Case Series

Modified silicone hourglass stents for the treatment of benign subglottic stenosis: a case series

Liran Zhang^, Cuixia Bian^

Department of Respiratory Medicine, Jining First People's Hospital, Jining, China

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Correspondence to: Cuixia Bian, MB. Department of Respiratory Medicine, Jining First People's Hospital, No. 6 Jiankang Road, Rencheng District, Jining 272000, China. Email: 15929945211@163.com.

Background: Benign subglottic stenosis has been a challenging illness to treat and manage in clinical because of its special anatomical location, and easy recurrence of the condition, which can cause life-threatening asphyxia. For patients who are not suitable for surgery or in urgent need of preoperative transitional treatment, respiratory endoscopy-guided stent placement becomes an alternative treatment option.

Case Description: Clinical data were collected from four patients who received treatment at the Jining First People's Hospital due to benign subglottic stenosis, which was achieved after tracheal intubation/tracheotomy. All patients were male, admitted with shortness of breath, with an average of 45±8.95 years. Among them, three patients refused the surgery, and one patient was unable to tolerate the surgery. Despite repeated intervention under bronchoscopy, airway stability was still not maintained. By inserting modified hourglass silicone stents, the patient's symptoms were improved and the clinical efficacy was satisfactory. Regular follow-up showed good stent position and no granulomatous growth at the ends of the stents.

Conclusions: This is an initial report of improved hourglass stents used for the treatment of benign subglottic airway stenosis. In these cases, the modified hourglass stents had good efficacy and fewer complications and were also accepted by patients.

Keywords: Benign subglottic stenosis; hourglass silicone stents; modified; case series

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Introduction

Subglottic airway stenosis is characterized by a lesion that encroaches within 2 cm of the subglottic area. It is difficult to manage and has poor prognosis. Silicone stenting or T-tube placement is often required when airway stability cannot be maintained during interventions such as high-frequency electric knives, lasers, balloon dilation, freezing, and drug injection. T-tubes are limited in clinical practice because of tracheostomy and aesthetic issues. Silicone stents are available in various shapes, such as hourglass-shaped silicone stents, which have two diameters and are effective in dilating narrow airways and reducing stent displacement. Modified hourglass-shaped silicone stents fit better the subsonic airway, with better conformability, and may reduce the associated complications. The advantages of modified hourglass stents are yet to be reported. We retrospectively

^ ORCID: Liran Zhang, 0009-0002-7310-193X; Cuixia Bian, 0009-0008-7507-7834.

analyzed herein four cases in which a modified hourglass-shaped silicone stent was used to treat benign subglottic airway stenosis; all of the cases came with excellent clinical outcomes. We aim to document our clinical experience in the treatment of benign subacoustic airway stenosis. We present this article in accordance with the AME Case Series reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-900/rc).

Case presentation

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patients for publication of this case series and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Case 1

A 34-year-old man admitted to our interventional pulmonology clinic with a complaint of chest tightness for three months. He underwent tracheal intubation due to severe pneumonia five months ago. Computed tomography (CT) revealed severe narrowing of the subsonic airway (*Figure 1A*). Bronchoscopy showed three degrees of subglottic circular scar stenosis, with diameter of approximately 6 mm (*Figure 1B*), the distance to the sound gate was 10 mm, and the narrow length was 20 mm. The patient underwent electrodissection, cryosurgery, dilation of the airway with a duraloscope and balloon, low temperature plasma radiofrequency ablation and submucosal tretinoin/methylprednisolone injections, which resulted in patency and relief of wheezing. In the past 10 months, he was admitted to the hospital almost monthly due to recurrent airway stenosis and exacerbation of chest tightness, which severely affected the patient's quality of life. Due to his refusal to undergo surgery and the T-tube, as well as considering the special nature and stenosis of the airway, we chose a 15 mm × 13 mm × 15 mm hourglass stent. To fit the lumbar part of the hourglass silicone stent to the stenosis, the stent was modified before the operation: no change in diameter was made, and the length of the stent was cut from 20-15-20 mm to 5-15-20 mm (*Figure 1C*). The stent was dilated at the site of stenosis using rigid scopes before placement, and the cut end was placed firmly in the subsonic area and at the lumbar part of the stenotic segment. After insertion, the tube lumen was clearly visible, and the stent was conformable and not angled with the airway. Regular follow-up in the six months following the implantation showed good stent position without granulation hyperplasia, and only a small amount of sputum remained at the lower end (*Figure 1D-1E*), and the patient was generally in good condition.

