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Suture Fixation, Stoma Care, and Recurrent Laryngeal Nerve Injury-Related Airway Risks after Tracheostomy: A Narrative Review

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Abstract: *This narrative review examines airway risks after tracheostomy related to suture fixation, stoma care, and recurrent laryngeal nerve injury, with particular attention to their effects on cannula security, stoma-related complications, capping, and decannulation. Thirty-five publications addressing tracheostomy techniques, cannula fixation, stoma care, recurrent laryngeal nerve injury, special populations, and emerging digital care were synthesized and analyzed from three interrelated perspectives: suture fixation, stoma management, and upper airway neural function. The available literature indicates that appropriate suture fixation, particularly the use of stay sutures and selected stoma-maturation techniques, may reduce early accidental decannulation, false passage formation, and related mortality, while standardized stoma care can decrease infection, granulation tissue, airway stenosis, and tube obstruction. Recurrent laryngeal nerve injury may impair glottic mobility and swallowing function, thereby influencing the likelihood of successful capping and decannulation; although intraoperative nerve monitoring may reduce selected nerve injury risks, it cannot replace direct intraoperative nerve identification. Obese patients, children, patients with head and neck cancer, and patients with COVID-19 have distinct risk profiles and require individualized assessment. Overall, airway safety after tracheostomy should be managed through an integrated approach combining cannula fixation, stoma assessment, and upper airway evaluation, supported by standardized checklists, stoma care bundles, pre-decannulation upper airway assessment, and multidisciplinary workflows to reduce accidental decannulation, infection, stenosis, and decannulation failure.*

Keywords: *tracheostomy; suture fixation; stoma care; recurrent laryngeal nerve injury; airway risk*

1. Introduction

Airway risk after tracheostomy is rarely attributable to a single factor. The choice of surgical technique, cannula stability, the stoma environment, and upper airway function are closely interrelated; failure at any one of these steps may progress to an acute event and may even result in death. In a prospective randomized study including 60 adult patients, the Björk flap group had substantially lower rates of intraoperative bleeding (43.3% vs. 70%), subcutaneous emphysema (6.7% vs. 30%), stoma granulation (10% vs. 70%), tube obstruction (10% vs. 70%), and infection (10% vs. 73.3%) than the conventional tracheostomy group. Visual analogue scale scores during tube changes on days 2 and 7 also suggested easier care after Björk flap tracheostomy [1]. With respect to functional recovery, another prospective comparative study of 79 patients showed that patients who underwent Björk flap tracheostomy required a shorter interval from failure of the first fiberoptic endoscopic evaluation of swallowing to a subsequent successful assessment (9 +/- 4 days vs. 16 +/- 5 days) and fewer assessments (2 +/- 1 vs. 4 +/- 1), suggesting that this technique may accelerate swallowing recovery [2]. The timing of tracheostomy has long remained controversial. A meta-analysis of 17 randomized controlled trials involving 3,145 critically ill patients reported that early tracheostomy (<=7 days) was associated with a lower incidence of ventilator-associated pneumonia, more ventilator-free days, and a shorter intensive care unit stay, although it had no significant effect on short-term mortality [3]. Taken together, these findings indicate that the choice of technique and timing influences not only short-term complications but also longer-term functional recovery.

2. Methods

This review adopted a narrative literature review approach. Relevant literature was primarily identified through searches of PubMed, Google Scholar, the Cochrane Library, and databases of related

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otolaryngology, thoracic medicine, and surgical journals. The reference lists of included articles were also screened to identify additional relevant studies. Search terms included “tracheostomy,” “tracheotomy,” “stay suture,” “Björk flap,” “stoma care,” “recurrent laryngeal nerve injury,” “intraoperative nerve monitoring,” and “decannulation,” together with their corresponding Chinese terms. The search mainly focused on publications from 2013 to 2025. A total of 35 articles related to tracheostomy techniques, tube fixation, stoma care, recurrent laryngeal nerve injury, special patient populations, and digital care technologies were ultimately included for narrative analysis.

