International Journal of Surgery 35 (2016) 172–178

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Importance of latency and amplitude values of recurrent laryngeal nerve during thyroidectomy in diabetic patients

Ibrahim Ali Ozemir [a,*], Ferman Ozyalvac [a], Gorkem Yildiz [a], Tunc Eren [a], Zeynep Aydin-Ozemir [b], Orhan Alimoglu [a]

[a] Istanbul Medeniyet University, Goztepe Training & Research Hospital, Department of General Surgery, Istanbul, Turkey
[b] Istanbul University, Istanbul Faculty of Medicine, Department of Neurology, Istanbul, Turkey

HIGHLIGHTS

- Diabetic patients have prolonged post-thyroidectomy latency values than non-diabetic patients.
- Diabetic patients have decreased post-thyroidectomy amplitude values than non-diabetic patients.
- Increased post-thyroidectomy latency values detected in diabetic patients compared to pre-thyroidectomy latecies.
- Recurrent nerve in diabetic patients is more sensitive to the surgical trauma than non-diabetics.

ARTICLE INFO

Article history:
Received 24 June 2016
Received in revised form
23 September 2016
Accepted 3 October 2016
Available online 5 October 2016

Keywords:
Latency
Amplitude
Recurrent laryngeal nerve
Diabetes mellitus

ABSTRACT

Background: Diabetes mellitus may cause degeneration in the myelin and/or axonal structures of peripheral nerves. The aim of this study was to investigate the effects of diabetic neuropathy on intraoperative neuromonitoring findings such as latency and amplitude values of the recurrent laryngeal nerves during thyroidectomy. To our knowledge this is the first study to report comparison of the electrophysiologic features of diabetic and non-diabetic patients.
Materials and methods: One-hundred-and-eleven consecutive patients who received neuromonitoring during thyroidectomy between 2013 and 2015 were included to study. The patients were divided into two groups according to the presence of diabetes mellitus. Pre-thyroidectomy and post thyroidectomy motor response latency and amplitude values of recurrent laryngeal nerves were compared between groups. Neuromonitoring findings, demographic data and postoperative complications were evaluated.
Results: The diabetic group consisted of 29 (26.1%) patients while 82 (73.9%) patients were in non-diabetic group. The mean post-thyroidectomy amplitude values (millivolts-mV) of the recurrent laryngeal nerve were significantly lower in diabetic group (0.51 ± 0.26 mV vs. 0,70 ± 0,46 mV, $p < 0.05$), whereas the latency values were significantly higher (2.50 ± 0.86 ms vs. 1.85 ± 0.59 ms, $p < 0.01$) compared to non-diabetic group. Additionally, post-thyroidectomy latency values were significantly increased compared to the pre-thyroidectomy latency values (2.50 ± 0.86 ms vs. 2.02 ± 0.43 ms) in diabetic group patients ($p < 0.05$). Although postoperative complication rates were higher in diabetic group (10.3% vs. 5.9%), there were no statistical significance differences.
Conclusions: Prolonged latency and decreased amplitude values in recurrent laryngeal nerves of diabetic patients show that diabetic neuropathy of the recurrent laryngeal nerves develop similarly to the peripheral nerves. Increased post-thyroidectomy latency values reveal that the recurrent laryngeal nerve is more susceptible to surgical trauma in diabetic patients.

1. Introduction

Recurrent laryngeal nerve (RLN) injury is one of the most significant complication of thyroid surgery. The incidence of RLN injury during thyroid surgery ranges from 0.3 to 18.9% [1]. Visual

* Corresponding author. Istanbul Medeniyet University Goztepe Training & Research Hospital, Department of General Surgery, Dr. Erkin Street, 34660, Goztepe, Kadikoy, Istanbul, Turkey.
E-mail address: draliozemir@hotmail.com (I.A. Ozemir).

http://dx.doi.org/10.1016/j.ijsu.2016.10.001

identification of the RLN is one of the most important factor that provide the nerve preservation. Absence of the visual identification of the RLN is correlated with an increased rate of RLN paralysis [2–4]. Intraoperative nerve monitoring (IONM) technology was first reported by Shedd and Durham in 1965 [5]. IONM might allow rapid identification and intraoperative assessment the function of RLN [6]. It also ensures the prescience of postoperative vocal cord function and avoid the bilateral RLN injury. Although it is a controversial topic, some authors reported that neuromonitoring significantly reduces the risk of transient RLN paralysis [7–11]. Positive stimulation of the RLN during surgery accompanied by postoperative vocal cord paralysis suggests that it will be transient [12,13]. There are increased number of publications in the literature about the usage of IONM as an adjunct to visual nerve identification during thyroid surgery. It estimates of 53% among general surgeons and up to 65% among otolaryngologists use IONM during thyroidectomy [14,15]. Despite this increased usage of IONM, reports of normative electrophysiological data are limited in the literature [4,10,16,17].

