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Original Article

Topographical Anatomy of External Branch of Superior Laryngeal Nerve as Related to thyroidectomy

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ABSTRACT

Background: *The External branch of superior laryngeal nerve is intimately associated with the superior thyroid artery, and is vulnerable to injury during thyroidectomy. EBSLN supplies the cricothyroid muscle which is the tensor of vocal cord. Injury to this nerve can have catastrophic consequences in people who use their voice professionally. Variations of EBSLN anatomy make its intra operative assessment challenging.*

Aim: *To describe the anatomic variations of the external branch of superior laryngeal nerve observed during thyroidectomy.*

Methods: *Patients who underwent thyroidectomy from 2010 to 2016 at a tertiary care centre in North Malabar were included. Intra operatively the EBSLN was identified and the topographic anatomy in relation to the superior thyroid pedicle and upper pole of the thyroid gland were noted.*

Results: *Total 406 thyroidectomy were analysed,. The nerve could be identified in 94.7% cases. Type IIa nerve was most commonly seen, and type IIb was the least. Fourth type nerve was not identified.*

Conclusion: *Preservation of EBSLN is important in every thyroid surgery. During surgery the risk of nerve injury do exist, although injury rates are not clearly established. Type IIa variant of EBSLN is the commonest followed by type I. With careful medial dissection and lateralisation in Jolls triangle, EBSLN is easly identified. Identification and ligation of individual vessels in the superior pole in a bloodless back ground will prevent damage to the nerve. Surgeons should show greater awareness regarding the anatomical interpretation of EBSLN and its branches to reduce the incidence of iatrogenic nerve injury.*

Keywords: *External branch of superior laryngeal nerve, Cricothyroid muscle, Joll's triangle, Cernea classification, Laryngeal nerves, Thyroidectomy. Kierner's classification.*

INTRODUCTION

Thyroidectomy is a common general surgical procedure which has enjoyed a relatively colourful history, advocated for the treatment of a wide variety of disorders of thyroid including Grave's disease, multi nodular goitre and malignancy. The major concern in thyroidectomy is morbidity due to injuries to the anatomical structures close by. The three important structures to be preserved in any thyroidectomy are namely the external branch of superior laryngeal nerve [EBSLN], the recurrent laryngeal nerve [RLN] and the parathyroid gland[PT] [1]. A quantum of work has been done to document the anatomy and preservation of RLN [2]. The EBSLN is intimately associated with the superior thyroid artery [STA] at the superior pole of the thyroid gland, where it is vulnerable to injury while the superior pedicle is tackled [3]. There are only a few studies depicting the relation of EBSLN with the superior pole of the thyroid gland. The EBSLN arises together with an internal branch from the superior laryngeal nerve [SLN], which is one of the uppermost branches of the vagus nerve. The EBSLN first descends dorso laterally to the carotid artery, crosses them, and finally passes to the larynx close to the STA, always lying closely with it. The topographical relationship to the STA and the superior thyroid pole represent the key point for EBSLN identification and protection of it during surgery. EBSLN gives of some twigs to pharyngeal plexus and inferior pharyngeal constrictors, it terminates within the cricothyroid muscle[CTM]. It also innervates the cricothyroid joint and also mucus lining inside cricothyroid membrane. EBSLN injury can have catastrophic conseq-uences in people who use their voice professionally. The clinical signs of EBSLN injury include hoarsness, decreased voice projection, decreased pitch range, and voice fatigue [4]. The anatomic variations of EBSLN make its intra operative assessment challenging. Variations of EBSLN with respect to their anatomical landmarks are observed during thyroidectomy. This along with meagre rates of EBSLN identification have discouraged thyroid surgeons from routine exploration and identification of it. Studies reports intra op EBSLN identification to a tune of 10-80% [5]. Contrary to the surgical principle of preservation of critical structures through identification, every day the modern thyroid surgeons still avoid exploration of the EBSLN.

AIM

To describe the anatomic variations of the external branch of superior laryngeal nerve as observed during thyroidectomy.

