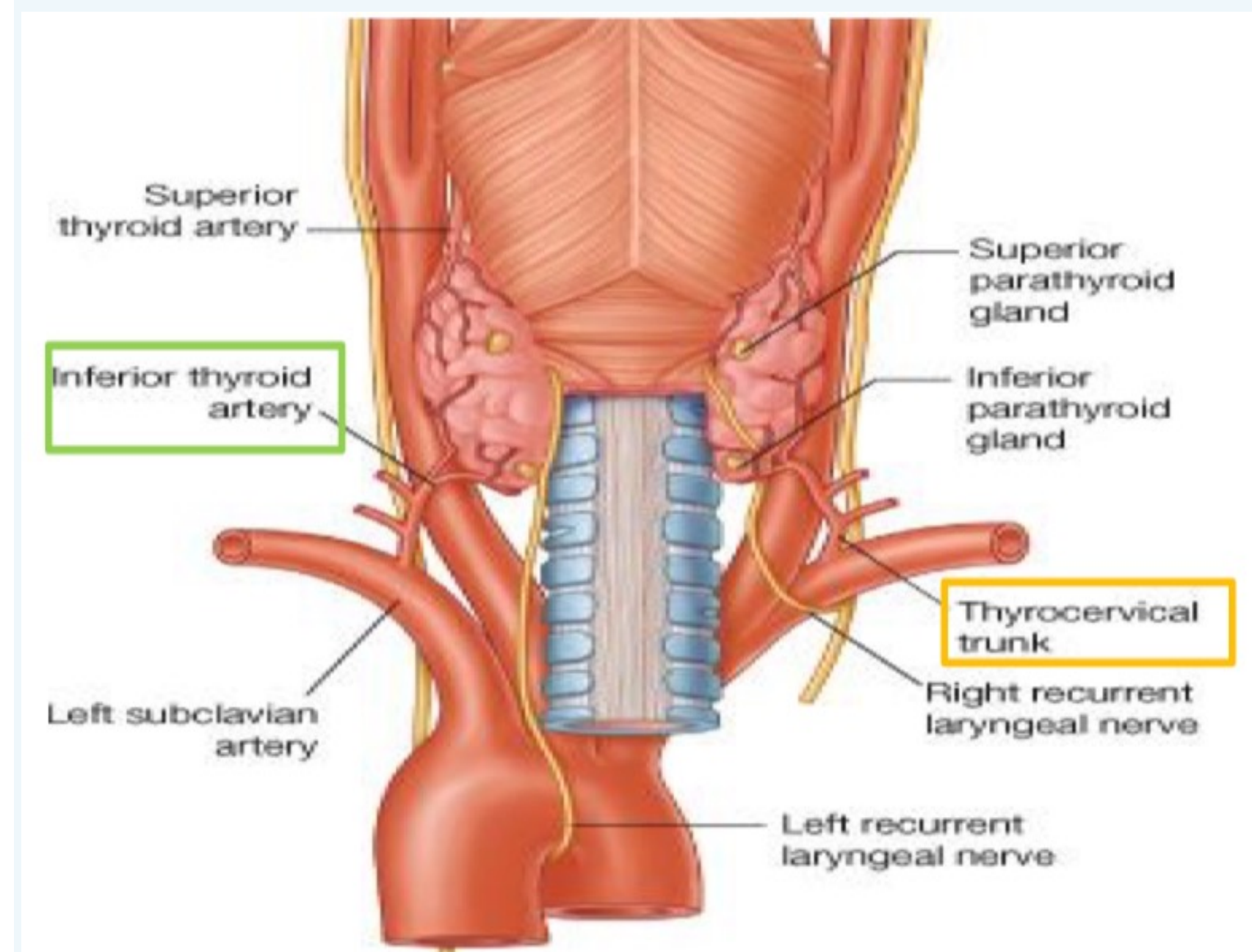


## Background

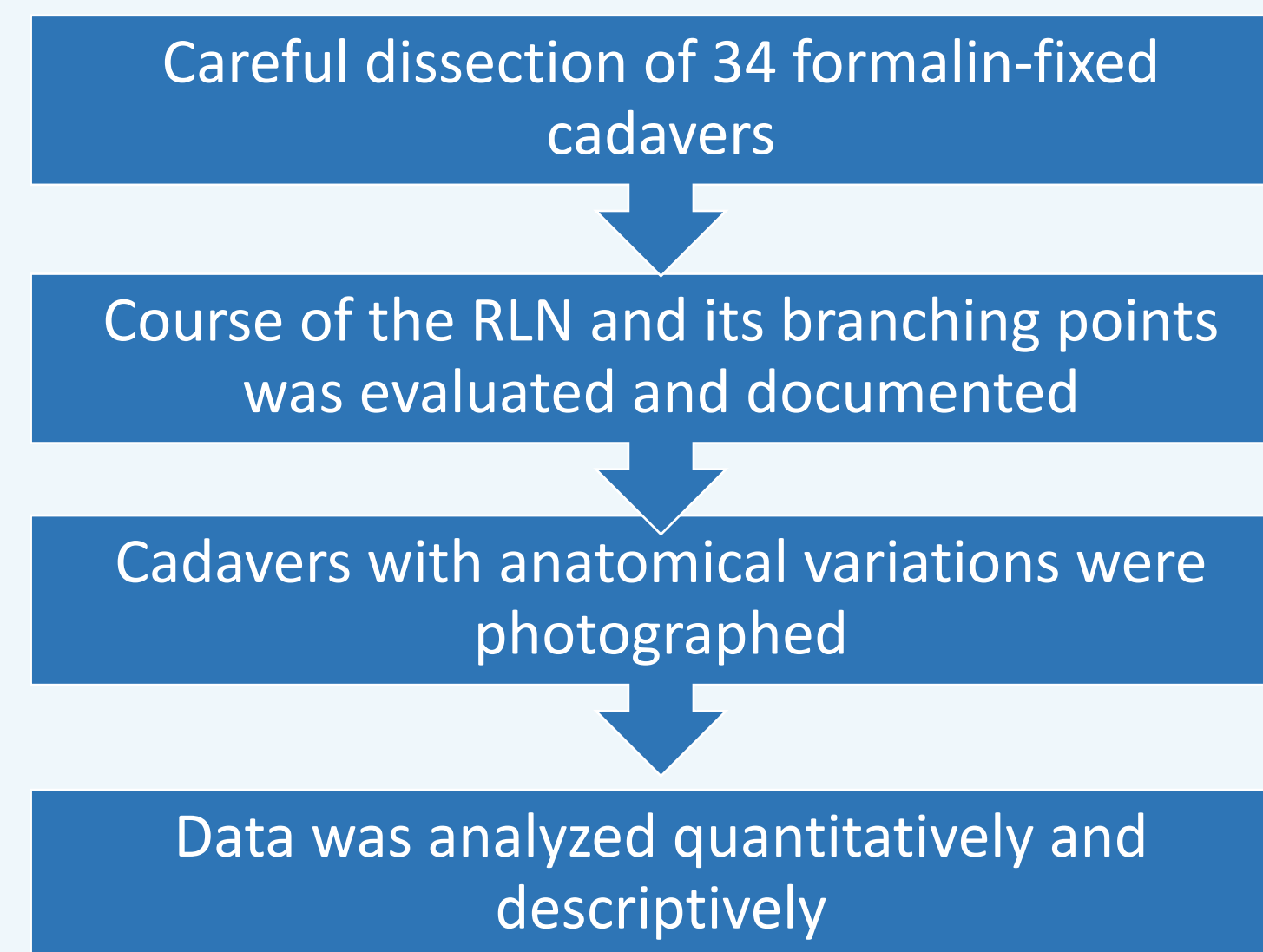
Recurrent laryngeal nerves (RLNs) branch off of the corresponding right & left vagus nerves taking a different route once they descend to the thorax. The right RLN loops around the right subclavian artery while the left RLN loops around the aortic arch and ascends back to the larynx. Both RLNs ascend through the tracheo-esophageal groove and make their way to the larynx, where they innervate all the laryngeal muscles except cricothyroid muscles<sup>1</sup>. Historically, the course of the RLN was described as branching superiorly to the inferior thyroid artery (ITA) and posterolaterally to the ligament of Berry<sup>2</sup>. However, it has been noted that the course of the nerve can be different and awareness of the anatomic location of the RLN is of great significance in procedures involving the thyroid. A common complication of thyroid surgeries is injury to the RLN which could lead to hoarseness and loss of voice. Incidence of permanent nerve palsy can be as high as 13% and 30% of patients during thyroid cancer operations and secondary thyroidectomy, respectively<sup>3</sup>. Injury to both RLNs can also cause closure of the vocal cords and blockage of air passage to the lungs. Although a lot of studies reported that the RLN usually branches after it enters the larynx, others showed that it can branch before. Therefore, the variable branching pattern of this nerve is important due to its implications in iatrogenic injury. According to Henry et al., the different branching patterns of the RLN, especially non-bifurcating patterns, may be underreported due to the lack of investigation of the RLN during intraoperative procedures<sup>4</sup>. In our study, we examined the location and different branching patterns of the RLN and its relationship with the ITA, and demonstrated its vulnerability during procedures of the thyroid. Our study specifically focuses on the anatomic variations of the RLN and its relationship with the ITA.



