEOUS NEUROMONITORING OF RECURRENT LARYNGEAL NERVES AND FACIAL NERVE DURING ONE OPERATION OF ADVANCED NECK TUMOR.

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Objectives

Neuroendocrine tumours (NETs) are a heterogeneous group of neoplasms with many different localizations. Their diagnosis and therapy can be problematic. Operations preserving nerves in advanced tumors causes no additional disability of seriously ill patients. We describe a patient, a 44-year-old male referred to our department with suspicion of medullary thyroid cancer and large pathological tumor of metastatic lymph nodes at right submandibular localization. The patient was subjected to total thyroidectomy with clearance of central and lateral lymph node compartments. Intraoperatively we performed intraoperative neuromonitoring of vagal nerves, recurrent laryngeal nerves and marginal mandibular branch of facial nerve due to localization of pathologic mass of metastatic lymph nodes.

Methods

We used Inomed C2 NerveMonitor with bipolar stimulation probe, laryngeal tube adhesive electrode and subdermal needle electrodes for recording EMG signals.

Results

The outcome of the patient was uneventful. Postoperative histopatology revealed nodular goiter with no tumor and neuroendocrine laryngeal cancer metastases to lymph nodes. The patient was then referred to Oncological Laryngology Department, next chemo- and radiotherapy were applied.

Conclusions

We suggest that surgical procedures with preservation of important nerves should be performed even in patients with advanced tumors. Neuromonitoring of different groups of nerves is possible with one monitoring system.
Abstract number: 0122

THE USE OF NEUROMONITORING IN PEDIATRIC SURGICAL PROCEDURES BASED ON SELECTED CASES - PRELIMINARY REPORT.


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Objectives
Intraoperative neurophysiological monitoring (IONM) of peripheral and cranial nerve motor function employing various neurophysiologic modalities is increasingly being used during surgical procedures, most commonly, but not exclusively, in thyroid surgery. Numerous reports have been published describing the use of IONM in adults. However, there is little published data regarding the use of IONM in children. We aimed to present our experience with the use of IONM in children.

Methods
We present our experience with the use of IONM of cranial and peripheral nerves in children treated in the Department of Pediatric Surgery during years 2013-2015. The patients were aged 15 months - 17 years; there were 7 girls and 2 boys. 4 children had thyroid disease, 2 children had brachial plexus tumors, 1 child had median nerve tumor and 1 had lymphatic malformation of the facial nerve area. The modalities used involved electromyography, evoked potentials and electroneurography. Observation time ranged from 2 months to 2 years.

Results
Very good results, defined as complete nerve function recovery was observed in 8 children. Good result, defined as neural function loss of less than 25%, was observed in 1 child. The results were assessed intraoperatively, based on IONM recording and postoperatively based on neurological examination.

Conclusions
The use of IONM in pediatric surgical patients is an exceedingly valuable and recommendable method, allowing both a more radical excision with reduced risk of nerve damage and a more reliable prognosis for postoperative neural function. Damage risk can be reduced by simultaneous use of different monitoring modalities and by continued cooperation with a neurologist. Apart from typical indications which are similar to those in adult patients, IONM can be particularly useful in the treatment of complex developmental malformations, such as lymphatic malformations.
Abstract number: 0130

NORMATIVE VAGAL AND RECURRENT LARYNGEAL NERVE ELECTROPHYSIOLOGICAL PARAMETERS IN BRAZILIAN PATIENTS UNDERGOING THYROID SURGERY.

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Objectives

Intraoperative nerve monitoring (IONM) has gained great acceptance in Brazil and is being used in many centers to facilitate identification of the recurrent laryngeal nerve (RLN), to aid in dissection and to prognosticate neural function postoperatively. Recent publications also state its usefulness in the identification of the external branch of the superior laryngeal nerve (EBSLN) and in the recognition of a non-recurrent inferior laryngeal nerve. The knowledge of normal IONM parameters is crucial for the interpretation of intraoperative findings. The aim of this study was to elucidate the normal eletroneuromyographic (EMG) parameters for both RLN and vagus nerve during thyroid surgery under IONM in a Brazilian population.

