A Simplified Insertion Technique for Tracheobronchial Silicone Stents*

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In many patients with central airway obstruction due to extrinsic compression or malacia, insertion of tracheobronchial stents can provide effective and permanent relief. Of the various types of prostheses described, the silicone Dumon-Artemis stents (Medicore, Brussels, Belgium) are probably the most efficient. The use of an elegant and safe specially designed stent introducer system combined with a special bronchoscope is proposed for insertion by Dumon. This combined stent insertion system, however, is relatively expensive and cumbersome, especially for centers where relatively limited numbers of patients are treated. We propose an alternative, simplified insertion technique of silicone Dumon-Artemis stents, which was proven safe and efficient in our series of patients. (Chest 1994; 106:520-23)

Key words: bronchoscopy; prosthesis; stenosis, bronchial; stenosis, tracheal

Tracheobronchial obstruction due to benign, eg, postsurgical stenosis, postintubation strictures or malignant, eg, tracheal tumors, neoplastic invasion from adjacent tumors, disorders can often be successfully managed by various endoscopic techniques, thus avoiding the potential morbidity of open surgery.1

In case of coexisting extrinsic compression or malacia, however, these techniques can offer—if feasible at all—only temporary relief. In these patients, insertion of tracheobronchial stents can provide safe, effective, and permanent distention of the compromised airway, thus improving the quality of life.2,3 Of the various types and models of prosthesis described, by far the greatest experience has been obtained with silicone Dumon-Artemis stents (Medicore, Brussels, Belgium).2,4

Classically, stent insertion is achieved by pushing the stent (which is mounted over the tip of the bronchoscope) off with a prosthesis pusher;5 to avoid the risk of vocal cord damage during passage of the stent-mounted bronchoscope, a special stent introducer system combined with a special bronchoscope featuring a series of interchangeable tubes of various size (Efer-Dumon, la Ciotat, France) has been designed and is proposed by Dumon.2,4,5 Though elegant and safe, this introducing system is rather cumbersome and expensive for most centers where relatively limited numbers of patients are treated. We describe our experience with tracheobronchial Dumon-Artemis prosthesis intubation, using a simplified insertion technique.

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METHODS

Eight patients with obstructing tracheal (five) or bronchial (three) disorders (six men, two women, mean age 72 ± 10 years, range 59 to 90 years) were treated. Five patients had neoplastic involvement by lung cancer (one adenocarcinoma, four squamous cell carcinoma), three patients had benign tracheal stenosis (one postintubation stricture, two inoperable intrathoracic goiter) (Table 1).

A simplified insertion technique was designed and tried out on a dummy (Nakashoent Bronchoscopy Model Scopin, CLA, Coburg, Germany). Prior to intubation, the lumen of the rigid bronchoscope (Storz, Tuttingen, Germany) was lubricated with a silicone spray (Silkospray, Rüsch AG, Weilbingen, Germany) for about 10 s. Dumon-Artemis silicone stents of various sizes (Medicore, Brussels, Belgium) were longitudinally folded and introduced into the external orifice of the bronchoscope, and pushed down the shaft using a foreign body forceps. All stent sizes up to 14-mm diameter could be passed through the shaft. During expulsion of the stent, the bronchoscope was simultaneously retracted over a distance equal to the length of the stent. The entire procedure was repeated numerous times, so as to obtain maximal expertise and thus perform the insertion as quickly as possible, since ventilation of the patient is impossible during the passage of the stent.

Rigid bronchoscopy was performed under general anesthesia (intravenous propofol, Diprivan, ICI Pharma) using an 8.5 rigid bronchoscope (Storz) amedined with a multiport head (Storz, Tuttingen, Germany). Ventilation was ensured with high-frequency jet ventilation (Acutronic) through a plastic 14F-diameter catheter previously introduced and fixed in the proximal part of the trachea (six patients) or via a sideport of the bronchoscope (two patients). Prior to intubation, the lumen of the bronchoscope was generously lubricated with the silicone spray. After Nd:YAG laser photoresection of the endoluminal component of the stenos is in five patients with malignant obstruction and in one patient with postintubation stricture, the bronchoscope was positioned with the tip distally to the stenotic lesion. A Dumon-Artemis silicone stent of appropriate dimension was then longitudinally folded and introduced into the external orifice of the bronchoscope, and inserted using the technique described above. During the expulsion of the stent, the bronchoscope was simultaneously retracted over a distance equal to the length of the stent (Fig 1). Final adjustments were made using the same forceps. Tracheobronchial balloon and verification of stent placement was performed with the flexible fiberoptic bronchoscope before extubation.
Regular follow-up with the fiberoptic bronchoscope was performed at a monthly basis.

