A CADAVERIC STUDY OF VARIABLE RELATIONSHIP BETWEEN RECURRENT LARYNGEAL NERVE AND INFERIOR THYROID ARTERY FROM THE PERSPECTIVE OF THYROIDECTOMY

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ABSTRACT

BACKGROUND
In this study, we have tried to find out a pattern of variable relationship between recurrent laryngeal nerve and inferior thyroid artery close to the lower pole of thyroid gland. The nerve is passing either in front, or behind the artery or the nerve branches may intermingle with the branches of the artery. Proper knowledge of the patterns is helpful for thyroid surgeons to avoid recurrent laryngeal nerve palsy (RLNP). As the RLN supplies all of the muscles of larynx except the cricothyroid, the RLNP leads to hoarseness of voice and if there is bilateral palsy, it may cause respiratory distress.

METHODS
25 properly embalmed cadavers of both sexes were dissected to identify 50 nerves and arteries in the tracheo-oesophageal groove. The relations are noted, and photographs are taken. Some exclusion criteria are decided before choosing the cadavers.

RESULTS
Most of the nerves (52%) are found intermingling with the arterial branches. In 28% cases, nerves are passing anterior to and in 20% cases posterior to the arteries. By plotting bar diagram and using chi square test we have seen the relationship between the nerve and the artery. There is no sexual variation, but there are variations between right and left side.

CONCLUSIONS
During thyroidectomy, before ligation of the inferior thyroid artery, it is important to explore the recurrent laryngeal nerve. Because of the variable relationship without any pattern, the surgeon must be aware of all possibilities. There may be racial differences though.

KEYWORDS
Thyroidectomy, Recurrent Laryngeal Nerve, Inferior Thyroid Artery.


BACKGROUND
Recurrent laryngeal nerve (RLN) supplies all the intrinsic muscles of larynx except the cricothyroid. Thus, it plays a vital role in respiration by sphincteric action of Rima Glottidis.\(^1\)\(^2\) More importantly synchronized movements of laryngeal muscles controlled by motor fibers of RLN produce sound of communication- the "VOICE" of a person. Most common cause of RLN palsy (RLNP) is iatrogenic and thyroidectomy remains the principal culprit, where the nerve is frequently affected during ligation of inferior thyroid artery (ITA). Presence of numerous types of anatomical variations in the course or location of the RLN in relation to the ITA makes it prone to surgical injury. RLN is a branch of the vagus nerve. Its origin and course are bilaterally different. On the right side it originates from anterior trunk of tenth cranial nerve at the level of 1\(^{st}\) part of the subclavian artery. Then it hooks below the subclavian artery only to ascend through tracheo-oesophageal (TE) groove. It terminates by supplying laryngeal muscles at the level of lower pole of lateral lobe of thyroid gland. Here it confronts with the ITA as the RLN crosses in front of, behind or between the branches of the ITA. On the left side RLN hooks the ligamentum arteriosum below arch of aorta and comes in variable relation with ITA in TE groove.\(^2\) These bilateral variations are noteworthy for the surgeons performing thyroidectomy to avoid RLNP leading to hoarseness of voice. In present study dissection was carried out in 25 cadavers in Medical College, Kolkata and rigorously observing the inclusion and exclusion criteria.

METHODS
A cross sectional study was conducted where right and left side of the neck of 25 properly embalmed donated cadavers were dissected within a span of 3 years in the Madhusudan Gupta Dissection Hall, Department of Anatomy, Medical College, Kolkata. Both male and female adult cadavers were dissected. Only fresh cadavers were chosen excluding the: a) cadavers which were already dissected, b) cadavers with scar in the neck, c) cadavers with prior neck surgery.
In supine cadavers, cervical region was extended. posterior margins of the sternocleidomastoids muscles of both sides are joined by a transverse incision at the level of upper border of thyroid cartilage. Another transverse incision was made along the clavicle through suprasternal notch. These incisions are joined by an incision along the median plane (Figure 1). Sub mandibular regions are sometimes dissected to expose more. In that case the vertical incision was extended above up to the symphysis menti and a horizontal incision was made connecting both sides of mandible along the lower border of the body of mandible. Skin was retracted along the incision line followed by retraction of superficial fascia along with platysma. Superficial neck veins and infrahyoid group of muscles are dissected. Contents of Carotid sheath were exposed by retracting sternocleidomastoid (SCM). Then in the groove between trachea and oesophagus RLN and ITA are searched and their relations noted. -Thyroid gland was kept in situ to avoid injury of the vessels and nerves.