Methods

In this prospective study, IONM applied to thyroid surgery was performed in consistency with published international guidelines. The patients who agreed to participate were operated at the Hospital Sao Camilo, in Sao Paulo, over a 5-year period. Intraoperative quantitative data on EMG parameters of vagal and RLN stimulation were recorded, print-documented and analyzed. Any patient with an abnormal pre or postoperative laryngeal exam was excluded.

Results

One hundred and fourteen patients underwent 115 operations, with 191 nerves at risk. The vagal nerve latency was significantly greater on the left side. There was no significant difference between RLN latencies and amplitudes on either side and vagal latencies were significantly greater than RLN latencies.

Conclusions

The normative data of amplitude and latency for bilateral vagus and RLN are presented. Like other studies, our survey shows that the left vagus nerve has a significantly longer latency. We believe that acquaintance with normal IONM parameters is a requirement for proper interpretation of intraoperative findings and might influence surgical strategy.
Abstract number: 0132

RIGHT INFERIOR P ARATHYROIDECTOMY WITH INTRA-OPERATIVE NERVE MONITORING (IONM) IN A PATIENT WITH LUSORIA ARTERY AND NON-RECURRENT LARYNGEAL NERVE: ANOTHER CASE REPORT OF USEFULNESS OF IONM.

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Objectives
Non recurrent laryngeal nerve is a rare anomaly and account for less than 0.6 % on right side and 0.04 % on left side. Intra-operative nerve monitoring (IONM) could represent an help to detect and monitor non recurrent laryngeal nerve during surgical neck procedure. We report a case of a woman with parathyroid adenoma and pre-operative finding of lusoria artery frequently associated with non-recurrent laryngeal nerve.

Methods
A 44 years old female patient with a previous seven years history of renal stones and bone pain showed a neck nodule of 3.6 cm at US evaluation. CT scan and Sestamibi scan pre-operatively was performed. After informed consent and pre-operative evaluation of vocal cord function, the patient underwent cervicotomy with intra-operative iPTH dosage.

Results
Pre-operative CT scan identify the lusoria artery. Right inferior parathyroidectomy with IONM was carried out in 72 min. Intra-operative i-PTH showed an optimal decrease from 840 pg/ml to 58 pg/ml. Identification and preservation of right non-recurrent laryngeal nerve is easily carried out and IONM helps to identify non-recurrent laryngeal nerve. No complications occurred. Post-operative stay was 3 days. Final histology showed atypical adenoma with complete integrity of nodule. The cosmetic result was excellent and no administration of analgesic drug has been necessary.

Conclusions
We report a case of usefulness of IONM in a patient with non-recurrent laryngeal nerve. IONM could represent an adjunctive in case of neck surgery with pre-operative suspect of non-recurrent laryngeal nerve that is at major risk of damage.
Abstract number: 0133

MINIMALLY INVASIVE VIDEO-ASSISTED THYROIDECTOMY (MIVAT) WITH INTRA-OPERATIVE NERVE MONITORING (IONM): INITIAL EXPERIENCE IN A REGIONAL REFERRAL CENTER.

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Objectives

Video-assisted thyroidectomy is actually recognized as a better surgical option in selected patients for a better cosmetic result and less post-operative pain. Intra-operative nerve monitoring (IONM) could represent a useful help to check recurrent laryngeal nerve during thyroidectomy. We analyze our initial experience in a regional referral center combining minimally invasive thyroidectomy (MIVAT) and IONM for small thyroid nodule.

Methods

Among 192 minimally invasive thyroidectomies performed, last 12 patients with 24 recurrent laryngeal nerves at risk undergoing both MIVAT and IONM were enrolled in a retrospective non-randomized study. All patients underwent vocal cord evaluation pre- and post-operatively. The procedure performed through a single (2/2.5 cm) central neck skin incision between the cricoid cartilage and the sternal notch. Demographics and intra-operative and postoperative complications following surgery were collected.