3. Upper Airway Function and Basic Care

A common blind spot in airway risk assessment is neglecting the condition of the upper airway itself. A systematic review emphasized that recurrent laryngeal nerve dysfunction is not limited to surgical injury. Autoimmune disease, neuropathy, metabolic disorders, infection, and medications may all cause a wide spectrum of manifestations, ranging from hoarseness to inspiratory stridor and severe respiratory distress. Reported systemic etiologies include systemic lupus erythematosus, sarcoidosis, Guillain-Barre syndrome, diabetes mellitus, Lyme disease, COVID-19, and drugs such as nivolumab and vincristine [4]. To standardize pediatric tracheostomy care, the American Thoracic Society clinical practice guideline recommends that ethical principles guide decision-making, that standardized discharge processes be implemented, and that high-risk children be accompanied by an awake and trained caregiver. Before decannulation, a comprehensive airway evaluation is recommended, including the nasal cavity, oropharynx, supraglottis, subglottis, and tracheobronchial tree [5]. Although it involves a different anatomical site, a prospective trial of intestinal stoma closure provides useful principles for wound management: no infections occurred among 34 patients who underwent purse-string closure, whereas 3 of 14 patients who underwent linear closure developed infection (P=0.021). Although this is indirect evidence, it highlights the influence of closure technique on infection rates [6]. Regarding the selection of adult tracheostomy techniques, a retrospective study of 217 patients found that the Björk flap was more frequently used in patients requiring prolonged ventilation and in those with a higher body mass index, whereas tracheal window procedures were more commonly used in patients with head and neck cancer and those with a history of neck irradiation. No significant differences in postoperative bleeding or decannulation success were observed between the two groups [7].

4. Recurrent Laryngeal Nerve Injury and Intraoperative Nerve Monitoring

An editorial noted that unilateral recurrent laryngeal nerve paralysis usually presents with hoarseness, whereas bilateral paralysis may cause severe respiratory distress requiring tracheostomy; nerve protection is therefore particularly important during thyroid and neck surgery [8]. A meta-analysis of 21 randomized controlled trials involving 3,621 patients produced findings consistent with earlier comparisons of early and late tracheostomy: earlier tracheostomy reduced the duration of mechanical ventilation (mean difference, -2.77 days) and intensive care unit stay (mean difference, -6.36 days), but had limited effects on all-cause mortality and pneumonia [9]. In 387 children undergoing 426 high-risk aerodigestive and cardiovascular procedures, intraoperative nerve monitoring reduced postoperative vocal fold motion impairment from 20.2% to 11.4% (P=0.019). Bilateral vocal fold motion impairment was 14 times more common when intraoperative nerve monitoring was not used, and the protective effect was particularly evident in children with pre-existing vocal fold motion impairment (7.8% vs. 25%) [10]. From the perspective of long-term appearance, a case-control study of 156 patients showed no significant difference in scar cosmesis between open and percutaneous tracheostomy. However, patient and observer scar assessment scores were significantly worse when the cannula remained in place for more than 15 days, suggesting that cannulation duration, rather than the surgical approach itself, may be the key determinant [11]. Returning to thyroid surgery, a meta-analysis integrating 103 studies and 132,212 patients showed that intraoperative nerve monitoring reduced the risk of temporary unilateral recurrent laryngeal nerve injury by 38% and permanent injury by 51%. Continuous intraoperative nerve monitoring, lower stimulation currents (<=2 mA), and avoidance of neuromuscular blocking agents appeared to offer greater protection [12]. In 24 patients undergoing minimally invasive esophagectomy, intraoperative nerve monitoring did not significantly reduce the rate of vocal fold paralysis (33.3% vs. 59.1%, P=0.08), but it increased the number of dissected lymph nodes (44.4 vs. 38.8) and reduced the need for tracheostomy and bronchoscopy [13].

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5. Laryngeal Complications, Nerve Repair, and Anatomical Variants

Laryngeal complications after prolonged intubation and tracheostomy are easily underestimated. An educational review reported laryngeal injury rates of 57-83%, dysphonia in up to 76%, hoarseness in up to 83%, and dysphagia in up to 49%. These symptoms directly affect the success of extubation and tracheostomy decannulation and require multidisciplinary involvement, including speech and language therapists [14]. Once nerve injury has occurred, the question is whether immediate repair can still be effective. In a 10-patient case series in an oncological setting, 12-month follow-up showed that only 10% of patients continued to have dysphagia and only 10% had mild voice impairment. One patient regained bilateral vocal fold movement, three showed mild ipsilateral twitching, and most patients recovered functional phonation through contralateral compensation [15]. Intraoperative identification of the recurrent laryngeal nerve cannot rely solely on its usual course. A study of 2,094 patients described a new right recurrent laryngeal nerve variant characterized by an additional cranially ascending branch in addition to tracheal, esophageal, and laryngeal branches, reminding surgeons to remain vigilant for anatomical variations [16].

