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SURGICAL ANATOMY OF RECURRENT LARYNGEAL NERVE DURING THYROID AND LARYNGEAL SURGERIES

Objective:
To determine the anatomic relationship of recurrent laryngeal nerve with inferior thyroid artery, tracheo-oesophageal groove and Berry's ligament and to determine the thickness and terminal branching pattern of recurrent laryngeal nerve.

Material and Methods:
Descriptive prospetive study was conducted in the department of Otorhinolaryngology and Head and Neck surgery in BPKIHS, Dharan, between July 2008- June 2009 including all patients undergoing thyroidectomy and total laryngectomy during the study period.

Result:
RLN frequently passed behind the inferior thyroid artery and occupied the tracheo-oesophageal groove in the left side than on the right. The average diameter of the nerve was 1.88 mm and the nerve commonly terminated as a single trunk.

Conclusion : The nerves were commonly found deep to the ITA (96.2% on left side and 88% on right). The segment of RLN vulnerable to surgical injury between the crossing point of ITA to its entry in the larynx was found to be 3.13 cm (SD=0.29cm). The average thickness of the nerve was 1.68mm however the thickness increased as the surgery progressed and at the end of surgery. All the RLNs on the left side were found completely within the TOG while some variations were seen on the right side.

Key words: Recurrent Laryngeal Nerve, Thyroidectomy

INTRODUCTION:

A correct knowledge of variations in regional neurovascular anatomy is essential for preventing complications during surgery in neck. The most important anatomic structures during thyroidectomy include the arteries and veins of thyroid gland, the position of the parathyroid glands and the position of the laryngeal nerves. Recurrent Laryngeal Nerve (RLN) is a branch of vagus nerve. The right RLN arises from the vagus nerve in the superior part of the thorax crosses the under-surface of the right subclavian artery and ascends in the neck and the left RLN hooks around the arch of aorta and ascends more vertically in the neck before reaching its point of penetration in the larynx. RLN palsy is a serious iatrogenic complication of the thyroid surgery which can cause hoarseness and breathing difficulties. Moreover, this palsy can be responsible for major psychological and social disturbance for the patients. The route of the RLN is not always consistent but it must be identified and dissected completely in the thyroid region during the surgery, in order to preserve it from iatrogenic injury.[1] The reported incidence of vocal cord paralysis has fallen over the last several decades due to improved experience of surgeons and better knowledge of anatomical details of the RLN. Still the incidence of postoperative vocal cord paresis or paralysis in recent large series is reported up to 5% for temporary and 0.5% for permanent paralysis.[2] Identification of the RLN early during thyroid surgery is important so as to avoid its inadvertent injury. This study was conducted with the objective of identifying the variations in RLN and its relation to the surrounding structures in patients undergoing thyroid and the laryngeal surgeries as this is the key in avoiding iatrogenic RLN injuries.

MATERIALS AND METHODS:

This is a descriptive prospective study conducted in the department of Otorhinolaryngology and Head and Neck surgery in BPKIHS, Dharan, between July 2008- June 2009. All patients undergoing thyroidectomy and total laryngectomy were included where the RLN could be traced to the extent technically possible by operating surgeon without jeopardizing the nerve and the intra-operative observations were noted. For measuring the thickness of the nerve it was compared with the thickness of electrical copper wire ranging in thickness from 10 to 20 gauges and its exact diameter was measured in mm with micrometer screw gauge. Prior ethical clearance was obtained from the institute's ethical committee. All photographic records were taken by Cannon Power Shot A620 7.1 mega pixels digital camera from an angle of about 45° to the body and a distance of 15 cm without using any zoom. Analysis of the data was done using appropriate statistical method (SPSS 14 for windows).

RESULTS:

A total of fifty-two RLNs were studied in 39 patients between the ages of 36-45 years. Out of 52 RLNs, 43 of the nerves were from females and 9 from male patients. Among the studied nerves, 27 (52%) were of the left and 25(48%) of the right side. In twelve patients RLN were studied on both sides, while in others only one of the RLN was studied. The commonest surgery in which the RLNs were studied was hemithyroidectomy, wherein 28 nerves were studied. On the right side, 88% were found passing behind the branches of the ITA and 12% between the branches of the ITA while on the left side 96.2% of the nerves passed behind the ITA and 3.8% between the branches of the ITA. No nerves were found passing superficial to the artery. The length of the most vulnerable segment of the RLN between crossing of the nerve with the inferior thyroid artery to the entry point of the RLN into the larynx just behind the cricothyroid joint is shown in fig 1.The average length was 3.13 cm (SD= 0.29cm). The variation in length between the two sides was 0.04cm which was statistically not significant (P value= 0.655). When the nerve was initially identified just as it crossed the inferior thyroid artery, the average thickness of the nerve was 1.68mm. The mean thickness on the right side was 1.66 mm whereas the mean thickness in the left side was 1.7 mm. This difference in thickness was statistically not significant (P=0.789). As the surgery progressed, increment in the thickness of the nerve was noted. At the end of the surgery the average thickness of the nerves

