Abstract

Endoscopic management of tracheal stenosis is a highly-sought alternative to surgical resection; however, it is plagued with long term failure rates of greater than 50%. Among the available endoscopic techniques, balloon dilation is currently used for arterial occlusive disease of the lower extremities. Clinical patency rates have been increased when supercooled at -10 °C. Perfused tracheal tissues was graded as moderate to severe, the cryoballoon trachea showed minimal to no collagen deposition (Figure 3).

CONCLUSION

This preliminary study suggests that dilation with balloon cryotherapy decreases collagen deposition in the injured airway.

SIGNIFICANCE

Long-term patency of immature tracheal stenosis may be improved with the addition of subfreezing temperatures to endoscopic dilation techniques.

Introduction

Endoscopic management of tracheal stenosis is a highly-sought alternative to surgical resection; however, it is plagued with long term failure rates of greater than 50%. Among the available endoscopic techniques, balloon dilation has been advocated because it applies a radial force rather than a shearing force to the tracheal wall, resulting in decreased tissue damage and subsequent restenosis. Balloon dilation alone is plagued by the same high recurrence rates as other endoscopic methods; however, if combined with cryotherapy, it may increase long-term patency in tracheal stenosis. The coupling of cryotherapy and balloon dilation is currently used for arterial occlusive disease of the lower extremities. Clinical patency rates have been increased when supercooled at -10 °C. Perfused tracheal tissues was graded as moderate to severe, the cryoballoon trachea showed minimal to no collagen deposition (Figure 3).

One animal was unable to tolerate the 30 second occlusion time and died during cryodilation. This animal had a predilation narrowing of the entire airway.

Evaluation of Stenosis

Endoscopies were performed at 3 weeks after injury. Stenosis was measured as a percentage of luminal narrowing by a consensus of 3 individuals viewing the procedure on a television monitor. Stenosis was graded as a percentage of narrowing of the entire airway.

Dilation

Three animals underwent dilation by passing a Controlled Radial Expansion (CRE) bronchial dilation balloon (Boston Scientific Corp, Boston, MA) through a Storz 3.5 bronchoscope to the stenotic segment and then inflating it to a diameter of 8 mm with room temperature saline for 30 seconds (Figure 2). The balloon was then deflated and removed immediately.

Three additional animals underwent dilation with the PolaraCh Peripheral Dilation System (Boston Scientific, Boston, MA). The process was the same as in the CRE dilation, except that the PolaraCh Peripheral Dilation System diluted immediately to 8 mm at room temperature for a 15-second test period, after which the balloon temperature immediately dropped to -10 °C. Total dilation time was also 30 seconds.

Postmortem Analysis

Animals were euthanized at 2 and 4 weeks after dilation. Tracheae were preserved in 10% neutral buffered formalin. Sections were made through the area of maximal stenosis and stained in paraffin blocks. Histologic staining was performed with hematoxylin and eosin and with Mason’s Trichrome to analyze collagen deposition. A blinded investigator (BK) then graded the submucosal collagen as follows: none = 0; mild = 1; moderate = 2; and severe = 3. Posterior submucosal thickness was measured from the inner surface of the tracheal wall to the mucosal surface. Lateral and anterior measurements were taken from the inner surface of the tracheal cartilage to the mucosal surface.

Results

Histologic Analysis

Table 1: Histologic data listed by week each animal was euthanized after dilation. Postmortem collagen grade in that animal was 3. In other animals tracheal collagen deposition at 2 weeks post dilation was all graded moderate to severe (Table 1). The 4-week post-dilation tracheae showed marked differences in collagen deposition. While the trachea dilated at room temperature was graded as moderate, the cryoballoon trachea showed minimal to no collagen deposition (Figure 3).

Conclusions

Ballon cryotherapy decreases collagen deposition in injured airways. Long-term patency of immature tracheal stenosis may be improved with the addition of subfreezing temperatures to endoscopic dilation techniques.