Abstract

Objectives: Techniques available for reconstruction of the crico-tracheal region in adults are currently sub-optimal. We sought to 1) Understand the anatomic basis for the perichondrial flap 2) Describe the technique of harvesting and intra-luminal placement 3) Learn the limitations of defects for which it can be used.

Methods: In fresh cadaveric specimens, the perichondrium of the outer layer of the thyroid cartilage was elevated by tracing the superior, medial and lateral borders of each thyroid cartilage ala (see steps below). The inferiorly based flap was then placed into the airway through the cricothyroid membrane. The extent of coverage was measured. The flaps were then placed against the anterior tracheal wall and the circumferential coverage of the airway lumen was measured.

Results: A total of 10 flaps were performed (6 male and 4 female). The average length of thyroid perichondrial flaps obtained was 1.67 cm. All flaps were able to completely cover the cricoid cartilage and extended to but did not cover the first tracheal ring. Once placed intraluminally the flaps extended 2.4 cm below the vocal cords. Using both flaps enabled coverage of the entire anterior 180 degrees of the airway lumen in all specimens. There were no significant differences in the male and female cartilages or right and left sided flaps.

Conclusions: The perichondrial flap is technically feasible and can provide coverage of anterior airway defects up to approximately 2.4 cm below the true vocal cords. This flap could enable transfer of vascularized tissue to aid in crico-tracheal reconstruction. Further work in animal models is in progress.

Introduction

Current operative management of subglottic stenosis is based on the size, degree, and length of the stenotic segment. While several endoscopic operative interventions have been utilized, in patients with severe stenosis open techniques are generally required. In open reconstruction the primary goal is to increase lumenal size either by resection of the stenotic segment with reanastomosis or by augmentation with an implanted material. The most widely utilized material is autogenous cartilage grafts which are most often placed as free grafts.

Several different donor sites have been utilized with multiple modifications to provide vascularized tissue to a free cartilage graft. Providing a vascularized implant provides the theoretic benefits of improved graft survival with decreased cartilage remodeling. Further use of local pedicled flaps have the advantage of utilizing the same operative site and the ability to be performed in the same operative setting. Thyroid perichondrial flaps have been utilized for a variety of procedures including reconstruction of partial laryngectomy defects, and as a vascular supply of the pedicled thyroid cartilage flap.

Further perichondrium has been utilized in the internal lumen of tracheal autografs to improve re-epithelialization and decrease granulation tissue formation. Given these principles we looked to investigate the feasibility of performing pedicled thyroid perichondrial flaps in a cadaver model and evaluate the extent to which they could be utilized for subglottic airway reconstruction.

Methods

In fresh cadaveric specimens, the perichondrium of the outer layer of the thyroid cartilage was elevated by tracing the superior, medial and lateral borders of each thyroid cartilage ala (see steps below). The inferiorly based flap was then placed into the airway through the cricothyroid membrane. The extent of coverage was measured. The flaps were then placed against the anterior tracheal wall and the circumferential coverage of the airway lumen was measured.

A 15 blade was used to incise the thyroid perichondrium in the midline and then traced around the lateral and superior margins on each side. Next a freer elevator was used to elevate inferiorly based perichondrial flaps on each side. Next the airway was divided in the midline through the cricoid down to the 3rd tracheal ring (similar to the incision made to place a costal cartilage graft.

Next both flaps were tunneled through the cricothyroid membrane, placed into the airway lumen and connected in the midline. The inferior extent of the flap was then measured as well as the extent to which it covered the intraluminal surface recorded.

Results

A total of 10 flaps were performed (6 male and 4 female). The average length of thyroid perichondrial flaps obtained was 1.67 cm (range 1.3-2 cm). All flaps were able to completely cover the cricoid cartilage and extended to but did not cover the first tracheal ring in 60% of specimens. The flaps were able to completely cover the 1st tracheal ring in 40% of specimens. Once placed intraluminally the flaps extended 2.4cm (range 2.1-2.6 cm) below the vocal cords. Using both flaps enabled coverage of the entire anterior 180 degrees of the airway lumen in all specimens. There were no significant differences in the male and female cartilages or right and left sided flaps, however all female flaps were able to completely cover the 1st tracheal ring while in male specimens flaps extended to but did not cover the 1st tracheal ring.

Conclusion

The thyroid perichondrial flap is technically feasible and can provide coverage of anterior airway defects up to approximately 2.4 cm below the true vocal cords. This flap could enable transfer of vascularized tissue to aid in crico-tracheal reconstruction. Further this flap has the advantage of being in the operative field and not requiring a separate incision. It can be coupled with a chondral graft of choice and lines the internal airway for improved epithelialization. Additional vascular tissue could be rotated to cover external tracheal lumen to further improve vascularity via a pedicled muscular flap or even a free flap.

The drawbacks of this flap include its relative delicate nature and the limitation of reconstructing only subglottic defects as it was not able to extend below the first tracheal ring. It is yet to be determined if this will have effects on donor cartilage however this is unlikely due to the fact that the internal perichondrial lining of the thyroid cartilage is left undisturbed. Also yet to be elucidated is the degree that this intraluminal flap will improve cartilage survival, decrease graft remodeling, and improve intraluminal re-epithelialization. Further work in animal models is in progress to examine these factors.

In conclusion this flap has shown to be technically feasible in human cadavers and can provide vascularized tissue and internal tracheal lining of defects up to 180 degrees of the anterior subglottis extending 2.4 cm below the vocal cords.

References


Acknowledgements

David Terris for generous research support.

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