Effect of Medialization Thyroplasty on Glottic Airway Anatomy: Cadaveric Model

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ABSTRACT

Objectives:
1. To investigate the changes in airway dimensions after medialization thyroplasty (MT) using a cadaveric model.
2. To evaluate tissue density at the level of the glottis to understand the effect of tissue displacement.

Study Design:
Cadaveric study.

Methods:
• 13 cadaveric larynges underwent fine-cut CT scans before and after MT using carved silastic blocks of 2 sizes (small block (SB) & large block (LB)).
• Cimatormin software was used to measure laryngeal dimensions: intraglottic volume (IGV), cross-sectional area (CSA), posterior-glottic diameter (PGD), and anterior-posterior diameter (APD), and density in Hounsfield units (HU).
• 8 sequential axial cuts (0.625mm) at the level of the true vocal folds were analyzed.
• Minimal CSA was compared to CSA of standard endotracheal tube (ETT).

RESULTS

• There was a statistically significant difference in IGV between the 3 conditions [F=23.5 (2,38)(p<0.0001)].
• There was a statistically significant difference in minimal CSA between the 3 conditions [F=34.65 (2,38)(p<0.0001)].

• There was no statistically significant difference in APD between the 3 conditions [F=1.419 (2,38)(p=0.2624)].

• There was a statistically significant difference in PGD between the 3 conditions [F=12.38 (2,38)(p<0.0012)]. However, there was no statistically significant difference between the SB and LB condition (p=0.0776).

• There was a statistically significant difference in density (HU) between the 3 conditions [F=17.29 (2,38)(p<0.0003)].

INTRODUCTION

One of the mainstays of surgical management of unilateral vocal fold paralysis (UVFPP) has been MT. Airway compromise in laryngeal framework is observed to be around 2.2% & is more likely after arytenoid adduction than after MT. Certain MT patients will go on to have further surgical procedures and one consideration after MT is related to future endotracheal intubation. The largest reported study reviewed 74 post-MT patients who underwent general anesthetic compared to 79 procedure-matched controls. Perioperative complications were found in 6.8%. 3 patients were managed conservatively for glottic edema. 1 patient required conversion from a laryngeal mask to an ETT. 1 patient required a tracheotomy. No airway complications were documented in the control group.

No published report has compared laryngeal volumetric anatomy with silastic placement after MT.

Objectives of present study:
1. Investigate the change in airway dimensions & plaque at the level of the glottis before and after MT.
2. Compare minimum glottic CSA after block placement to standard endotracheal tube CSA.

METHODS AND MATERIALS

• St. Michael’s Research Ethics Board Approval.
• 13 human cadaveric larynges underwent MT (6 ♂, 7 ♀). 2 blocks were carved for each specimen (Type B shim with a length of 2 cm (♀) and 2.5 cm (♂)). The blocks were carved in two sizes with a medialization dimension of 8 & 10 mm for ♂. The ♀ had blocks carved with a 10 & 12 mm of medialization.

• Helical CT scanning of performed on all 13 larynges under 3 test conditions: NB, SB & LB.
• The axial images were analyzed using Carestream Client software.
• Parameters collected included CSA, PGD and APD. A total of 8 consecutive axial glottic sections (0.625 mm cuts) were analyzed to obtain IGV. The tissue density (HU) of the true vocal immediately anterior to the vocal process as at the level of minimal CSA.
• Minimum CSA from each larynx was compared to the CSA of the outer diameter (OD) of standard adult endotracheal tubes.

DISCUSSION

• This study has shown that all parameters studied (IGV, minimal CSA, IGV, PGD) are significantly reduced after MT with a silastic block implant.

• The minimal CSA in ♂ was reduced from 174.3mm2 to 124.4 mm2 with LB. In ♀, the minimal CSA was reduced from 92.38 mm2 to 70.17 mm2 with. The CSA of a standard number 6, 7.5 and 8 ETT is 52.8 mm2, 81.5 mm2 and 95.0 mm2 respectively. Despite using a large dimension implant, the minimal CSA of each ♂ specimen was larger than a standard size 6 ETT & each ♀ specimen was larger than a 7.5 ETT.

• There are no studies which look at radiological imaging of a standard endotracheal (ETT) intubation based on axial imaging post-thyroplasty. Long-term studies for follow up of future airway compromise are rare and only two reports were identified in the English literature.

• The change in the airway minimal CSA is dramatically less than the CSA of the implant. Tissue density of the true vocal fold was found to significantly increased after implant placement, which likely represents tissue compression.

CONCLUSIONS

• This is the first study to compare airway volumetric anatomy with silastic placement after MT.
• The cadaver MT model shows significant changes to the volume, CSA and PGD at the level of the glottis.
• This study indicates that the minimal CSA after MT is adequate for intubation.
• Tissue displacement and some degree of tissue compression must explain the change in tissue density and airway dimensions.
• A further study is planned using CT imaging of larynges in order to design individualized implant.

REFERENCES

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