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ORIGINAL ARTICLE

Effective role of diode laser in the management of acquired subglottic and tracheal stenoses.

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ABSTRACT… Objective: To assess the efficacy of Diode Laser-assisted Transoral Laser Microsurgery (TLM) in the management of acquired subglottic and tracheal stenoses. **Study Design:** Descriptive Case Series. **Setting:** Department of ENT Surgery, KRL Hospital Islamabad. **Period:** 01.07.2021 to 30.01.2023. **Methods:** Subglottic and tracheal stenosis represent a major therapeutic challenge. Minimally invasive endoscopic treatment strategies including trans-oral laser surgery and pneumatic dilatation, with or without temporary stenting, yield good results. In this unique study, 62 patients were included via non-probability consecutive sampling. They underwent transoral endoscopic laser surgery. Clinical findings in outpatient tracheoscopy were recorded and all data was analyzed using SPSS. **Results:** Half of the patients were <25 years, with significant male predominance. Percentage frequency of stenosis was 8.1%, 38.7%, 33.8% and 19.4% for Myer Cotton grade I, II, III and IV respectively. The glottis to lesion distance ranged from 1.5 to 11 cm with a mean of 2.7±1.71 cm while the length of the stenotic segment ranged from 1 to 6 cm with a mean of 1.28±0.95 cm. Successful decannulation of the tracheostomy tube was achieved in 85.48% patients. Time between first surgery and decannulation ranged from 0 to 18 months with a mean of 9.78±5.52 months as many patients, particularly Myer and Cotton grade I and II stenosis were extubated at the time of primary surgery. **Conclusion:** We conclude that trans-oral endoscopic treatment with diode laser has highly successful outcomes in expert hands. This minimally invasive technique has advantages of no skin incisions, expedited recovery and improved quality of life for tracheostomy dependent patients.

Key words: Diode Laser, Subglottic Stenosis, Trans-oral Endoscopic Microsurgery.

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INTRODUCTION

Acquired subglottic and tracheal stenoses always pose a great surgical challenge. It stems from progressive inflammatory disorder or injury resulting in fibrotic narrowing. This complex disorder causes progressive dyspnea and may present with severe respiratory distress. Causative factors include post intubation trauma[1], external trauma (penetrating or blunt), chondroradionecrosis after radiation therapy[2], chronic infection, chronic inflammatory diseases including Wegener granulomatosis, sarcoidosis, relapsing polychondritis and neoplasms with post intubation injury being the most frequent cause. Such injury may be the result of either endotracheal intubation or tracheostomy.[3] This usually follows periods of prolonged intubation in intensive care units for mechanical ventilatory support. Following mucosal ischemia and ulceration caused by either tube cuff pressure or mechanical irritation, healing occurs with the formation of a firm fibrous scar resulting in varying degrees of stenosis.[4] It is assessed by flexible laryngotracheobronchoscopy in outpatient setting or examination rigid under general anesthesia may be required. Severity is classified using the Myer- Cotton classification.[5]

Treatment options for acquired laryngotracheal stenosis are still under research with current management strategies ranging from permanent tracheostomy to tracheal resection with end-to-end anastomosis and cricotracheal resection each associated with significant morbidity and mortality.[6] Despite initial criticism, endoscopic endotracheal treatments are now getting increasing acceptance and are being successfully used in highly specialized centers as an alternative to open surgery. Studies have been done to determine the efficacy of laser treatment in acquired laryngotracheal stenosis.

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The efficacy of CO_2 LASER in treating subglottic stenosis with decannulation rate of 81.3% has been reported.[7] This study, however, was a retrospective study employing the use of CO_2 laser instead of the Diode laser that we have employed in our study. There are currently some trials ongoing in this field in other parts of the globe such as the multicentre AERATE trial which is going to compare endoscopic laser surgery for subglottic stenosis to mechanical dilatation.[8]

The preference of minimally invasive surgery seems quite obvious considering the advantages of low morbidity, good functional results, lower costs, and shorter hospital stay.[9] Using Diode laser in transoral endoscopic surgery is safe and effective in the management of laryngotracheal stenosis. Meticulous use ensures a precise balance of cutting and coagulation and excellent tissue vaporization. It not only has excellent hemostatic properties as a result of higher absorption by hemoglobin and oxyhemoglobin but also has added advantages of being portable, compact, relatively inexpensive and simple to use. Energy is delivered down a fine quartz glass fiber allowing surgeon to hold the handpiece in a pencil holding grip for accurate manipulation. The malleable fiber guidance system tip can be angled, which allows easier access to deep trachea compared to CO_2 laser.