MATERIAL AND METHODS

All patients who underwent thyroidectomy from 2010 to 2016 for various indications in a single surgical unit at a tertiary care centre in North Malabar were included in this study after an informed consent. Intra operatively the EBSLN was identified and the topographic anatomy in relation to the superior thyroid pedicle and upper pole of the thyroid gland were noted. Patients with prior neck irradiation, previous laryngeal or thyroid surgeries or any other cervical exploration were excluded from the study. The procedure was standardised to avoid operational bias. Surgeries were performed by a senior surgeon following a previously described approach in all cases. In total thyroidectomy, each side of the gland was considered as a separate unit. Thyroid was approached via the neck crease incision. Flaps were raised, cervical fascia incised and the strap muscle were separated in the midline. The sternohyoid was elevated laterally up to the hyoid bone to allow visualisation of sternothyroid (ST) insertion to the oblique line of thyroid cartilage. It was retracted laterally until the lateral edge of the thyroid gland was reached.

The thyroid lobe was delivered out after division of middle thyroid vein. The medial 1cm of the ST was detached to visualise the inferior constrictor cricothyroid junction and the structures in the superior pole. With the grasping forceps the superior pole was pulled laterally, which is termed lateralisation. The dissection starts at the superior pole of the thyroid which is termed medial dissection. The crossing point of the type IIB nerve is within 1 cm of the upper pole of the thyroid gland. Hence this nerve is always at risk during the dissection at the apex of the joll's triangle. The EBSLN was identified there, and classified as per Cernea et al. The superior thyroid vessels were ligated and divided.

RESULTS

Total 406 thyroidectomy were analysed, done in 127 males (31.28%) and 279 females (68.72%). Indications for surgery were solitary nodule thyroid (63), multinodular goitre(204), papilary carcinoma thyroid(44), follicular carcinoma (12) and thyrotoxicosis (51). There were 343 total thyroidectomy and 63 hemithyroidectomy. Out of the expected 749 EBSLN we could identify 710 nerves(94.7%). On the right side, type 1 was 120, IIa 246, and II B was 12. On the left type I was 113, IIa 213, and type II b 06. [Fig 1,2,3]. Totally there was 32.8% type I, 64.64% type IIa, and 2.53 % type IIb.