Case 2

A 54-year-old man with history of hypertension, coronary heart disease, and hypertrophic cardiomyopathy presented to our emergency department with difficulty in breathing for 20 days. He was given tracheal intubation because of cardiac arrest two months ago, and had new cerebral infarction during the treatment period. Bronchoscopy revealed severe subglottic stenosis, and the diameter was approximately 5 mm (*Figure 2A*), the distance to the sound gate was 10 mm, and the narrow length was 18 mm. In addition, scattered nodular protrusions can be seen in the trachea and bilateral bronchi (*Figure 2B*), which were pathologically confirmed as granulation tissue. We performed an endoscopic intervention treatment for the patient, including electric resection, cryosurgery, and balloon dilation. The second bronchoscopy examination showed significant narrowing of the airway after 17 days, and we decided to implant a silicone stent after consultation with the patient and his family considering the patient's physical condition. We chose a 15 mm × 13 mm × 15 mm hourglass

Highlight box

Key findings

- In four cases, by inserting an improved hourglass silicone stent, good clinical efficacy was achieved, and there were no significant complications during the follow-up process.

What is known and what is new?

- For airway stenosis or softening in which stable airway patency cannot be maintained by intervention, a T-tube or silicone stent is often required.
- Improved hourglass stents may be an excellent tool for treating subglottic airway stenosis.

What is the implication, and what should change now?

- Airway stenting is not a life-long intervention and should be removed. If the condition stabilizes, we plan to gradually remove the stents.

