Effects of Systemic and Local Hydration on Voice

An Essay

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

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Arwa Saeed

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List of abbreviations

AQP	*Aquaporion*
CaCC	*Calcium activated chloride channel*
cAMP	*Cyclic Adinosine mono-phosphate*
CFTR	*cystic Fibrosis Transmembrane regulator*
ECM	*Extracellular matrix*
EnaC	*epithelial sodium channel*
ESTR	*Entertainer's Secret Throat Relief*
F0	*fundamental frequency*
GAGs	*Glycosaminoglycans*
HA	*Hyaluronic acid*
HH	*High Hydration, High Humidity*
HVR	*Hydration Vocal Rest*
LH	*Low Hydration , Low Humidity*
MPT	*maximum phonation time*
MUC	*Mucin*
Non HVR	*Non Hydration Vocal Rest*
P.	*Poise*
PPE	*Perceived phonatory effort*
PTP, P_{th}	*Phonation threshold pressure*
RH	*Relative humidity*
RT	*Transepithelial resistance*

SS	*Sj€ogren's Syndrome*
TBW	*Total Body Water*
TWIMS	*Trans-epithelial Water and Ion Measurement System*
VF	*Vocal fold*
VF LP	*Vocal fold lamina propria*
VFs	*Vocal folds*
VFSF	*Vocal fold surface fluid*

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Introduction

INTRODUCTION

There has been a good deal of speculation about the significance of hydration in vocal fold tissue for normal phonation. Hydration increases efficiency of phonation and decreases phonation threshold pressure and so, hydration is critical in the physiology of normal phonation as vocal fold surface liquid homeostasis contributes to optimal vocal physiology**.** Theoretically, initiation of phonation is affected significantly by the mobility and deformability of the vocal fold mucosa, and it is thought that hydration and surface moisture are important to the condition of these tissues**.** The driving pressure needed to initiate phonation can be reduced and the efficiency of how that pressure is converted into acoustic intensity can be increased by superficial hydration of the vocal folds ***(Jiang et al., 1999).***

Vocal folds are covered by a thin layer of liquid ***(Fukuda et al., 1988).*** This liquid serves as a physical and biochemical barrier that protects the underlying tissue from damage from inhaled particulates and pathogens. Presence of surface liquid is also posited to maintain optimal biomechanical characteristics of vocal fold mucosa, increase efficiency of vocal fold oscillation, and promote normal voice quality ***(Verdolini et al., 1994).*** This is consistent with the well-accepted clinical practice of recognizing the importance of vocal fold hydration in maintaining optimal vocal physiology. It is maintained in part by salt and water fluxes across the epithelium through a trans-cellular pathway ***(Leydon et al., 2009).***

Overall body hydration may also affect vocal fold tissue viscosity. The viscosity of pure water is 0.01 poise (P), whereas the viscosity of vocal fold tissue is generally higher, ranging from 1 to 10 P. The increase in water components in vocal fold epithelium would therefore decrease viscosity and vocal fold stiffness and thus reduce the pressure needed to sustain vibration. Blowing dry air through vocal fold preparations rapidly affected the vibration, to the point of cessation of phonation & loss of vibratory sound production within less than five minutes ***(Jiang et al., 1999).***

The superficial layer of mucous and fluid therefore appears to be a very important factor in whether or not airflow through approximated vocal folds causes vibration and voice sounds. During the time frame of drying there was probably not significant dehydration of deeper tissues. Superficial vocal fold dehydration may be induced by short-term oral breathing, leading to increased phonation threshold pressure and increased tissue stiffness in healthy female speakers ***(Sivasankar and Fisher, 2002)***.

Phonatory effort correlated well with phonation threshold pressure (PTP), which is defined as the lowest lung pressure required to initiate phonation ***(Titze, 1988; Titze 1992).*** This varied across subject and pitch, in addition, increased environmental and/or systemic hydration, presumably associated with decreased viscosity and this supports the hypothesis that systemic hydration affects phonation threshold pressure by decreasing it especially at high pitches ***(Verdolini et al., 1994; Fisher et al., 2001).*** Optimal viscoelastic properties of vocal folds are necessary to maintain ease of phonation; also, they prevent or minimize vocal fatigue ***(Chan and Titze, 1999).***

A study concerned with vocal folds hydration with sex differences showed that women are more likely than men to have voice disorders ***(Smith et al., 1998).*** Men's voices would be less susceptible to the effects of altered hydration, in two markedly different states of systemic hydration. A previous study made on four subjects (men & women), mirror clinical impressions that some individuals display obvious visible laryngeal effects of strenuous voice use, while others do not ***(Solomon et al., 2003).***

This difference in vocal folds hydration among sex lead to a recent research on histochemical evidence that suggests fundamental differences between human vocal fold microstructure in women and men. The change in a study of a group of trained theatre performers noted an increase in the fundamental frequency in men but a lowering of fundamental frequency in women following their performances. So, the change in fundamental frequency may be gender-dependent, as a result of lately reported differences in vocal fold hydration between human males & females ***(Yiu and Chan, 2003).***

Humidity and hydration have been understood empirically to be important in allowing performing singers to sustain voice quality and maximize the ease and quality of voice production and so, making singing easier ***(Sataloff, 1987).***

In a previous study made on amateur karaoke singers aiming to determine whether regular hydration and brief vocal rests during singing would minimize the changes in vocal quality and function as measured by perceptual voice evaluation, acoustic analysis, voice range profile analysis, and subjects' self-perception of vocal fatigue. It was hypothesized that a combination of hydration and vocal rests during continuous karaoke singing would prolong normal vocal function and preserves the voice quality. The group that was given water and vocal rests sang significantly longer than the group without taking water or rests and this result suggests that frequent brief hydration and vocal rests were useful in prolonging singing time before feeling vocal fatigue during karaoke singing in amateur singers ***(Yiu and Chan, 2003).***

Vocal fatigue usually refers to tiredness of voice following prolonged voice use ***(Stemple et al., 1995). ,*** commonly occurring among singers as professional voice users. It requires an individual to use more effort to continue speaking and may be accompanied by changes in vocal quality, loudness, pitch, effort in voicing ***(Titze, 1988),*** and feeling of laryngeal discomfort such as laryngeal aching, throat fullness, soreness, neck tightness, and pharyngeal/ laryngeal dryness , such symptoms were much improved with good hydration of vocal folds ***(Gelfer et al., 1996).***

For that reason, clinically, persons with voice disorders are often advised to drink water. Several studies have provided data that indicate high incidence of vocal fatigue & decreased vocal function when people are under-hydrated (***Verdolini et al., 1994 and Fisher et al., 2001).***