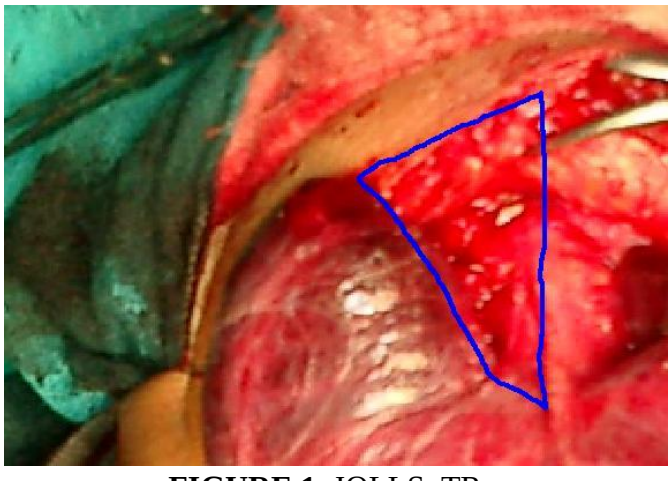

FIGURE 1. JOLLS TR

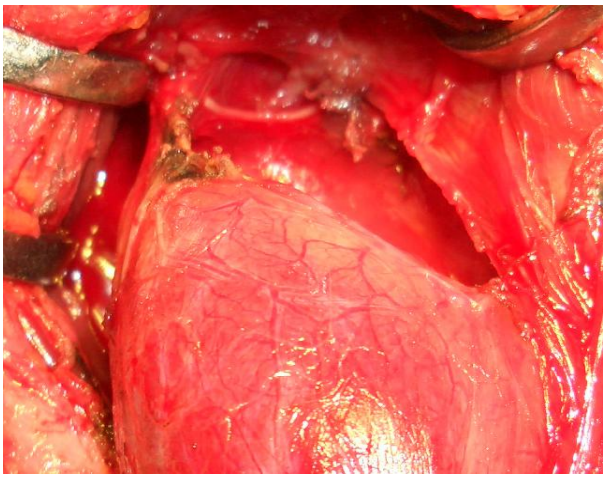

FIGURE 2. TYPE 1 EBSLN

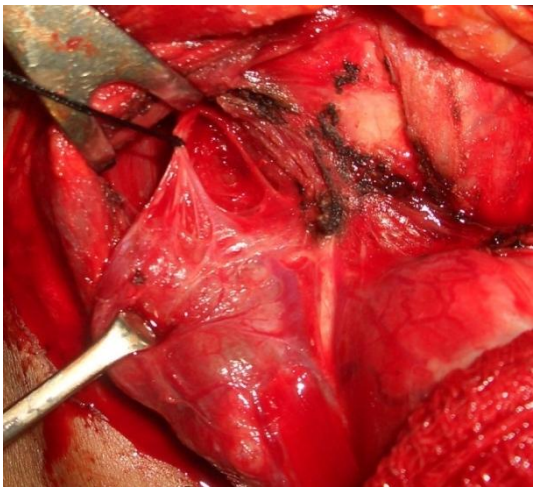

FIGURE 3.TYPE IIA EBSLN

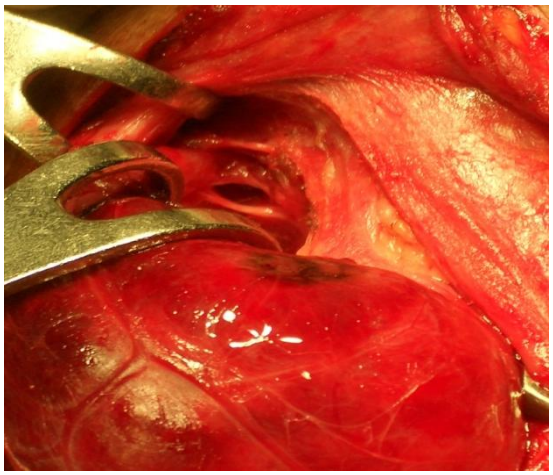

FIGURE 4. TYPE II B EBSLN

DISCUSSION

EBSLN has received much less attention and emphasis during thyroidectomy [6]. It was described as the "neglected nerve" in thyroidectomy by Lennquist et al [7]. The most famous person to sustain injury to EBSLN

during thyroidectomy was Amelita Galli - Cursi, the great operah singer [8].

