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Case Report

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Tracheal stent migration in malignant central airway obstruction – a case report and systematic review of literature

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Abstract

Airway stents are critical in maintaining airway patency and managing Central Airway Obstruction (CAO) caused by malignant and benign conditions. Despite their effectiveness, complications such as stent migration are common. We report a case of a 25-year-old female with malignant CAO, which was initially managed with an ultra-flex Self-Expanding Metal Stent (SEMS) followed by stent migration and subsequently interlocking SEMS with Y stent deployment. This case report highlights the complexity of managing malignant CAO. More research is needed to establish optimal practices for preventing stent migration and improving patient outcomes. A systematic review of the literature on airway stent migration was also conducted, revealing an incidence of 5-17%, with higher rates in tracheal stents. Factors such as lesion characteristics and location significantly impact migration risk. This review discusses the advantages and challenges of SEMS compared to silicone stents, emphasizing the need for tailored approaches in stent placement and fixation to mitigate migration risks.

Introduction

An airway stent functions as an endobronchial prosthesis made from diverse materials, serving to uphold and preserve the patency of the tubular airway structures. Its applications include hindering tumor expansion within the airway, aiding in managing airway fistulas, and reinforcing the airway wall to prevent collapse or external pressure. Airway stents play a crucial role in the treatment of patients suffering from Central Airway Obstruction (CAO) caused by various malignant and benign disorders. Although airway stents effectively reduce symptoms, complications are common, especially in long-term follow-up and benign disorders. CAO is an obstruction in the trachea or mainstem bronchi, typically caused by primary or metastatic tumors. This condition can be categorized into extraluminal, endoluminal, or mixed obstructions. Most cases of malignant CAO are advanced stage and necessitate a multimodality palliative approach, including stent placement.[1] Here, we present a case of malignant CAO, which was managed with an ultra-flex Self-Expanding Metallic Stent (SEMS), but soon, there was stent migration for which repositioning was done. An additional Y stent was also placed along with the tracheal stent. We also present a systematic literature review of studies that have reported airway stent migration in malignant airway obstruction.

Case Report

A 25-year-old female, non-addict, presented to the Respiratory Medicine Outpatient Department with complaints of shortness of breath, hoarseness of voice, and dysphagia to solid

food for fifteen days. The patient had no significant past medical history. On examination, the patient had tachycardia; otherwise, it was vitally stable. The patient underwent a chest X-ray, which was suggestive of mediastinal widening. A High-Resolution Computed Tomography (HRCT) of the chest was done, which showed extrinsic compression of the trachea from the posterior aspect. The patient was subjected to an Endoscopic Ultrasound (EUS)-guided biopsy of the mass, which was suggestive of a well-differentiated squamous cell carcinoma of the esophagus. After a complete evaluation and workup, as per medical oncology opinion, the patient was given one cycle of chemotherapy with carboplatin and paclitaxel combination. After about 15 days, the patient complained of increased shortness of breath, difficulty in expectorating sputum, and increased hoarseness of voice. On evaluation, the patient had tachycardia, tachypnea, and stridor. A repeat chest X-ray suggested an increase in the mediastinal mass size.

The patient was subjected to a check bronchoscopy, which revealed increased extrinsic compression of the posterior trachea, extending from the subglottis to just above the carina. The scope could be negotiated beyond the compression, and the main carina with both main bronchi appeared normal. Over time, the patient developed dysphagia to liquids and worsening shortness of breath, due to which she got intubated. A ryle tube was inserted for feeding purposes. For her extrinsic tracheal compression, the patient was subjected to self-expanding cross-weave design metallic stent placement, 14x60 mm, over a guide wire, with the distal end of the stent just above the carina followed by Controlled Radial Expansion (CRE) balloon

dilatation to ensure proper deployment of the stent and it is apposition with the tracheal wall. An endotracheal tube was placed, and the patient was shifted to the Intensive Care Unit (ICU) for observation. The chest X-ray post-procedure showed that the stent had displaced in the right main bronchus (Figure 1). The patient was planning for another procedure to mobilize the stent in the trachea; however, before the procedure, the patient self-extubated, and the stent got expelled due to vigorous coughing. The patient developed respiratory distress and stridor due to the compression of the trachea and had to be re-intubated. The patient was planned for a re-stenting of the trachea with interlock design SEMS this time, and subsequently, the patient was extubated. Given improved performance status, the patient was subjected to a second cycle of chemotherapy with carboplatin and paclitaxel. After another 10 days, the patient again complained of stridor, increased respiratory distress, and was unable to cough out her sputum. The patient developed hypoxia with retention of carbon dioxide and was intubated and mechanically ventilated. Post intubation, the patient had high peak pressures and a bronchoscopy was done, which revealed extensive granulation tissue beyond the length of the stent with extrinsic compression of the left main bronchus. The patient was subjected to a Y-shaped stent, with a stent in-stent procedure (Figure 1). After placing this second stent, the patient's ventilation improved, and she was extubated. The patient's respiratory distress was reduced, and she was weaned off oxygen support.