RESULTS
Total 25 cadavers were dissected. Out of them male constituting 68% (17) and rest of 32% (8) were female. Among the total 50 specimens on both sides 14 (28%) RLNs are passing anterior to the ITA, 10 (20%) RLNs are passing posterior to the ITA and in the rest of 26 (52%) cases nerves are intermingled with the arterial branches or the nerve trunk passing between the ITA branches.

Among the 34 RLNs on the both sides of 17 male cadavers 10 (29.41%) are passing anterior to the ITA, 7 (20.59%) are posterior to the ITA and 17 (50%) are intermingled with each other or RLNs are passing within the branches of the ITA.

Among the 16 RLNs on the both sides of 8 female cadavers, 4 (25%) RLNs are passing anterior to the ITA, 3 (18.75%) are posterior to the ITA and 9 (56.25%) are either intermingled with each other or nerves are passing within the branches of the ITA. Comparing both sides of the male and female cadavers it is clearly evident that the values (percentage) are very close (Chart 1) and also not significant statistically (Table 1). So, it can be said that the relationship between the ITA and RLN does not change significantly with sex.

<table>
<thead>
<tr>
<th>Relation</th>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>Row Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>10</td>
<td>4</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Posterior</td>
<td>7</td>
<td>3</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Intermingled</td>
<td>17</td>
<td>9</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Column Totals</td>
<td>34</td>
<td>16</td>
<td>50 (Grand Total)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Relationship of RLN & ITA in Male & Female Cadavers. Chi Square Test is Applied to Determine Significance Level. It Shows the Value (χ²) 2.7429. The p-value is 0.253744. The Result is Not Significant at p < 0.05

After comparison of both sides of the 25 cadavers by plotting the values (%) in a bar diagram (Chart 1), we observed visible difference in 2 types of relations: 1) nerve passing posterior to the ITA (the % is more than double of the value on the left side than the right side) and 2) nerve passing anterior to the ITA (the % value of right side is close to the doubled value of left side). But the % of RLN & ITA intermingled with each other or nerve passing between the branches of the ITA is same on both sides- 52%.

When we are considering each cadaver separately, we found only 6 cadavers (3 males, 3 female) had same
relationship on both sides. So rest of 19 (76%) among 25 cadavers had bilateral variability (Chart 2).