Postoperatively her voice became hoarse, which prompted the critics to write " the amazing voice gone, perhaps forever'. Later it was clarified that Galli-Curci suffered from a physiological decline of her performances due to the normal aging process. The principles of head and neck surgery are based on the identification and preservation as opposed to avoidance of critical structures. These would straight away set identification and preservation of EBSLN as a standard step during thyroidectomy. The nerve is always at risk, and morbidity of this is very high. Inspite of all these, EBSLN is not routinely identified and preserved during thyroidectomy. Many studies have stated about the apparent inconsistency of the nerve during surgery as the cause of non identification of it [9]. Surgical anatomy of EBSLN shows that it originates from the nodose ganglion and it receives branches from superior cervical sympathetic ganglion [10]. It descends posteriorly and then medially to the internal carotid artery [ICA], where it divides into an internal(sensory and autonomic) and an external (motor) branch [11]. The internal branch pierces the thyrohyoid membrane with the superior laryngeal artery, and divides into an upper and lower branch. The EBSLN passes inferiorly, over the inferior constrictor (IC) and pierces it to reach the cricothyroid muscle [12]. The EBSLN is identified in the Joll's triangle [13] (FIG 1). It is bounded laterally by upper pole of thyroid gland and the vessels, superiorly the attachment of the strap muscles and investing layer of deep cervical fascia to hyoid and medially by the midline. The floor is formed by the CTM. The EBSLN lies within this triangle. It is the only motor innervation of the CTM that serves as the tensor of the vocal cord[14]. Unilateral EBSLN injury may result in mild voice huskiness, it is the bilateral injury which is more devastating. Temporary or permanent paralysis of CTM results in deterioration of quality of one's voice and or weakness, huskiness, decreased pitch, voice fatigue, inability to produce certain sounds [15]. Variability of the position of EBSLN was classified by Cernea et al as type 1, 2a or 2b [16]. This was intended to help the thyroid surgeon for easy identification of the nerve. Type 1 nerve crosses the superior thyroid vessels 1 or more cm superior to the thyroid apex, in type 2a it crosses the vessel less than 1cm superior to the apex of the superior thyroid pole, and in type 2b the nerve is inferior to the apex of the thyroid upper pole. Kierner et al did cadaveric studies and described about its variations [17]. The type 2b is more injury prone, whereas type 1 is the least. The type 2b variants are increased in case of superior displacement of the upper pole of thyroid [18]. When the surgeon is ligating the superior pedicle without identifying EBSLN, it cannot be assumed that it will be a high crossing variant and therefore is not at risk. . In a study from University hospital Vienna, four types of EBSLN were found. Type 1,2 & 3 corresponds to type 1, 2a, 2b as described by Cernea et al. Type 4 refers to the EBSLN that does not cross the trunk of STA at all, but runs dorsal to it until it has ramified. Micheal Friedman et al focused on to the anatomy of EBSLN and its insertion into the CTM [19]. Terminal branches penetrate the horizontal and oblique bellies of CTM as well as the IC. Three variations has been described by him, type 1 it runs its whole course superficially or laterally to the inferior constrictor, down with the STA to the CTM. In type 2 the nerve penetrates the lower portion of the inferior constrictor. Type 3 passes underneath the superior most fibres of the IC and remain under cover of the CTM. Lennquist in his anatomical studies has described the relation of EBSLN with CTM [20]. Individual methods like skeleton-sation and ligation of STA adjacent to the

capsule, prior identification of the nerve before ligation of STA, use of nerve stimulator or intra operative neuro imaging has been used. The incidence of nerve injury varies from 0.9-58% in Jansonn's series. Bellantone et al and Page et al has questioned routine identification of EBSLN during thyroidectomy.

The EBSLN is intimately associated with the STA in close relation to the superior pole of thyroid gland, thus rendering it vulnerable to injury during surgery. It may be subjected to traction or transaction when superior thyroid vessels are divided. Meticulous dissection and individual ligation of superior thyroid vessels will be safest technique to avoid EBSLN injury. The sequel of nerve injury is trivial unless the patient is a professional singer or speaker. Antonius. C. Kierner in his 31 cadaveric studies found four types of EBSLN. 42% was type I, 30% type IIA, 14% type IIb, and 14% type IV. Dr. Claudio R. Cernea based on cadaveric analysis of 30 superior poles described a new classification of EBSLN, 65% was type I, 20% type IIa, and 15% type IIb. Study by Mishra Anand kumar et al, the EBSLN was identified in 92.31%. There were 36.2% type I, 53.54% type IIa, and 10.25% type IIb. In our study the EBSLN was identified by a standardised approach. The nerve can be identified in the Jolls triangle. The nerve could be identified in 94.7% cases. Type IIa nerve was most commonly seen, and type IIb was the least. Fourth type nerve was not identified. The identification rate was at par with other study groups. The most common type of EBSLN in Indian population seems to be type IIa as per our study and the one by Mishra Anand kumar et al even though Pradeep et al differs with that showing that variations in EBSLN anatomy is possible in patients located within the same geographical area.

CONCLUSION

Preservation of EBSLN is important in every thyroid surgery for optimal function of larynx. The nerve is at risk during surgery, although injury rates are not clearly established they do exist. Type IIa variant of EBSLN is the commonest followed by type I. With careful medial dissection and lateralisation in Jolls triangle, EBSLN is easly identified. Identification and ligation of individual vessels in the superior pole in a bloodless back ground will prevent damage to the nerve. Surgeons should show greater awareness regarding the anatomical interpret-ation of EBSLN and its branches to reduce the incidence of iatrogenic nerve injury.

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The authors declare that there are no conflicts of interest

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