Intraoperative nerve monitoring in thyroid surgery

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BACKGROUND: *Nerve injury is one of the specific complications of thyroid surgery despite many advances in surgical technique. The recurrent laryngeal nerve (RLN) and the external branch of superior laryngeal nerve are the nerves at risk during thyroid surgery (1). Morbidity related to recurrent laryngeal nerve injury varies from changes in voice quality to severe dyspnea requiring tracheal intubation or tracheostomy. To minimize the risk of nerve injury, intraoperative nerve monitoring (IONM) being suggested as a tool for helping visual control for RLN has gained significant interest in recent years (1,2). We aimed to determine the effectiveness of nerve monitoring during thyroid surgery and to provide a clinical experience.*
MATERIALS AND METHODS: *This study was performed from June 2010 to June 2012. We prospectively evaluated 94 patients who had thyroid surgery with or without nerve monitoring. Of those patients 48 were in monitored group (M) and 46 were in unmonitored group (UM).*
RESULTS: *The mean age was 48 (27-76) in M group and 52 (73-17) in UM. There was only one patient had transient hoarseness in M group and also one patient had transient hoarseness in UM group. One each in both groups had persistent hoarseness. No patients experienced airway problem. Operation time was significantly shorter in M group ($p<0.001$).*
CONCLUSIONS: *Use of a nerve monitoring system does not substitute for careful dissection and visual identification of nerves, but monitoring can assist the surgeon in identifying the RLN anatomic variability and may decrease the operation time during thyroid surgery.*

KEY WORDS: Complications, Injuries, Nerve monitoring injury, Operation time, Thyroid, surgery

Introduction

Nerve injury is one of the most concerning complications of thyroid surgery. The recurrent laryngeal nerve (RLN) and the external branch of superior laryngeal nerve are the nerves mostly at risk during thyroid surgery[1]. Recurrent laryngeal nerve injury may cause morbidities such as loss of voice quality or severe airway problem requiring tracheal intubation or tracheostomy [1,2]. Reported rates of RLN injury range from 1% to 8% [2]. It is highly predisposed to injury during thyroidectomy due to misidentification of RLN [3]. Variations are the most common problems that are non-RLN, a rare variation with an incidence of 0.3–1.6% and most are observed on the right side, and extra laryngeal branching, with an incidence of 64.53%. The other possible causes of RLN injury can result from transection, clamping, stretching, electro-thermal injury, ligature or ischemia during dissection. Therefore, it is needed to verify of functional and anatomical RLN

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integrity intraoperatively for a safe thyroid operation. Recently, intraoperative nerve monitoring (IONM) has gained significant interest [4]. So far, surgeons experience has been reported as the most important reason of nerve injury [4]. We aimed to determine if nerve monitoring has any effect during thyroid surgery. IONM during thyroid and parathyroid surgery has gained widespread acceptance as an adjunct to the gold standard of visual nerve identification, adding a new functional dynamic during thyroid surgery [5].

Materials and Methods

This prospective observational study was performed by the Endocrine Surgeons in the department of General Surgery at the Samsun Ondokuz Mayis University from June 2010 to June 2012. Patients consecutively underwent thyroid surgery via monitored or unmonitored. The study was approved by the institutional review of board of our institution and informed consent of each patients were obtained. Of those patients 48 were in monitored group (M) and 46 were in unmonitored group (UM). For patients who had previously thyroidectomy, an ear-nose-throat specialist performed laryngoscopy preoperatively, and anesthetists assessed postoperative vocal cord mobility by using laryngoscopy immediately after anesthesia. Transient and permanent hoarseness were evaluated during postoperative follow- up. An ear-nose-throat specialist repeated laryngoscopy within 48 hours. All thyroidectomies were performed with visual control of the recurrent nerve at the entry into the larynx by using the inferior thyroid artery as a landmark in both groups. Medtronic Xomed (Minneapolis, Minnesota) a system commonly used in the Unites States was used in this study. The NIM-Response Nerve Integrity Monitoring System (Xomed Medtronics, Jacksonville, FL, USA) was used in all procedures with 2 mA stimulation. A Prass stimulation fine probe (Medtronic Xomed) was used for nerve stimulation during the thyroidectomy procedure. It was a nerve integrity monitor (NIM) system uses a special endotracheal tube with the vocal cord electrodes. During the induction of anesthesia, the anesthesiologist set up the endotracheal tube electrodes prior to intubation, if IONM will use. The anesthesiologist intubated all patients, and the tube was positioned at the level of the true vocal folds oriented at 3 and 9-o'clock positions and neuro-muscular blockade was not used during induction. In the unmonitored group a standard endotracheal tube was used. The vocal cords were observed to be in contact with the endotracheal tube electrodes. All surgical procedures were performed with similar surgical technique by three experienced surgeons.