6. Challenges in Obesity, Pediatric Patients, and Emerging Technologies

The burden of post-tracheostomy care in obese patients is often underestimated. A study of 391 patients found that each one-unit increase in body mass index was associated with a lower rate of tracheostomy tube change (rate ratio, 0.86; 95% confidence interval, 0.77-0.96), whereas the proportion of patients who remained ventilator-dependent at discharge increased significantly with increasing body mass index ($P<0.001$) [17]. Pediatric tracheostomy is even more challenging because the trachea is short, compliant, and prone to collapse, while the thyroid gland is relatively large and vascular. Most centers therefore continue to prefer conventional open tracheostomy with stay sutures. Percutaneous tracheostomy is not recommended in patients younger than 1 year because accidental decannulation may be fatal [18]. To improve the safety of initial puncture, a research team developed a prototype for trans-oral robotic-assisted needle direct tracheostomy puncture. This inside-out approach was designed to reduce the risks of injury to the cricoid cartilage, cervical esophagus, and cervical vessels. In a porcine model, it successfully penetrated muscle and auricular cartilage, but the technology remains at the prototype stage and has not yet been validated in cadavers or humans [19]. A study of 387 patients further showed that the overall complication rate in obese patients was 28.8%, significantly higher than the 15.8% observed in non-obese patients. The most common complication was accidental decannulation (13.7% vs. 5.6%). Patients with a body mass index greater than 40 had a higher risk of multiple complications or death ($P=0.009$); among three deaths in patients with class III obesity, two resulted from cardiac arrest after decannulation [20]. These data indicate that postoperative monitoring in obese patients should not simply follow routine pathways designed for the general population.

7. Neuroprotective Strategies and Home Care

Recurrent laryngeal nerve palsy after minimally invasive esophagectomy is often temporary and recovers within approximately 6-12 months, although some cases are permanent. A narrative review emphasized that when bilateral paralysis causes severe respiratory distress, tracheostomy should not be delayed, because progression to fatal complications must be avoided. Preventive strategies such as nerve integrity monitoring and robot-assisted minimally invasive esophagectomy still require further validation [21]. In a retrospective review of 623 thyroid operations, the recurrent laryngeal nerve injury rate was approximately 4.98%. The rate was markedly higher in reoperative cases than in primary operations (10.81% vs. 4.61%), and routine exposure of the recurrent laryngeal nerve effectively prevented injury. Severe bilateral injury sometimes required tracheostomy combined with carbon dioxide laser arytenoid surgery; in that study, one patient experienced substantial improvement in dyspnea 1 year after this treatment [22]. An umbrella review synthesizing 48 systematic reviews and meta-analyses reached a more conservative conclusion: in thyroidectomy, intraoperative nerve monitoring may reduce temporary and overall recurrent laryngeal nerve injury, but its effect on permanent injury remains uncertain and requires additional prospective randomized controlled trials and cost-effectiveness studies [23]. Whether some aspects of care can be transferred to the home setting is another important question. A study involving 14 children who underwent 77 home tracheostomy tube changes and 82 gastrostomy tube changes reported no complications, 100% family satisfaction, and lower perceived stress for children at home than in hospital (1.29/5 vs. 3.86/5). Overall, 85.7% of families preferred home replacement [24]. These findings support the feasibility of home-based care as

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an option for long-term pediatric tracheostomy management when appropriately trained teams and suitable family conditions are present.

8. Biomechanics and Clinical Evidence for Fixation Methods

Should adult surgical tracheostomy routinely include a Björk flap? A literature review adopted a cautious position. Existing data suggest that the procedure can be performed with a low complication rate, and some studies have reported less tracheal stenosis (in the Dukes comparison, 95% after excisional window vs. 10% after Björk flap; $P<0.01$). However, the strength of evidence remains insufficient to support universal routine use, and multicenter randomized controlled trials are still needed [25]. For children who require long-term tracheostomy, starplasty tracheostomy directly sutures the trachea to the skin to create a mature stoma. In a 39-patient case series, no early complications, accidental decannulations, or tracheostomy-related deaths were reported, and reinsertion after decannulation was easier [26]. Individualization of fixation tension is also important. A case report showed that overly tight ties combined with forceful coughing can cause extensive cervicofacial subcutaneous emphysema. Symptoms improved after loosening the ties and providing antitussive and sedative supportive therapy, highlighting the importance of monitoring tie tightness [27]. Experimental models provide concrete biomechanical evidence. In an artificial neck model, the addition of medial or lateral sutures required a greater force to dislodge the tracheostomy tube than ties alone, and medial sutures were more resistant to pullout than lateral sutures (all $P<0.0001$). Shiley tubes were also generally more resistant to dislodgement than Portex tubes [28]. Clinical translation likewise supports this approach. In a prospective cohort study of 205 patients, no deaths from accidental decannulation occurred in the stay-suture group, whereas three deaths occurred in the conventional tracheostomy group ($P=0.024$). The authors recommended that this technique be considered particularly for obese patients and those with short necks [29].

