The Margin of Safety of a Left Double-Lumen Tracheobronchial Tube Depends on the Length of the Bronchial Cuff and Tip

L. PARTRIDGE*, W. J. RUSSELL†

Department of Anaesthesia, University of Adelaide and Royal Adelaide Hospital, North Terrace, Adelaide, South Australia, Australia

SUMMARY
The left tracheobronchial double-lumen tube is the commonest device to separate the left and right lungs for differential ventilation. With the appropriate tube, the left bronchial cuff is positioned in the bronchus so that the cuff is beyond the carina but the tip of the tube does not occlude the aperture of the left upper lobe bronchus. The difference between the length of the left main bronchus and the length of the cuff and tip of the bronchial segment of the tube has been termed “the margin of safety” by Benumof. If the length of the cuff plus the tip exceeds that of the left main bronchus, there will be occlusion of the left upper lobe bronchus.

The bronchial cuff and bronchial tip lengths were measured on two hundred and twenty left tracheobronchial (double-lumen) tubes from four manufacturers. The largest cuff-tip length was 40 mm with a Portex 41Fr tube but some 41Fr tubes from all manufacturers had cuff-tip lengths of 33 mm or greater which exceed the length of the shortest left main bronchus measured by Benumof. There was also a marked variation in cuff-tip lengths of the same size tube from the same manufacturer. The largest variation was 18 mm for the Portex 41 but substantial variation of 8 mm or more was found in at least one French size of all manufacturers.

Users must be aware that significant cuff-tip length variation occurs and match the selected tube to the patient to ensure an adequate margin of safety.

Key Words: double-lumen tube, lung isolation, equipment, margin of safety


Address for reprints: Professor W.J. Russell, Department of Anaesthesia, Royal Adelaide Hospital, North Terrace, Adelaide, S.A. 5000.
Accepted for publication on July 4, 2006.
of safety to avoid occlusion at the carina or of the left upper lobe bronchus. Although manufacturer’s data have been quoted, there are no previous independent data on the dimensions of the various sizes from various manufacturers of the tracheobronchial tubes.

This study measured the actual lengths of the cuff and tip on the common sizes of left tracheobronchial tube provided by the four major manufacturers to give the tube dimension of the margin of safety.

METHODS

Left-sided tracheobronchial tubes were collected after they had been used. They were decontaminated and then measured. The bronchial cuff was measured fully inflated so to provide a clearly defined proximal and distal margin of the cuff. This cuff length was then measured with a pair of calipers. The length of the bronchial tip was measured from the end of the cuff to the longest point on the tip. These figures were then added together, to provide the cuff-tip measurement.

The technique of these measurements is similar to that by Russell and Strong for the diameter of the bronchial segments of tracheobronchial tubes.

RESULTS

Two hundred and twenty left-sided double-lumen tracheobronchial tubes were measured. The mean, standard deviation and range of tip lengths and of cuff lengths for each size for each manufacturer are given in Table 1. The mean and range of lengths for the combined cuff and tip for each size for each manufacturer are shown in Figure 2.

Contrary to claims made by the manufacturers

**DISCUSSION**

Using the concept of the margin of safety when choosing a tracheobronchial (double-lumen) tube may help with efficient and efficacious placement of the tube. Patient size and gender indicators can be misleading, and it is important to determine the actual dimensions of the patient’s LMB, giving one an estimate of the likely margin of safety. However we cannot rely on the consistency of tracheobronchial dimensions to simplify the calculation of a margin of safety; if a small LMB is encountered, actual measurements of the cuff-tip lengths of the available tubes of appropriate diameter are essential to provide
the best (shortest) tube with the widest margin of safety. Without a margin of safety, flexion of the neck could move the bronchial segment of the tube in 8 mm or more and cause an obstruction.

At present, if the anaesthetist is aware of a possible length problem in the left main bronchus of the patient, the approximate length of a tracheobronchial tube cuff-tip can be measured through the transparent wrapping and an appropriate tube selected. It would however, be ideal if this information was available on the tube or on the packaging.

The best solution to the problem could be that manufacturers supply a more rigorous quality control, enabling the practitioner to work on the basis that the cuff-tip length is standardized and thus the cuff-tip length is a known quantity and there is a precise figure to work with.