Discussion

Airway stents have increasingly become a favored option for managing complex tracheobronchial obstructions, mainly due to their straightforward deployment method and the absence of better alternatives (Table 1).[1-16] The first instances of endoscopically implantable stents for airways can be traced back to 1914. Introduced in 1960, the Montgomery T-tube debuted the first dedicated airway stent (Figure 2). Later, in 1989, Dumon initiated placing tracheal stents in the lower sections of the airways, beginning with silicone stents, thereby broadening the scope of airway stenting.[17] With their expanding use, the literature surrounding these fascinating tools has grown, detailing their application across diverse clinical contexts. Despite the significant and often critical improvements in airway function that precise and cautious stent placement can achieve, it is also associated with notable risks. An ideal stent should fulfill these requirements: i) insertion and removal should be easy, ii) it needs enough expansion force to keep the airway open against external pressures without harming the mucosa, iii) it should come in various sizes to fit different airway dimensions and obstructions, iv) it must stay in place within the airway and avoid migration v) it should be composed of an inert material that does not irritate the airway, cause infections, or encourage the growth of granulation tissue, vi) it should not obstruct any branches of the airway, and vii) it must allow for mucociliary mobility and the adequate clearance of secretions. Unfortunately, no single stent can ideally fulfill all these requirements in every situation.[16] Silicone stents are more prone to migration compared to metal stents, and there is a risk that they might even be expelled. This tendency is linked to the intrinsic properties of the materials and their deployment methods. Metal stents are usually inserted in a collapsed state and may be

expanded with a balloon to achieve a fit that is as custom as possible. On the other hand, silicone stents are typically folded and then released to grow to their pre-set shape, which means they are only as secure as their pre-determined size allows.[16] When comparing SEMS with silicone stents, SEMS offer several advantages: they can be effectively inserted using flexible bronchoscopy, they generally have a lower complication rate, including reduced chances of stent migration and fewer occurrences of mucus plug formation or tumor ingrowth. Furthermore, SEMS tend to have a thinner wall, which provides a larger internal diameter and better fit in airways, which is especially beneficial in complex stenosis with irregular airway shapes. Their design enhances placement stability through intrinsic radial force that embeds the stent ends into the bronchial mucosa. However, SEMS have drawbacks: they are difficult to remove, typically more expensive, and there is a higher risk of granulation tissue formation, leading to obstruction and further migration of the stent.[18]

Systematic review

As seen in the index patient, tracheal stent migration is not very uncommon and leads to repeated invasive procedures; thus, we searched the Pubmed (total search results =12) and Google Scholar databases (total search results =1160) and finally included 14 studies (Figure 3) for final systematic review which report tracheal stent migration (Table 1). Managing malignant tracheal stenosis is complex and necessitates a multidisciplinary approach tailored to each case. Bronchoscopic stent insertion serves as a palliative treatment option for

symptomatic patients with proximal tracheal stenosis when radical surgical resection is not feasible or is contraindicated due to medical unfitness or an unresectable lesion, depending on the location and length of the stenosis. A tracheal stent provides immediate and significant symptomatic and functional relief, preserves phonation functions, and enhances the quality of life. Additionally, it can increase the survival rates of these patients.[18]

The incidence of migration was estimated to be 5-17%, with a greater tendency for migration in tracheal stents compared to bronchial stents. Several factors, including the characteristics and location of lesions, contribute to an increased risk of stent migration. Notably, severe funnel-shaped lesions significantly elevate this risk. Lesions high in the trachea, particularly those within 2 cm of the vocal cords, are also highly susceptible to migration. This displacement can lead to various issues: distal migration causes a symptomatic recurrence of the original stricture, while proximal migration can result in dysphonia, coughing, and severe respiratory distress. Stent fixation aims to address or mitigate the issue of migration, especially in cases deemed high-risk. Fixation helps maintain airway patency and alleviate symptoms associated with the stenosis. Furthermore, securing the stent in place can lessen local mucosal irritation caused by minor movements of the stent. Stent fixation should be considered for select patients who are not candidates for surgery and have experienced repeated stent migrations.[18]