Fig: 1. Showing length of the RLNs (cm) from its point of crossing inferior thyroid artery to its entry into the larynx just behind the cricothyroid joint.

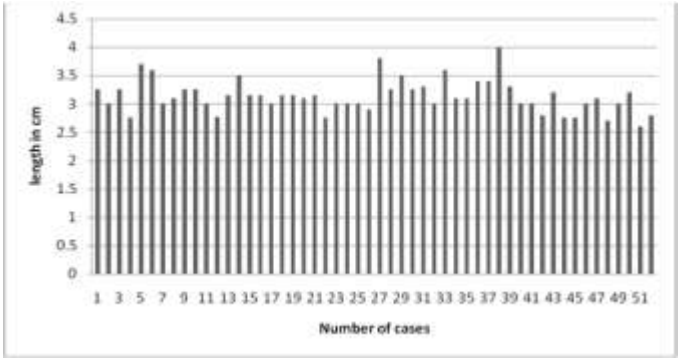
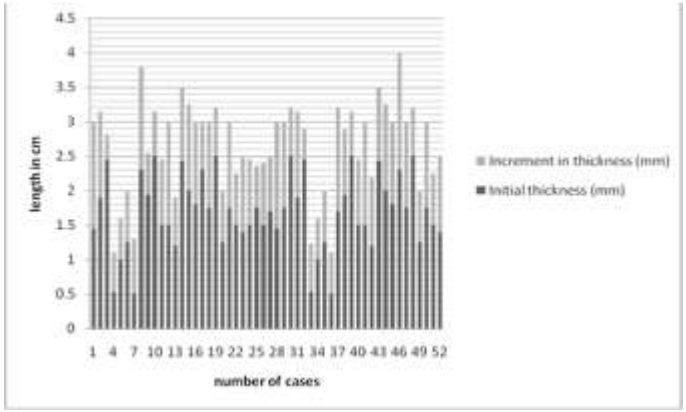


Fig: 2. Showing increment in the thickness of the nerve at the end of the surgery



was increased by 54.76% to 2.60mm as shown in fig 2. All the RLNs in the left side were found to be completely within the tracheo-oesophageal groove (TOG) while some variation was seen in the right side. Among the 25 nerves on the right side, 20(80%) were completely within the (TOG), 4(16%) were initially outside and entered into the groove higher up and 1(4%) was completely outside the groove. All the nerves passed dorsolateral to the Berry's ligament and remained close to it but it was not found to enter through the ligament. No nerves were adherent to the thyroid or passed through the thyroid. The vertical length of the ligament in midline ranged from 1.2 to 2.7 cm (n=1.66cm). Forty-seven nerves (90%) were observed passing as a single trunk into the larynx while 5 nerves (10%) bifurcated before its entry into the larynx. Four (80%) of the bifurcated nerves were on the left and 1 was on the right side. No nerves were found to be

