Short Communication

Paradoxical Vocal-Cord Dysfunction in Young Athletes: The Need for an Assessment-Therapeutic Protocol

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Abstract

Paradoxical vocal cord dysfunction (PVCD) has been recognized with increasing frequency in the athletic population. The impact of such disorder on athletics, athletics coaches and teammates is significant. The ultimate goal of this pilot study was to evaluate the demographic and video laryngoscopic features of five Qatari athletes, three of them diagnosed with PVCD, as a first step toward designing and validating a symptom questionnaire with a high predictive value for PVCD. The results of the laryngoscopic evaluation revealed that 3 out of the 5 participants evaluated in this study were found to have PVCD as the sole cause, or as a contributing factor, to their breathing difficulties during performing their daily sport activities. The clinical history results as obtained by the trial version of PVCD questionnaire showed the following symptomatic presentations of PVCD: stridor on inhalation, throat clearing to open, sensation of closure in airway, laryngeal or upper chest tightness, and a recovery period between 5 to 10 minutes. The laryngoscopic evaluation showed narrow vocal cord opening visualized when symptomatic on inspiration and expiration. Results of this pilot study showed cutoff score of over than 30. Sensitivity was 90%. Specificity for this criterion was 100%. Results indicated the need to validate the current symptom questionnaire to assess its predictive value in identifying athletes with PVCD. A further step would be obtaining concurrent validity of the questionnaire by validating it with an objective procedure of choice such as Fiberoptic laryngoscopy in a larger cohort of participants. Future studies may investigate the efficacy of laryngeal relaxation exercises in reducing the symptoms of PVCD.

ABBREVIATIONS

PVCD: Paradoxical Vocal Cord Dysfunction; EIA: Exercise-Induced Asthma; GERD: Gastroesophageal Reflux Disease; TVC: True Vocal Cords; FVC: False Vocal Cords; LCS: Liquid Cleaning Solution; DLD: Dry Laundry Detergent

INTRODUCTION

Paradoxical vocal cord dysfunction (PVCD) is a common disorder recognized in the athletic population [1]. This disorder is characterized by paroxysmal periods of true vocal cord adduction during inspiration, or phonatory expiration, or both [2]. Athletes with PVCD typically exhibit sporadic attack of stridor or wheezing during their athletic activities. Typical manifestation of such disorder among athletes is exercise-induced dyspnea [3]. The impact of such disorder on athletics, athletics coaches and teammates is significant. If this disorder is left undiagnosed and/ or misdiagnosed, the athlete becomes less capable of performing necessary cardiovascular fitness exercises and consequently less able to meet the demands of athletic participation [3]. These airway restrictive symptoms can lead to the athletes be rushed to emergency departments for treatment of uncontrolled shortness of breath [4]. Often the continued symptoms coupled with ineffective treatment increases the emotional stress which increases the intensity of the symptoms.

Although PVCD has been well studied in pulmonary and otolaryngology literature, little information about this disorder has been presented in sports medicine literature. The lack of information about PVCD denies athletes and coaches knowledge of the condition. It is well-known that patients with PVCD might have coexisting medical conditions that have similar manifestation of the disease. Not uncommonly athletes are misdiagnosed as asthmatic (reactive airway disease) and undergo extended bronchodilator and corticosteroid therapy [5]. Recent studies showed that asthma and PVCD may coexist in approximately half of the studied population [2]. Asthma, exercise-induced asthma (EIA), gastroesophageal reflux disease...
(GERD), and pharyngeal erythema may increase the sensitivity of the larynx which may trigger similar symptoms [3].

Therefore, the differential diagnosis of PVCD may avoid the unnecessary steroid based treatment. Many studies showed that PVCD symptoms can be detected via transnasal fiberoptic laryngoscopy while the patient is asymptomatic while at rest [2]. Fiberoptic examination may show paroxysmal adduction of the vocal cords during inspiration. The current practice for assessing PVCD is to induce true vocal cord adduction using exercise tasks or exposure to chemical irritants [2].

Although transnasal fiberoptic laryngoscopy has been found to be useful in confirming diagnosis of PVCD, certain pulmonary laboratory parameters are required to differentiate or show co-existing asthma in these patients. For example, pulse oximetry, blood gas values, and flow loops obtained during attacks may help differentiate PVCD from asthma. Other investigators recommended methacholine challenge testing to differentiate between PVCD and asthma as this procedure was found to be effective in ruling out concomitant reactive airway disease in patients with PVCD [6]. The process of establishing a diagnosis is of importance for those athletes who do not respond to traditional treatment strategies for exercise-related asthma. The diagnosis and subsequent management of PVCD is best undertaken by Otolaryngologist, pulmonologist, and speech language pathologist within a multidisciplinary team.