Data regarding age, gender, surgical procedures, operation time, thyroid volumes and final pathology reports were evaluated for all patients and compared between the groups. Ultrasonographic (USG) volumetric calculation is an accurate method and using the preoperative USG measurement of thyroid, an ellipsoid volumetric analysis was performed. Thyroid volume was calculated by ellipsoid formula (volume = width x height x depth x 0.479) [6]. Recurrent laryngeal palsy rates (paresis and paralysis) were compared between two groups. Statistical analysis was performed using Fisher exact test, chi-square test and Mann Whitney U test $p<0.05$ was accepted as statistically significant.

Results

The mean age was 48 (27-76) in M group and 52 (73-17) in UM. Male female ratio was 8/40 in M group vs. 12/ 34 in UM group. Thyroid volumes, type of surgeries, and final pathology diagnosis were similar in both groups (Table I). Fifteen patients (16%) had no fine needle aspiration cytology preoperatively because of patient, physician, or technique related reasons.

Documentation of type of surgeries were; 35 bilateral total thyroidectomy, 2 unilateral lobectomy, contralateral subtotal thyroidectomy, 3 completion thyroidectomy, 4 unilateral lobectomy, 2 bilateral total thyroidectomy plus parathyroidectomy in UM group; 17 bilateral total thyroidectomy, 17 near total thyroidectomy, 3 unilateral lobectomy, contralateral subtotal thyroidectomy, 5 completion of thyroidectomy, 6 unilateral lobectomy in M group ($p>0.05$). Final pathology reports were 9 papillary, 2 medullary, 1 anaplastic, 1 hurtle cell, 1 epidermoid cancer, 29 nodular colloidal goiter, 3 thyroiditis in UM group; 9 papillary, 2 follicular cancer, 8 lymphocytic thyroiditis, 29 nodular colloidal goiter in M group (x^2: 0.409, $p>0.05$).

No patients experienced a complication from the intubation of either type of tube. There was only one patient had transient hoarseness in M group. Also one patient had transient hoarseness in UM group. One each in both groups had persistent hoarseness. No patients experienced airway problem in both groups. In comparing the overall injury rates (paresis and paralysis), we found no statistically significant difference between two groups ($p>0.05$). Operation time was 107 minutes in M group and was significantly shorter than UM group ($p<0.001$).

Discussion

The routine identification of nerves during thyroid surgery has been suggested and has significantly reduced the RLN palsy rate. Many techniques have been described to reduce the risk of nerve injury.

Intraoperative identification of the nerve has been shown to decrease the risk of postoperative nerve dysfunction [7-9]. Hermann et al. suggested that recurrent nerve dissection significantly reduces the risk of RLN injury and showed that RLN injury rate decreased from 1.1% to 0.4% when they

Table I - *Data regarding age, gender, surgical procedures, operation time, thyroid volumes and final pathology reports of the groups.*

	M **n= 48(%)**	**UM** **n= 46(%)**	
Age (mean, year)(range)	48(27-76)	52 (17-73)	
Gender (Male/Female)	8/40	12/34	
Thyroid volumes	48±7	39±5	X^2:1,49, p>0.05
Preoperatif FNAC diagnosis	41(85)	38(83)	
Type of Surgery			
Total Thyroidectomy	34(71)	37(80)	X^2:0.275, p>0.05
Bilateral Total Thyroidectoy	17(35.4)	35(76)	
Bilateral total thyroidectomy&parathyroidectomy	–	2(4)	
Near- total Thyroidectomy	17(35.4)	–	
Unilateral Lobectomy	6(12.5)	4(9)	X^2:0.74, p>0.05
Unilateral Lobectomy& Contralateral subtotal Thyroidectomy	3(6.25)	2(4)	X^2:1.00, p>0.05
Completion of Thyroidectomy	5(14)	3(7)	X^2:0.715, p>0.05
Final Pathology Reports			
Malignancy n (%)	11(23)	14(30)	X^2:0409, p>0.05
Papillary carcinoma	9	9	
Follicular carcinoma	2	2	
Medullary carcinoma	–	1	
Anaplastic carcinoma	–	1	
Hurtle cell carcinoma	–	1	
Epidermoid carcinoma			
Benign pathology n(%)	37(77)	32(70)	X^2:0,72, p>0.05
Nodular colloidal goiter	29	29	
Thyroiditis	**8**	**3**	
Operation Time (mean±SD)	107±5	158±8	*P<0.001

M: Monitored group; UM: Unmonitored; group SD: Standard deviation; *Mann-Whitney U test.