Fig: 3. Showing a bifurcated RLN in the left side

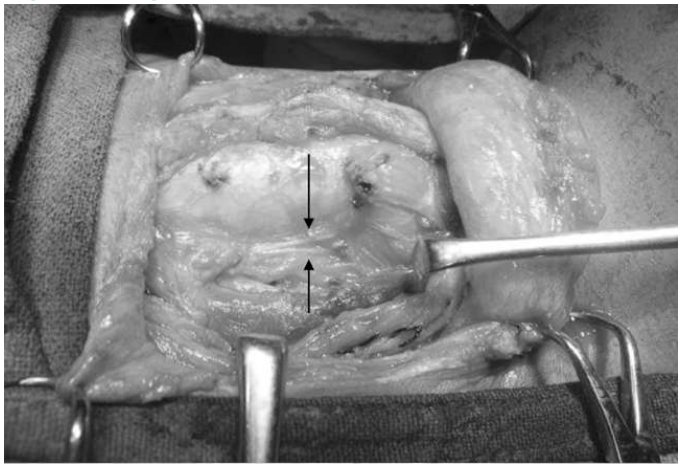
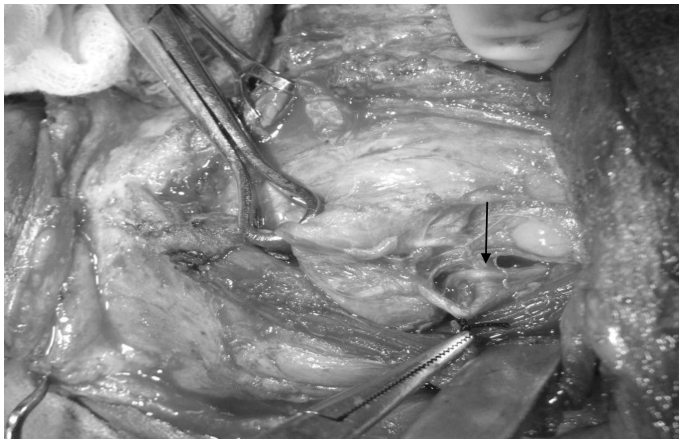


Fig: 4. Showing RLN passing between the branches of the Inferior thyroid artery



trifurcating or dividing into more than 3 branches before entering the larynx. These bifurcations occurred within the distal 2cm of the nerve. In our study the rate of RLN palsy was 0% when the RLN was identified and traced completely and no non recurrent inferior laryngeal nerve was identified.

DISCUSSIONS:

In this study, 88% of the RLNs were found passing behind the branches of the ITA and 12% passed between its branches on the right while on the left side 96.2% passed behind and 3.8% between the branches of the ITA. The study showed that the RLN usually passed behind the ITA on both the side however on rare occasions the nerve passed between the branches of ITA. Similar observation was recorded in a study done by Ardito et al[3], where 1.9% were in front of the left inferior thyroid artery; 77.4% deep to the left inferior thyroid artery, and 20.5% between the branches of the left inferior thyroid artery. In the right side, 12% laid in front of the inferior thyroid artery, 61% deep 27% between the branches of the right inferior thyroid artery. However many authors have observed wide variation in this relation in the right side with up to 67% of the nerves observed superficial to the ITA.[1] Others have reported the RLN to be more frequently between the branches of ITA. In a study done by Campos et al[4], the RLN lay more frequently between branches of the ITA. It was found in this position in 47.3% of male corpses and 42.8% of female ones. On the right, RLN was found between branches of the ITA in 49.3% of the cases, anterior to it in 38.04%, and posterior in 11.26%. On the left, the RLN lay between branches of the ITA in 44.45%, posterior to the ITA in 37.05%, and anterior to it in 18.05% of the cases. There seemed to be variation in the pattern of the relationship between the RLN and the ITA and which can be seen from the results of various studies. These variations may be genetic and could depend on the race of the patients. Our observation in male patients showed that RLN were deep to the ITA in both the sides in 100% of the cases. In females RLN was deep to the ITA in 85% and 95.65% in the right and left side respectively. As compared to males, the RLN were found more frequently superficial to the ITA in females. These findings were consistent with the study of Page et al[1] where 51% of the nerves were superficial to the artery in the right side and 95% of the nerves were deep to the artery in the left side of the male patients. In the females, 70% of the nerves were superficial to the artery in the right side and 87% were deep to the artery in the left side. In our study the average distance of the nerve from the cricoarytenoid joint to the crossing point of the ITA was observed to be 3.15 cm on the right and 3.11cm on the left side (SD 0.32cm and 0.24cm respectively). The variation in length between the two sides was 0.04cm which was statistically not significant. (P-0.655). This segment of RLN is most venerable to surgical trauma and must me dissected carefully in order to preserve it. We believe that the tumour size of the thyroid may not significantly alter this length in most as the nerve lies deeper.