PVCD has been well studied in adult population, nevertheless, there has been little effort to study the condition in young athletic population. A literature review revealed less than ten studies that assessed PVCD in this cohort of patients [e.g., 1; 2; 3; 7; 8; 9] [7, 8]. PVCD in young athletes might be different from PVCD in older athletes with regard to co-morbidity and chronicity of the symptoms, therefore, young athletic population might compose a different cohort of disease spectrum.

Furthermore, young athletes with PVCD are special cohort of patients because the breathing dysfunction poses threat to their participation and performance in sport. The lack of efficacious treatment means athletes may struggle with PVCD indefinitely. It is important for sport personnel to familiarize themselves with such breathing dysfunction and its associated psychological symptoms. Nascimento and Tenenbaum (2013) [9] reported the common psychological experiences reported by young athletes in their study. These included: physical exhaustion, emotional exhaustion, devaluing sport, feelings of isolation, reduced accomplishment and confidence, and questioning athletic identity. These psychological facets suggest that the sport personnel need to plan their treatment and support of athletes in their care.

In the recent decade the state of Qatar has seen a significant investment in resources for athletes and other sports. Qatar presently invests heavily in its young athletes as they will represent Qatar in many sport activities. Qatar hosts one of the largest young athletes communities in the Middle East located in Doha at the Aspire Academy.

Aspire Academy is an internationally recognized national sports academy for the development of Qatar’s athletically talented boys. The academy provides integrated sports development, sports science and academic learning for boys from Grade 7 (12 - 13 years) to Grade 12 (17 - 18 years) who are on sports scholarships.

**OBJECTIVES/ SIGNIFICANCE**

The objectives of this paper are threefold

1. To study the demographic and videolaryngoscopic features in five young male athletes, between the ages of 12 and 15 years, who complained from occasional shortness of breath during their regular sports activities, (2) to evaluate the suitability of a trail version of a symptom questionnaire as a first step toward validating questionnaire with videolaryngoscopic findings in a larger cohort of participants (undergoing study in collaboration with Aspire Academy in Doha-Qatar), and (3) to promote further research in this area.

It is anticipated that findings of this study will increase knowledge of the condition amongst the athletes, sports medical staff and others. It may allow the athlete to gain control over episodic dyspnea, increase the athlete participation in sports activities with less complications, and indeed reduce unnecessary treatment that is usually prescribed to treat asthma.

**MATERIALS AND METHODS**

**Participants**

Five young athletes (12-15 years) found to be symptomatic for PVCD as identified by clinical history and findings of “trail version of Arabic PVCD questionnaire” were recruited from Aspire Sports Academy for a full pulmonary, otolaryngology, and voice evaluation. This trail questionnaire (Appendix 1) is adapted from three common questionnaires: The Minnesota Voice Speech Clinic questionnaire, Baylon Institute for Rehabilitation questionnaire, and the Newcastle laryngeal hypersensitivity questionnaire [10]. The medical history of five participants with difficulty breathing and stridor was obtained until the clinician thoroughly understands the pattern and characteristics of the problem. A full demographic, social, sport and medical history were taken (Table 1). All data were gathered during the participants’ first visit to the voice clinic at Hamad Medical Corporation at Doha. Each participant was tested individually under appropriate testing conditions.

**Evaluation Protocol**

Institutional review board approval of assessment protocol was obtained. All of the five participants were evaluated by an experienced speech language pathologist (author) with the diagnoses confirmed by a trained laryngologist. Flexible videolaryngoscopy was used to make the diagnoses of PVCD. Following Forrest et al [p 845, 2012] [11], the primary criteria for diagnosing PVCD on the video study included:

1. Observing respiration in the absence of gagging or coughing.
2. Inappropriate adduction of the vocal cords during inspiration or during both inspiration and expiration with at least two episodes per 10 respiratory cycles.
3. Evidence of normal abduction at some point during the exam.
4. Absence of other causes of airway obstruction.

5. In the absence of inappropriate adduction during quiet respiration, provoking probing with exercise (climbing the stairs) or chemical challenge was performed.

