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Research Article

New Determination Method of Inspiratory Muscle Endurance: A Pilot Study

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Abstract

Determination of inspiratory muscle strength method is clear. But the endurance protocols are quite varied. Thus, the aim of the present study is developing a new determination method of inspiratory muscle endurance (IME). For this purpose 33 male athletes participated in the study as subject. Maximal voluntary ventilation (MVV) measurement was applied on subjects before and after specific inspiratory muscle endurance exercise protocol that was formed 5 x 1 minute deep breathing with specific inspiratory muscle endurance training device. In order to verifying data of endurance, subjects performed maximal inspiratory pressure (MIP) measurements before and after 50m sprint swimming. Percent decrement of the MVV used for the IME data, and percent decrement of the MIP used for verifying data for IME. Correlation between the MIP decrement and the IME was found significant and high level correlate (r: 0.968, p: 0.001). The results showed new protocol able to prove endurance value for inspiratory muscles. It could be said that the repeated measurement of MVV before and after inspiratory muscle endurance training can reveal the endurance parameter of inspiratory muscles.

Keywords: *Respiratory Muscles; Endurance; Performance*

Introduction

Pulmonary function is an important indicator of a healthy life and physical capacity [1]. Previous studies have shown that inadequate pulmonary function capacity could increase mortality [2,3]. Recent conflicting research has also revealed that respiratory performance affects physical performance both negatively [4-6] and positively [7-12]. Improvements in respiratory muscles have been suggested to provide better physical performance and a healthy life [9,10,13-18]. Such information presents the significance of respiratory performance as endurance.

We hypothesized that repeated measurements of MVV before and after an inspiratory muscle endurance training related to inspiratory muscle endurance performance. Therefore, in the present study, we investigated the new determination method of inspiratory muscle endurance.

Method

Experimental design

The study design included one familiarization visit followed by two testing sessions. The subjects performed the MVV measurement before and after inspiratory muscle endurance training session for determining the IME. Also, the subjects performed, in other session, the MIP test before and after 50m sprint swimming, for verifying to IME. The study was performed in accordance with the Declaration

of Helsinki [19] and the participants were informed and signed a voluntary consent form before the study. All tests were performed for scientific purposes using routine and familiar non-invasive techniques, thus ethical approval was not sought.

Subjects

We recruited 33 healthy male national-level competitive swimmers (age: 19.42 years, height: 179.40 cm, weight: 71.41 kg) with no pulmonary or other relevant health problems to participate in the study. The participants had no injuries at the time of data collection, and all of them were sprint distance specialists. All of the participants had received competitive swim training for at least 5 years prior to the beginning of the study.

The new IME protocol

The MVV measurement before and after inspiratory muscle endurance training used for determining the new IME protocol. The percent MVV decrement between before and after the inspiratory muscle endurance training calculated and used for endurance parameter. The percentage value closer to zero indicated better endurance.

MVV measurement

The subjects wore nose clips and breathed deeply (greater than the tidal volume but lower than the vital capacity) and rapidly for a 15sec interval with spirometer (PocketSpiro USB100, Medical Electronic Construction R&D, Brussels, Belgium). After the first three breaths, the subjects were actively encouraged to maintain the same volume and frequency by following an on-line display of the maneuver on a computer screen. At least two acceptable maneuvers were obtained and, after flow integration, the highest value was recorded by extrapolating the 15 seconds accumulated volume to 1 minute MVV (L/min) [20].

Inspiratory muscle endurance training

The exercise was conducted with the subjects biting the handle mouthpiece while sitting and looking at the main body of the Respifit S (Biegler GmbH, Mauerbach, Austria). The operator operated the main body to initiate the respiratory endurance training, which was displayed like a game on the main screen. At the midpoint of the training, if the patient felt fatigued or dizzy, a rest was permitted before resuming the remainder of the training. The training consist of 5 x 1 minute forced breaths with device mouthpiece and the balloon game on device display. The purpose of the device game is moving the balloon to up and down without touching the pointed indicators [21].

Verifying to the new IME protocol

To verifying the data of the new IME protocol, the subjects performed the MIP test before and after 50m sprint swimming.

MIP measurement

MIP was measured to indicate respiratory muscle strength using a respiratory pressure meter (PocketSpiro MPM-100, Medical Electronic Construction R&D, Brussels, Belgium) according to the 2002 guidelines of the American Thoracic Society and European Respiratory Society [22]. Measurement started from the residual volume. The nose was occluded throughout the effort. To obtain the best values, all subjects performed three to five attempts with no more than a 5% difference between two attempts. An average of three acceptable attempts was used as the MIP value [23-26].

Front-crawl 50m sprint swimming

Participants completed 50m freestyle swimming sprints, starting from a stationary position on the pool starting blocks, as in official competitions. Sprints were completed individually in a 25m indoor pool, and performance times were measured with a single stopwatch by an experienced time-keeper (swimming referee). Participants were instructed to complete the sprint as fast as possible, and strong verbal encouragement was provided throughout the sprints [27].

Statistical analysis

SPSS version 22.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analyses. The data were expressed in terms of mean, standard deviation, standard error, minimum and maximum values. The Shapiro–Wilk test was used to assess normality. Significance was defined as $p \leq 0.05$. Correlation between the new IME protocol values and the MIP decrement analyzed by Pearson's bivariate test.

Results

The descriptive statistics was showed on table 1. The new IME protocol and the MIP decrements were showed on the table.

	N	Min.	Max.	Mean	Std. Dev.	Std. Error
IME protocol (%)	33	-14.94	-6.62	-10.27	2.02	0.35
MIP decrement (%)	33	-16.52	-8.67	-12.73	2.16	0.45

Table 1: *Descriptive statistics.*

The table 2 showed the correlation between MIP decrement and the IME protocol. High level correlation was found between them and significance was showed (r: 0.968, p: 0.001). The results showed new protocol able to prove endurance value for inspiratory muscles.

		MIP Decrement
IME protocol	r	0.968
	p	0.001
	N	33

Table 2: *Correlation between endurance protocol and MIP decrement.*

Discussion and Conclusion

According to sport scientist, it is accepted that respiratory muscles are a requirement for presenting performance. Endurance of respiratory muscles is essential for resistance to fatigue. Fatigue and endurance show relation between them [8,28,29].

Trunk endurance is related to local and global trunk muscles. The global muscles include rectus abdominis, obliques, latissimus dorsi, and erector spinae [30-32]. They control extension and flexion of trunk. The local muscles include transverse abdominis, multifidous, and pelvic floor. They improve trunk endurance. Diaphragm that is serves as the roof of the trunk muscles is most important muscle of inspiration [33-35]. Besides, upper body trunk muscles are responsible for supporting to rising demands of breathing [36,37]. These muscle groups is important for inspiration [38] and also their endurance is occurred with less decrement in their strength. In the present study high level correlation was found between inspiratory muscle strength decrement and the new IME method (r: 0.968, p: 0.001). The results occurred new protocol able to prove endurance value for inspiratory muscles.

In summary, in the present study, maximal voluntary ventilation measurement before and after an inspiratory muscle endurance training with specific inspiratory muscle training device can reveal the endurance parameter of inspiratory muscles, as percent decrement in repeated MVV.

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