The risk of SEMS migration is particularly noted in complex proximal tracheal lesions, representing a significant potential complication. Although challenging, internal fixation of the stent is a viable approach for addressing and preventing stent migration, and it can be performed

without notable post-procedural complications or discomfort to the patient. Therefore, internal fixation should be considered concurrently in selected patients with complex proximal tracheal lesions and at high risk of stent migration.[18] Internal stent fixation also appears to be better from a cosmetic point of view, and suture placement is done directly through vision. In contrast, external suturing creates cosmetic concerns and risks damaging tracheal cartilage and causing cartilage rupture.

The inherent need for a stent dictates the importance of remaining stationary after placement. The Montgomery T-tube, the first dedicated airway stent, had a horizontal limb that prevented stent migration. We searched the literature for elucidating the different built-in mechanisms in contemporary stents that prevent stent migration (Table 2). One of the predominant and obvious mechanisms among contemporary stents is direct pressure on the tracheal/bronchial wall, which prevents migration, and this can be optimized only when the sizing of the stent is adequate; the sizing of the stent can further be done with the help of radiology and a check bronchoscopy before the procedure. Apart from this, the formation of granulation tissue near the stent (seen more commonly with uncovered stents) can also prevent stent migration. Other notable inbuild features to prevent migration are the anti-migration fins that embed in the airway mucosa, as seen in a few stents. Another mechanism that can be used to avoid migration is the use of Y stents, which prevent migration due to their anatomical structure. Lastly, the design of stent wire alignment (interlock or cross-weave design) also prevents stent migration, which we observed in our case (Figure 4). Initially, we placed a SEMS with cross weave design,

which eventually resulted in stent migration, after which we put an SEMS with an interlocking design, which was subsequently successfully placed; on top of that, a Y stent also prevented the migration in our case. A cross-weave design does not allow immediate expansion of the stent and usually takes about 24-48 hours to retain its actual shape, which has a potential for stent migration. Meanwhile, the interlocking design allows instant firm ductal grip just after deployment and thus has a lesser risk of stent migration.

Conclusions

Tracheal stent migration cases can be challenging, and to date, there is no proven standard of care. However, various subsequent steps can be taken, as discussed in this review. We need more data to find the best strategy to overcome tracheal stent migration.

References

1. Makkar P, Revelo A, Lee R, Chawla M. A single center experience of feasibility of a novel Self-Expanding Metallic Airway Stent (Bonastent): a case series. J Bronchology Interv Pulmonol. 2019;26:254-9.
2. Grosu HB, Eapen GA, Morice RC, et al. Stents are associated with an increased risk of respiratory infections in patients undergoing airway interventions for malignant airway disease. Chest. 2013;144:441-9.
3. Huang S, Xu J, An Z, et al. Clinical assessment of airway stent placement in patients with malignant airway lesions. J Thorac Dis. 2018;10:3277-88.
4. Iyoda A, Azuma Y, Sano A, et al. Long-term survival of airway silicone stents in patients with central airway stenosis or obstruction due to thoracic malignancy. Gen Thorac Cardiovasc Surg. 2021;69:1303-7.
5. Marchese R, Poidomani G, Paglino G, et al. Fully covered self-expandable metal stent in tracheobronchial disorders: clinical experience. Respiration. 2015;89:49-56.
6. Marchese R, Poidomani G, Palumbo VD, et al. Secondary carina and lobar bronchi stenting in patients with advanced lung cancer: is it worth the effort? A clinical experience. Ann Thorac Cardiovasc Surg. 2020;26:320-6.
7. Marchioni A, Andrisani D, Tonelli R, et al. Integrated interventional bronchoscopy in treating locally advanced non-small lung cancer with central Malignant airway

Obstructions: a multicentric retrospective study (EVERMORE). Lung Cancer. 2020;148:40-7.

8. Miyazawa T, Miyazu Y, Iwamoto Y, et al. Stenting at the flow-limiting segment in tracheobronchial stenosis due to lung cancer. Am J Respir Crit Care Med. 2004;169:1096-102.

9. Monnier P, Mudry A, Stanzel F, et al. The covered Wallstent is used for the palliative treatment of inoperable tracheobronchial cancers. A prospective, multicenter study. Chest. 1996;110:1161-8.

