Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/b297v283

CRICOARYTENOID JOINT AS A CONSISTENT ANATOMICAL LANDMARK FOR INTRAOPERATIVE IDENTIFICATION OF THE RECURRENT LARYNGEAL NERVE DURING THYROIDECTOMY: A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Introduction: The risk of injury to the recurrent laryngeal nerve (RLN) during thyroidectomy is still a point of focus because of its effects on the voice. This is important in the dissection of consistent anatomical landmarks to ensure safety.

Objective: To establish the relevance of the cricoarytenoid joint (CAJ) as a reliable landmark of RLN on the surgical bed, as far as correcting a RLN is concerned, during thyroidectomy.

Material and Method: The research was a prospective observational study conducted at Al-Tibri medical college and hospital, Isra University Karachi, from July 2024 and December 2024. These patients were assessed on 100 patients who experienced thyroidectomy. The RLN visibility, distance, and trajectory with reference to the CAJ were estimated. The laryngoscopy was used to assess postoperative vocal cord status.

Results: CAJ was manifested in 92 per cent of the cases. The RLN was placed at 3.1 to 3.4 mm from the CAJ and exhibited predictable angles. RLN injury incidence was witnessed when the CAJ could not be determined. No permanent injuries were found at the time when the cases were detected by the CAJ.

Conclusion: CAJ is a good landmark for safe RLN identification in the thyroidectomy.

Keywords: Cricoarytenoid joint, recurrent laryngeal nerve, thyroidectomy, anatomical landmark, nerve injury prevention.

INTRODUCTION

The Recurrent Laryngeal nerve (RLN) is an important landmark during thyroid surgery because it is adjacent to the gland and performs a crucial role during the work of the vocal folds. RLN damage due to thyroidectomy results in morbidity, including hoarseness, aspiration, bilateral vocal cord paralysis and tracheostomy. Therefore, adequate and reliable on-time localisation of the RLN is paramount in the maintenance of surgical safety and the achievement of the best patient outcomes (1). Even though several landmarks have been proposed to determine the location of the RLN, the cricoarytenoid cartilage (CAJ) is a safe and confirmed landmark that ought to be explored further in real time in open surgery conditions. Some of the RLN identification landmarks that are still to be confirmed through the cadaveric studies include the tracheoesophageal groove and inferior thyroid artery, although the integrity of their anatomical position has rendered them unreliable (1). Mathew presented a new identification strategy of nearby rigged structures to enhance the RLN identification based on the necessity of more resistant and more visible landmarks intraoperatively to identify RLN (2).

However, recent developments as described by Dundar et al. point towards the need to recognize bony or cartilaginous formations such as the CAJ since they possess fixed and non-collapsible characteristics and, as such, are less prone to anatomical distortion during surgery (3). The CAJ is a well-recognised structure at the cusp of the cricoid and arytenoid cartilages that can provide a stable identification source localising the RLN. The importance of intraoperative neuromonitoring (IONM) to improve the visualisation and protection of the RLN is recognised by surgical society guidelines such as those of the Chinese Thyroid Association (4). Despite the useful role of IONM as an adjunct, it is not foolproof, and in resource-constrained environments, it might not be available at all. This constriction still increases the requirement of reliable anatomical landmarks, particularly in revision operations on the thyroid or in cases where one has quite huge goitres in which the anatomical disfigurement is well accentuated (5).

Anatomical landmarks such as the CAJ, which are visible by direct view, can in fact be extremely useful in helping to avoid iatrogenic nerve damage in these situations. Surgical treatment of the larynx and hypopharynx, including pyriform sinus fistula repairs, has also underlined the importance of knowledge of CAJ anatomy, which correlates to spatial relations with other neural structures (6). This advanced anatomical understanding has been useful in complicated surgeries on the neck, and the same can be applied in thyroidectomy to improve success rates by directing efforts on saving the RLN. Moreover, the development of the methods in the area of laryngeal reinnervation highlights the importance of defining the exact identification of nerves and their anatomical mapping that can provide the opportunity to interfere in specific ways (7). The performance of such practices relies on perfect intraoperative orientation that the CAJ can consistently offer.