It is known that neural degeneration may be occur in the myelin and axonal structures of peripheral nerves in the presence of diabetes mellitus (DM). Overall, two-thirds of diabetic patients have objective evidence for some variety of neuropathy, but only about 20% have symptoms [18]. This disease can affect both the central and the peripheral somatic and autonomic nervous system structures, presenting with various clinical manifestations. The etiology of diabetic sensorimotor peripheral neuropathy is multifactorial [19]. In diabetic neuropathy, a symmetrical polyneuropathy is usually detected starting from the distal nerve fibers, affecting sensory, motor and autonomic fibers and causing axonal type degeneration [18]. In the electrophysiological conduction studies, decrease in amplitudes, decrease in conduction speed and elongation in latencies can be seen in sensory and motor nerves of diabetic patients with neuropathy, associated with the type of fibre and the intensity of damage [20,21]. Nerve degeneration increases and the regeneration ability decreases in diabetic patients [18].

In addition to factors that cause direct nerve damages including cutting or knotting, injury associated with thermal device usage, operative trauma and the traction of the nerve also have a role in the development of vocal cord paralysis in postoperative period. It is unknown whether pre-existent diabetic neuropathy is a facilitating factor or not, for RLN injury during thyroidectomy in diabetic patients. The aim of this study was to determine the RLN motor amplitude and latency values in the patient with DM. And investigate the alteration of post-thyroidectomy motor amplitude and latency values in diabetic patients whether is it more affected from the surgical trauma than non-diabetic patients or not.

2. Methods

2.1. Patient selection

This prospective study has been approved by the Istanbul Medeniyet University ethical committee, and informed consent was obtained from all participants. Two-hundred and seventy-three patients underwent thyroidectomy for various reasons, and 111 patients who received IONM included to the study between June 2013 and March 2015. Unilateral thyroidectomy was performed on 17 (15.3%) of these patients while 94 (84.7%) received bilateral thyroidectomy. In total, 205 RLNs were stimulated pre- and post-thyroidectomy with bipolar probe and RLN motor amplitude and latency values were recorded.

2.2. Evaluation of the patients

Demographic data including age and gender of the patients, preoperative diagnosis, the presence of DM according to criteria of American Diabetes Association [22], the presence of concomitant diseases, laboratory findings (serum thyroxine (T4), triiodothyronine (T3), thyroid stimulating hormone (TSH) and fasting blood glucose), fine-needle aspiration biopsy (FNAB) results, the type of operation performed, the presence of complications, and hospitalization duration were recorded prospectively.

2.3. Surgery

All patients are operated by experienced endocrine surgeons. In terms of the standardization of the data, same protocols for inhaler and muscle relaxants were applied to the patients. Succinyl choline at a dose of 2–2.5 mg/kg or a small dose of a nondepolarizing muscle relaxant (0.5 mg/kg of rocuronium and atracurium) were used at intubation to allow for normal return of spontaneous respiration and resumption of normal muscle twitch activities within several minutes [23–26]. Muscle relaxants were not administered during thyroidectomy. Following the Kocher's incision, cervical layers dissected. After entering the thyroid region, vena thyroidea media was located, ligated and cut. Superior thyroid artery was revealed, ligated and separated with energy device. After the upper pole of the thyroid was liberated, the Simon's triangle was located and RLN was found in the trachea-oesophageal groove about the level of second tracheal ring. RLN was stimulated with a bipolar probe from the first point it was visualized after drying the surgical site. Afterward, amplitude and latency values were recorded from the electromyogram (EMG) data. Inferior thyroid artery and veins at the lower pole were ligated and cut. RLN was separated from the surrounding fatty tissue and followed until the Berry ligament, via bipolar cautery in order to reduce nerve damage. Thyroidectomy was completed after ligation and cutting the Berry ligament. RLN was re-stimulated from the first stimulated point and the post-thyroidectomy latency and amplitude values were recorded.

2.4. Intraoperative neuromonitoring

IONM was applied according to a strict study protocol applying a standardized set up using the noninvasive endotracheal tube surface electrodes and using the Avalanche® (XT, Dr. Langer Medical GmbH) with a bipolar electrode that stimulates with 3-Hz pulses at 1 mA. It is reported that bipolar probes are less exposed to current spread, therefore enabling a superior discrimination of structures within the surgical field [27]. This system records EMG activity and monitors the thyroarytenoid laryngeal muscle that is innervated by the recurrent laryngeal nerve with EMG depiction, visible on a monitor and additional audio feedback.

The compound muscle action potential (CMAP) in the vocal muscle was recorded before and after the resection of each sides of the thyroid gland. Alert is transmitted along the nerve, exceeds the neuromuscular junction, and reach the muscle fibers lead to movement in the vocal cords. The typically biphasic waveform represents the CMAP of the ipsilateral vocal cord muscle (Fig. 1). "*Latency*" is dimensioned in millisecond (ms) and defined as process between the stimulation artefact spike and onset of the initial response, defined by either negative or positive deflection from the baseline (shown as "X" in Fig. 1). The latency defines the time it takes the action potential to travel from the stimulation site to the recording site and depends mainly on the conduction time in the peripheral axons. If demyelination affects the majority of the nerve fibers more or less equally without a conduction block, stimulation