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IS THERE ANY RELATIONSHIP BETWEEN THE NECK FLEXOR MUSCLES ENDURANCE, PHONATION TIME AND PEAK EXPIRATORY FLOW RATE IN YOUNG INDIVIDUALS?

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this study was to investigate the correlation between neck flexor muscle endurance, phonation time, and peak expiratory flow rate that are used very often in the rehabilitation of dysphagia.

Methods: Sixty-one healthy individuals participated in this study (31 females and 30 males). The mean age of the subjects was 20.7±1.33 (19 to 25) years. Demographic characteristics of individuals were recorded. Neck flexor muscles endurance test was performed in supine position. Subjects were asked to lift their head about two fingers above the bed. Time that subjects could maintain the position was recorded. Phonation time was measured while sitting upright position. After a strong inspiration the patients were asked to sustain a vowel sound /a/ as strong and long as possible. Peak expiratory flow (PEF) rate was evaluated using a peak flowmeter.

Results: Statistically, there were positive relationships between neck flexor muscles endurance and phonation time ($r=0.475$, $p<0.001$), neck flexor muscles endurance and PEF ($r=0.421$, $p=0.001$), and phonation time and PEF ($r=0.421$, $p=0.001$).

Conclusion: There were positive, moderate correlations between the flexor muscle endurance and phonation time, and between flexor muscle endurance and PEF and also between phonation time and PEF. Neck flexor muscle endurance exercises and phonation exercises could be used in dysphagia rehabilitation. These exercises also need to be investigated in patients with swallowing difficulty. In addition, to prevent patients from the negative effects of the aspiration, expiratory breathing exercises could be included in rehabilitation programs.

Key Words: Dysphagia; Neck Muscles; Phonation; Peak Expiratory Flow Rate.

GENÇ BİREYLERDE BOYUN FLEKSÖR ENDURANSI, FONASYON ZAMANI VE TEPE EKSPİRATUAR AKIM HIZI ARASINDA İLİŞKİ VAR MIDIR?

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çalışmamızın amacı, disfaji rehabilitasyonunda sıklıkla kullanılan, boyun fleksör kas enduransı, fonasyon zamanı ve tepe ekspiratuar akım hızı arasında bir ilişki olup olmadığını araştırmaktı.

Yöntem: Bu çalışmaya 61 sağlıklı birey (31 kadın, 30 erkek) dahil edildi. Çalışmaya katılan bireylerin yaş ortalaması 20,7±1,33 (19-25) yıldı. Bireylerin demografik özellikleri kaydedildi. Boyun fleksör kas enduransı sırtüstü yatar pozisyonda yapıldı. Hastalardan başlarını yatak üzerinde yaklaşık iki parmak kadar kaldırmaları istendi. Hastaların pozisyonu koruyabildikleri süre kaydedildi. Fonasyon süresi için, katılımcı dik pozisyonda otururken, derin inspirasyondan sonra güçlü ve uzun süre /a/ söylemesi istendi ve süre kaydedildi. PEFmetre ile tepe ekspiratuar akım hızı değerlendirildi.

Sonuçlar: İstatistiksel olarak, boyun fleksör kas enduransı ve fonasyon süresi arasında ($r=0,475$, $p<0,001$), boyun fleksör kas enduransı ve tepe ekspiratuar akım hızı arasında ($r=0,421$, $p=0,001$), fonasyon süresi ve tepe ekspiratuar akım hızı ($r=0,421$, $p=0,001$) arasında anlamlı pozitif bir ilişki bulundu.

Tartışma: Boyun fleksör kas enduransı ve fonasyon süresi, boyun fleksör kas enduransı ve zirve ekspiratuar akım oranı, fonasyon süresi ve tepe ekspiratuar akım hızı arasında orta derecede pozitif yönlü ilişki vardı. Disfaji rehabilitasyonunda boyun fleksör kas endurans egzersizleri ve fonasyon egzersizleri kullanılabilir. Bu egzersizlerin yutma güçlüğü çeken hastalar üzerinde de araştırılması gereklidir.

Anahtar Kelimeler: Disfaji; Boyun Kasları; Fonasyon; Tepe Ekspiratuar Akım Hızı.