**Figure 1:** This image shows both RLNs and demonstrate their relationships with the respective ITAs. The close proximity of the nerve to the ITA makes it especially susceptible to iatrogenic injury during thyroid surgeries<sup>5</sup>.

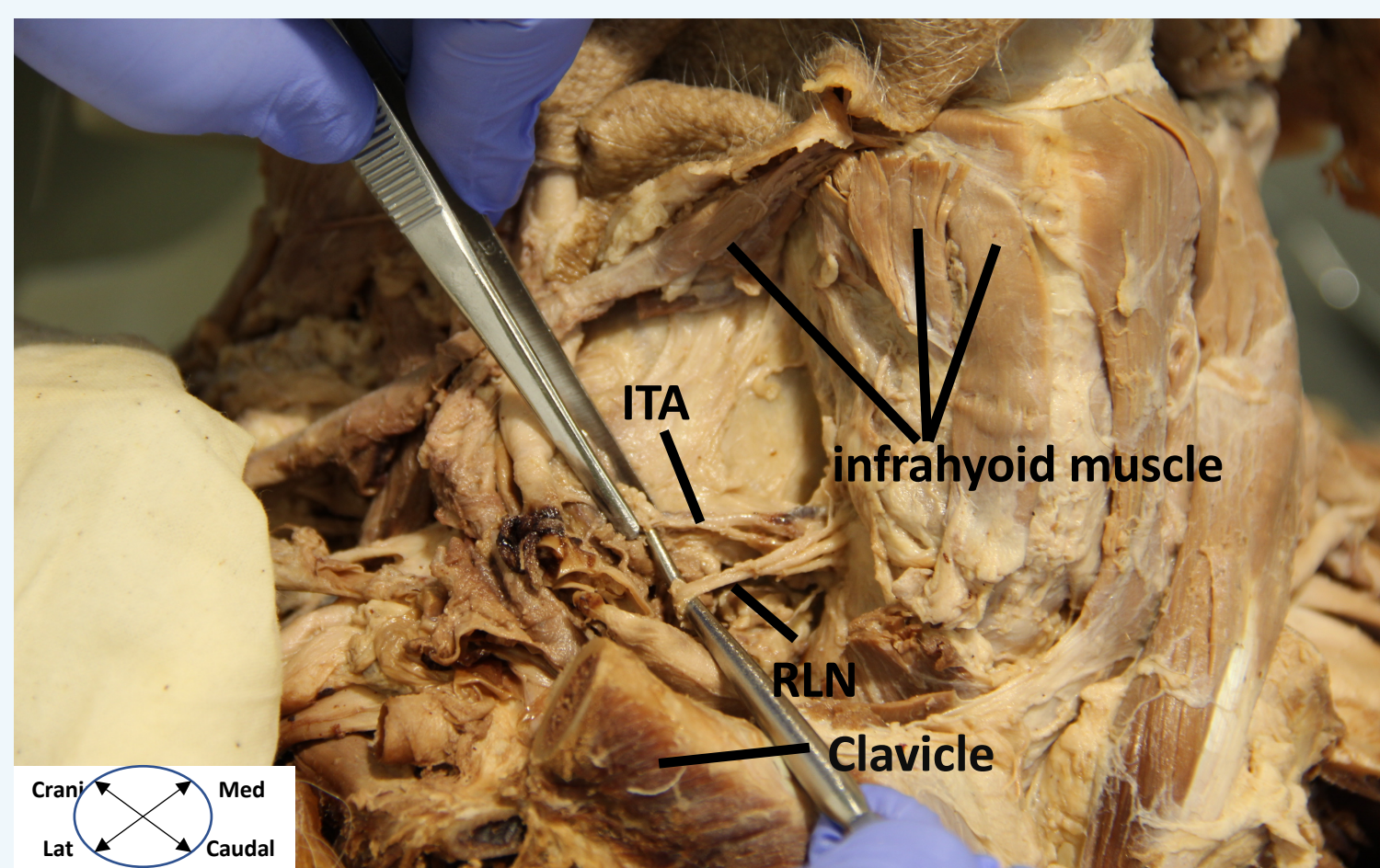
## Materials and Methods

34 formalin-fixed cadavers provided by the Oakland University William Beaumont School of Medicine were carefully dissected and examined. The course and branching patterns of the RLNs were carefully evaluated and documented bilaterally, together with the RLN's relationship with the surrounding structures, mainly the ITA.