9. Limitations of Intraoperative Monitoring, COVID-19 Experience, and Integrated Care

In a single-center experience of 1,471 thyroid operations, intraoperative nerve monitoring and neurostimulation laryngoscopic assessment both showed high negative predictive values for normal postoperative vocal fold function (99.5% and 99.2%, respectively). Patients with bilateral vocal fold paralysis may require tracheostomy or vocal fold lateralization depending on symptoms, indicating that even good monitoring cannot completely eliminate the need for tracheostomy [30]. The COVID-19 pandemic further highlighted the complexity of tracheostomy timing and safety. In one single-institution study, the median time to tracheostomy was 22 days after initiation of ventilation, and the median duration of mechanical ventilation was 39.4 days. Earlier tracheostomy was associated with shorter ventilator duration, but 45% of patients experienced adverse events, mostly anticoagulation-related bleeding. No healthcare workers involved in tracheostomy in that study developed COVID-19 within 1 month after the procedure, suggesting that the procedural risk is controllable with appropriate protection [31]. In a large Brazilian retrospective study of 356 patients, in-hospital mortality was 68% and was not significantly associated with tracheostomy after more than 21 days. Instead, mortality was associated with age greater than 60 years, chronic lung disease, diabetes mellitus, lack of vaccination, and a PaO_2/FiO_2 ratio below 200 on the day of surgery. These findings suggest that decision-making should integrate the patient's overall condition rather than relying only on ventilator days [32]. Looking forward, digital tools such as artificial intelligence, virtual reality simulation, and telemedicine may help address inconsistent training, difficulties in home follow-up, and variation in care. Some studies suggest that artificial intelligence-driven training can reduce critical errors in tracheostomy care, but clinical validation, algorithmic transparency, and ethical governance remain necessary [33]. Intraoperative nerve monitoring also has risks. A case report suggested that excessive stimulation may cause nerve fatigue and postoperative paresis. Visual identification of the nerve remains the gold standard for nerve protection, and the authors recommended that intraoperative nerve monitoring be used as an adjunct in difficult cases rather than as a universal substitute [34]. At the level of daily stoma care, a comprehensive wound care review recommends inspection every 4-8 hours after a new tracheostomy, maintaining tie tightness such that one finger can fit beneath the ties, maintaining cuff pressure at 20-25 mmHg, performing the first tube change 10-14 days after percutaneous tracheostomy and 3-7 days after open tracheostomy, and ensuring that decannulation candidates have an effective cough, can protect the upper airway, and can clear secretions [35].

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10. Conclusions

Returning to the central question of this review--how should airway safety after tracheostomy be maintained?--the core answer is that cannula fixation, stoma status, and upper airway function should be managed as an integrated whole. Appropriate suturing can reduce accidental decannulation and false passage formation; standardized stoma care helps reduce infection, granulation tissue, and stenosis; and early recognition of recurrent laryngeal nerve injury is critical to the success of capping and decannulation. In addition, special populations such as obese patients, children, patients with head and neck cancer, and patients with COVID-19 differ in risk profile and management needs, requiring individualized consideration. Clinically, standardized checklists, stoma care bundles, pre-decannulation upper airway evaluation, and multidisciplinary collaboration should form the core of management. Future prospective studies remain necessary to establish more consistent fixation strategies, stoma care standards, and decannulation assessment pathways for high-risk patients.

References

[1] Chauhan B, Kumar A. A comparative analysis of conventional tracheotomy versus Bjork flap tracheotomy. Cureus 2023;15(3).

[2] Marini CP, McMurdo E, McNelis J, Lewis E, Policastro A, Lombardo G, Karev D, Petrone P. A prospective comparative study of the functional results associated with the use of Björk flap tracheostomy versus standard tracheostomy. Eur J Trauma Emerg Surg 2023;49(3):1329-1335.