In a tertiary care centre as ours, subglottic and tracheal stenosis is a common healthcare challenge. No study has been done in Pakistan to determine the effectiveness of Diode laser treatment. The aim of this study is to present this minimally invasive treatment modality for acquired laryngotracheal stenosis which greatly enhances the quality of life of the patient in terms of a tracheostomy free airway.[10]

METHODS

This descriptive case series study was conducted at the Department of ENT and Head & Neck Surgery, KRL Hospital Islamabad after obtaining the approval of ethical research committee vide Reference Number: KRL-HI-ERC/May21/19 Dated 4th May 2021. The duration of study was 18 months from 01/07/2021 to 30/01/2023.

The sample size was calculated by WHO calculator taking confidence level as 95%, anticipated population proportion as 81.3%[7] and absolute precision as 0.10. The sample size calculated was 62 and patients were selected by Non-Probability, Consecutive Sampling.

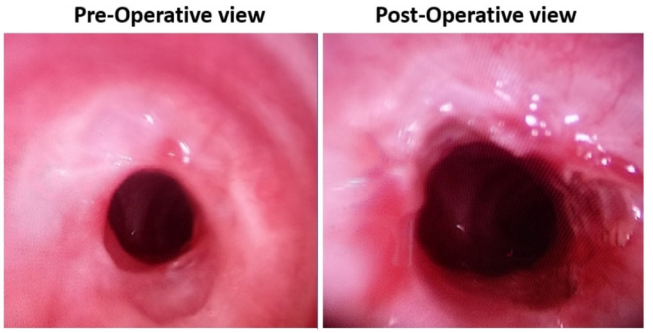
The study included patients of both genders with acquired subglottic and tracheal stenoses secondary to endotracheal tube related injury or external trauma. All patients were dependent on tracheostomy tubes for the maintenance and protection of their airway before transoral endoscopic diode laser-assisted surgery was carried out at our centre with or without stenting of stenotic segment. This study did not include extreme age groups i.e. paediatric or geriatric populations, patients with congenital or acquired subglottic stenosis secondary to Wegener's granulomatosis, sarcoidosis, relapsing polychondritis or chondroradionecrosis.

In our study, all operations were carried out by the same surgeon to maintain the treatment standards. The surgery is accomplished by initially obtaining good exposure in head extended position with laryngoscope in supported suspension. With necessary radiological information on board, preoperative endo-tracheoscopy is carried out to evaluate grade and length of stenotic segment. Using meticulously controlled anaesthesia parameters, intermittent phases of apnoea are utilized for laser surgery using radial cuts and careful evaporation of tissue in the stenotic segment to create air space. It is more challenging in complete stenosis where exceptional care is taken to avoid potential risk of tracheal perforation. This is routinely followed by pneumatic dilatation. Triamcinolone may be injected at the base of the radial cuts to prevent recurrence. Lastly mitomycin-c is applied as an anti-mitotic agent to further discourage fibroblastic activity. One representative photograph of a case of supra-carinal tracheal stenosis is shown. The main bronchi can be clearly visualized below the operated segment. (Figure-1)

Postoperatively patients are kept on mycophenolate mofetil as an immunomodulator[9,11] for varying lengths of time to avoid recurrence of this very stubborn pathology and we have very good outcomes of this strategy in out centre.

FIGURE-1

Comparative pictorial analysis



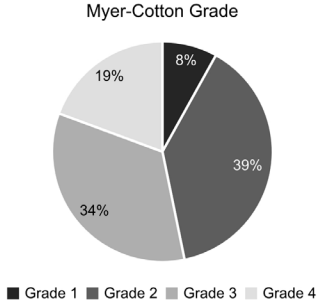
Some patients require temporary stenting with Montgomery T tubes in their journey towards decannulation which may even be a permanent solution in rare cases such as those who have tracheomalacia or severe tendency for recurrence. In this study, this population is not analyzed separately from those who found cure in a single endoscopic intervention.