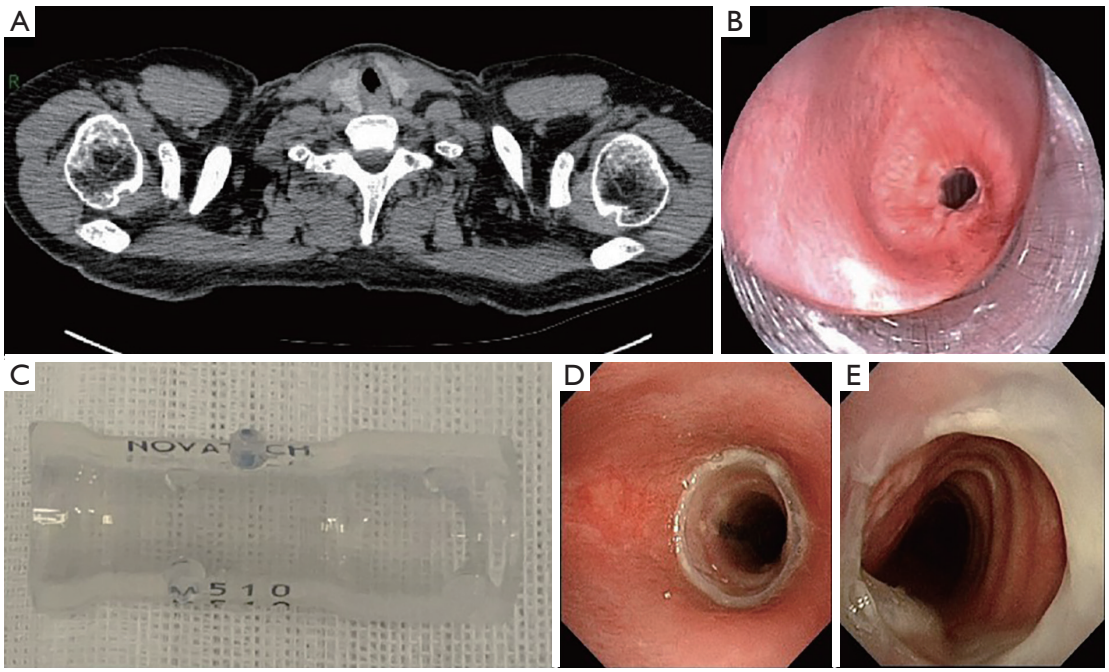

Figure 1 Severe subglottic stenosis treated with modified hourglass stent of case 1. (A) CT demonstrating severe stenosis of the subglottic airway. (B) Bronchoscopy showed circular scar stenosis, diameter of the narrow mouth approximately 6 mm. (C) Modified hourglass stent. Half year follow-up. (D) The upper end of the stent. (E) The lower end of the stent.

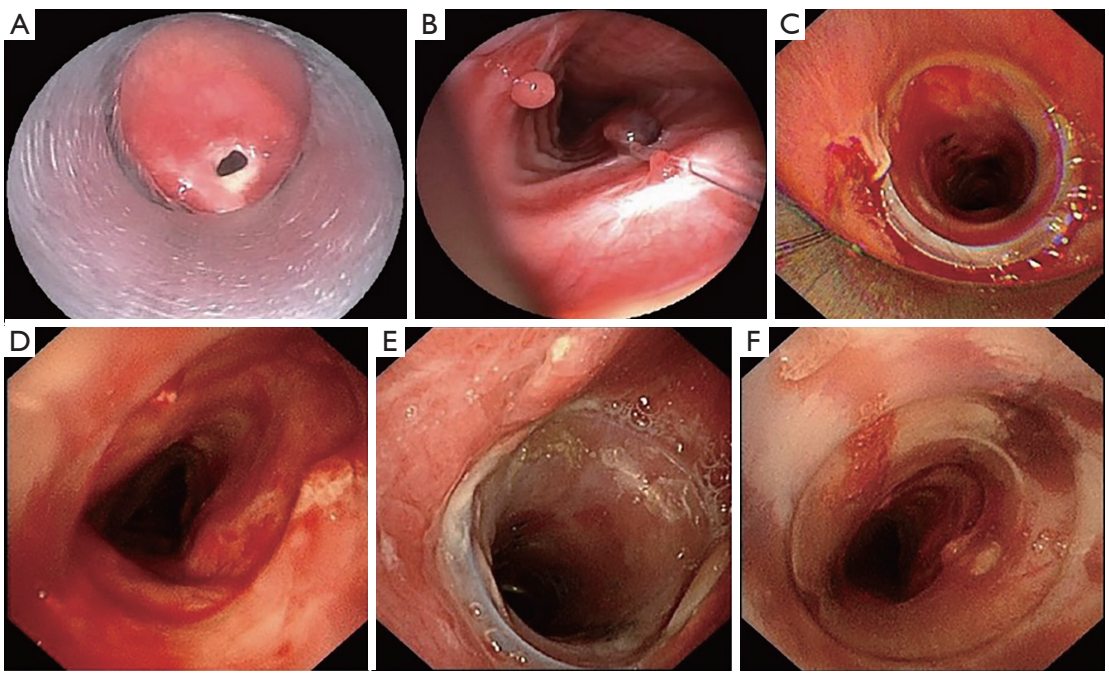

Figure 2 Microscopic presentation and stent placement of case 2. (A) The bronchoscopic view of severe scar contracture stenosis. (B) Multiple nodules in the airway. (C,D) Immediate placement of hourglass stent. (E,F) Half year follow-up: The position of the upper and lower edges of the stent is good, and there is no granulation proliferation.