10. Nakajima Y, Kurihara Y, Niimi H, et al. Efficacy and complications of the Gianturco-Z tracheobronchial stent for malignant airway stenosis. Cardiovasc Intervent Radiol. 1999;22:287-92.

11. Razi SS, Lebovics RS, Schwartz G, et al. Timely airway stenting improves survival in patients with malignant central airway obstruction. Ann Thorac Surg. 2010;90:1088-93.

12. Righini C, Aniwidyaningsih W, Ferretti G, et al. Computed tomography measurements for airway stent insertion in malignant airway obstruction. J Bronchology Interv Pulmonol. 2010;17:22-8.

13. Akram MJ, Khalid U, Abu Bakar M, et al. Indications and clinical outcomes of fully covered self-expandable metallic tracheobronchial stents in patients with malignant airway diseases. Expert Rev Respir Med. 2020;14:1173-81.

14. Bolliger CT, Breitenbuecher A, Brutsche M, et al. Use of studded Polyflex stents in patients with neoplastic obstructions of the central airways. Respiration. 2004;71:83-7.

15. Chhajed PN, Somandin S, Baty F, et al. Therapeutic bronchoscopy for malignant airway stenoses: choice of modality and survival. J Cancer Res Ther. 2010;6:204-9.

16. Zakaluzny SA, Lane JD, Mair EA. Complications of tracheobronchial airway stents. Otolaryngol Head Neck Surg. 2003;128:478-88.

17. Wahidi MM, Herth FJF, Chen A, et al. State of the art: interventional pulmonology. Chest. 2020;157:724-36.

18. Ehab A, Hagemann M. Internal fixation of the proximal tracheal self-expandable metallic stent (SEMS): migration prevention in high-risk patients. J Thorac Dis. 2020;12:3211-6.

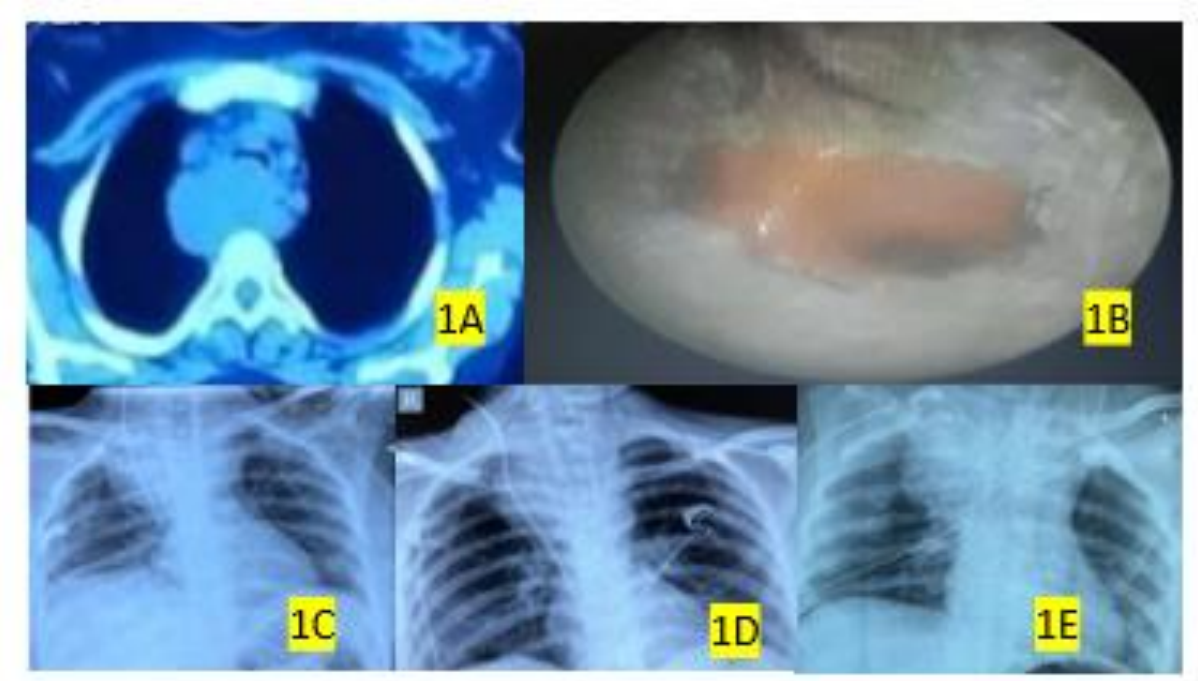

Figure 1. Radiographic and bronchoscopic images. **A)** Mass lesion causing critical airway lumen narrowing. **B)** Bronchoscopic view: post-stent deployment just above the carina. **C)** Chest radiograph showing endotracheal stent *in situ*. **D)** Migration of tracheal stent. **E)** Re-deployment of endotracheal stent along with Y stent.