RESULTS

Results are summarized in Table 1. Eight stents were successfully inserted in eight patients. There were no complications during the procedure. Prelubricating of the bronchoscope shaft allowed quick and uncomplicated introduction of stents up to 14 mm in diameter and in two patients not included in this series, 16-mm-diameter stents were uneventfully introduced using the “classical” external prosthesis pusher method.\(^5\) In one patient in our series, reintubation had to be performed 48 hours after insertion, due to airway obstruction with necrotic tumor material and imperfect stent placement. After mechanical debridement and stent placement readjustment, the postoperative evolution was uneventful. In the patients treated for malignant tracheobronchial involvement, airway patency was ensured until death, except for one patient in whom the stent was removed after 6 months due to bulky tumor growth distal to the prosthesis. In one patient with benign airway stenosis, the stent is still in place 1 year after insertion; in the other patient the stent has been successful for 4 months (with the patient’s death due to acute myocardial infarction).

We did not observe migration of stents; the stents were well tolerated, and irritative cough did not occur. There were no cases of stent obstruction due to dried secretions. Follow-up included regular fiberoptic bronchoscopy at monthly intervals. We observed one case of superinfection with *Staphylococcus aureus* that responded well to antibiotic therapy (oral floxacinil, 500 mg three times a day during 3 weeks).

DISCUSSION

We propose an insertion technique of silicone tracheobronchial stents that is cheap, simple, safe, and efficient.

Airway obstruction with dyspnea, hypoxemia, and ultimately suffocation represents a major complication of various upper airway disorders. Malignant airway disease is the most frequent cause of airway obstruction: an estimated 20 to 30 percent of patients will have retro-obstructive complications, and pa-

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**Table 1—Patient Characteristics, Obstructive Lesions, and Complications***

<table>
<thead>
<tr>
<th>Patient/Sex/Age, yr</th>
<th>Obstructing Disorder</th>
<th>Laser Treatment</th>
<th>Minor Complications</th>
<th>Stent Type and Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/66</td>
<td>Adenocarcinoma LMB</td>
<td>+</td>
<td>–</td>
<td>BD; 30X12 mm</td>
</tr>
<tr>
<td>2/M/68</td>
<td>Postintubation stricture</td>
<td>+</td>
<td>–</td>
<td>TD; 30X14 mm</td>
</tr>
<tr>
<td>3/M/75</td>
<td>Squamous cell care T</td>
<td>+</td>
<td>–</td>
<td>TD; 40X14 mm</td>
</tr>
<tr>
<td>4/M/72</td>
<td>Squamous cell care T</td>
<td>+</td>
<td>–</td>
<td>TD; 40X14 mm</td>
</tr>
<tr>
<td>5/M/62</td>
<td>Squamous cell care LMB</td>
<td>+</td>
<td>–</td>
<td>BD; 30X10 mm</td>
</tr>
<tr>
<td>6/M/59</td>
<td>Squamous cell care RMB</td>
<td>+</td>
<td>Superinfection <em>S aureus</em></td>
<td>BD; 30X10 mm</td>
</tr>
<tr>
<td>7/F/90</td>
<td>Infrathoracic goiter</td>
<td>–</td>
<td>Stent obstruction &lt;24 h; removal of debris + stent readjustment</td>
<td>TD; 50X14 mm</td>
</tr>
<tr>
<td>8/F/89</td>
<td>Infrathoracic goiter</td>
<td>–</td>
<td></td>
<td>TD; 40X14 mm</td>
</tr>
</tbody>
</table>

*1,LMB=left main bronchus; T=trachea; RMB=right main bronchus; TD=tracheal type; BD=standard bronchial type; carc=carcinoma.

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**Figure 1.** A, Under visual control, and after eventual Nd:YAG laser treatment, the previously lubricated bronchoscope is positioned with its tip distal to the stenosis. B, The telescope is removed and the longitudinally folded stent is inserted in the fixed-positioned bronchoscope. The stent is grasped with a foreign-body forceps and pushed distally. C. During expulsion of the stent into the stenosis, the bronchoscope is simultaneously retracted.
Table 2—Various Types and Models of Tracheobronchial Stents Reported in the Literature