INTRODUCTION

Suprahyoid and vocal cord muscles, which take an active role in swallowing, should work simultaneously with the expiratory muscles. The endurance and strength of these muscles are important to ensure the safe swallowing and to prevent aspiration. Swallowing rehabilitation program consists of phonation exercises, aiming to improve the strength of vocal cord adduction, Shaker exercises, with the inclusion of neck flexion and breathing exercises, which improve expiratory muscle strength (1,2). Previous studies have been shown that suprahyoid muscles were activated during head and neck flexion (3). Suprahyoid muscles have an importance in the upward movement of the hyoid bone and in the control of upper oesophageal sphincter (4-7). Laryngeal movement is important to prevent the aspiration (6-8). Another contributing factor to prevent aspiration is vocal cords, which are also responsible for phonation. Phonation exercises, which are given for vocal cords are responsible for increasing the laryngeal and pharyngeal mobility (9). Phonation exercises reduce oral transit time and increase closure time of the glottis, increase vertical larynx movement, and also increase the pressure of the posterior root of the tongue (10). Exercises, to increase the expiratory muscle strength also increase mobility of the hyolaryngeal complex (2).

The hyolaryngeal complex includes the hyoid bone, thyrohyoid membrane, and laryngeal cartilages serving as an attachment site for the cricopharyngeus muscle that forms the upper oesophageal sphincter. Suprahyoid muscles initiate swallowing by moving the larynx up and forward direction. Suprahyoid muscles are the most important muscle groups that responsible for the proper function of this complex (11).

In an adult, swallowing occurs during the expiratory phase of breathing, and respiration resumes with continued expiration after swallowing (12). In swallowing rehabilitation, specific maneuvres applied during the expiratory phase of respiration to complete the swallowing safely while keeping the airway open. Wheeler et al. reported that the expiratory muscle strength training improves activation of the suprahyoid muscles and range of upward movement of the hyoid bone (13). In particular, recent studies have emphasized that strengthening of the expiratory muscles should be a part of the rehabilitation of the patients, with aspiration problems (2). It is very common to give exercises to improve the strength of the expiratory muscles during rehabilitation of the swallowing disorders. However, there is no study investigating respiratory muscle strength.

Shaker exercises involving neck flexion, phonation exercises, and expiratory muscle training are frequently used in swallowing rehabilitation. To our knowledge, there is a lack of study in the literature, which examines the relationship between the neck flexor muscles endurance, phonation time, and expiratory muscle strength in the swallowing rehabilitation. Therefore, we aimed to investigate the relationship between the neck flexor muscles endurance, phonation time, and expiratory muscle strength. We hypothesized that there would be a positive relationship between the neck flexor muscles endurance, phonation time, and expiratory muscle strength.

METHODS

This study was carried out from September 1-30 2015 in the Department of Physiotherapy and Rehabilitation, Acibadem University. Sixty-one young individuals participated in this study (30 males and 31 females). The mean age of the subjects was 20.7±1.33 (from 19 to 25) years. Inclusion criteria were to be age 18 and 25 years, have no problem during swallowing, no systemic disease or a neck problem. Exclusion criteria were having a sore throat, hoarseness, eating difficulties, speech or voice problems, receiving orthodontic therapy and having neck pain. The participant, who were experiencing swallowing disorders, neurologic or otolaryngologic disorders or any cancer history were also excluded from the study.

This study was approved by Ethics Committee of Acıbadem University, Istanbul (Decision Number: 2015-7/3). All research participants accepted to join this study voluntarily and signed an informed consent form prior to participating. Nevertheless, four participants did not accept to blow flowmeter, they did not want to explain the reason but they accepted to take part in other measurements and the results of these measurements were used for

statistical analysis.

All individuals were evaluated in a quiet room, before the lunch by the same physiotherapist. Demographic characteristics of individuals were recorded. The neck flexor muscles endurance test was performed with subjects in supine position. The subjects were asked to lift their head nearly two fingers above the bed and maintain this position. The time period was recorded (14). When the participant was no longer able to maintain the position, the test was stopped. There is no standard measurement method described in the literature to evaluate maximum phonation time (MPT) (15) but in this study for MPT, the participant was asked to sit upright and keep the standing position with clamping his hands on level of the chest. Then, after a strong inspiration, the patient was asked to sustain a vowel sound /a/ as strong and long as possible. This test was repeated three times with one-minute breaks (15,16). The maximum value was recorded.

Finally, peak expiratory flow rate (PEF) was measured by a Mini-Wright Peak Flowmeter (Clement Clarke Ltd., London, England). All participants were asked to blow out as hard as possible in standing position. The test was repeated three times and the maximum value was recorded (17).