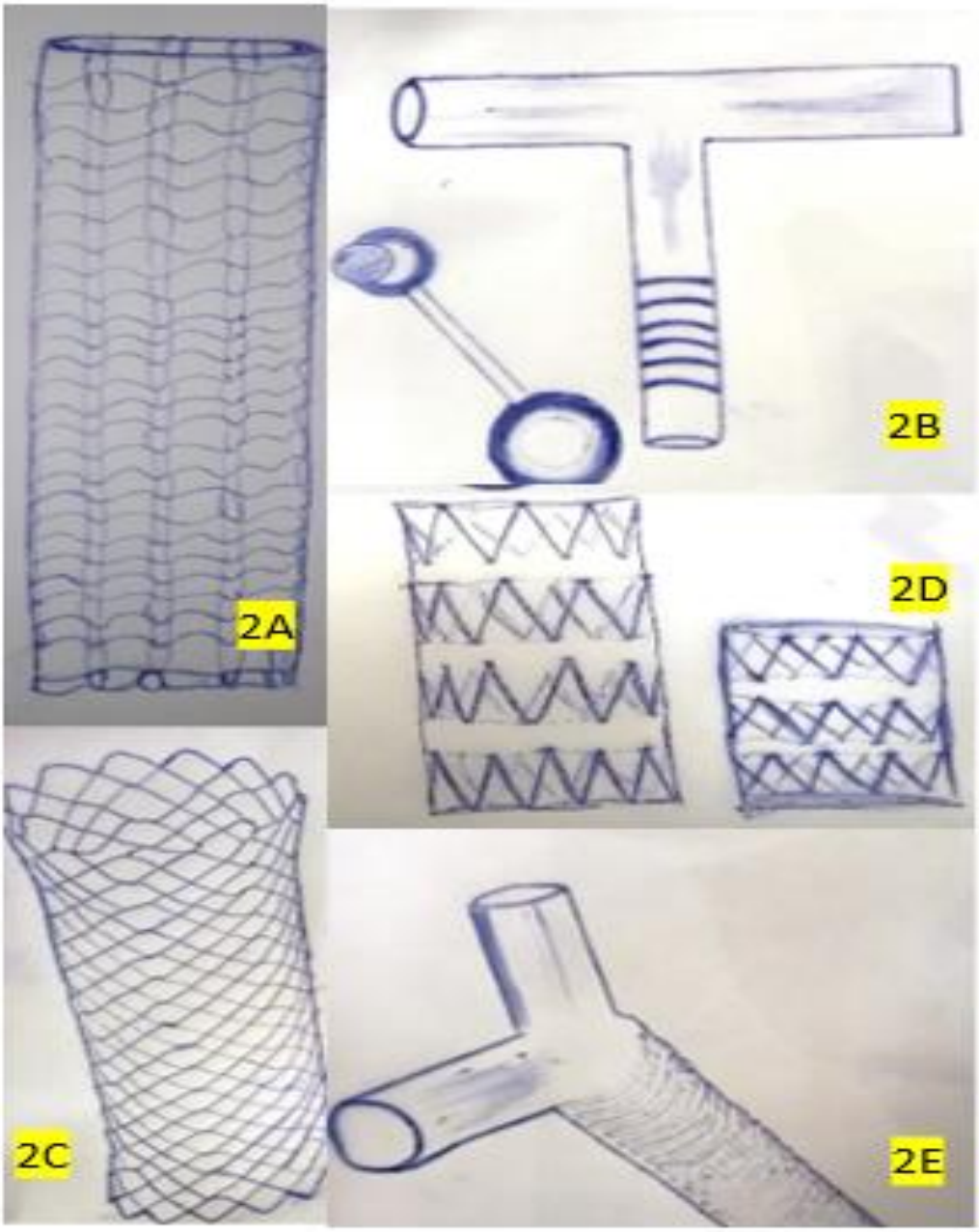

Figure 2. Showing diagrams of different stents. **A)** Ultraflex stent; **B)** Montgomery T-tube; **C)** Bona stent; **D)** Merik stent with anti-migration fins; **E)** Dynamic Y stent.