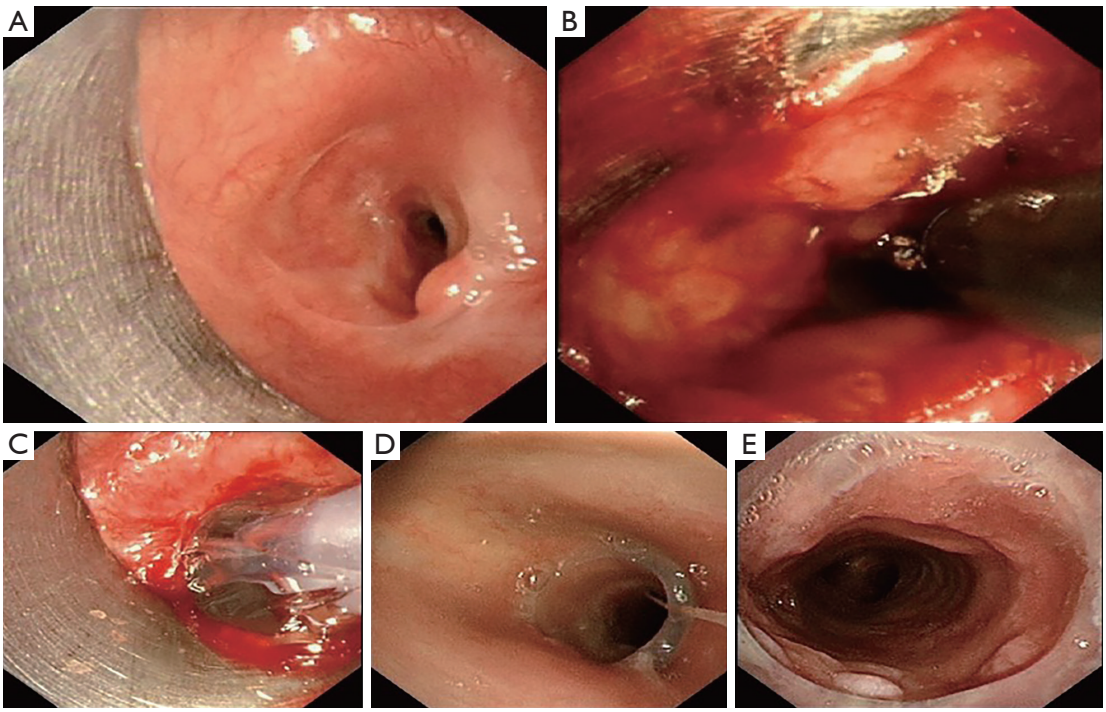

Figure 3 Microscopic presentation, intervention and stent placement of case 3. (A) Bronchoscopic images showing 90% narrowing of the lumen. (B,C) Tracheoscopic interventions. Follow-up at 10 months after stent placement. (D) A little sputum was seen at the upper end of the stent, without displacement or granulomas. (E) A little sputum and slight granulomatous hyperplasia were seen at the lower end of the stent.

stent which had also been modified (*Figure 2C*,*2D*). After insertion, his symptoms improved. For the past six months, regular reviews showed that the support was in good shape (*Figure 2E*,*2F*).

Case 3

A 42-year-old man presented to our emergency department with difficulty breathing for one week. He was given tracheal intubation and tracheotomy successively due to pesticide poisoning a month ago. Under bronchoscopy, the airway mucosa was thickened, granulation tissue was proliferated, and the lumen was narrowed by about 90% (*Figure 3A*). The diameter of the stenotic segment was approximately 4 mm, the distance to the sound gate was 8 mm, and the narrow length was 22 mm. We repeated 6 times of endoscopic intervention treatment for the patient (*Figure 3B*,*3C*), but still failed to maintain stability. The patient expressed that did not want to be repeatedly admitted for endoscopic intervention treatment and would like to seek other methods, but he refused surgical treatment. We implanted the customized hourglass stent (14 mm × 13 mm × 14 mm). The stent had been implanted for 10 months and was in good condition (*Figure 3D*,*3E*). We plan to remove the bracket in the next step.