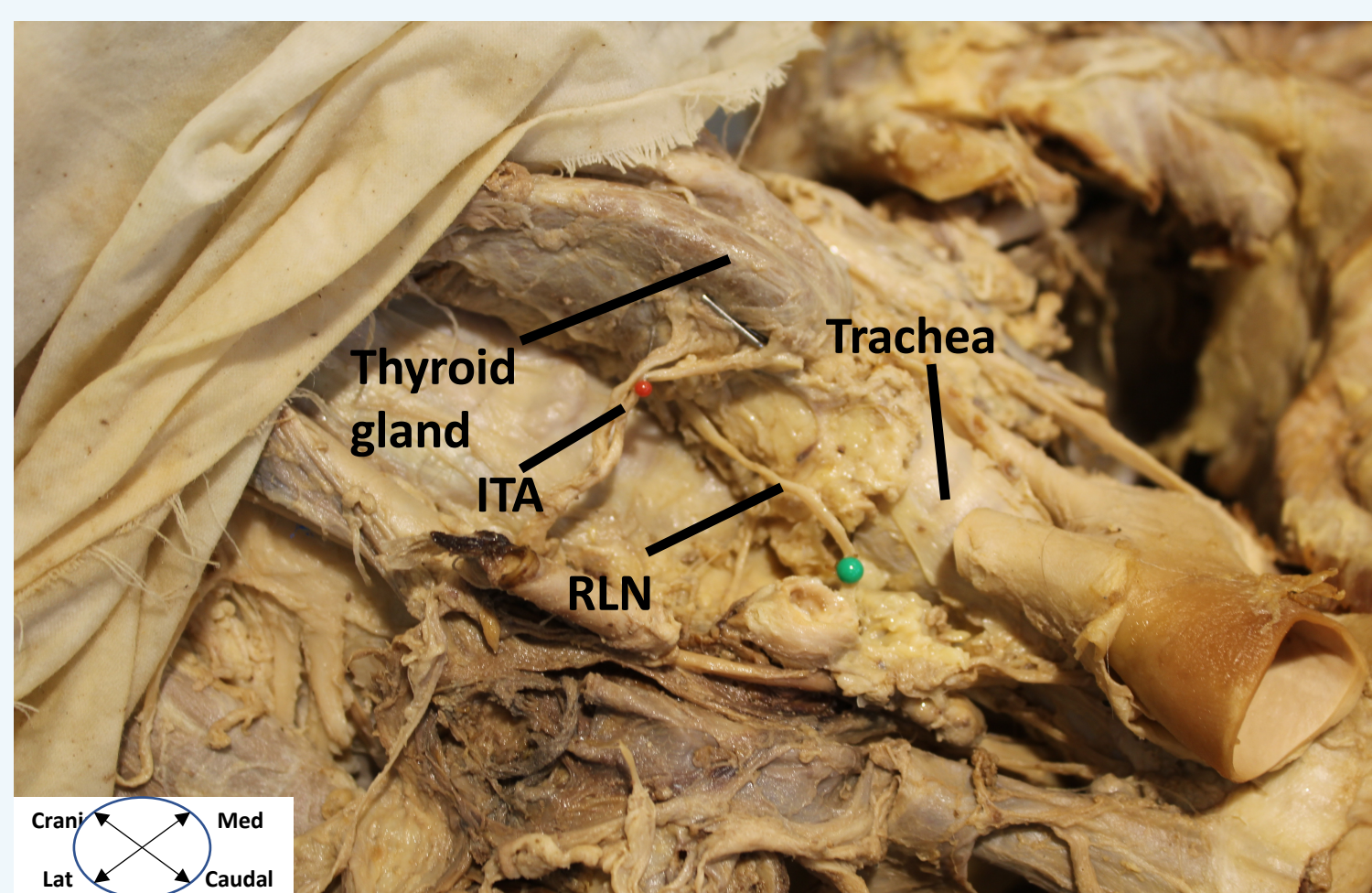
## Results and Discussion

### The RLN is Related Superiorly to the ITA



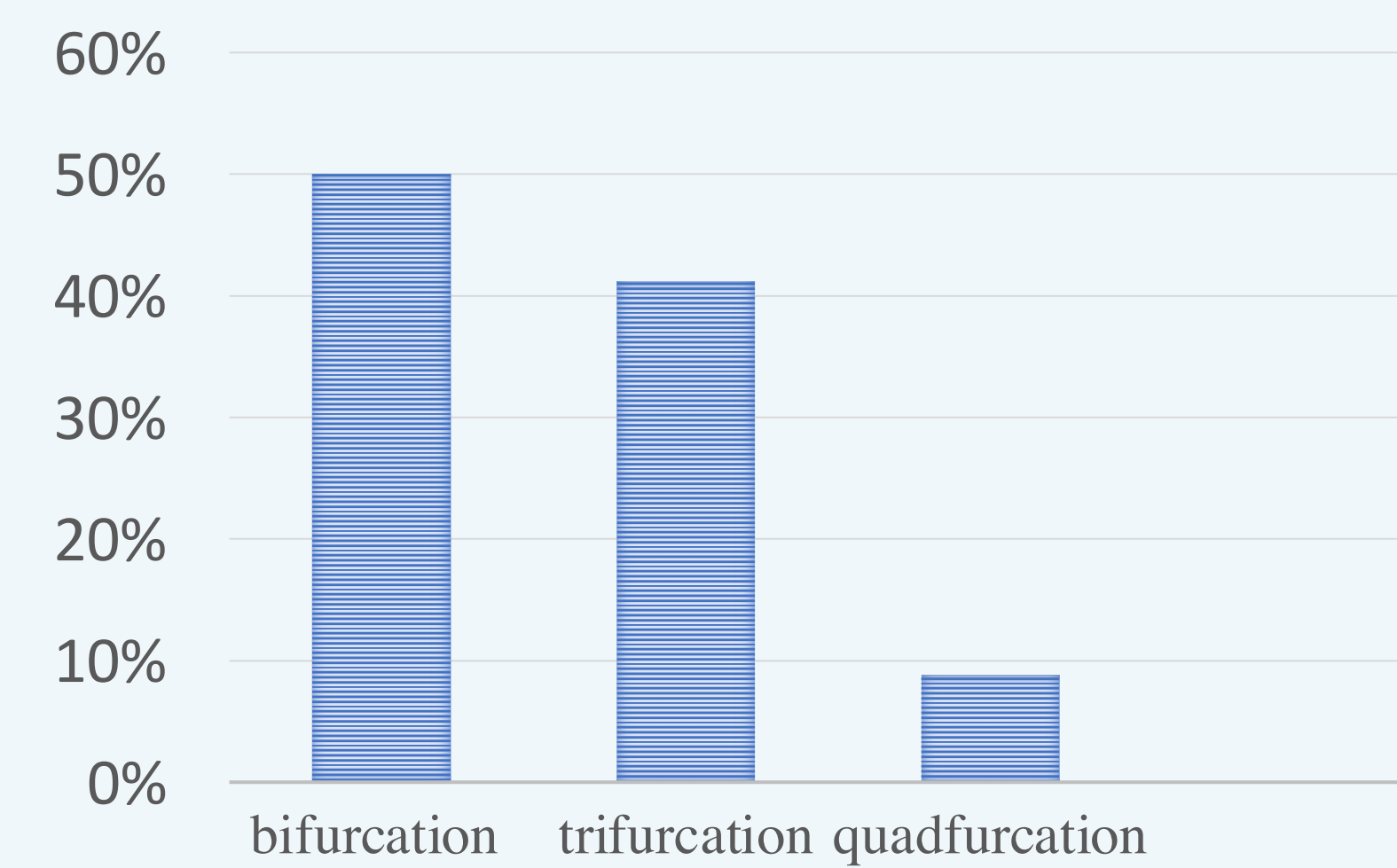
**Figure 2:** The recurrent laryngeal nerve is superior to the inferior thyroid artery. The image also shows the infrahyoid muscles and the clavicle. 55.88% of our data demonstrated this relationship, in which the RLN is positioned superiorly to the ITA.