Average thickness of the nerve just after its identification as it crossed the inferior thyroid artery was 1.68mm. In a study by Liebermann et al[5], where post-mortem en bloc specimens were studied by macroscopic dissection, showed RLNs to be 2 - 3mm thick compact slack cords. Comparatively our study showed thinner nerves and this could lead to difficulty in its identification during surgery. This variation in thickness of the nerve could be due to a smaller overall built of the Asian population. Our study was done during thyroid and laryngeal surgeries of live patients while the other study was done on post-mortem en block specimens which could also have been responsible for the difference. Towards the end of the surgery the thickness of the nerve was found to have increased. The mean thickness of the nerve increased to 2.6 mm which was 54.76% increase. This could be attributed to oedema of the nerve due to its handling during the surgery. In our study, among the 25 nerves on the right side 20(80%) were completely within the TOG, 4(16%) were partially outside and partially inside and 1(4%) were completely outside the groove. All the RLNs on the left side (28) were found to be completely within the TOG. In the study by Ardito et al[3], in the right side 61.4% were located in the TOG, 37.8% were located lateral to the trachea, and 0.6% anterolateral to the trachea. While on the left side 67.3% were located in the TOG, 31% were located lateral to the trachea, and 1.6% was anterolateral to the trachea. Uen et al[6] in their study found that the right and left RLNs were found in the TOG in 78.3% and 91.3% of cases, respectively. Liebermann et al[5] found the nerve passing upward within the lateral peritracheal, and less frequent periesophageal, loose connective tissue, with the left RLN being closer to the TOG than the

right. All the nerves in the study passed dorsolateral to the Berry's ligament and remained close to it but it was not found to enter through the ligament. Similar results were seen in the study by Sasou et al[7] where all nerves identified by surgery and autopsy were located latero-dorsal to the ligament of Berry. They were clearly separated, and no nerve penetrated the ligament. Cakir et al[8], in 65 adult autopsies found all the RLN to lie posterolateral to the Berry ligament. Lekacos et al[9] found that most of the RLNs were within 3 mm of Berry's ligament. However Yalçin et al[10] examined 102 sides and found that in two the anterior (motor) laryngeal branch of the RLN penetrated the ligament unilaterally. These anterior branches of the RLN can penetrate the ligament sometimes leading to its injury during the dissection of the ligament.[10] In our study 47 nerves (90%) were observed passing as a single trunk into the larynx while 5 nerves (10%) bifurcated before its entry into the larynx. No nerves were found to be trifurcating or dividing into more than 3 branches before entering the larynx. Other studies however showed bifurcation or trifurcations to be more common. In the study by Beneragama et al[12], seventy-seven (36%) nerves bifurcated or trifurcated before their entry into the larynx. Bilaterally branched RLN were observed in 14 (18%) of 77 patients undergoing a bilateral procedure. Our study showed 4 (80%) of the bifurcated nerves to be in the left sided and 1 on the right side. Similar results were seen in the study by Makay et al[11] where bifurcation of the nerve was mostly observed on the left side. However Casella et al[13] found 36 of 195 (18.5%) nerves showing extra-laryngeal branching of which 27 (25.5%) were right and 9 left sided ($p = 0.0088$). Trifurcation of the RLN was identified in two dissections (1%). Bilateral bifurcations were observed in 3 of 80 (3.7%) patients. In the present study the bifurcations occurred within the distal 2cm of the nerve. Ardito et al[3], in their study found that the distance of bifurcation from the inferior border of the cricoid cartilage ranged from 0.3 to 4.5 cm. Similarly He et al[14] found that in most cases, the recurrent laryngeal nerve diverged at 1.0-2.5 cm below the cricothyroid articulation. Unseen branches of the RLN are at risk of injury during surgery. Therefore, great care is required following presumed identification of the RLN to ensure that there are no other extra laryngeal branches.

CONCLUSIONS:

Wide variation in the anatomical relation between the RLN and its surrounding structures has been noted by many authors and this variation may depend on the race and ethnicity of the patients. This study highlights the relationship between the RLN and its surrounding structures in south Asian population. In this study fifty two RLNs were included. The relation of the RLN with the ITA was variable on both the sides. The nerves were commonly found deep to the ITA (96.2% on left side and 88% on right). The segment of RLN vulnerable to surgical injury between the crossing point of ITA to its entry in the larynx was found to be 3.13 cm (SD=0.29cm). The average thickness of the nerve was 1.68mm however the thickness increased as the surgery progressed and at the end of surgery, the average thickness increased by 54.76% to 2.60mm measured at the same point. All the RLNs on the left side were found completely within the TOG while some variations were seen on the right side. On the right side 80% of the nerves were completely within the TOG, 16% were initially outside and later entered the groove higher up and 4% were completely outside the groove. All the nerves passed dorsolateral to the Berry's ligament and remained close to it but did not pass through the ligament. No nerves were adherent to the thyroid or passed through the thyroid gland. Ninety percent of the nerves passed as a single trunk into the larynx while 10% bifurcated before their entry into the larynx. When the RLN was identified and traced till its entry into the larynx systematically, the rate of RLN palsy was 0%.

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