<table>
<thead>
<tr>
<th>Stent Type and Material</th>
<th>Characteristic/Remarks</th>
<th>Reference No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone/plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silicone rubber T tube (Montgomery)</td>
<td>Tracheostomy orifice necessary; used in subglottic stenosis, tracheal injury, tracheal stenosis, and complicated tracheal resections</td>
<td>13-19</td>
</tr>
<tr>
<td>Modified (lengthened and/or bifurcated) T tube</td>
<td>Saddles the carina; tracheostomy orifice necessary</td>
<td>20,28,39</td>
</tr>
<tr>
<td>Modified (removed tracheostomy side limb) T tube</td>
<td>Tracheostomy orifice no longer needed</td>
<td>21-23</td>
</tr>
<tr>
<td>Dacron-silicone stent</td>
<td>Intubation of trachea and both mainstem bronchi</td>
<td>24</td>
</tr>
<tr>
<td>Molded silicone (Dumon-Artemis)</td>
<td>Various sizes and types commercially available. No fenestration. Easily removed or changed. Largest experience reported.</td>
<td>4-11</td>
</tr>
<tr>
<td>Fenestrated silicone drain</td>
<td>Case report</td>
<td>25</td>
</tr>
<tr>
<td>Tailor-made modified tracheostomy cannulas</td>
<td>Case report</td>
<td>26</td>
</tr>
<tr>
<td>Endotracheal tube via tracheostomy</td>
<td>Case report</td>
<td>27</td>
</tr>
<tr>
<td>Metal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal alloy tube</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Stainless steel wire coil</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Modified soutar tube</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Stainless steel expandable wire Z stent (Gianturco)</td>
<td>Are inserted rather easily. Do not prevent recurrence by intraluminal tumor growth through the zig-zag wires. Cannot be removed or displaced.</td>
<td>31-34,37</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stainless steel wire springs covered with silicone</td>
<td>Offers protection against encroachment by intraluminal tumor growth</td>
<td>35</td>
</tr>
<tr>
<td>Nylon and PVC-covered expandable metal stents</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>Self-expanding stainless steel wire mesh Scheider prosthesis</td>
<td>Originally designed for use in blood vessels</td>
<td>38</td>
</tr>
</tbody>
</table>

Patients with lung cancer in whom all therapeutic options are exhausted are often at risk for severe airway compromise. Benign causes of airway obstruction include postintubation or postoperative tracheal or bronchial stenosis and/or malacia. Endoluminal obstruction can be managed with a variety of endoscopic techniques such as Nd:YAG laser photodestruction, mechanical tumor removal with forceps or with the tip of the rigid bronchoscope, diathermy, cryotherapy, or photodynamic therapy. If extrinsic compression or malacia are involved, however, these techniques offer, when feasible at all, only temporary relief. Stent insertion can maintain airway patency in these cases. A wide variety of types and models of tracheobronchial stents have been used in the past few decades (Table 2). Recently, a dedicated stent made of molded silicone on which the outer surface bears regularly placed pitted studs to ensure adherence to the airway wall was introduced by Dumon, by far, the largest experience has been built up with this type of stent. The use of a specially designed rigid Dumon-Harrell Universal Bronchoscope (Efer-Dumon, la Ciotat, France) with a specifically designed stent introducer system (Efer-Dumon, la Ciotat, France) for the insertion of these increasingly used silicone stents is propagated although insertion with a fiberoptic bronchoscope is possible.

We agree with Dumon that, although fiberoptic bronchoscopy is often useful simultaneously with rigid bronchoscopy, eg, for laser photodestruction (personal experience), the rigid system is easier and safer for interventional endoscopic procedures such as hemostasis, aspiration, removal, or repositioning of stent.

In most centers, however, therapeutic bronchoscopy with stent insertions is not routinely performed, and relatively limited numbers of patients are treated and in our hospital, it is about ten to fifteen patients a year. Acquisition of the relatively expensive ($25,000) bronchoscope-stent introducer system is, therefore, not easily justifiable. Moreover, the proposed introducer system seems rather cumbersome: the stent is folded and aspirated into a prosthesis introducer tube through a hockey-puck-shaped funnel loader using a vacuum aspiration; the introducer tube is passed down the open bronchoscope, and a prosthesis pusher is then used to expel the stent out into the stenotic segment. The system features a system of interchangeable tubes of various sizes that are used to calibrate and dilate the stenosis. Although the results of this introducer system appear excellent in experienced hands in specialized referral centers, we developed a cheaper and less cumbersome stent introducer system requiring only a “simple” rigid bronchoscope size 8.5 and a foreign body forceps. As shown, the results are excellent in stents with a maximal diameter of 14 mm. For larger tracheal stents, the “classical” system can still be used (personal data).
In conclusion, obstruction of central airways by extrinsic compression or malacia can often be managed by tracheobronchial stents. The silicone Dumon-Artemis stent offers several advantages over other types of prosthesis: they are well tolerated, easily removable or interchangeable, inpenetrable for tumor growth, and resistant to obstruction by dry secretions.\textsuperscript{2,4} The stent insertion system and bronchoscope proposed by Dumon, however, is relatively expensive and cumbersome. Since numbers of patients actually candidates for this type of treatment are usually limited in most hospitals, an alternative simple, safe, efficient, and cheap Dumon-Artemis stent insertion technique is proposed.

ACKNOWLEDGMENTS: The authors thank Hilde De Smedt for secretarial work and are grateful for the invaluable aid offered by the nursing staff: Bea Van Ewijk, May Diericks, Carine Michiels, Anne Ringoir, and Daniel Schuermans.

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