Statistical Analysis

Data were analyzed using SPSS Statistics 21 (SPSS, Inc. Chicago, IL, USA). The variables were investigated by using visual (histogram, probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's test) to determine whether or not they are normally distributed. The phonation time, PEF, height, and weight were distributed normally. However, the neck flexor muscle endurance time rate was not normally distributed. While investigating the association normally or non-normally distributed, the correlation coefficients and their significance were calculated using the Pearson or Spearman test. A correlation coefficient range between 0.30 and 0.39 reflects poor agreement, between 0.40 and 0.59 reflect moderate agreement, between 0.60 and 0.69 reflect good agreement, between 0.70 and 0.75 reflect very good and those >0.75 indicates high agreement (18).

We calculated that we needed a sample size of at least 41 participants to detect a statistically significant correlation between neck flexor endurance and MPT with 80% power and at 5% significance ($p<0.05$). In addition, we included extra 10% more participants to our resource in order to prevent a potential problem.

RESULTS

The mean weight, height, and body mass index are shown in Table 1. The mean phonation time was 20.16±6.97 sec and the mean PEF was 466.93±140.12 L/min. The median neck flexor muscle endurance was 47.02 sec (7.01-308.45 sec) (Table 2).

There were moderate positive correlations between neck flexor muscle endurance and MPT ($r=0.475$, $p<0.001$), neck flexor muscle endurance and PEF ($r=0.421$, $p=0.001$), MPT and PEF ($r=0.421$, $p=0.001$). In addition, there was a very good positive correlation between height and PEF ($r=0.736$, $p<0.001$) and a good positive correlation between weight and PEF ($r=0.675$ and $p<0.001$). Finally, there was a weak correlation between height and MPT ($r=0.316$, $p=0.012$), between neck flexor muscle endurance and height ($r=0.366$, $p=0.004$) and between neck flexor muscle endurance and weight ($r=0.357$, $p=0.005$). However, there was no correlation between MPT and weight ($p=0.096$). The cor-

Table 1: Demographics of the Participants (n=61).

Variables	Mean±SD	min-max
Weight (kg)	65.87±13.46	43,0-95,0
Height (cm)	171.32±9.33	155,0-194,0
BMI (kg/m²)	22.24±3.01	17.22-29.73

BMI: Body Mass Index, SD:Standard deviation, Min: Minimum, Max: Maximum

Table 2: Values of Phonation Time, Peak Expiratory Flow Rate, and Flexor Muscle Endurance.

Variables	n	Mean±SD	Median	min-max
Phonation Time (sec)	61	20.16±6.97	-	7.11-40.12
PEF (L/min)	57	466.93±140.12	-	200.0-730.0
Flexor Muscle Endurance (sec)	61	-	47.02	7.01-308.45

PEF: Peak Expiratory Flow Rate, Min: Minimum, Max: Maximum

relations between the variables were presented in Table 3.

DISCUSSION

The aim of this study was to evaluate the relationship between the neck flexor muscles endurance, phonation time, and PEF in young adults. Although neck flexor muscles and vowel exercises were often used in rehabilitation of dysphagia, we could not find any research on the relationship between flexor muscle endurance, phonation time and PEF in the literature. This study showed that there were positive, moderate correlations between the flexor muscle endurance and phonation time, between flexor muscle endurance and PEF, also between phonation time and PEF. In addition, there were correlation between height and PEF, weight and PEF, height and MPT, neck flexor muscle endurance and height, neck flexor muscle endurance and weight. It has been previously shown that there was no relationship between age and endurance or strength of neck flexor muscles in women (19). Healthy people have sufficient muscle strength and activation time for swallowing function. If there are problems in muscle strength, anatomic structure or activation time, people will have swallowing disorders, in another words, dysphagia. Several rehabilitation methods described and especially, exercises are used to activate swallowing muscles because they have a primary role during swallowing (20,21). Swallowing problems reduced after exercise training (22). Therefore, vocal exercises and neck flexor muscle strengthening exercises are frequently used in therapeutic applications of dysphagia (9,23) and the neck flexor muscle strengthening exercises are especially used to enhance the effectiveness of swallowing (24). The results of the present study was in corporation with the previous findings that the neck flexor muscle endurance was related with phonation time and PEF.