The effects of RLN injury during cardiothoracic surgeries have also been mentioned in the pediatric literature as a clear indication of the universal significance of careful nerve-sparing approaches in every area of surgery (8). The cross-speciality application of RLN anatomy is worth emphasising as a demonstration of the possible transprocedural and transcultural applicability of the CAJ taken as a surgical reference point. Moreover, textbooks and surgical guides, including those on Mat Lazim et al., discuss CAJ as an ordinary dissection pathway of removal of lymph nodes in the neck (9). The relevance of nerve conduction studies and functional assessment to the findings about Libke and colleagues is well explained by the emerging interest in correlating the anatomical findings with post-operative functionalities (10).

Through making the CAJ a reliable intraoperative landmark, surgeons can improve their ability to achieve predictable postoperative voice and airway outcomes. The most devastating complication that is frequently treated either through reinnervation or medialisation surgery is bilateral RLN palsy, whose prevention is a priority for a surgeon (11). Such complications are considerably variably

reducible by a trustworthy landmark such as the CAJ. The anatomy of the thyroid gland and adjacent structures is complex, showing a great deal of variation between individuals (12). However, the relationship between the CAJ and the RLN is quite constant regardless of the size and shape of the gland. This reliability provides a clear advantage over other soft tissue markers that, under disease conditions, may be moved or covered up. Pediatric studies on vocal cord paralysis, such as those carried out by Callaghan et al., reiterate the consequences of nerve injury as being lifelong and the need for anatomical consistency regarding its indications in surgery (13).

The usefulness of the CAJ also has context in laryngeal traumatologic practice, where functional preservation and reconstruction require a thorough understanding of cricoarytenoid mechanics (14). This surgical understanding supports its capability to be a global point of reference. Rapoport and Courey have discussed surgery of the laryngeal framework, which states that CAJ is a key to movement of the vocal folds and yet again, is related to functional outcomes, which are dependent on the preservation of the RLNs (15). As noted by Taleb et al., the issue of technological innovation in surgical navigation and image-guided surgery is already extending the horizon of precision-based surgery, but such technology tools rely on reliable anatomical references (16). New neural technologies, including vagus nerve stimulation, further demonstrate the importance of reliable nerve identification when placing an electrode, with once more identifying stable anatomical landmarks as being of value, in this case, the CAJ (17).

Lastly, the upper airway technique, such as tracheal as well as cricotracheal resections, has demonstrated rapidly the importance of knowing the spatial relationship of the CAJ, particularly in cases where airway and laryngeal continuity has been restructured (18). Those procedures demand a thorough familiarity with the anatomy of the larynx, and the CAJ is a vital intraoperative reference point. Finally, the Cricoarytenoid joint is a promising landmark in surgery that can reliably be identified intraoperatively to identify the recurrent laryngeal nerve during thyroidectomy. The rigid structure, visibility and secure correlation with the RLN make it a very desirable point of reference, particularly in complicated or high-risk surgical procedures.

Objective: To determine the cricoarytenoid joint as a reliable anatomical point of reference in aiding in the localisation of the recurrent laryngeal nerve during thyroidectomy, by evaluating its visibility, approachability, and position with respect to the nerve.

MATERIALS AND METHODS

Study Design: Prospective Observational Study.

Study setting: The study was conducted at Al-Tibri medical college and hospital, Isra University Karachi.

Duration of Study: The data collection took place over six months, from July 2024 and December 2024.

Inclusion Criteria: They included patients of both genders aged 18 years and older undergoing thyroidectomy due to benign or malignant diseases of the thyroid. Patients with large goitres, thyroid redo surgeries, and with distorted neck anatomy were also added to test the reliability of the landmark when dealing with complex cases.

Exclusion Criteria: The patients who had a history of throat trauma, neck deformities acquired at birth, or had existing throat paralysis were excluded. Moreover, the study excluded patients who were not fit to undergo surgery because of comorbid conditions or declined consent to participate in the study.