Case 4

A 49-year-old man was admitted to our hospital with repeated wheezing for 5 months and would like to seek stent treatment. Tracheal intubation was performed 6 months ago due to a fall from height, followed by airway stenosis. Nine times of tracheoscopy intervention including balloon dilatations and cryotherapy were performed outside the hospital, but there was a lack of effectiveness. The patient requested the placement of an airway stent and refused the surgery. Severe subglottic tracheal stenosis was seen under bronchoscopy, the diameter of the stenotic segment was approximately 6 mm (*Figure 4A*), the distance to the sound gate was 6 mm, and the narrow length was 20 mm. The patient and the family still refused the option of surgery after communication on the next treatment options. We placed

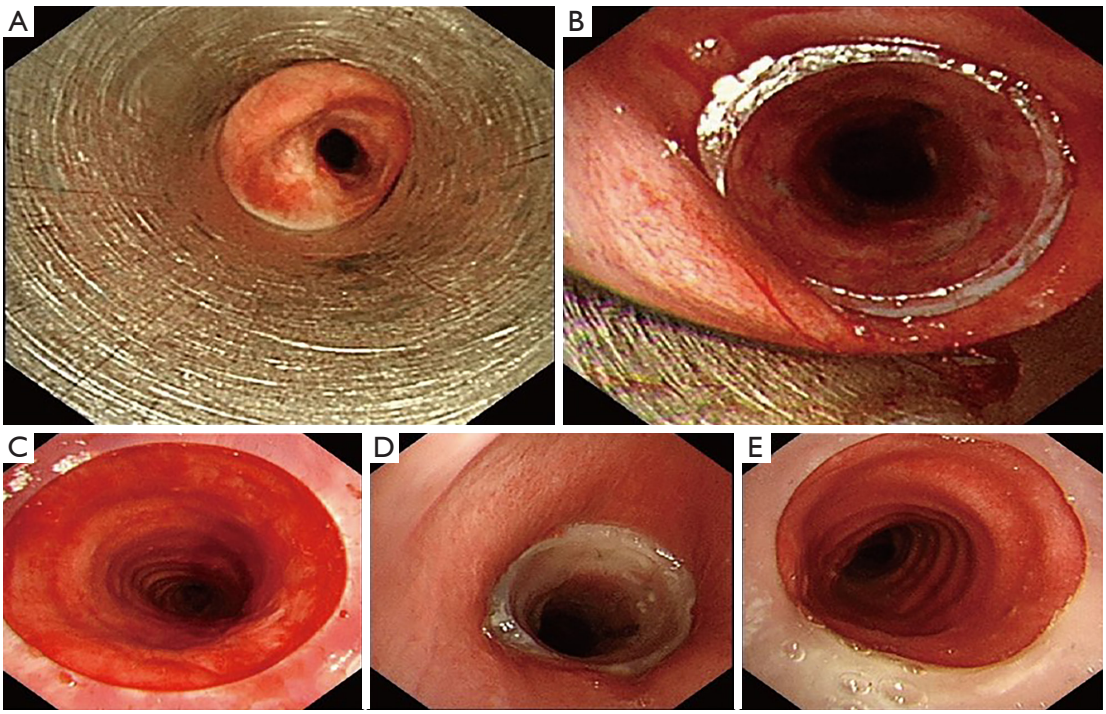

Figure 4 Microscopic presentation, stent placement, and follow-up of case 4. (A) Bronchoscopic images of keloid stenosis. (B) The cut end is adjacent to the subglottic area, proximal end. (C) The lower end of the stent is placed in a position where the airway is essentially normal, distal end. Follow-up observation at 2 months of stent placement. (D,E) Good stent position and no granulomatous growth at the ends of the stents. (D) The upper end of bracket. (E) The lower end of bracket.

a modified hourglass stent (15 mm × 13 mm × 15 mm) (*Figure 4B*,*4C*). Regular follow-up in the two months, the patient was in good condition and there was no granulomatous growth at the ends of the stent (*Figure 4D*,*4E*).

