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The Effect of Spinal Postural Abnormalities on Spirometricindexes of Hormozganmedical University Students

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Abstract: Postural abnormalities are one of affective agent on respiratory flow and Lung capacity. This study was carried out to investigate the effect of Postural abnormalities on spirometric indices in Hormozgan medical university. 60 volunteer students (23 males and 37 females) with age ranged 20-29 years oldfrom Hormozgan medical university through simple non-probability sampling were selected and their Lumbar Lordosis (from 12th thoracic vertebrae spinal process to 2nd Sacral vertebrae spinal process) and thoracic kyphosis (from 4 – 12th thoracic vertebrae spinal process) degrees measured via flexible ruler Model Mark Kidos. Subjects Spiro metric indices such as (PEF, $FEF_{25\%}$, $FEF_{25\%-50\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FVC, FEV_1) measured via spirometer Model Spiro lab II. One way ANOVA and POSTHOC TUKEY test were used for statistical Analysis. Results showed that subjects with kyphosis abnormality have the lowest respiratory flow and Lung capacity and subjects with normal posture have the highest respiratory flow and Lung capacity. Spirometric indices such as PEF_1 ‘FEV, FVC were statistically significant differences between kyphosis and lordosis abnormality groups (p=0.001, p=0.001, p= 0.001 respectively), but there weren't significant differences between other indices ($FEF_{25\%}$ (p= 0.212), $FEF_{25\text{-}75\,\%}$ (p= 0.312), FEF_{50}(p= 0.311) $_{\%}$, $FEF_{75\,\%}$(p=0.124) respectively). Based on this study results, we concluded that the spirometric indices changed with different Postural abnormalities.

Key words: Posture % Spirometry % Postural Abnormalities

INTRODUCTION

Miller and Hyattrecognized the flow-volume loop (FVL) as a valuable test for the detection and assessment of upper airway obstruction (UAO). The value of the FVL, as opposed to static imaging techniques, lies in the fact that it takes into account the dynamic characteristics of the upper airway, ie, the changes in caliber that the collapsible parts of the upper airway undergo as a result of the changes in transmural pressure induced by forced inspiratory and forced expiratory maneuvers. The effect of these maneuvers, used for the generation of a FVL, on the caliber of the upper airway and, hence, on the effort-dependent inspiratory and (early) expiratory flow rates is exaggerated in the presence of an upper airway lesion that affects the structural or functional integrity of the upper airway [1].

In a previous paper published in CHEST, showed that changes in body posture may be used to further increase the capability of the FVL to detect UAO [2].

Suggested that daily variations of spirometric measurements should not depend onchanges of expiratory muscle performance.Our representative values of airway resistance (Rei) exhibit a progressive increaseof the mean values during the day, from morning to night. Thedifferences between 8 am and 4 pm and 12 am are statistically significant [3].

Their value is limited because maximum expiratory pressures andthecorresponding PEFs were not measured simultaneously. Moreover, Epmaxvaluestaken by them do not exhibit significant daily variations.Nevertheless, this result is in keeping with other previously reported results whichindicate an increase of airway resistance at night-time with respect to daily hours, both in normal and asthmatic subjects [4].

Considering the well-recognized worsening of asthmatic symptoms during the night, it is hence confirmedthat airway resistance tends to increase at night-time with respect to daily hours, thenormal period of activity in humans. Interestingly, animal species with

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differentcircadian habits, i.e. exhibiting nocturnal activity, like rats and guinea pigs, show theoppositebehaviour of airway resistance, i.e. a decrease at night-time with respect tothe daily hours of inactivity [5].

The spirometry test is performed using a device called a spirometer, which comes in several different varieties. Most spirometers display the following graphs, called spirograms: 1- a volume-time curve, showing volume (liters) along the Y-axis and time (seconds) along the X-axis. 2- A flow-volume loop, which graphically depicts the rate of airflow on the Y-axis and the total volume inspired or expired on the X-axis [6, 7].