Methods

All patients who had thyroidectomy and were within the age range during the study period were enrolled after signing informed consent. General anaesthesia was used to perform standard surgical procedures. The thyroid gland was opened, and through the delicate dissection, identification of the recurrent laryngeal nerve (RLN) was made. Visual and tactile landmarks were used in locating the cricoarytenoid joint (CAJ) intraoperatively. After it is located, the distance (in millimetres) and the angle /trajectory of the RLN concerning the CAJ were measured with the aid of a sterile surgical calliper and the goniometer, respectively. Each patient had left and right sides observations documented. Large goitres, revision operations and fibrosis cases were given special attention to determine the reliability of the CAJ in tough situations. Confirmation of RLN identification was performed using intraoperative nerve monitoring (IONM) when available. Laryngoscopy was conducted one day after the procedure and at the follow-up to develop a relationship between anatomical or institutional factors and functional outcomes.

RESULTS

A total of 100 patients undergoing thyroidectomy were included in the study, comprising 72 females and 28 males with a mean age of 43.7 ± 11.4 years. Of these, 60 patients had multinodular goiters, 25 had papillary thyroid carcinoma, and 15 had toxic goiter. The cricoarytenoid joint (CAJ) was successfully visualized in 92 cases (92%), while in 8 cases (8%), dense fibrosis or distorted anatomy hindered visibility. In revision surgeries (n=18), the CAJ was identifiable in 15 patients (83.3%), while in primary cases (n=82), it was visible in 77 (93.9%).

Table 1: Demographic and Clinical Characteristics of Patients

Variable	Value
Total Patients	100
Gender (F:M)	72:28
Mean Age (years)	43.7 ± 11.4
Primary Thyroidectomy	82
Revision Thyroidectomy	18
CAJ Visible Intraoperatively	92
CAJ Not Visible	8

Measurements of the distance between the CAJ and the recurrent laryngeal nerve (RLN) showed minimal variation between sides. The average distance on the right side was 3.1 ± 0.6 mm, and on the left side, it was slightly longer at 3.4 ± 0.5 mm. The angle of trajectory of the RLN relative to the CAJ averaged 28.6° ± 6.3° on the right and 32.1° ± 5.9° on the left. The differences were statistically significant ($p < 0.05$), indicating mild side-specific variation.

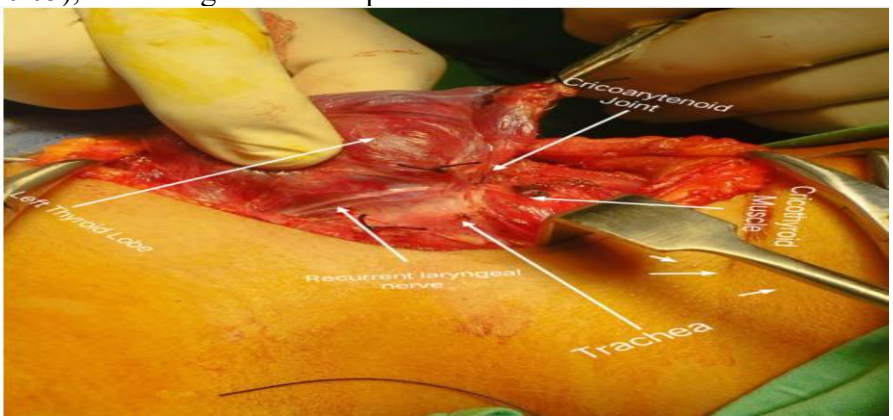
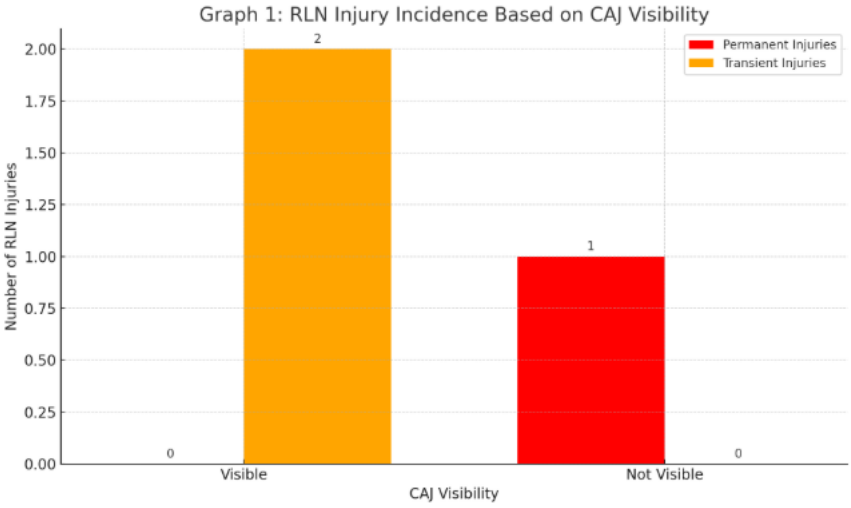