RESULTS

The age of the patients ranged from 12 years to 61 years with a mean of 28.95±12.42 years. Majority (n=31, 50.0%) of the patients were aged <25 years, followed by 20 (32.3%) patients aged between 25-40 and 11 (17.7%) patients aged above 40 years. There were 47 (75.8%) male and 15 (24.2%) female patients with a male to female ratio of 3.1:1. Stenosis resulted from intubation injury in 48 (77.4%) patients while laryngotracheal trauma was identified as underlying cause in 14 (22.6%) patients. 5 (8.1%) patients had Myer-Cotton Grade-I stenosis while Grade-II, Grade-III and Grade-IV stenosis was noted in 38.7%, 33.8% and 19.4% patients respectively. This is represented in Figure-2.

FIGURE-2

Percentage of patients with various grades of stenosis classified using the Myer-Cotton grading system



The glottis to lesion distance ranged from 1.5 cm to 11 cm with a mean of 2.70±1.71 cm while the length of the stenotic segment ranged from 1 cm to 6 cm with a mean of 1.28±0.95 cm. These findings have been summarized in Table-I.

TABLE-I

Baseline characteristics of study population

Characteristics	Participants n=62
Age (years)	28.95±12.42
• ≤25 years	31 (50.0%)
• 25-40 years	20 (32.3%)
• >40 years	11 (17.7%)
Gender	
• Male	47 (75.8%)
• Female	15 (24.2%)
Etiology	
• Laryngeal Trauma	14 (22.6%)
• Intubation Injury	48 (77.4%)
Myer-Cotton Grade	
• Grade-I	5 (8.1%)
• Grade-II	24 (38.7%)
• Grade-III	21 (33.8%)
• Grade-IV	12 (19.4%)
Glottis to Lesion Distance (cm)	2.70±1.71
• <4cm	56 (90.3%)
• ≥4cm	6 (9.7%)
Length of Stenosed Segment (cm)	1.28±0.95
• <3cm	55 (88.7%)
• ≥3cm	7 (11.3%)

Decannulation was achieved in 53 (85.48%) patients. The time lapse between first procedure and decannulation ranged from 0 to 18 months with a mean of 9.78±5.52 months. Transoral endoscopic laser surgery was found to be effective in 53 (85.48%) patients with acquired subglottic or tracheal stenosis as shown in Table-II.

When stratified, the frequency of effectiveness decreased with increasing length of the stenotic segment; <3cm vs. ≥3cm (83.6% vs. 57.1%; p-value=0.095), however the difference didn't reach statistical significance. There was also no statistically significant difference in the frequency of effectiveness across various subgroups of

patients based on age (p-value=0.732), gender (p-value=0.410), etiology (p-value=0.823), Myer-Cotton grade (p-value=0.627) and glottis to lesion distance (p-value=0.861) as shown in Table-III.

TABLE-II

Frequency of effectiveness of transoral endoscopic laser treatment in patients with acquired subglottic/tracheal stenosis n=62

Effectiveness	Frequency (n)	Percent (%)
Yes	53	85.48%
No	9	14.52%
Total	62	100.0%

TABLE-III

Frequency of effectiveness of transoral endoscopic laser treatment across various subgroups of patients with acquired subglottic stenosis n=62

Subgroups	n	Effectiveness n (%)	P-Value
Age			
• ≤25 years	31	26 (83.9%)	0.732
• 25-40 years	20	15 (75.0%)	
• >40 years	11	9 (81.8%)	
Gender			
• Male	47	39 (83.0%)	0.410
• Female	15	11 (73.3%)	
Etiology			
• Laryngeal Trauma	14	11 (78.6%)	0.823
• Intubation Injury	48	39 (81.2%)	
Myer-Cotton Grade			
• Grade-I	5	5 (100.0%)	0.627
• Grade-II	24	18 (75.0%)	
• Grade-III	21	17 (81.0%)	
• Grade-IV	12	10 (83.3%)	
Glottis to Lesion Distance			
• <4cm	56	45 (80.4%)	0.861
• ≥4cm	6	5 (83.3%)	
Length of Stenosed Segment			
• <3cm	55	46 (83.6%)	0.095
• ≥3cm	7	4 (57.1%)	

Observed difference was statistically insignificant across all the above listed variables which means that the effectiveness of transoral endoscopic laser surgery was almost equal among each category except for the length of stenosed segment which is slightly significant and suggests special care needed for the patients having length of the stenotic segment greater than 3 cm.