Discussion

The incidence of benign subglottic airway stenosis, most often secondary to tracheal intubation or tracheotomy (1), is increasing, and seriously affects the quality of life of patients. For subglottic airway stenosis, the main treatment modalities nowadays are surgical treatment, tracheostomy, endoscopic-guided stent placement, and pharmacologic treatment. For patients who already have difficulty breathing and are not suitable for surgery, or who urgently need preoperative transitional treatment, respiratory endoscopic intervention therapy has become an important treatment method. For airway stenosis or softening in which stable airway patency cannot be maintained by intervention, a T-tube or silicone stent is often required (2). T-tube placement is an option for patients with or without an intact subglottis. For patients with an intact subglottis, who refuse tracheostomy and T-tube, silicone stent placement may be considered. Straight silicone stents with a single diameter do not fit the tracheal wall well and are prone to displacement, whereas an hourglass silicone stent with a certain anti-displacement effect is a better choice and worthy of clinical application.

As the name implies, hourglass stents come in the shape of an hourglass, which has two diameters, with the center diameter (the "waist") smaller than that of the two ends. There are different diameter specifications to choose from, such as 14-12-14, 15-13-15, 16-14-16, 18-16-18 mm, and with bracket length of 50 mm (waist 20 mm, 15 mm at each end). For the subglottic stenosis placement with an hourglass-shaped stent, the waist part of the stent fits the airway stenosis. The two ends of the stent can fit effectively in the upper and lower airway and match the airway diameter variation. An inappropriate stent shape and diameter have been reported to increase the chances of granulation tissue development (3). Moreover, in benign airway stenosis, which is generally dominated by scar

proliferation and contracture (4), the tissue at the lesion site is hard. The hourglass-shaped silicone stent has a thickness of 1.5 mm, which is less deformable and more supportive compared to the ordinary silicone stent of 1 mm. Additionally, the placement of an hourglass-shaped silicone stent, which provides continuous dilation with moderate tension at the site of airway stenosis, causes less damage to the airway mucosa, reduces postoperative sarcoidosis and airway collapse, and reduces the incidence of airway restenosis. In conclusion, hourglass-shaped silicone stents are advantageous for the treatment of benign subacoustic airway stenosis.

Airway stenosis directly below the acoustic cavity requires modification of the hourglass-shaped silicone stent to completely fit the waist of the stent to the stenosis; otherwise, it may cause coughing, granulation, airway restenosis, and stent displacement. Modifications to the stent can better accommodate anatomical and pathological alterations of the airway (5). Two factors are mainly considered for the modification: to make the stent waist fit with the stenosis, and to keep the upper edge of the stenosis at a suitable distance from the acoustic canal. The hourglass silicone stent is more suitable for subacoustic stenosis with a stenosis length of approximately 20 mm. In the four cases described herein, the average length of the stenosis site was 20±1.63 mm, which matched the stent waist length. The average distance between the upper edge of the stenosis and acoustic door was 5.25±0.96 mm. Based on this distance, we cut the upper end of the stent to 5 mm, which not only allowed the upper end of the stent to be just below the acoustic door lumen and leave a certain distance from the acoustic door, but also helped completely overlap the waist of the stent and the stenosis. After placement of the modified hourglass silicone stent, the lumen was open, the stent conformability was good, and all the patients experienced immediate relief from wheezing symptoms without cough or sore throat.

In our cases, simple modification of hourglass stents can provide conformability to fit subglottic stenosis anatomy and pathology, and with good safety, very few complications, and good reproducibility. Definitely, longer follow-up observation is required. Additionally, airway stenting, when necessary, is not a life-long intervention and can be removed after a period of approximately 12 months (6). If the condition stabilizes, the stents can be gradually considered for removal.

Conclusions

Presently, hourglass-shaped silicone stents have not been fully applied for the treatment of subglottic stenosis. Respiratory endoscopy operators should progressively explore the use of hourglass-shaped silicone stents.

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Footnote

Reporting Checklist: The authors have completed the AME Case Series reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-900/rc

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-900/prf

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-900/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patients for publication of this case series and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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