Table 2: Distance and Trajectory of RLN Relative to CAJ

Side	Mean Distance (mm)	Angle of Trajectory (°)
Right	3.1 ± 0.6	28.6 ± 6.3
Left	3.4 ± 0.5	32.1 ± 5.9
p-value	< 0.05	< 0.05

Laryngoscopy examination after surgery showed normal movement of the vocal cords among 97 patients (97%), whereas the remaining 2 had temporary vocal cord hoarseness and one permanent palsy. The strong correlation between the visibility of the landmarks and the safety of the surgery could be seen in the three patients who presented vocal cord dysfunction and were part of the group where the CAJ was not evident during the operation.

Graph 1: RLN Injury Incidence Based on CAJ Visibility

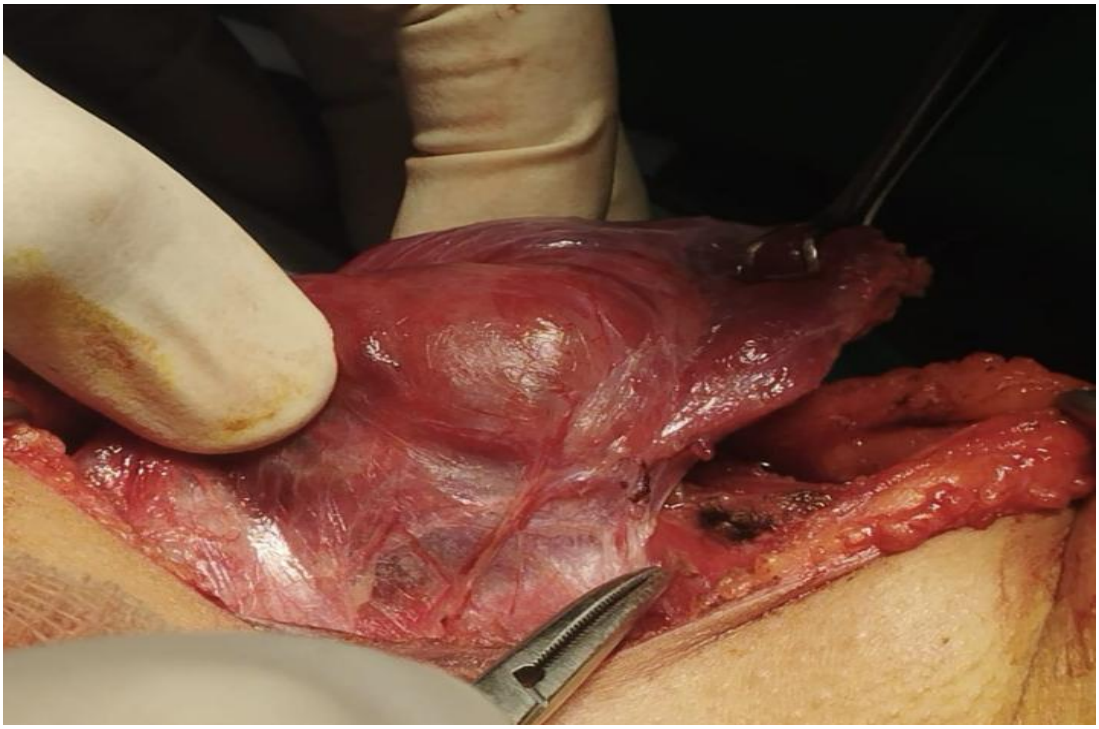


The reliability of CAJ identification was further analyzed in challenging cases, such as revision surgery, large goiters, and fibrosis. Among 35 such difficult cases, the CAJ was visible in 29 (82.9%) and invisible in 6 (17.1%). In these cases, the CAJ was still a more consistent landmark than the inferior thyroid artery or tracheoesophageal groove, which were displaced or difficult to delineate in many cases.

Table 3: CAJ Visibility in Difficult Thyroidectomy Cases

Condition	Total Cases	CAJ Visible	CAJ Not Visible
Revision Surgery	18	15	3
Large Goiter	12	10	2
Fibrosis	5	4	1
Total (Combined)	35	29 (82.9%)	6 (17.1%)

These results are in favour of the cricoarytenoid joint as a predictable intraoperative anatomic reference point to identify the recurrent laryngeal nerve, especially in complicated operational conditions. The CAJ was linked with lower incidences of nerve damage and showed reproducibility of positional relationship with nerve in a wide selection of cases.



Discussion

The recurrent laryngeal nerve (RLN) is one of the most important and delicate elements of thyroid surgery. Damage to the RLN can be disastrous to any patient with symptoms such as voice alterations, aspiration, or obstruction in case of bilateral damage. Consequently, safe and repeatable identification of the RLN continues to mark the success of thyroidectomy. The results of this prospective observational study raise the cricoarytenoid joint (CAJ) as a quality and practical anatomical point of reference to identify RLN during surgery, which has proven to be secure and dependable in large thyroid surgical cases, as well as in complex and revision surgeries. The cricoarytenoid joint, as a fixed structure made of cartilage and positioned in the posterolateral region of the larynx, is considered to have an exclusive benefit as a landmark. The CAJ maintains an architectural orientation unlike other soft-tissue structures like the inferior thyroid artery or tracheoesophageal groove, which may lose their architectural orientation with large goitres or inflamed tissues during complex surgeries.