DISCUSSION

The laryngotracheal complex has a key role in pulmonary ventilation and also provides a pathway for expectorating pulmonary secretions. Therefore, airway stenosis has a significant impact not only on the sufferer's quality of life but potentially on life, itself[12] as it causes breathlessness, especially during physical activity. Retention of pulmonary secretions may lead to lung infection or collapse. The incidence of laryngotracheal stenotic pathology is significantly surging as survival rates following trauma and periods of ventilation on Intensive Care Units (ICUs) are improving.[13]

Lasers have long been employed for tissue excision and vaporization. These include CO_2, Diode, Argon, Nd:YAG, Holmium:YAG mainly, along with other lasers. We find Diode laser preferred for endoscopic treatment of subglottic and tracheal stenoses because this enables precise cutting and evaporation with minimal lateral thermal damage, thereby preserving viable cells for re-epithelialization of the injured area.

Ozkul Y et al.[7] published a study on CO_2 laser-assisted transoral endoscopic treatment for subglottic stenosis and favored its use in future practice but it does have significant limitations such as increased cost and limited access in the deep trachea. The diode laser, with its flexible fiber and ability to reach deep and curved areas through a handheld fiber delivery system can be used to cure even 'supracarinal' tracheal stenosis which we have defined and published in the British Medical Journal in September 2024.[9]

Sathe et al. have described the successful use of CO_2 laser-assisted endoscopic management of three cases of tracheal stenosis in 2022.[14] Delivery of laser beam effectively in deeper trachea is however a limiting factor. Diode Laser has superior coagulation making it a very useful tool for management of not only airway but many other ENT pathologies as well as we widely employ at our centre.[15,16,17]

Mulakaluri et al in their recent (2023) study on 13 patients undergoing tracheal resection and anastomosis for post intubation tracheal stenosis reported a postoperative bleed in 7.6% of their patients and the mean duration of hospital stay was 5 days with an interquartile range of 2 to 15.[18] In comparison to this, of our 62 patients, not even one suffered any post operative bleed and they are usually discharged from the ward on the 2nd post-operative day.

The present study is first of its kind in local population and adds to the very limited published international research evidence on the topic. The strengths of the present study are its large sample size of 62 cases and long-term follow up of 18 months. We also stratified the data to address various effect modifiers. In the present study, transoral endoscopic treatment with Diode laser resolved acquired subglottic and tracheal stenosis in 85.48% of patients. As we have already discussed the comparison with other laser systems, Diode laser is relatively inexpensive, portable, safer and easier to use. Owing to these advantages and apparent comparable efficacy the present study advocates the use of Diode laser in the management of such patients in future practice. The objective of this study was to determine the effectiveness of transoral endoscopic laser-assisted surgery in acquired subglottic and tracheal stenosis. We observed that with transoral endoscopic Diode laser surgery, decannulation was possible in 85.48% patients with acquired subglottic and tracheal stenosis within the follow up period of 18 months.

It was further noted that the effectiveness of treatment decreased with increasing length of the stenotic segment which suggests its potential role in the risk stratification and management planning of such cases and thus, necessitates further studies in this regard. Furthermore, this technique requires extensive training of not only the primary surgeon but also the anaesthetists[19], assistant surgeons and complete operation theatre staff to ensure patient and healthcare providers' safety while the laser is being used.[20]

CONCLUSION

In the present study, transoral endoscopic treatment with diode laser resolved acquired subglottic and tracheal stenosis in 85.48% of patients which along with its inexpensive and portable nature, good hemostatic properties and ease of administration advocates the preferred use of diode laser in the management of such patients in future practice.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Palacios JM, Bellido DA, Valdivia FB, Ampuero PA, Figueroa CF, Medina C, et al. **Tracheal stenosis as a complication of prolonged intubation in coronavirus disease 2019 (COVID-19) patients: A Peruvian cohort.** Journal of Thoracic Disease. 2022 Apr; 14(4):995.
2. Kim J, Kim SI, Lee CG, Chang JS, Kim TH. **Chondroradionecrosis of the trachea after definitive radiotherapy for cervical esophageal cancer: A case report.** Clinical Case Reports. 2021 Sep; 9(9):e04622.
3. James P, Parmar S, Hussain K, Praveen P. **Tracheal stenosis after tracheostomy.** British Journal of Oral and Maxillofacial Surgery. 2021 Jan 1; 59(1):82-5.
4. Ghiani A, Tsitouras K, Paderewska J, Munker D, Walcher S, Neurohr C, et al. **Tracheal stenosis in prolonged mechanically ventilated patients: Prevalence, risk factors, and bronchoscopic management.** BMC Pulmonary Medicine. 2022 Jan 6; 22(1):24.
5. Ahmadian D, Wehbi N, Tseng PK, Bixby B, Yip HT. **Assessing the interrater and intrarater reliability of subglottic stenosis grading systems.** American Journal of Otolaryngology. 2024 Jul 1; 45(4):104323.
6. Ly NM, Van Dinh N, Trang DT, Hai NV, Hung TX. **Apnoeic oxygenation with high-flow oxygen for tracheal resection and reconstruction surgery.** BMC Anesthesiology. 2022 Mar 18; 22(1):73.
7. Ozkul Y, Songu M, Imre A, Ates D, Arslanoglu S, Pinar E, et al. **CO2 laser treatment of tracheal stenosis.** Acta Otolaryngol. 2015; 135(11):1160-2.
8. Soumagne T, Guibert N, Atallah I, Lacasse Y, Dutau H, Fortin M. **Dilation versus laser resection in subglottic stenosis: protocol for a prospective international multicenter randomized controlled trial (AERATE trial).** BMJ open. 2022 Mar 1; 12(3):e053730.
9. Sarwar M, Sarwar Z, Khan MS, Khan S. **Laser-assisted endoscopic transoral surgery in apnoeic phase—management strategy for acquired supracarinal tracheal stenosis.** BMJ Case Reports CP. 2024 Sep 1; 17(9):e260397.

