Vector analysis of cricoid traction strategies to improve swallowing

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**INTRODUCTION**

Oropharyngeal dysphagia is both common and costly yet current treatment therapy and surgeries are often ineffective. A novel dysphagia surgery involving placement of a traction suture around the cricoid cartilage to allow manual control of the oropharynx-oesophageal segment (PES) has been described. The author demonstrated improved PES opening with anterior cricoid traction in a cohort of dysphagic patients. However, superior traction of the cricoid cartilage has not been addressed. Furthermore, cricoid traction’s affect on swallowing mechanics has not been examined. The objective of this study was to evaluate PES opening via kinematics and swallowing biomechanics via morphometric analysis during varying angles of cricoid traction.

**METHODS AND MATERIALS**

This case study involved one head and neck cancer patient who developed severe dysphagia following chemoradiation therapy (CRT). A traction suture was placed at the cricoid cartilage and swallowing attempts were recorded via MBSS. Coordinates mapping 10 anatomical landmarks were collected from all image frames including 3 sequential swallows from 3 different vector conditions (no traction, anterior traction, and superior traction). Multivariate discriminant function analysis of swallowing coordinates was used to determine biomechanics associated with PES opening. Regression analysis was performed using discriminant function scores of PES opening as the criterion variable and cricoid traction as the predictor variable.

Results: Discriminant function analysis revealed significant differences in shape change in open vs. closed PES (Mahalanobis distance = 2.99, p < .0001) with eigenvectors showing increased laryngeal elevation and hyoid excursion to open the PES. Regression analysis of PES opening and cricoid pull revealed a \( r = .41 \) with superior traction and \( r = .51 \) with anterior traction.

Conclusion: In this case study, cricoid traction achieves swallowing shape changes associated with PES opening with the anterior pull being more predictive of PES opening. Multivariate morphometric analysis of MBSS imaging provides an objective analysis of the biomechanics of swallowing resulting from surgical intervention and may play a role in patient selection and type of surgery recommended in dysphagic individuals.

**RESULTS**

- PES opening is significantly greater with cricoid cartilage traction than without traction (\( p < .0001 \)) (Figure 2).
- There was no statistical difference in PES opening between anterior and superior traction (\( p = .27 \)) (Table 1).
- Morphometric discriminant function analysis revealed significant differences in shape change in open vs. closed PES (Mahalanobis distance = 2.99, p < .0001) with eigenvectors (vectors of shape change) showing increased laryngeal elevation and hyoid excursion to open the PES (Figure 3).
- Morphometric discriminant function analysis was performed comparing no traction to anterior traction and no traction to superior traction with eigenvectors demonstrating shape change (Figure 4).
- Regression analysis using discriminant function scores of PES opening as the criterion variable and cricoid traction as the predictor variable revealed a \( r = .41 \) with superior traction and \( r = .51 \) with anterior traction (Figure 5).

**DISCUSSION**

- Cricoid cartilage traction causing increased PES opening is previously described.
- This case study agrees with previous findings and in addition illustrates no significant difference in PES opening between anterior and superior cricoid traction.
- Furthermore, this case study examined swallowing mechanics associated with superior and anterior traction using morphometric analysis of coordinates mapping the swallowing mechanism frame-by-frame.
- Shape changes associated with anterior traction were found to be more predictive of PES opening swallowing shape changes.
- Eigenvectors show anterior traction is more synergistic with swallowing mechanics and likely more useful for rehabilitation of swallowing.

**CONCLUSIONS**

1.) In this case study, anterior traction of the cricoid cartilage achieves PES opening, and is more predictive of PES opening swallowing mechanics than superior traction.
2.) Multivariate morphometric analysis of swallowing using coordinates collected from MBSS imaging provides patient specific analysis of swallowing mechanics useful for evaluating surgical treatment of swallowing dysfunction.

**REFERENCES**