Results

There were 11 women and one man with a mean age of 38.5 +/- 12.5 years. Pre-operative diagnosis was follicular thyroid lesion in 7 case, follicular thyroid lesion with atypia in 4 cases and small papillary thyroid cancer in one case. Mean operative time was 69 +/-12 min. IONM reports showed recurrent laryngeal nerve integrity in all cases even in one on the right side. Mean post-operative stay was 2.6 days (range: 2-5). Four transient post-operative hypocalcemias were registered. No other complication occurred. Final histology showed benign disease in 4 patient and small papillary carcinoma in 8 patients.

Conclusions

Video-assisted thyroidectomy with intra-operative nerve monitoring is feasible and safe even in a regional referral center with medium volume of surgical procedures. Furthermore the procedure showed some advantages in terms of better cosmetic result, less post-operative pain and in adjunct to visual identification of recurrent laryngeal nerve IONM could be safe and effective for nerve monitoring. Larger series and comparative studies are necessary to show more advantages compared with video-assisted thyroidectomy alone.
Abstract number: 0134

EVALUATION OF THE USEFULNESS OF NEUROMONITORIZATION RECURRENT LARYNGEAL NERVE IN THYROID SURGERY TEACHING.

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Objectives
To evaluate the usefulness of neuromonitorization recurrent laryngeal nerve in thyroid surgery teaching in a university hospital, particularly in the training of endocrine surgery resident in general surgery.

Methods
162 patients who underwent total thyroidectomy with neuromonitorization (group A: 78) and without neuromonitorization (control group B: 84). This study was done retrospectively conducting a survey among 10 residents of general surgery in order to obtain subjectively the opinion of each. Residents surveyed surgeons are 4th and 5th years of residence and the period comprises five years, from 2009 to 2014. In the surgeries performed was always a senior surgeon experienced in thyroid surgery.

Results
10% of the residents said that the monitoring of the recurrent nerve is not essential for total thyroidectomy in practice thyroidectomy, 10% stated that the recurrent nerve monitoring is needed and 80% said it was highly necessary as a tool in thyroidectomy. As regards complications there were no significant differences between the two groups surgically.

Conclusions
Neuromonitorization helps in identifying the recurrent laryngeal nerve, increases the safety of the surgeon in the art and do it consistently recommended in thyroid surgery. We consider it very important to teach surgeons at the stage of residence in order to learn and understand globally thyroid surgery tool. The technique using the neuromonitorization recurrent nerve is easy and we believe it is essential for education and implementation in order to improve the quality of care.
Abstract number: 0135

INTRAOPERATIVE LARYNGEAL NERVE MONITORING. CURRENT PRACTICE PATTERNS OF USE AMONG SURGEONS IN LATINAMERICA. A SURVEY STUDY

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Objectives
There is not consensus regarding the use of laryngeal nerve intraoperative monitoring (IONM). In Latin America dissemination and use of laryngeal nerve intraoperative monitoring (IONM) is quite low and we have no information about its use. The present survey depicts and describes the patterns of use, indications and management of IONM during thyroid and parathyroid surgery in Latinamerica.

Methods
A survey was constructed and disseminated using the professional version of the internet-based survey mechanism Survey Monkey and consisted of 21 questions regarding IONM. Information was collected on participants’ training history, practice setting, annual volume of thyroid and parathyroid surgeries, indications, compliance with guidelines and attitudes in a patient with a loss of signal (LOS).

Results
38% surveys were completed, of respondents 61% were Head and Neck Surgeons, 25% endocrine surgeons and the rest General Surgeons. The majority of respondents reported being high-volume surgeons with more than 100 procedures per year. The most commonly cited reasons for IONM use were recurrent laryngeal nerve (RLN) identification, decrease of the lesions of the RLN, medical-legal protection and increased confidence. 55% used IONM in high risk patients and only 7% always use IONM. Reoperative cases (85%), previous RLN lesion (56%), substernal goiter (48%), central neck dissection (41%) and thyroid cancer (33%) were the high risk patients. Only 33% of the participants had experience with the standardized approach of IONM technique. In a patient with cancer and LOS, 88% continue as routine with the second side and 44% do not perform contralateral lobectomy in benign disease.