10. Aung WT, Ong NY, Yeo SQ, Juhari NS, Kong G, Lim NA, et al. **Impact of pediatric tracheostomy on family caregivers' burden and quality of life: A systematic review and meta-analysis.** Frontiers in Public Health. 2025 Jan 15; 12:1485544.
11. Krawczyk A, Kravčenia B, Maślanka T. **Mycophenolate mofetil: An update on its mechanism of action and effect on lymphoid tissue.** Frontiers in Immunology. 2025 Jan 7; 15:1463429.
12. Kumar V, Malhotra V, Sinha V. **Evaluation of individual quality of life (QOL) among patients with tracheostomy using WHO-QOL BREF questionnaire.** Indian Journal of Otolaryngology and Head & Neck Surgery. 2022 Dec; 74(Suppl 3):5207-16.
13. Ghiani A, Tsitouras K, Paderewska J, Munker D, Walcher S, Neurohr C, et al. **Tracheal stenosis in prolonged mechanically ventilated patients: Prevalence, risk factors, and bronchoscopic management.** BMC Pulmonary Medicine. 2022 Jan 6; 22(1):24.
14. Sathe NU, Srinivas A, Ahmed S, Magdum R. **Management of intrathoracic tracheal stenosis: A challenge.** The Egyptian Journal of Otolaryngology. 2022 Dec; 38(1):31.
15. Sarwar M, Sarwar Z, Khan MS, Jamil M, Khan MY, Khan S. **The role of diode laser assistance in functional endoscopic sinus surgery to reduce perioperative morbidity.** The Professional Medical Journal. 2025 Mar 10; 32(03):260-5. https://doi.org/10.29309/TPMJ/2025.32.03.8870
16. Sarwar M, Sarwar Z, Khan MS, Sarwar R. **Transoral diode laser-assisted resection of a tongue base schwannoma.** BMJ Case Reports CP. 2024 Aug 1; 17(8):e260536.
17. Sheikh S, Sarwar F, Khan NU, Khan MS. **Endonasal endoscopic laser-assisted resection of septal glomangiopericytoma.** Case Reports. 2018 Apr 17; 2018:bcr-2017.
18. Mulakaluri A, Pateel GN, Babu MS, Rao RB. **Achieving successful extubation and cost-effective recovery following anesthetic airway management in supracarinal tracheal reconstruction surgeries: A retrospective analysis.** Cureus. 2023 Jan 26; 15(1):e34225.
19. Stenhoff S, Mills J. **Basic principles of lasers.** Anaesthesia & Intensive Care Medicine. 2024 Feb 1; 25(2):133-7.
20. Roitman A, Dailey SH, Wilson M, Bowen AJ, Schroeder KM, Thibeault SL. **Revisiting fire safety guidelines in CO2 Laser Airway Surgery.** The Laryngoscope. 2026; 136(2):882-89.

AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Zahra Sarwar:** Literature review.
2	**Mavra Sarwar:** Data collection.
3	**Zahra Azeem:** Data analysis.
4	**Muhammad Sarwar Khan:** Data entry.
5	**Muhammad Yasir Khan:** Results writing.
6	**Rukaiya Sarwar:** Draft writing.