### The RLN is Related Inferiorly to the ITA



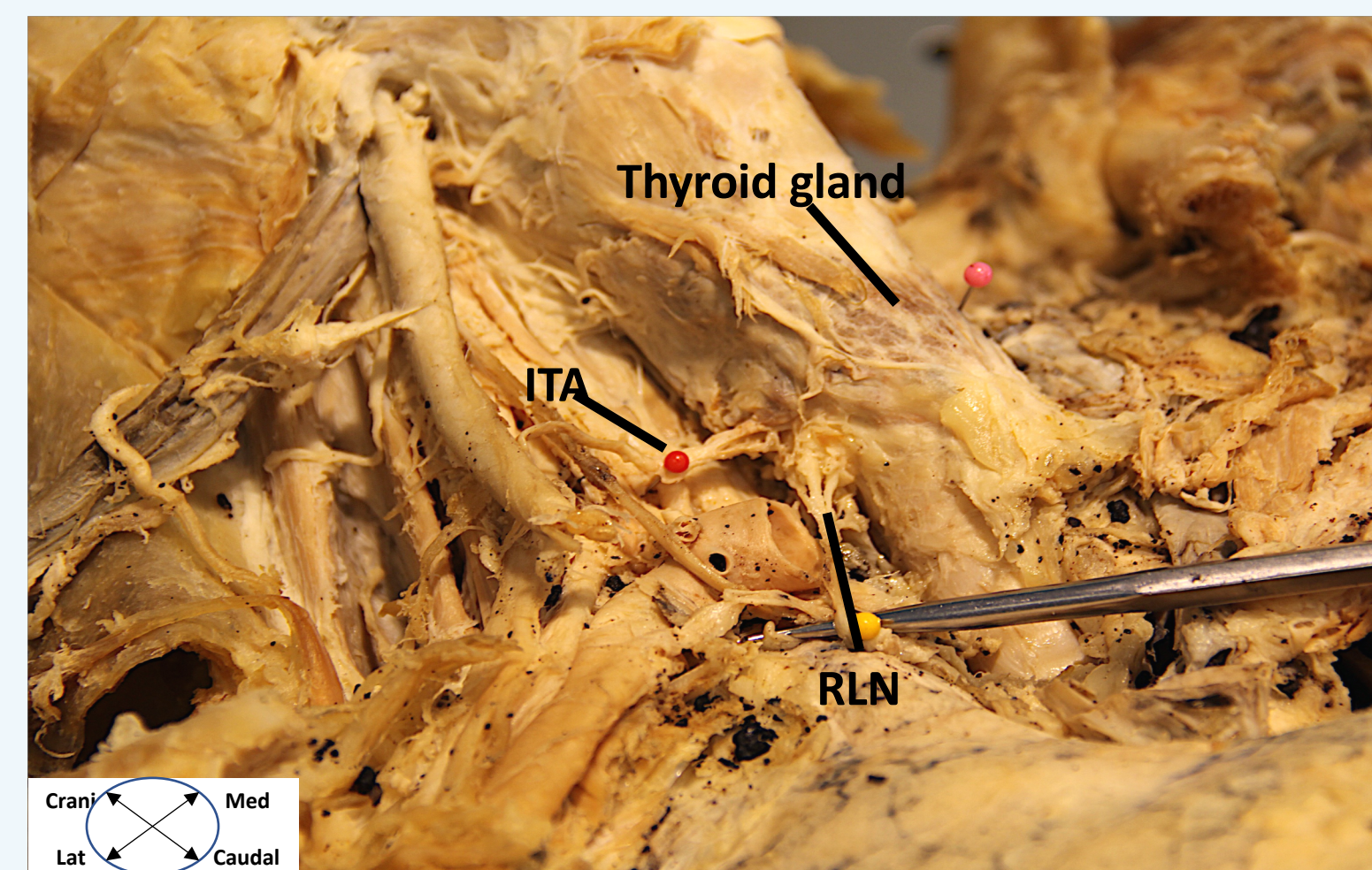
**Figure 3:** The recurrent laryngeal nerve is inferior to the inferior thyroid artery. The image also shows the thyroid gland and the trachea. 44.11% of our data demonstrated this relationship, in which the RLN is positioned inferiorly to the ITA. The variation in the RLN's relationship with the ITA outlines the different routes the nerve can take and the importance of being aware of these variations during thyroid surgeries.