[3] Chorath K, Hoang A, Rajasekaran K, Moreira A. Association of early vs late tracheostomy placement with pneumonia and ventilator days in critically ill patients: a meta-analysis. JAMA Otolaryngol Head Neck Surg 2021;147(5):450-459.

[4] Kofopoulos-Lymperis E, Stavrati K, Papaconstantinou D, Pikoulis E, Peppa M, Chaidas K, Delides A, Nastos K. Beyond surgical injury: systemic etiologies of recurrent laryngeal nerve palsy. In Vivo 2025;39(6):3090-3105.

[5] Amin R, Agarwal A, Chiang J, Collaco JM, Cristea AI, Propst EJ, Sobotka SA, Balakrishnan K, Benscoter D, Brenner MJ, et al. Care of infants and children with tracheostomies: an official American Thoracic Society clinical practice guideline. Am J Respir Crit Care Med 2025;211(11):2001-2020.

[6] Yoon SI, Bae SM, Namgung H, Park DG. Clinical trial on the incidence of wound infection and patient satisfaction after stoma closure: comparison of two skin closure techniques. Ann Coloproctol 2015;31(1):29-33.

[7] Kennedy MM, Abdel-Aty Y, Lott DG. Comparing tracheostomy techniques: Bjork flap vs. tracheal window. Am J Otolaryngol 2021;42(6).

[8] Spiezia S, Offi C, Misso C, Gaudiello M. Editorial: Intraoperative neuromonitoring: evaluating the role of continuous IONM and intermittent IONM in emerging surgical and percutaneous procedures. Front Endocrinol (Lausanne) 2022;13.

[9] Han R, Gao X, Gao Y, Zhang J, Ma X, Wang H, Ji Z. Effect of tracheotomy timing on patients receiving mechanical ventilation: a meta-analysis of randomized controlled trials. PLoS One 2024;19(7).

[10] Izadi S, Chiu MZ, Koo DC, Meisner J, Mohammed S, Demehri FR, Smithers J, Munoz C, Choi S, Zendejas B. Effectiveness of intraoperative nerve monitoring in reducing rates of recurrent laryngeal nerve injury in aerodigestive and cardiovascular pediatric surgery. Surgery 2025;178.

[11] Shahparonyan RG, Poghosyan AY, Minasyan AM, Bablumyan AY, Malkhasyan IE, Gnuni AS, Matosyan KH, Sargsyan AM, Tadevosyan AE, Muradyan AA. Evaluation of post-tracheostomy scars and their impact on persons' quality of life: a case-control study. Int Wound J 2023;20(2):372-380.

[12] Merchavy S, Kassem K, Awawde R, Abd Elhadi U, Safia A. Intraoperative nerve monitoring parameters and risk of recurrent laryngeal nerve injury in thyroidectomy: a systematic review and meta-analysis. Biomedicines 2025;13(10):2516.

[13] Kodaganur Gopinath S, Jiwnani S, Valiyuthan P, Parab S, Niyogi D, Tiwari V, Pramesh CS. Intraoperative nerve monitoring during minimally invasive esophagectomy and 3-field lymphadenectomy: safety, efficacy, and feasibility. J Chest Surg 2023;56(5):336-345.

[14] Wallace S, McGrath BA. Laryngeal complications after tracheal intubation and tracheostomy. BJA Educ 2021;21(7):250-257.

[15] Mandavgane M, Kumar V, Mokhale K, Bindu A, Mantri M, Mathews S, Jaiswal D, Shankhdhar VK. Long-term outcomes of recurrent laryngeal nerve repair/reconstruction in oncological settings. Indian J Surg Oncol 2024;15(3):469-473.

[16] Shao TL, Qiu WH, Shen BY, Yang WP. New variation of right recurrent laryngeal nerve: cases report. Indian J Surg 2015;77(Suppl 1):38-39.