visualized the nerve [9]. Recently, intraoperative nerve monitoring (IONM) has gained significant interest during thyroid surgery [4]. The nerve position can be confirmed by direct stimulation to differentiate it from surrounding vasculature or fibrous attachment. Prior studies have reported on the benefit of continuous RLN monitoring as well [7]. Whether its use truly reduces the risk of RLN injury is still controversial. In a large retrospective study, Shindo and Chheda et al. reported that there was a modest reduction in postoperative RLN palsy in monitored group but this difference was not statistically significant [7]. Friedrich et al. reported a prospective study to compare the rates of RLN palsy in monitored and unmonitored groups, and they found the rate of transient RLN palsy in 10.7% of the monitored group compared with a rate in 9.6% of the unmonitored group. In terms of permanent vocal cord palsy, a 1.8% reduction was seen in the monitored group compared with a 3% reduction in unmonitored group in 3.0%, but this result was not statistically significant [10]. On the other hand, Duclos et al. found recurrent laryngeal nerve palsy 7.6% in IONM group and 4.7% in unmonitored group. They explained that the cases of infiltrating carcinoma were not excluded in their study; the case distribution in IONM group and unmonitored group was not equal; completion thyroidectomy 8.4% vs. 2.8% and thyroidectomy with lymph node dissection in 9.1% vs. 3.8%, respectively [11]. The multi-institutional prospective randomized study in 2004 published by Dralle et al. showed that only for surgeons with lesser number of surgical volumes decreased the risk of RLN paralysis from 1.4% to 0.9% with RLN monitoring [8]. Surgeries performed by the high-volume experienced thyroid surgeon who is completely familiar with thyroid and recurrent laryngeal nerve (RLN) anatomy have very low risk for complication [8,12]. In present study the case distribution in IONM group and unmonitored group was similar and there was no difference between M and UM group, in term of nerve related complications. Although, it was a prospective study and the same surgeons performed the surgeries in the same manner, lesser number of patients is the limitation of this study and only one voice problem of each group was not enough to compare the groups. The considerable result of this study is to show the advantages of using monitor in terms of assistance to surgeon with decreased operation time that was not addressed in previous studies.

Even though IONM provides comfort during thyroid surgery with a challenging anatomy, identification, dissection, and control of recurrent laryngeal nerves during surgery, a false sense of security of its use should be considered [1,8,13-16].
Use of a nerve monitoring system cannot be an alternative of careful dissection and visual identification of nerves. It should always be remembered that RLN monitoring does not make an unsafe surgeon a safe surgeon as Angelos has emphasized briefly in his article [4].

Conclusion

With the guidance of the literature, anatomical RLN integrity by monitoring is currently suggested monitoring may be considered as an assisting tool for the surgeon in identifying the RLN anatomic variability and may effect to decrease the operation time during thyroid surgery.

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Riassunto

PREMESSA: La lesione nervosa è una delle complicanze specifiche della chirurgia della tiroide, nonostante molti progressi nella tecnica chirurgica. Il nervo laringeo ricorrente (RLN) e il ramo esterno del nervo laringeo superiore sono quelli a rischio nella chirurgia della tiroide [1]. La morbilità relativa a lesioni del nervo laringeo ricorrente varia da cambiamenti nella qualità della voce alla dispnea grave che richiede l'intubazione tracheale o la tracheostomia. Per ridurre al minimo il rischio di lesioni nervose, il monitoraggio intraoperatorio del nervo (IONM) introdotto quale mezzo strumentale per aiutare la ricerca ed il controllo visivo per ul nervo ricorrente ha acquisito un notevole interesse negli ultimi anni [1,2]. Questo studio è stato condotto con l'obiettivo di determinare l'efficacia del controllo del nervo durante l'intervento chirurgico alla tiroide e per fornire la nostra esperienza clinica.
MATERIALI E METODI: Lo studio è stato eseguito da giugno 2010 a giugno 2012, valutando prospetticamente 94 pazienti sottoposti ad un intervento chirurgico alla tiroide, con o senza il controllo dei nervi: 48 di questi pazienti sono stati monitorati (gruppo M) e 46 sono stati operati senza monitoraggio (um).
RISULTATI: L'età media dei pazienti era di 48 anni (27-76) nel gruppo M e 52 anni (73-17) nel gruppo UM. Un solo paziente è andato incontro a raucedine transitoria nel gruppo M, ed anche un paziente ha sofferto di raucedine transitoria nel gruppo UM.
Un paziente in entrambi i gruppi è andato incontro ad una persistenza di raucedine. Nessun paziente ha avuto un problema delle vie aeree. La durata dell'intervento è stata significativamente più breve nel gruppo M (p <0,001).
CONCLUSIONI: L'uso di un sistema di controllo nervoso non sostituisce la necessità di una dissezione attenta e l'identificazione visiva dei nervi, ma il monitoraggio può aiutare il chirurgo a identificare la variabilità anatomica RLN e può ridurre il tempo dell'intervento chirurgico sulla tiroide.

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