### Recurrent Laryngeal Nerve's Branching Patterns

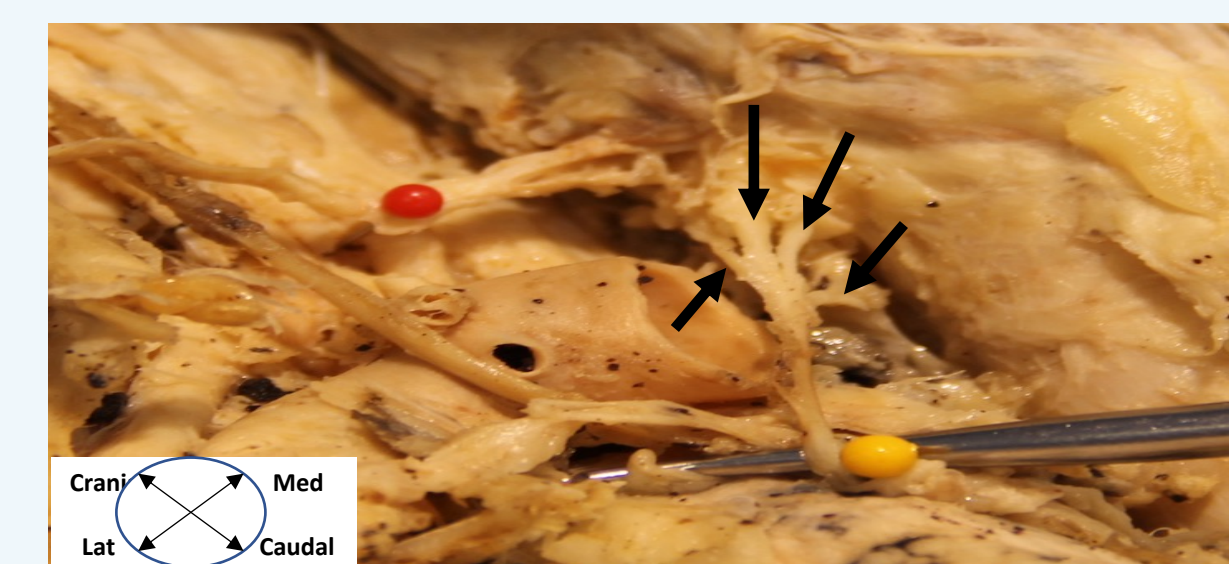


**Figure 4:** The percentages of the different branches that the RLNs had in our dissected cadavers are as follows: 50% bifurcated, 41.17% trifurcated, 8.82% quadfurcated (4 branches). The different branching patterns of the RLN, especially non-bifurcating ones, may be underreported due to the lack of investigation of the RLN during intraoperative procedures<sup>2</sup>. These findings demonstrate that the RLN can have multiple branching patterns, and therefore it is important to find these branches during thyroid surgeries to avoid injury and minimize post-operative complications.

### Recurrent Laryngeal Nerve with 4 Branches



**Figure 5:** This is a unique recurrent laryngeal nerve (RLN) with 4 branches.



**Figure 6:** This is a zoomed-in version of figure 5 with 4 arrows pointing to the 4 branches of the RLN. This is an example of the different branching patterns that the RLN can take, and outlines the importance of finding these branches during procedures involving the thyroid to minimize iatrogenic injury.

## Conclusion

- The recurrent laryngeal nerve is commonly injured during procedures involving the thyroid, leading to post-operative complications with voice hoarseness being the most common.
- The RLN is variable, and although most of the population has its branches in the form of bifurcation<sup>3</sup>, it is important to consider different branching patterns, such as trifurcations and multiple branching.
- Our study further proved the variability of the RLN's relationship with the ITA, where 55.88% of our cadavers had the RLN superior to the ITA, and 44.11% had the RLN inferior to the ITA, as shown in figures 2 and 3.
- Our study further showed the different branching patterns of the RLN where 50% of our dissected RLNs bifurcated, 41.7% trifurcated, and 8.82% quadfurcated, as outlined in figure 4.
