Three Dimensional Compartmentalization of Myosin Heavy Chain Isoforms in the Human Thyroarytenoid Muscle

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ABSTRACT

Educational Objective: At the conclusion of this presentation, the participants should be able to 1) Discuss the variability in myosin content throughout various compartments of the human thyroarytenoid muscle 2) Understand the range of myosin heavy chain isoforms present in the muscle 3) Explain the variability in fatigue resistance, power, and muscle-shortening velocity among different isoforms and 4) Compare this range of isoforms to that present in other muscle types and in other mammals.

Objectives: Myosin heavy chain (MHC) is the primary determinant of muscle-shortening velocity in muscle fibers. Isoforms include MHC-I, II-A, II-D, and II-B, in order of increasing velocity and power. Previous animal work has demonstrated a wide and compartmentalized range of MHC isoforms in the thyroarytenoid muscle, consistent with its multiple functions of phonation, respiration, and airway protection. This study seeks to elucidate the detailed pattern of MHC isoforms in the human thyroarytenoid muscle.

Study Design: Basic science research.

Methods: Five longitudinally-oriented specimens from fresh cadaveric thyroarytenoid muscles were obtained from medial to lateral (M1-L5) at the midline of the cord. Another five specimens were obtained from superior to inferior at both the medial edge (M1-S5) and the lateral edge (L1-L5) of the thyroarytenoid muscle. Specimens were weighed, prepared for gel electrophoresis, and analyzed for total MHC content and percentage of each isoform.

Results: Total MHC content varied markedly between medial and lateral compartments, with highest myosin content laterally. Within both medial and lateral compartments there was a higher MHC-II-D content superiorly. MHC-IIA was the predominant isoform, comprising 60-70% of MHC content. MHC-I was present overall at a higher percentage than in other mammals.

Conclusions: The high level of MHC laterally was striking. We therefore hypothesize that greater force is generated laterally, farthest from the vocal ligament. Furthermore, the isoforms associated with slower contraction velocities and increased fatigue resistance, MHC-IIA and MHC-I, predominated in the human samples compared to the dog.

METHODS

Whole, frozen larynges were obtained from the Cooperative Human Tissue Network. Larynges were harvested within 24 hours following death. The medial and lateral surfaces of the thyroarytenoid muscle were sampled in an superior-to-inferior direction (six samples from both surfaces). The samples were homogenized and analyzed with protein gel electrophoresis. The gels were designed to yield separation of myosin heavy chain isoforms. The gels were silver-stained and the relative amount of each MHC isoform in each gel was determined by scanning densitometry.


CONCLUSIONS

1. Three MHC isoforms were detected in human thyroarytenoid muscle. Sampling up to 15 sites within individual muscles did not reveal any additional MHC isoforms.
2. The lateral surface of the human thyroarytenoid muscle appears to contain a significantly greater amount of MHC, suggesting much higher force generation in fibers constituting this layer.
3. There appears to be a gradient in the expression of the physiologically faster MHC isoform, MHC-II-D, along the medial and lateral surfaces of the human thyroarytenoid. This is expected to impact the speed of contractions and the power output of muscle fibers, with faster and more powerful contractions at the superior portion of both layers.

ACKNOWLEDGMENT

Whole larynges were obtained through the valuable assistance of the Cooperative Human Tissue Network.

Patient 1: 65 YO male, Caucasian, COPD

![Figure 1](image1.png)


![Figure 2](image2.png)

Patient 3: 54 YO, male, Caucasian, colon adenocarcinoma.

![Figure 3](image3.png)