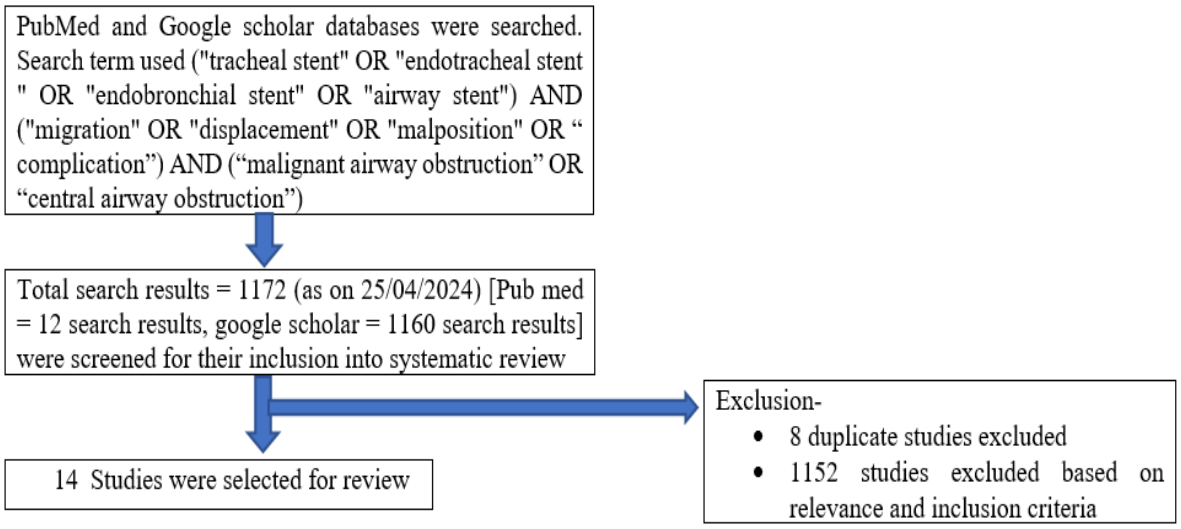

Figure 3. Flowchart for article selection.

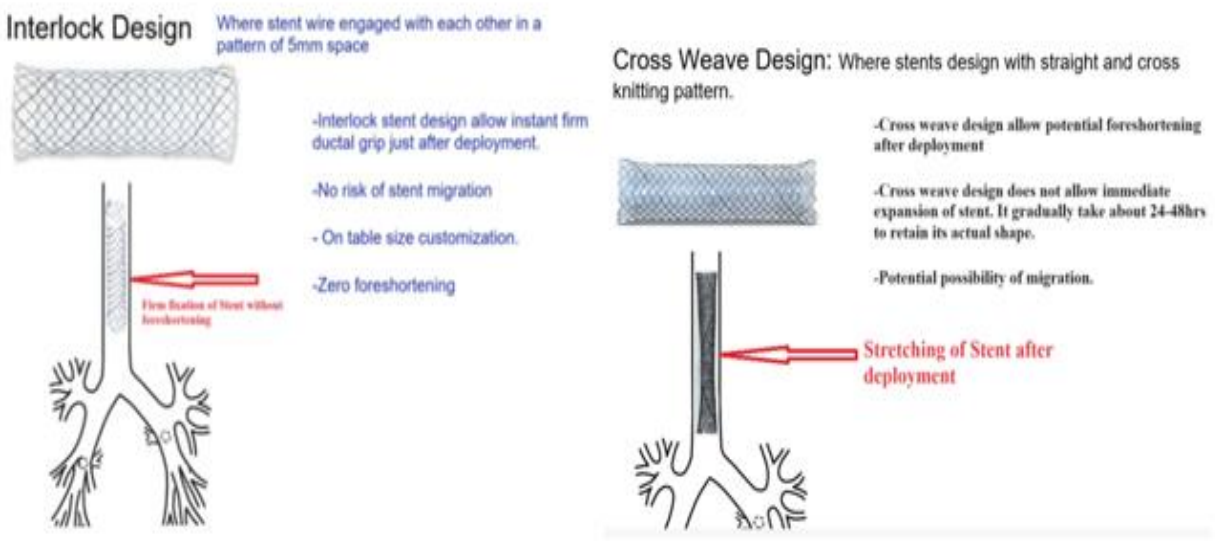

Figure 4. Comparison between interlock design and cross-weave design.