If a situation occurs where either because of a long cuff-tip length on the selected tube or because the patient has a very short left main bronchus, the margin of safety is less than 10 mm, this is a strong argument for inspection of the final position of the bronchial segment of double-lumen tube with a fiberoptic bronchoscope even if this is not the anaesthetist’s routine practice.


des of left tracheobronchial bronchial segments (cuffs and tips) in mm

<table>
<thead>
<tr>
<th>Make</th>
<th>Size</th>
<th>N</th>
<th>Cuff Mean</th>
<th>Cuff SD</th>
<th>Cuff Min</th>
<th>Cuff Max</th>
<th>Tip Mean</th>
<th>Tip SD</th>
<th>Tip Min</th>
<th>Tip Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallinckrodt</td>
<td>41</td>
<td>14</td>
<td>20.86</td>
<td>1.70</td>
<td>18</td>
<td>24</td>
<td>10.00</td>
<td>1.71</td>
<td>7.0</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>27</td>
<td>19.63</td>
<td>1.74</td>
<td>16</td>
<td>23</td>
<td>10.74</td>
<td>1.53</td>
<td>8.0</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>17</td>
<td>19.35</td>
<td>1.37</td>
<td>17</td>
<td>21</td>
<td>10.41</td>
<td>1.42</td>
<td>8.0</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>9</td>
<td>20.06</td>
<td>1.55</td>
<td>17.5</td>
<td>22</td>
<td>10.22</td>
<td>1.12</td>
<td>8.5</td>
<td>11.5</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>7</td>
<td>14.71</td>
<td>2.56</td>
<td>10</td>
<td>18</td>
<td>8.57</td>
<td>1.51</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>4</td>
<td>12.75</td>
<td>1.89</td>
<td>10</td>
<td>14</td>
<td>10.50</td>
<td>0.58</td>
<td>10.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Sheridan</td>
<td>41</td>
<td>20</td>
<td>23.10</td>
<td>2.43</td>
<td>17</td>
<td>27</td>
<td>7.30</td>
<td>3.51</td>
<td>4.0</td>
<td>18.0</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>26</td>
<td>22.77</td>
<td>1.45</td>
<td>20</td>
<td>25</td>
<td>6.67</td>
<td>1.22</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>30</td>
<td>23.27</td>
<td>1.46</td>
<td>20</td>
<td>25</td>
<td>6.37</td>
<td>0.90</td>
<td>5.0</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>14</td>
<td>22.64</td>
<td>2.24</td>
<td>18</td>
<td>26</td>
<td>7.75</td>
<td>4.20</td>
<td>5.0</td>
<td>18.0</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>7</td>
<td>Not avail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>6</td>
<td>22.25</td>
<td>1.72</td>
<td>19</td>
<td>24</td>
<td>5.58</td>
<td>0.92</td>
<td>4.0</td>
<td>6.5</td>
</tr>
<tr>
<td>Portex</td>
<td>41</td>
<td>4</td>
<td>24.50</td>
<td>5.74</td>
<td>16</td>
<td>28</td>
<td>8.00</td>
<td>2.83</td>
<td>6.0</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>7</td>
<td>27.57</td>
<td>0.79</td>
<td>27</td>
<td>29</td>
<td>7.00</td>
<td>0.82</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>11</td>
<td>23.09</td>
<td>1.14</td>
<td>21</td>
<td>24</td>
<td>5.73</td>
<td>0.47</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>10</td>
<td>22.70</td>
<td>1.42</td>
<td>21</td>
<td>25</td>
<td>5.30</td>
<td>0.48</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>7</td>
<td>Not avail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rüsch</td>
<td>41</td>
<td>2</td>
<td>21.00</td>
<td>8.49</td>
<td>15</td>
<td>27</td>
<td>8.00</td>
<td>1.41</td>
<td>7.0</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>3</td>
<td>17.00</td>
<td>1.73</td>
<td>15</td>
<td>18</td>
<td>4.33</td>
<td>1.53</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>4</td>
<td>15.25</td>
<td>0.50</td>
<td>15</td>
<td>16</td>
<td>4.75</td>
<td>1.26</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>3</td>
<td>14.67</td>
<td>2.31</td>
<td>12</td>
<td>16</td>
<td>5.00</td>
<td>2.00</td>
<td>3.0</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>7</td>
<td>Not avail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>2</td>
<td>11.00</td>
<td>1.41</td>
<td>10</td>
<td>12</td>
<td>5.00</td>
<td>1.41</td>
<td>4.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

REFERENCES

Anaesthesia and Intensive Care, Vol. 34, No. 5, October 2006