Conclusions
This is the first approach to the situation of the neuromonitoring in Latinamerica, most surgeons who responded to this survey performed IONM on selected patients previously defined as high risk. Actually there is a tendency to adopt IONM as an aid in the operating room.
Abstract number: 0136

**SUPERIOR LARYNGEAL NERVE EXTERNAL BRANCH: NORMATIVE ELECTROPHYSIOLOGICAL PARAMETERS IN BRAZILIAN PATIENTS UNDERGOING THYROID SURGERY**

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**Objectives**

Injury to the external branch of the superior laryngeal nerve (EBSLN) can occur during thyroid surgery when the superior pole is being dissected. Electrical stimulation may aid in the identification of this nerve by the direct observation of the cricothyroid muscle (CTM) twitch. In the majority of cases, however, a waveform can also be recorded by intra-operative nerve monitoring (IONM). The purpose of this study is to elucidate the normative EBSLN and recurrent laryngeal nerve (RLN) electroneuromyographic parameters that may serve as reference during standard IONM application.

**Methods**

In this prospective study, IONM was performed in consistency with published international guidelines. The patients who agreed to participate underwent thyroid surgery at the Hospital Sao Camilo, in Sao Paulo, Brazil, from 2010 to 2015. Intraoperative quantitative parameters of EBSLN and RLN stimulation were recorded, print-documented and analyzed. Any patient with an abnormal pre or postoperative laryngeal exam was excluded.

**Results**

One hundred and fourteen patients underwent 115 operations. In all cases CTM contraction could be identified following probe-stimulation of the EBSLN. Electroneuromyographic response was recorded in 89 cases. The mean amplitude of EBSLN response was 226

**Conclusions**

IONM of the EBSLN aids in EBSLN identification and electroneuromyographic activity can be recorded in most of the cases. The parameters for EBSLN IONM are presented.
THE SAFE RANGE OF ELECTRICAL STIMULATION INTENSITY DURING INTRAOPERATIVE NEUROMONITORING OF THE RECURRENT LARYNGEAL NERVE: AN EXPERIMENTAL CANINE MODEL.

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Objectives
To develop an experimental canine model to determine whether the stimulus of IONM could induce nerve damage and investigate the safe range of stimulation current intensity.

Methods
After the performance of total thyroidectomies on twenty dogs, the RLNs were stimulated using a current of 5.0 to 20.0mA (stepwise by 5.0mA increments) for 1 minute. The parameters of evoked electromyography (EEMG) of vocal muscles before and after the high-intensity electrical stimulation were recorded and compared. The acute microstructural morphological changes of the RLNs were observed immediately after the operation under electron microscope.

Results
The average stimulating threshold of the nerves haven’t significantly changed compared to the normal data measured previously in any group. And obvious acute microstructural morphological changes under electron microscope only occurred in the nerve stimulated by an intensity of 20mA.

Conclusions
A stimulation intensity less than 15mA would be safe during IONM of RLN.
Abstract number: 0145

DISSECTION OF RIGHT UPPER PARAESOPHAGEAL LYMPH NODE FOR MANAGEMENT OF RECURRENT OR PERSISTENT NODAL LESION IN PATIENT WITH PAPILLARY THYROID CANCER.

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Objectives

Central compartment lymph node is one of most common metastatic lesion for recurrent or persistent papillary thyroid cancer. Although there are some studies about right upper paraesophageal lymph node (RPELN) for initial operation in PTC, the study about RPELN in recurrent or persistent PTC is rare. The purpose of this study is to investigate the incidence of RPELN metastasis for management of recurrent or persistent nodal lesion and the complications of reoperation for central compartment lymph node (CLN) in patient with PTC.

Methods

This study is a retrospective study of 79 patients who underwent therapeutic or prophylactic central compartment lymph node dissection for management of recurrent or persistent nodal lesion between Jan. 2005 and Dec. 2013.

Results

Twenty-seven among 28 (96.4%) patients who underwent therapeutic right CLND were found metastatic lymph nodes in recurrent or persistent PTC. Seven of 22 (31.8%) patients who underwent the dissection for RPELN exhibited nodal metastasis. Three among 17 (23.5%) patients who underwent prophylactic right CLND found metastatic lesion in recurrent or persistent nodal PTC. One of seven (14.3%) patients who underwent prophylactic dissection for RPELN found metastatic lymph node. One case had permanent vocal fold palsy, three cases had permanent hypoparathyroidism.