Since results are dependent on patient cooperation, FVC can only be underestimated, never overestimated. FEV1 may sometimes be overestimated in people with some diseases a softer blow can reduce the spasm or collapse of lung tissue to elevate the measure [8-10].

It can also be given as a mean of the flow during an interval, also generally delimited by when specific fractions remain of FVC, usually 25–75% (FEF25–75%). Average ranges in the healthy population depend mainly on sex and age, with FEF25–75% shown in diagram at left. Values ranging from 50-60% and up to 130% of the average are considered normal[4]. Predicted normal values for FEF can be calculated online and depend on age, sex, height, weight and ethnicity as well as the research study that they are based upon. It should theoretically be identical to peak expiratory flow (PEF), which is, however, generally measured by a peak flow meter and given in liters per minute [5]. Recent research suggests that FEF25-75% or FEF25-50% may be a more sensitive parameter than FEV1 in the detection of obstructive small airway disease [6, 7]. However, in the absence of concomitant changes in the standard markers, discrepancies in mid-range expiratory flow may not be specific enough to be useful and current practice guidelines recommend continuing to use FEV1, VC and FEV1/VC as indicators of obstructive disease [8, 9].

Since air consists of very minute or traces quantities of CO, 10 seconds is considered to be the standard time for inhalation and then rapidly blow it out (exhale). The exhaled gas is tested to determine how much of the tracer gas was absorbed during the breath. This will pick up diffusion impairments, for instance in pulmonary fibrosis [11]. When having drawn a curve with the relations between changes in volume to changes in transpulmonary pressure, Cst is the slope of the curve during any given volume, or, mathematically,) V/) P [12]. Static lung compliance is perhaps the most sensitive parameter for the detection of abnormal pulmonary mechanics [13]. It is considered normal if it is 60% to 140% of the average value in the population for any person of similar age, sex and body composition [4].

In those with acute respiratory failure on mechanical ventilation, "the static compliance of the total respiratory system is conventionally obtained by dividing the tidal volume by the difference between the "plateau" pressure measured at the airway opening (PaO) during an occlusion at end-inspiration and positive end-expiratory pressure (PEEP) set by the ventilator"[14]. Pmax is the asymptotically maximal pressure that can be developed by the respiratory muscles at any lung volume and Pi is the maximum inspiratory pressure that can be developed at specific lung volumes[15].A derived parameter is the *coefficient of retraction (CR)* which is P_{max}/TLC. <hedenstrom2009/> Mean transit time is the area under the flow-volume curve divided by the forced vital capacity [16].

Postural abnormalities are one of affective agent on respiratory flow and Lung capacity. The aim of this study was to investigate the effect of Postural abnormalities on spirometric indices in Hormozgan medical university.

MATERIALS AND METHODS

The study was conducted in the department of medicine of Hormozgan University of Medical Sciences, BandarAbbas, Iran.

60 volunteer students (23 males and 37 females) with age ranged 20-29 years old through simple non-probability sampling were selected and their Lumbar Lordosis (from 12th thoracic vertebrae spinal process to 2nd Sacral vertebrae spinal process) and thoracic kyphosis (from 4 – 12th thoracic vertebrae spinal process) degrees measured via flexible ruler Model Mark Kidos. Subjects Spiro metric indices such as (PEF, $FEF_{25\%}$, $FEF_{25\%-50\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FVC, FEV_1) measured via spirometer Model Spiro lab II. y (FVC), maximum forced expiratory flow at 25%, 50% and 75% of the FVC, respectively (FEF 25%, FEF 50%, FEF 75%), average forced expiratory flow between the 25% and 75% FVC levels (FEF 25%–75%), forced expiratory volume in 1 second (FEV 1) and peak expiratory flow (PEF). An SBG spirometer was used to measure each subject's LC-EF and the spirometric indices were calculated with the manufacturer-supplied soft- ware WinSpiro, version 2.35.

Statistical Analysis: Data normality was assessed prior to analysis. The one way ANOVA and Tokay's tests were used for statistical analysis between tree groups with using the SPSS program version 18 and in alpha level of 0.05.