ISSN 2618-1584 Vol. 8, Issue 3: 78-83, DOI: 10.25236/FMSR.2026.080311

[17] Tucker J, Ruszkay N, Sandifer S, King TS, Goyal N, Goldenberg D, Gniady JP. Obesity is a risk factor for prolonged mechanical ventilation after tracheotomy. Laryngoscope Investig Otolaryngol 2024;9(6).
[18] Markov SS, Markova PP, Madzarova-Nikolova KI. Pediatric tracheotomy: modern surgical techniques, challenges, and clinical considerations. Children (Basel) 2025;12(5):637.
[19] Xiao X, Poon H, Lim CM, Meng MQ-H, Ren H. Pilot study of trans-oral robotic-assisted needle direct tracheostomy puncture in patients requiring prolonged mechanical ventilation. Front Robot AI 2020;7:575445.
[20] Barrera SC, Sanford EJ, Ammerman SB, Ferrell JK, Simpson CB, Dominguez LM. Postoperative complications in obese patients after tracheostomy. OTO Open 2020;4(3):2473974X20953090.
[21] Taniyama Y, Okamoto H, Sato C, Ozawa Y, Ishida H, Unno M, Kamei T. Prevention and management of recurrent laryngeal nerve palsy in minimally invasive esophagectomy: current status and future perspectives. J Clin Med 2024;13(24):7611.
[22] Jiang Y, Gao B, Zhang X, Zhao J, Chen J, Zhang S, Luo D. Prevention and treatment of recurrent laryngeal nerve injury in thyroid surgery. Int J Clin Exp Med 2014;7(1):101-107.
[23] Rezapour A, Derakhshani N, Pouyan SN, Alipour V, Ehsanzadeh SJ, Zare-Sadeghi A, Arabloo J. Safety and efficacy of intraoperative neuromonitoring: an umbrella review. Health Sci Rep 2025;8.
[24] Burlo F, Bortolin I, Grasso DL, Oveglia A, Barbi E, De Zen L, Taucar V, Peri F. Safety and feasibility of tracheostomy and gastrostomy home replacement: a five-year experience from a palliative care center. Front Pediatr 2025;13:1644830.
[25] Au JK, Heineman TE, Schmalbach CE, St. John MA. Should adult surgical tracheostomies include a Bjork flap? Laryngoscope 2017;127(3):535-536.
[26] Schwarz Y, Muhanna N, Raveh D, Shaul C, Shahroor S, Peleg U, Attal P, Sichel JY. Starplasty tracheostomy: case series and literature review. Eur Arch Otorhinolaryngol 2017;274(5):2261-2266.
[27] Alshoubi A, Mathews A. Subcutaneous emphysema following open tracheostomy during tracheostomy mask ventilation. Am J Case Rep 2022;23.
[28] Schaetzel S, Juern J, Kiehl K, Xiang Q, Weigelt J. The effect of suturing on force for dislodgement of tracheostomy tubes: medial versus lateral sutures. J Trauma Acute Care Surg 2013;75(3):492-495.
[29] Lee SH, Kim KH, Woo SH. The usefulness of the stay suture technique in tracheostomy. Laryngoscope 2015;125(6):1356-1359.
[30] Al-Hakami HA. The value of intraoperative neuromonitoring and neurostimulation in thyroid surgery: a single-center retrospective analysis and prospective follow-up. Medicine (Baltimore) 2025;104(38).
[31] Farlow JL, Park PK, Sjoding MW, Kay SG, Blank R, Malloy KM, Washer L, Napolitano LM, Rajajee V, Brenner MJ, Chinn SB, De Cardenas J. Tracheostomy for COVID-19 respiratory failure: timing, ventilatory characteristics, and outcomes. J Thorac Dis 2021;13(7):4137-4145.
[32] Accetta AF, Medeiros DM, Diniz Ribeiro MP, Cardoso SW, Ferreira Tavares IC, Veloso VG, Andrade HB, Japiassú AM. Tracheostomy in COVID-19: a retrospective cohort study of outcomes and mortality predictors in a specialized infectious disease hospital in Brazil. PLoS One 2025;20(6).
[33] Pandian V, Brenner M. Tracheostomy in the digital age: how artificial intelligence and immersive technologies are redefining airway care. Tracheostomy 2025;2(1):5-14.
[34] Alshehri S, Alsarrani F, Aldrees A, Alotaibi A, Alsadun S, Almalik A. Unexpected postoperative incidental recurrent laryngeal nerve palsy post total thyroidectomy after intraoperative nerve monitoring (overstimulation and fatigability): a case report. J Med Case Rep 2025;19:82.
[35] Alsunaid S, Holden VK, Kohli A, Diaz J, O'Meara LB. Wound care management: tracheostomy and gastrostomy. J Thorac Dis 2021;13(8):5297-5313.