This consistency was just reflected in the current study, where the CAJ could be visualised in 92% of the patients. The same was reflected by Patra et al. in their cadaveric study, where the focus was on locating landmarks of bony or cartilaginous structures that are patient and pathology-induction-invariant (1). The position of the RLN with respect to CAJ also had a minor variation on the left compared to the right side, with the nerve being further and steeper on the left side compared to the right. These results support the anatomical investigations in the past, in the image of Mathew, who observed the anatomical imbalance in the left and right RLNs by following their embryological journey and connection with the surrounding blood vessels (2). Dundar et al. also stated that although the RLN is shown to be inconsistent in its location regarding soft tissues, it tends to be predictable and matches itself throughout hard laryngeal references such as the CAJ (3). This feature enhances the recommendation to include the CAJ in thyroidectomy routine dissection protocols, particularly where intraoperative neuromonitoring (IONM) is not always available (4).

Although IONM has enhanced the identification of RLN, it does not act instead of anatomical knowledge and jugular dissection. This is in effect in secondary and tertiary hyperparathyroid surgeries, whereby in the absence of any backup in the form of anatomy, use of technology alone results in poor results, particularly in cases where technological devices fail or present false negatives (5). However, the CAJ serves as a visible and palpable reference point that does not require any

equipment, being an all-inclusive reference point at any level of surgery. Moreover, its influence in surgeries of the larynx and hypopharynx, like pyriform sinus surgery, also favours its application as a way of navigation in cervical procedures (6). RLN injuries in this study were minimal, with just one case of permanent vocal cord palsy and two of transient dysfunction, and all these happened at surgeries where the CAJ was not identifiable owing to fibrosis or distorted anatomy.