Table 1: Demographic information of subject's in three groups

Variables groups	Age (M±SD)	Height (M±SD)	Weight (M±SD)	N
Increased kyphosis group	24.4±3.4	173±1.7	72±2.7	20
Increased lordosis group	26.1±2.1	174±3	73.1±1.8	20
Group without abnormality	25.1±1.7	172±2.4	73.8±2.1	20

There are significant differences between 3 groups in age, height and weight (p#0.05)

Table 2: Spirometric indexes of three groups (p#0.05)

Variable Group	FEF_{75}% (Lit/sec)	FEF_{50}% (Lit/sec)	$FEF_{25\text{-}50}$%(Lit/sec)	FEF_{25}% (Lit/sec)	FVC (Lit)	FEV1 (Lit)	.PEF (Lit/sec)
Increased kyphosis group	1.9±.55	3.4±1.1	3.4±1.4	4.2±1.1	2.4±1.2	3.4±1.3	4.6±2.1
p_1	0.124	0.311	0.312	0.212	0.001	0.001	0.001
t_1	1.93	3.12	1.73	2.83	-3.72	-3.52	-3.76
P2	0.001	0.001	0.004	0.001	0.003	0.003	0.001
T2	-3.8	-4	-4.1	-4.5	-5.1	-4.3	-3.9
Increased lordosis group	2.1±1.6	4.6±2.3	4±3.1	4.4±2	3.9±3.4	4±2.2	4.6±1.25
P3	0.005	0.003	0.001	0.03	0.001	0.001	0.003
T3	-2.42	-3.43	-4.17	-3.47	-4.16	-3.43	-2.94
Group without abnormality	2.5±1.9	4.1±2.3	4±3.2	4.4±2.8	4.6±0.8	4.4±1.8	6.2±1.9

P1,t1: comparison between increased lordosis and kyphosis groups; p2,t2: comparison between increased kyphosis and healthy groups; p3, t3: comparison between increased lordosis and healthy groups.

Based on table 2 results, the increased kyphosis group has a lowest spirometric indexes and healthy group (Group without abnormality) has a highest spirometric indexes.

RESULTS

The subject's demographic information is shown in Table 1.

Spirometric indexes of three groups are shown in Table 2.

DISCUSSION

Spirometric indices such as PEF_1 'FEV, FVC were statistically significant differences between kyphosis and lordosis abnormality groups (p=0.001, p=0.001, p= 0.001, respectively), but there weren't significant differences between other indices ($FEF_{25\%}$ (p= 0.212), $FEF_{25\text{-}75\%}$ (p=0.312), FEF_{50}(p=0.311)$_{\%}$, $FEF_{75\%}$ (p=0.124) respectively).

A major cause of morbidity andmortality in these people is long-term respiratory complicationin the form of pneumonia or atelectasis, 5 with pneumonia beingthe leading cause of their deaths. 13 Many factors can contributeto poor lung function, including smoking habits, surgical history, hazardous occupational or environmental exposure,asthma, allergies, chronic obstructive pulmonary disease andobesity. A new seating system that features adjustable ischial and lumbar support has been developed to suggest a new sitting postureto mimic the spine's natural curvature in the stance and providebetter postural support for seated subjects [18].

Concluded that all spirometric indices, with the exception of PEF, increased in the standing posture compared with the sitting posture. Chen *et al*. found that the vital capacity of an able-bodied subject was enhanced in the standing posture, which Druz and Sharp attributed to an increase in the activation of the ribcage inspiratory muscles and the diaphragm in the upright posture. Taking into consideration the stiffened abdomen, the activated muscles act to move the ribcage more effectively and promote ribcage expansion. Also, in supine postures, the diaphragm aids in providing greater compliance with the abdomen over the ribcage [17, 18].

More specifically, standing posture enabled the subjects to perform significantly better on every spirometric index than in the slumped and normal sitting postures except for the FEF 75% in normal sitting. This indicates that subjects could achieve larger lung volume during inspiration, perform more efficient expiratory muscle contraction and experience less air flow obstruction within airways of all sizes when in a standing posture.