- We concluded that the different branching patterns of the RLN increase its vulnerability during ligation of the ITA → higher possibility of iatrogenic injury → hoarseness, loss of voice, or closure of the vocal cords during bilateral RLN damage.
- Knowledge of the variable relationships is critical for identification and isolation of the neurovascular structures to preserve the nerve, prevent voice hoarseness, and minimize the risk of voice loss in thyroid surgeries.
- In the future, we plan on dissecting more cadavers to collect more data and increase our sample size. We will analyze the differences between the RLN's relationship with the ITA on each side of the body separately. We hope to be able to provide surgeons with cadaveric data to raise awareness of the variability of these structures.

## REFERENCES

1. Senturk M, Cakir M, Tekin A, Kucukkartallar T, Yildirim M, Alkan S, Findik S. Comparison of primary repair and repair with polyglycolic acid coated tube in recurrent laryngeal nerve cuts (an experimental study). *The American Journal of Surgery*. 2019. doi: 10.1016/j.amsurg.2019.06.015.
2. Kandil E, Abdelghani S, Friedlander P, Alrasheedi S, Tufano R, Bellows C, Slakey D. Motor and sensory branching of the recurrent laryngeal nerve in thyroid surgery. *Surgery*. 2011. doi: 10.1016/j.surg.2011.09.002.
3. Lo CY, Kwok KF, Yuen PW. A Prospective Evaluation of Recurrent Laryngeal Nerve Paralysis During Thyroidectomy. *JAMA Surgery*. 2000. doi: 10.1001/archsurg.135.2.204.
4. Henry BM, Viske J, Graves M, Sanna S, Sanna B, Tomaszewska I, Tubbs RS, Tomaszewski K. Extralaryngeal branching of the recurrent laryngeal nerve: a meta-analysis of 28,387 nerves. *Langenbecks Arch Surg*. 2016. doi: 10.1007/s00423-016-1455-7.
5. Kumari TK, Sajey PS, Romi S, et al. A study of relation of recurrent laryngeal nerve to inferior thyroid artery and thyroid gland. *J. Evid. Based Med. Healthc*. 2017; 4(56), 3406-3409. DOI: 10.18410/jebmh/2017/678