Although the purposes of the neck and head flexion are different between each other, they are both used in dysphagia treatment (25). Head flexion is used to decrease the severity of penetration, because the superior laryngeal inlet is more vertical during head flexion. Therefore, this position could prevent aspiration (26,27). Head flexion increases the efficiency of swallowing muscles, so it helps to swallow safely and easily (28). On the other hand, neck flexion can be used to control bolus in patients with delayed swallowing reflex problem (27,11). We often see aspiration or penetration problems more than delayed reaction time in the clinic. Therefore, we preferred to evaluate head flexion position in our study.

Table 3: Relationship between Flexor Muscle Endurance, Maximum Phonation Time, Peak Expiratory Flow Rate, and Weight$^{\phi}$.

Veriables	MPT	PEF	Height	Weight
Flexor Muscle Endurance*	0.475 **<0.001**$^{\beta*}$	0.421 **0.001**$^{\beta*}$	0.366 **0.004**$^{\beta*}$	0.357 **0.005**$^{\beta*}$
MPT	-	0.421 **0.001**§*	0.316 **0.012**§*	0.216 0.96§*
PEF	-	-	0.736 **<0.001**§*	0.675 **1<0.001**§*
Height	-	-	-	0.795 **1<0.001**§*

*p<0.05. $^{\phi}$r and p. $^{\beta}$Spearman Correlation Analysis; §Pearson Correlation Analysis
MPT: Mphonation Time, PEF: Peak Expiratory Flow Rate.

Vocal exercises are often used for dysphagia or swallowing problem. The aim of vocal exercises is to increase movement of tongue and pharynx, to decrease oral transit time and to improve oropharyngeal efficiency (9). Especially, vowel phonation increases glottic closure and larynx movement in the vertical direction and also increase the posterior tongue pressure and bolus control in the oral cavity (10). Expiratory muscle training is important for rehabilitation of dysphagia. After the aspiration, the aim of coughing is to eject the foreign objects through trachea. Therefore, expiratory muscle strength should be increased, strengthening exercises should be added to the rehabilitation (2). Improvement of neck flexor muscle endurance, MPT or expiratory muscle strength may have a positive effect to each other during rehabilitation of dysphagia. The moderate correlation of the present study supports this claim. Therefore, adding these exercises into the dysphagia rehabilitation program may increase the effectiveness of rehabilitation, may prevent the aspiration pneumonia.

In our study, all parameters were correlated with one another (height, weight, neck flexor muscles endurance, MPT and PEF). Previously, it was found that there was a relationship between PEF and height (29). In another study, there was no correlation with height and maximum expiratory pressure but there was a correlation between body mass index and maximum expiratory pressure (30). On the contrary, we found a very good positive relation between height and PEF and a good positive relation between weight and PEF. This result was not a surprise, because, if people are tall, they will have a big lung volume and strong muscle capacity. In addition, our participants were young without any health problems, which could affect the results. Obesity has an adverse effect on the respiratory function (31). The participants in the present study were not overweight. The mean BMI was 22.24 kg/m^2. In another study, weight and height of individuals did not affect their MPT rate (15). Our findings related with height are in correspondence with the previous studies. We expected a correlation would be between respiratory capacity and weight. However, we did not find any correlation. Since, there was no study on the relations between neck flexor muscles endurance and weight or height in the literature. In our study, there was a moderate-strong correlation between neck flexor muscles endurance and weight and height. Grimmer et al. (32) indicated that the neck flexor muscles endurance time was longer in males than females. Our results were similar with Grimmer et al. fingdings that the neck flexor muscles endurance time was longer in males than females.

There were some limitations in the present study. During PEF test, four participants did not accept to blow flowmeter may be there some participants who did not blow flowmeter hard enough. Therefore, the value of PEF might be low. Third, it would be more appropriate to perform expiratory muscle strength measurement instead of PEF measurement.

The results of this study showed that there were moderate positive correlations between flexor muscle endurance and phonation time, between flexor muscle endurance and PEF and between phonation time and PEF. According to these findings, the rehabilitation programs should include the flexor muscle strength and endurance exercises with phonation exercises. In addition, we believe that if addition of expiratory exercises in the rehabilitation programs, they may help patients to prevent the negative effects of the aspiration.

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Conflict of Interest: The authors have no conflict of interest to declare.

Ethical Approval: This study was approved by Ethics Committee of Acıbadem University in İstanbul (Decision number: 2015-7/3).

Informed Consent: Written informed consent was obtained from all study participants.

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