Conclusions

RPELN should be removed during the lymph node dissection for management of recurrent or persistent nodal lesion in patients with PTC.
CONTRIBUTION OF NERVE MONITORING TO SECONDARY PARATHYROID SURGERY

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Objectives
Recurrent laryngeal nerve (RLN) paralysis can also occur in surgical interventions for hyperparathyroidism. RLN paralysis risk is remarkably higher in secondary interventions. We aimed to evaluate effect of intraoperative nerve monitoring (IONM) on RLN paralysis.

Methods
The prospective data of patients, who underwent surgery for primary or secondary hyperparathyroidism with IONM between Jan 2013-Apr 2015, were evaluated. Vocal cords of all patients were examined preoperatively and postoperatively. Patients were divided into two groups. Group 1 consisted of primary and group 2 of secondary intervented patients, who underwent parathyroidectomy and/or thyroidectomy before. Temporary and permanent vocal cord paralysis (VCP) rates were compared between two groups. VCP rates were calculated according to number of RLNs explored.

Results
80 (64F, 16M) patients underwent surgery for hyperparathyroidism. Median age was 51.8 (32-76). Group 1 was of 64 cases consisting of 54 primary hyperparathyroidism (53 primary cases, 1 persistent/recurrent case) and 9 secondary hyperparathyroidism. Group 2 was of 18 cases consisting of 15 primary hyperparathyroidism (11 primary cases, 4 persistent/recurrent cases) and 3 secondary hyperparathyroidism. 98 RLNs were consisting of 35 patients bilaterally and 28 unilaterally explored of 63 patients in group 1. 20 RLNs were consisting of 17 patients unilaterally and 2 bilaterally explored of 18 patients in group 2. No signal was taken with IONM due to technical problems in 4 patients. The RLNs weren’t explored in 18 patients, whose operations were completed with only vagal nerve stimulation (V1, V2). The rates of the transient VCP are 1(%1) and 2(%10) in groups, respectively. No significant difference was determined between the groups. There was not any permanent VCP in both of groups.

Conclusions
The parathyroid surgery can be performed with minimal morbidity, by IONM. In some patients, surgery can be completed with vagus stimulation without RLNs being explored. The secondary interventions can be performed with low complication rates similar to primary cases.
Abstract number: 0147

AUTOMATIC PERIOD STIMULATION VAGAL MONITORING IN THYROIDECTOMY - A RETROSPECTIVE REVIEW

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Objectives
Automatic periodic stimulation (APS® - Medtronic) of the vagus nerve allows continuous monitoring of recurrent laryngeal nerve (RLN) integrity during thyroid surgery. This allows the surgeon to detect potential or incipient nerve injury through fluctuations in nerve latency or amplitude, without the necessity of direct dissection or skeletonisation of the RLN. The technology operates along the same electromyographic principles as conventional RLN monitoring, with the addition of a vagal stimulation electrode, which is applied prior to thyroid lobe dissection by dissection of the carotid sheath.

Methods
Retrospective review of data from patients undergoing total thyroidectomy or hemithyroidectomy, with surgery performed by the senior author, with conventional RLN monitoring and APS® monitoring.

Results
344 episodes of thyroid surgery were identified (January 2010 – present), with a total of 441 nerves monitored. 222 nerves were monitored using APS®, and 219 using conventional surgeon-operated RLN monitoring. 98 procedures (28%) were performed for malignancy with similar distributions between groups. Vocal cord weakness was noted in 11.9% of conventionally-monitored nerves, and 8.1% of APS®-monitored nerves. Long-lasting palsy occurred in 1.4% and 2.7% of nerves, respectively.

Conclusions
APS® monitoring is a helpful new adjunct to careful anatomical preservation of the recurrent laryngeal nerve in thyroidectomy procedures. This study demonstrates comparable rates of RLN injury or neuropraxia between conventional and APS® monitoring techniques in a single-operator case series. Further study of the relationship between the electrophysiological readout from the APS® monitor and clinical nerve outcomes is desirable.
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