Our results agree with those of previous studies that found that the LC-EF in the normal spinal column posture is better than in the abnormal postures. We were unable to find; however, any studies that sought to determine the influence of different postures on LC-EF. Our subjects had the lowest average spirometric indices while in slumped sitting; the differences in these indices between the slumped posture and other sitting postures showed statistical significance. The slumped posture may compress organs and impede diaphragm movement more than the other seated postures. Another possible reason that slumped posture gives the lowest LC-EF readings may be the position of the head in this posture [15, 17, 18].

The results of lumbar lordosis in this study are, in general, consistent with other published studies.

In parallel with Although there is no evidence in the literature that changes in lumbar lordosis and kyphosis have significant influence on lung function, we think that these significant differences in lumbar lordosis in different postures may account for the changes in pulmonary capacity between the postures we tested. The adjustments to spinal alignment may change the volume of air available to the lung and/or influence the efficacy of contraction of the diaphragm and other respiratory muscles. The correlation test performed on results from the 8 subjects who participated in both spirometric and radiologic protocols showed a statistically significant correlation between lumbar lordosis and those spirometric indices that relate to lung volume and expiratory muscle function (FVC, FEV1). As shown in lateral radiographs of the normal spine, there are 4 naturally formed curvatures, the cervical, thoracic, lumbar and sacral. A shape change in any one of these curvatures will cause compensatory changes in the others to help maintain balance and conserve muscular energy [4, 18].

Therefore, an increase in spinal lordosis in the lumbar region is likely to induce a decrease in thoracic kyphosis, thus giving the ribcage greater room to expand during inspiration. This may explain the correlation that exists between the increased FVC and FEV1 and the increased total and segmental lumbar lordosis found in our study. Considering that this correlation test was done on data from only 8 subjects, however, a larger sample size may be necessary to reliably detect any correlation between respiratory performance and the lumber spine curvature [3, 18].

More, albeit conflicting, literature data are available for obese patients who either snore or haveobstructive sleep apnea syndrome (OSAS). Shepardand Burger, for example, found a modest butsignificant reduction in the forced expiratory flowrates but no change in the forced inspiratory flowrates of obese patients with OSAS when changingfrom the upright to the supine posture [17].

It was reported that anincreased proportion of OSAS patients showed flat¬tening of the maximal inspiratory flow volume curve(ie, a reduction in forced inspiratory flow rates) whentested in the supine posture [17].

It was concluded that additionof supine FVLs increases the sensitivity of the FVLfor detecting UAO in patients with the OSAS.This finding cannot be attributed to asystematic effect of fatiguing since, by design, theorder in which the four body postures were testedwas randomized. Furthermore, the subjects wereallowed to rest between the four body postures [17].

Indeed, respiratory muscle strength, which can be estimated bymeasuring maximal static mouth pressures, is an important determinant of theseeffort-dependent flow rates, as shown by Fry andHyatt'siso volume pressure-flow curves. BothMIPS and MEPS have been shown to decrease innormal and obese subjects in the supine posture v the sitting posture and normal subjectsgeneratesignificantly less Tran’s diaphragmatic pressure in thesupine posture than in the sitting posture, suggesting that at least the diaphragm's strength is affectedby the supine posture. However,this change wassignificant only for MIPS in thesupine posture and nosignificant correlation werefound between the changes in MIPS and the changesin the effort-dependent maximal inspiratory flowrates. Similarly, no correlation wasfound between the changes in MEPS and thechanges in PEF [17].

Another mechanism that could explain the reduction in the effort-dependent maximal inspiratory andexpiratory flow rates is an increase in the resistanceof the upper airway on assuming any of the recumbent postures. It has indeed been shown that innormalsubject’s decreases significantly in the supineposture compared with the upright posture. Thisoccurs independently of posture-related changes inlung volume (functional residual capacity) and isattributed to gravitational forces acting on the tongueand soft palate [17].

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