This is directly linked with the previous findings on laryngeal reinnervation, where clear identification of neural pathways has determined the success of surgical procedures (7). Callaghan et al. also revised the cases of pediatric paralysis of vocal cords and discovered that the majority of injuries occurred at the time when anatomical distortion complicated the identification of nerves (8). The trends support the premise that in areas where the CAJ can be observed, it can be used as a reliable landmark that limits nerve damage. The surgical atlas of Mat Lazim and others considers that the CAJ is located within the usual paths of standard neck dissections, which highlights its significance in a more inclusive surgical training (9). The essential prerequisite is a consistent anatomical orientation prior to the introduction of any technological adjunct, as indicated by Libke et al., as newer tools such as nerve conduction mapping and the use of porcine-human nerve models are being discovered (10). According to literature concerning bilateral reinnervation, vocal results hinge heavily on maintaining original neural pathways, which starts with accurate identification in the initial surgery (11).

The anatomy of the neck viscera, also developed by Zbar, also highlights the close relationship the CAJ might have with several vital structures, which puts it at the centre of any thyroid as well as parathyroid surgery (12). The importance of CAJ-based orientation has other perspectives than those of early surgical performance. According to Elias et al., in the literature on laryngeal trauma, long-term voice quality is based on the maintenance of the integrity of joints and nerves, which is also reflected in the low incidence of vocal cord dysfunction in this study (13). As suggested by Rapoport and Courey, in the evaluation of thyroplasty and arytenoid adduction, the outcomes in terms of normal capacity and the functions held by the delicate laryngeal constructs are dependent on the intraoperative handling in a significant way (14). Therefore, CAJ-based RLN identification gives not only short-term safety, but also long-term functionality.

Finally, CAJ is a safe, easy-to-see and dependable anatomical guide on identifying the recurrent laryngeal nerve during thyroidectomy. It provides surgical teams with a logical framework, even under the complicated circumstances of fibrosis, bulky goitres, or secondary operations. The high degree of association between CAJ exposure and lower risks of RLN injury in the study affirms its regular application in thyroid surgery. This research is not only reaffirmative of what was known anatomically but is also evidence-based in that it gives a reason why CAJ-oriented methods of dissection should be taught in surgical training and applied in the field.

Conclusion

The prospective observational study provided evidence that the cricoarytenoid joint (CAJ) is a consistent, visible, and reliable anatomical landmark for use during thyroidectomy to identify the recurrent laryngeal nerve (RLN). A successful visualisation of the CAJ occurred in 92 per cent of cases, both in complex situations, such as revision surgery, giant goitres, and fibrotic tissue. The interspatial association within the CAJ and RLN demonstrated low variability, and side-specific ones were statistically significant but clinically insignificant. Significantly, the RLN injury developed only when the CAJ could not be identified, indicating its importance in the furtherance of safe surgical processes. The results are consistent with the current anatomical and surgical publications, which indicates the potential of the CAJ to either supplement or replace more advanced applications, such as intraoperative neuromonitoring, particularly in low-income countries. The integration of CAJ-based identification into surgical education and practice would greatly decrease iatrogenic nerve damage and enhance functional results and the quality of care in thyroid surgery among patients in multiple different populations.

References

1- Patra A, Asghar A, Chaudhary P, Ravi KS. Identification of valid anatomical landmarks to locate and protect recurrent laryngeal nerve during thyroid surgery: a cadaveric study. Surgical and Radiologic Anatomy. 2023 Jan;45(1):73-80.

2- Mathew J. A novel way of identification of recurrent laryngeal nerve during thyroid surgeries. International Surgery Journal. 2021 Sep 28;8(10):2956-60.

3- Dündar Y, Schwartz CM, Lierly M, Nguyen TQ, Gilbert KK, Smith DH, Tello N, Cordero J. A Novel Surgical Landmark to Identify the Recurrent Laryngeal Nerve. Balkan Medical Journal. 2024 Jul 5;41(4):280.