Table 1. Studies included in the systematic review.

S. No.	Author and year	Type of study	Number of subjects	Diagnosis	Stent used	Complication (stent migration)
1	Grosu *et al.*[2]	Retrospective cohort study	72	Non-small cell lung cancer (32), renal cell (10), sarcoma (6), colon (4), thyroid (4), melanoma (3), breast (2), head and neck (1), small cell (1), lymphoma (1), other solid tumors metastatic to lung (8)	Ultraflex stent; Aero stent; Dumon tube stent; Silicone Y-stent; Polyflex stent	Migration: 1
2	Huang *et al.*[3]	Retrospective cohort study	56	Lung cancer (29), esophageal cancer (27) pathology: others and unknown (17), squamous carcinoma(35), adenocarcinoma (4)	Covered SEMS and Y stent. (Tube stent - 31 stents placed, Y-shaped stent - 25 stents placed)	Migration: 5
3	Iyoda *et al.*[4]	Case series	106	Lung cancer (52) (SS: 23 and MS: 29), esophageal cancer (39)	Silicone Stent (SS) or Metallic Stent (MS)	Migration: SS 5, MS 3.

				(SS: 14 and MS: 25), other (15) (SS: 8 and MS: 7). Primary cancer 77 (SS: 33, MS: 44), recurrent cancer 27 (SS: 11, MS: 16).	placement. SS (number of stents): Dumon (27), Dumon Y (18). MS (number of stents): Ultraflex (55), Aero (6).	
4	Marchese *et al.*[5]	Case series	51	Lung cancer (44): non-small cell lung cancer (18), squamous cell cancer (19), small cell lung cancer (7). Metastasis (5): colon cancer (1) esophageal cancer (1) endometrial cancer (2) laryngeal cancer. Hemangiopericytoma (1).	Fully covered SEMS Silamet stent	Stent migration in 7 patients (13.4%)
5	Marchese *et al.*[6]	Case series	51	Advanced unresectable lung cancer	Both metallic and silicone stents were used: fully covered SEMS	Migration: 6 patients (11.53%)

					Silmet® (Novatech, La Ciotat, France); covered Ultraflex® (Boston Scientific, Natick, USA); Dumon stents straight, Y-shape; and Oki stent (Novatech). A total of 52 stents were placed.	
6	Marchioni *et al.*[7]	Retrospective cohort study	100	NSCLC/Stage IB	Silicone stent (NOVATECH Doumon stents, Boston Medical Products, Inc., Westborough, USA). Total number of stenting	Migration: 8 patients (15%)

					procedures: 54 (90%).	
7	Miyazawa *et al.*[8]	Prospective case-control	64	Adenocarcinoma (38), squamous cell carcinoma (18), and small cell carcinoma (8)	64 Dumon stents were placed, including 36 Y and 28 uncovered Ultraflex stents	Migration in 8% of patients
8	Monnier *et al.*[9]	Prospective multicenter study	40	Primary tracheal or bronchial squamous cell carcinoma	50 Wall stents were inserted	Stent migration: 5
9	Nakajima *et al.*[10]	Case series	22	Bronchogenic carcinoma (14), esophageal carcinoma (7), and thyroid carcinoma (1)	A total of 32 stents were placed	Migration: 4 patients
10	Razi *et al.*[11]	Case series	50	Non-small cell lung cancer (38), small cell lung cancer (4), esophageal cancer (4), mediastinal sarcoma (2), and metastatic colon and breast cancer (2)	Ultraflex tracheobronchial stent (Boston Scientific), Dynamic (Y) stent systems (Boston Scientific), and AERO stents	Migration: 2 patients

					(Merit Medical Endotek, South Jordan, USA)	
11	Righini *et al.*[12]	Case series	69	Tracheobronchial cancers (32), esophageal cancer (19), thyroid cancer (9), mediastinal malignancy (6), other malignancies (three, one of each: pulmonary sarcoma, distant metastasis from malignant melanoma, and endometrial carcinoma)	Nitinol stent placement (Ultraflex Microinvasive, Boston Scientific, Watertown, USA)	Migration: 2 patients
12	Akram *et al.*[13]	Case series	51	Esophageal cancer (37), lung cancer (6), osteosarcoma (2), Hodgkins's disease (1), breast carcinoma (1), rectal carcinoma (1), mixed germ cell tumor (1), sarcomatoid	Fully Covered Self-Expanding Metallic Stents (FC-SEMS)	Stent migration: 8 patients (15.7%)

