Immunohistochemical Analysis of Aquaporins in the Fetal and Adult Vocal Fold

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ABSTRACT

Objectives:
The purpose of this study is to identify and compare the presence and location of aquaporins in the fetal and adult larynx using immunohistochemical techniques.

Methods:
Immunohistochemical staining was performed on adult and fetal true vocal fold specimens. The presence and location of aquaporins -1, -2 and -3 in the fetal specimens were then compared to the adult specimens.

Results:
Immunohistochemical analysis revealed a homogenous distribution of aquaporin -3 in the cell cytoplasm of adult lamina propria with a higher concentration in the superficial layer (Figs 1 & 2). Aquaporins -1 and -2 were not identified in either the adult specimens. No evidence of aquaporins were identified in the fetal lamina propria.

Conclusion:
Aquaporin -3 was found in the lamina propria of adult true vocal cord specimens with a higher concentration in the superficial layer. No evidence of aquaporins -1, -2, or -3 was found in fetal specimens.

INTRODUCTION

The newborn is heavily dependent on vocal communication to obtain resources in order to survive, requiring higher vocal demands and expenditures than the adult. Specifically, newborns are capable of sustained, maximal, high frequency phonation whose relative loudness output per mass performance exceeds that of the adult. The newborn larynx has been found to exhibit significant, task-specific histological and biochemical differences when compared to the adult’s. One such difference is a decreased distribution and concentration hyaluronic acid in the neonatal vocal fold.

Hyaluronic acid is a large, space-occupying glycosaminoglycan responsible for regulating the water content in a tissue. A recent study by Schweinfurth demonstrated a lower sub-epithelial tissue concentration of hyaluronic acid in the neonatal vocal fold compared to the adult and therefore a lower associated vocal fold viscosity.

Cellular homeostasis is dependent on a variety of types of inter- and intracellular networks of water flow. Although hyaluronic acid is a major determinant of water content in soft tissues, another potential explanation for differences in use-related changes in vocal fold hydrodynamics is the presence and location of aquaporins. Aquaporins are membrane proteins found in all forms of life that permit osmotic flow of water molecules via a transcellular path across the plasma membranes of cells. A recent study by Lodewyck et al found aquaporins associated with the plasma membrane of ovine vocal fold epithelial cells, demonstrating the presence of an intrinsic mechanism to permit transcellular water flux in response to osmotic gradients.

The purpose of this study is to identify and compare the presence and location of aquaporins in the fetal and adult larynx using immunohistochemical techniques. To our knowledge, this is the first study to investigate the presence of aquaporins in human vocal fold epithelia.

METHODS

The lamina propria of vocal cord epithelia was harvested from 10 intact cadaveric fetal and 10 intact cadaveric adult larynges. Immunohistochemical staining was then performed on paraffin-embedded specimens fixed in 10% neutral buffered formalin with anti-aquaporin type 1, 2 and 3 antibodies. Rat kidney (cytoplasmic positivity) served as positive controls for each antibody and human lymph node (nonepithelial tissue) served as negative controls.

RESULTS

Immunohistochemical analysis revealed a homogenous distribution of aquaporin -3 in the cell cytoplasm of adult lamina propria with a higher concentration in the superficial layer (Figs 1 & 2). Aquaporins -1 and -2 were not identified in either the adult specimens. No evidence of aquaporins were identified in the fetal lamina propria (Figs 3 & 4).

DISCUSSION

Immunohistochemical analysis revealed a homogenous distribution of aquaporin -3 in the cell cytoplasm of adult lamina propria with a higher concentration in the superficial layer.

Hyaluronic acid is a large, space-occupying glycosaminoglycan responsible for regulating the water content in a tissue. A recent study by Schweinfurth demonstrated a lower sub-epithelial tissue concentration of hyaluronic acid in the neonatal vocal fold compared to the adult and therefore a lower associated vocal fold viscosity.

It is hypothesized that the potentially deleterious effects of use-related water translocation predicates a conservative distribution of aquaporins in the infant larynx compared to the adult. To our knowledge, this is the first study to investigate the presence of aquaporins in human vocal fold epithelia.

CONCLUSIONS

The newborn is heavily dependent on vocal communication to obtain resources in order to survive, requiring higher vocal demands and expenditures than the adult. Specifically, newborns are capable of sustained, maximal, high frequency phonation whose relative loudness output per mass performance exceeds that of the adult. The newborn larynx has been found to exhibit significant, task-specific histological and biochemical differences when compared to the adult’s. One such difference is a decreased distribution and concentration hyaluronic acid (HA) in the neonatal vocal fold. The purpose of this study was to identify and compare the presence and location of aquaporins in the fetal and adult larynx using immunohistochemical techniques. Immunohistochemical analysis revealed a homogenous distribution of aquaporin -3 in the adult lamina propria with a higher concentration in the superficial layer. Aquaporins -1 and -2 were not identified in either the adult specimens. No evidence of aquaporins were identified in the fetal lamina propria.

REFERENCES