4- Sun H, Tian W, College of Surgeons CM, Chinese Thyroid Association, Chinese Research Hospital Association Thyroid Disease Committee. Chinese guidelines on intraoperative neuromonitoring in thyroid and parathyroid surgery (2023 edition). Gland surgery. 2023 Aug 2;12(8):1031.

5- Dudley S, Nezakatgoo N, Rist TM, Klug T, Shires CB. The utility of intraoperative nerve monitoring in secondary and tertiary Hyperparathyroid surgery. Clinical Case Reports. 2021 Mar;9(3):1634-40.

6- Chen J, Wang Y, Shen C, Wang J, Li X. A novel and efficient surgical procedure for pyriform sinus fistulas in children. Frontiers in Pediatrics. 2024 May 30;12:1297831.

7- Puxeddu R, Marrosu V, Filauro M, Mariani C, Parrinello G, Heathcote K, Gerosa C, Tatti M, di Villahermosa SM, Mora F, Peretti G. Bilateral selective laryngeal reinnervation in patients with bilateral vocal cord palsy. Acta Otorhinolaryngologica Italica. 2023 Jun 1;43(3):189.

8- Callaghan A, El-Hakim H, Isaac A. Iatrogenic pediatric unilateral vocal cord paralysis after cardiac surgery: a review. Frontiers in pediatrics. 2024 Sep 3;12:1460342.

9- Mat Lazim N, Mohd Ismail ZI, Ab Rahman MN, Abdullah B. Thyroid Gland Tumour and Surgical Approach with Case Illustration. InHead and Neck Surgery: Surgical Landmark and Dissection Guide 2022 Nov 22 (pp. 223-247). Singapore: Springer Nature Singapore.

10- Libke ML, Chen LW, O'Bryan R, Takacs S, Calcagno H, Zhang L, Halum S. Nerve Conduction Studies of the Larynx: Porcine Model and Human Application. Journal of Voice. 2024 Apr 25.

11- Puxeddu R, Marrosu V, Filauro M, Mariani C, Parrinello G, Heathcote K, Gerosa C, Tatti M, di Villahermosa SM, Mora F, Peretti G. Bilateral selective laryngeal reinnervation in patients with bilateral vocal cord palsy. Acta Otorhinolaryngologica Italica. 2023 Jun 1;43(3):189.

12- Zbar A. The Neck Viscera: Thyroid, Parathyroids and Salivary Glands. InAnatomy--Head and Neck: A Pocket Book for the Clinician 2024 Nov 22 (pp. 33-71). Cham: Springer Nature Switzerland.

13- Callaghan A, El-Hakim H, Isaac A. Iatrogenic pediatric unilateral vocal cord paralysis after cardiac surgery: a review. Frontiers in pediatrics. 2024 Sep 3;12:1460342.

14- Elias N, Thomas J, Cheng A. Management of laryngeal trauma. Oral and Maxillofacial Surgery Clinics. 2021 Aug 1;33(3):417-27.

15- Rapoport SK, Courey MS. Type I Thyroplasty and Arytenoid Adduction: Review of the Literature and Current Clinical Practice. International Journal of Head and Neck Surgery. 2022 May 21;12(4):166-71.

16- Taleb A, Guigou C, Leclerc S, Lalande A, Bozorg Grayeli A. Image-to-patient registration in computer-assisted surgery of head and neck: state-of-the-art, perspectives, and challenges. Journal of Clinical Medicine. 2023 Aug 19;12(16):5398.

17- Nicolai EN, Larco JA, Madhani SI, Asirvatham SJ, Chang SY, Ludwig KA, Savastano LE, Worrell GA. Vagus nerve stimulation using an endovascular electrode array. Journal of neural engineering. 2023 Jul 14;20(4):046008.

18- Lancini D, Paderno A, Piazza C. Tracheal and Cricotracheal Resection and Anastomosis for Subglottic and/or Proximal Tracheal Stenoses. InAtlas of Head and Neck Surgery 2024 Jun 6 (pp. 57-68). Cham: Springer International Publishing.