				mediastinal cancer (1), thyroid cancer (1)		
13	Bolliger *et al.*[14]	Prospective study	26	Bronchogenic carcinoma (18), esophageal carcinoma (4), metastases (2), tracheal carcinoma (1), schwannoma (1)	Studded Polyflex stents; a total of 27 stents were used	Migration: 1 patient
14	Chhajed *et al.*[15]	Case series	130	Lung cancer (103), esophageal cancer (9), and pulmonary metastases (55)	One hundred eight total stents were used. In total, 15 Y stents and 93 tube stents (Dumon 34, Polyflex 13, Ultraflex 46) were placed.	Migration: 5 patients

Table 2. Types of available stents and inbuilt mechanisms to prevent migration.

S. No.	Types of available stent (material)	Manufacturer	Placement technique	Sizes available (outer diameter *vs* length)	Anti-migration mechanism
1.	Montgomery T-tube (silicone)	Boston Medical Products, Westborough, USA	Tracheostomy and umbilical tape or Kelly technique	Pediatric: 6-9 mm vertical limb and 6- or 8-mm horizontal limb; adult: 10-16 mm vertical limb and 8 or 11 horizontal limb. The length of all limbs can be customized.	The horizontal limb prevents migration
2.	Tubular silicone	A (Hood Laboratories, Pembroke, USA); B (Boston Medical Products, Westborough, USA); C (Bryan Corporation/Lymol Medical, Woburn, USA)	Rigid Bronchoscopy	Wide range from 9 mm x 20 mm to 20 mm x 80 mm	External silicone studs and direct pressure on the wall

3.	Silicone Y-stent	A (Novatech, Grasse, France); B (Bryan Corporation/Lymol Medical, Woburn, USA)	Rigid bronchoscopy, direct laryngoscopy with “pull technique", modified laryngoscopy and “push technique”	Wide range in diameters of tracheal-bronchial-bronchial 14-10-10 to 18-14-14	The Y shape prevents migration
4.	Dynamic or Freitag stent (Silicone outer construction with C-shaped stainless steel support struts and BA+ sulfate impregnation for increased radiopacity)	Boston Scientific, Natick, USA	Direct laryngoscopy with “pull technique”, modified laryngoscopy and “push technique”	3 sizes: 11x88, 13x10x10, 15x12x12 with tracheal lengths of 110 and R-bronchial 25 mm and L-bronchial 40 mm	The Y shape prevents migration

5.	Ultraflex stent (woven nitinol or nickel-titanium alloy structure with or without a polyurethane cover)	Boston Scientific, Natick, USA	Flexible bronchoscopy with wire-guided fluoroscopy; rigid bronchoscopy with direct visualization	Wide range from 8 mm x 20 mm to 20 mm x 80 mm	In uncovered stent, pressure on wall and granulation tissue prevents migration. In covered stent, proximal and distal 5mm are uncovered to prevent migration.
6.	Merit Endotek or Alveolus (laser-cut nitinol or nickel-titanium alloy structure with polyurethane cover)	Merit Medical Systems, South Jordan, USA	Flexible bronchoscopy with direct visualization; flexible bronchoscopy with wire-guided fluoroscopy;	Wide range from 8 mm x 15 mm to 20 mm x 80 mm	Anti-migration fins that embed in the airway mucosa

			rigid bronchoscopy with direct visualization		
7.	Bona stent (woven nitinol wire structure with silicone cover)	EndoChoice, Alpharetta, USA	Flexible bronchoscopy with wire-guided fluoroscopy; rigid bronchoscopy with direct visualization	Wide range from 10x30 to 20-80 mm	Direct pressure on the wall
8.	Polyflex stent (polyester mesh structure on the outer stent and silicone)	Boston Scientific, Natick, USA	Rigid bronchoscopy	Wide range from 8 mm x 20 mm to 22 mm x 80 mm	Direct pressure on the wall
9.	Balloon-expanding stents (fully	Atrium iCast, Maquet Getinge, Hudson, USA	Flexible bronchoscopy: the balloon and	Wide range from 5 mm x 16 mm to 10. mm x 38 mm	Direct pressure on the wall

	covered stainless steel in two layers of polytetrafluoroethylene)		stent fit through a 2.8-mm working channel		