**DISCUSSION**

Relation of RLN and ITA and its branches is a well exercised topic of research for a long time. Because of their variability in terms of relation make the topic relevant and the clinical importance of RLN palsy (RLNP) is also compelling the researchers. The effects of RLNP are hoarseness of voice, respiratory difficulty. Though these effects are well known, but there is controversies on how to preserve RLN. Although some authors7-10 defend the display of the RLN except in specific situations, most of the researchers agree that the routine display of the RLN is essential for its protection.11-16 To identify the nerve, the ITA is regarded as a fixed reference point17-18 by most of the clinicians as well as researcher due to their proximity. We have compared results of some previous studies in relation with the present study result. Out of 5 analysed works, most showed the predominance of the posterior position of the nerve in relation to the ITA.17-21 (table 2). In our study on the left side RLN branches were predominantly intermingling with the ITA in 52% cases. The result resembles with only one study done by Campos et al. They found the RLN was crossing most frequently (44.45%) the ITA branches between them on the left side.21 On the right, the variation is larger. Analysing the same 5 works mostly showed that the RLN passing more frequently between the branches of the ITA. Perhaps for this reason Debre C et al. had commented that “on the right side there are almost equal chances of finding the nerve anterior, posterior or intermingled with the branches of the ITA.22 Our study result also follows the majority, as more than half (52%) of the nerves on the right side were noticed to be intermingled with the ITA branches or passing between them.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>Number of Specimen (RLN)</th>
<th>RLN Anterior to ITA (%)</th>
<th>RLN Posterior to ITA (%)</th>
<th>RLN between Branches of ITA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wade</td>
<td>1955</td>
<td>UK</td>
<td>200</td>
<td>10.5</td>
<td>47.5</td>
<td>34.5</td>
</tr>
<tr>
<td>Skandalakis</td>
<td>1976</td>
<td>USA</td>
<td>204</td>
<td>20.6</td>
<td>41.6</td>
<td>37.7</td>
</tr>
<tr>
<td>Flameng19</td>
<td>1981</td>
<td>France</td>
<td>700</td>
<td>19.45</td>
<td>38.2</td>
<td>50.35</td>
</tr>
<tr>
<td>Hirata20</td>
<td>1992</td>
<td>Japan</td>
<td>784</td>
<td>18.65</td>
<td>46.25</td>
<td>35.1</td>
</tr>
<tr>
<td>Campos21</td>
<td>2000</td>
<td>Brazil</td>
<td>143</td>
<td>27.97</td>
<td>24.47</td>
<td>46.86</td>
</tr>
</tbody>
</table>

**Table 2. Study Result from Different Countries**

In the present study, the results and analysis are slightly similar to the ones of the Japanese author. The comparisons between 2 sexes and between both sides are found statistically insignificant in our study. After plotting the result in the bar diagram, it is evident that there is least chance of sexual variation. So, the insignificant p value (p>0.05) is acceptable. But comparing bilateral relationship of the nerve and the ITA by plotting the values in the bar diagram, shows significant visible difference. In spite of that the study is found statistically insignificant by chi square test. The reason behind it may be small sample size. In the previous studies only Costa et al.23 Had not found a significant difference in the relationship between the RLN and the ITA between the two sides.

Considering the cadavers individually similar relationship of RLN and ITA on both sides has been found in 6 cadavers (3 males and 3 females). But in 19 (76%) cadavers on both sides different relationship was noted. So the myth of bilateral variability is established.

Analysing all of the previous studies along with the present one it is clear that they have different results and proportions of the 3 major relationships of RLN and ITA. They have a large range if we consider all of these studies separately. The factors that determine these observed differences in various studies in the anatomical variations of the RLN are still not established. Pereira24 in a study of non-recurrent laryngeal nerve in patients undergoing surgery commented that the racial factor should receive greater attention regarding these different results in various studies. Lages25 echoed the same in a study on cadavers. Both findings had occurred in crossbred female individuals, according to the authors. Steinberg al. In South Africa dissected 180 nerves in 90 corpses that were not embalmed. Among the corpses, 80% were of black race, 12% were of Caucasian race, and 8% were of Asian race. The authors found, regarding its relationship with the ITA, the RLN had divided into 2 main branches in 68% of the cases. In a small percentage, one of these branches was also subdivided. The branches of the RLN interdigitated with the branches of the ITA in 75% cadavers dissected.26 So here this study is comparable with the result we got.

It would be interesting to analyse the influence of racial differences on the relationship between the RLN and the ITA, based on works of different nationalities.17-21 (Table 2) But even those research works are not providing any data of racial characterization of the samples. From this standpoint it is difficult to conclude by pointing out any racial specification. But we can continue the study further looking for racial variation.

**CONCLUSIONS**

There is no variation between sexes regarding relationship of RLN and ITA. But bilateral variation is very much evident, though any particular pattern of this relationship is hard to demonstrate by comparing with the previous studies. In our study, RLN tends to pass between the arterial branches or intermingling with them, but due to small sample size, the finding is statistically insignificant. A probability of racial effect behind these kinds of different results has been proposed. The ultimate necessity of exploration of the RLN during thyroid surgery and in some other neck surgeries to
avoid its damage, has found a firm ground. Further detailed study with a larger sample size can be conducted in future to have statistically significant and more precise results in this West Bengal population.

REFERENCES