The speech language pathologist explained the testing procedure. After explaining the procedure to the participant including risk factors and obtaining consent form, the participant was asked to climb the stairs (three meters way from the voice clinic) and come immediately to the examining room. The fiberoptic scope was then immediately inserted to examine the laryngeal motion while the participant is setting in an upright position and leaning toward the examiner. There was no need to perform chemical challenge in three participants as they exhibited paradoxical motion of the vocal cords during the exam, the other two participants were challenged with a liquid cleaning solution and dry laundry detergent as they informed the examiner of their sensitivity to these two stimuli during history taking.

**Vocal Cord Dysfunction Questionnaire**

The first draft of the questionnaire consisted from eight sections. After implementing the eight section and computing internal consistency between items of each section, two main sections were excluded from the questionnaire due to their poor discriminative value. These were swallowing related items and voice abnormalities related items. One section was found to be general and can be include in the remaining five sections to avoid redundancy. The final draft of the questionnaire included five sections. The first section includes fourteen items as introductory information to the breathing difficulties. It is designed to differentiate laryngopharyngeal reflux symptoms (LPR) from respiratory-type laryngeal dystonia symptoms. It also screens participants for potential psychogenic stridor. The second section includes two main items with subtitles that are designed to differentiate Asthma-associated and hyper-immune laryngeal dysfunction from LPR, and respiratory-type laryngeal dystonia symptoms. The third section includes two main items with subtitles that are designed to assess the nature, duration, and variability of breathing difficulties. The fourth section includes nineteen items that investigate differential features of PVCD such as type of breathing difficulty, pattern of stridor, triggers and timing associated with breathing difficulties, and associated symptoms. The fifth section includes six specific relevant past medical history items that are designed to differentiate PVCD from brainstem abnormalities and drug-induced laryngeal dystonic reactions. The total number of questionnaire items was 43 items distributed over five sections.

The participants were asked to check each item as it applies to them. Then we added up the numbers for each corresponding category (LPR, respiratory-type laryngeal dystonia, asthma-associated and hyper-immune laryngeal dysfunction, brainstem abnormalities, and drug-induced laryngeal dystonia reactions. Then we ranked the diagnostic groups from high to low by the sums in a probabilistic term. This led us to favor certain diagnosis over another before conducting the stroboscopic study.

**RESULTS AND DISCUSSION**

A full results of pulmonary functions test is beyond the scope of this paper. However, abnormal flow-volume loop was seen and documented in four participants (three of them diagnosed with PVCD and one diagnosed with asthma and high probability of PVCD). The results of the laryngoscopic evaluation revealed that 3 out of the 5 participants evaluated in this study were found to have PVCD as the sole cause, or as a contributing factor, to their breathing difficulties during performing their daily sport activities. The clinical history results and the filled trail version of the questionnaire showed that these three participants had reported the following symptomatic presentations of PVCD: stridor on inhalation, cough (to open sensation of closure in airway), throat clearing to open, sensation of closure in airway, laryngeal or upper chest tightness, and a recovery period between 5 to 10 minutes. The laryngoscopic evaluation showed narrow vocal cord opening visualized when symptomatic on inspiration, expiration or both (Figure 1), edema and pachyderma (Table 2). One of the other two participants had a diagnosis of asthma and allergy. Although he did not exhibit overt symptoms of PVCD during the exam, he was still considered to have a high probability of PVCD because symptoms were elicited by having participant breathing deeply and phonate post laryngoscopic examination. The last participant was excluded from diagnosis of PVCD due to normal true vocal cord respiratory motion.

The positive findings in the three participants indicated that PVCD is not uncommonly finding among young athletes. This perception confirms that there is a lack of good quality research on PVCD in the young athletic age group. The literature review showed few studies reported on prevalence rate of PVCD in young athletes. Rice et al (1985) [12] indicated that a PVCD prevalence

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**Table 1: Demographic Findings for Five Participants.**

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Age</th>
<th>Sex</th>
<th>Sports activity</th>
<th>Illness</th>
<th>Smoking</th>
<th>Allergy</th>
<th>Confirmed PVCD</th>
<th>High probability PVCD</th>
<th>Excluded PVCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>13</td>
<td>M</td>
<td>Soccer</td>
<td>Asthma</td>
<td>No</td>
<td>LCS</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>P2</td>
<td>15</td>
<td>M</td>
<td>Soccer/Swimming</td>
<td>None</td>
<td>No</td>
<td>None</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P3</td>
<td>13</td>
<td>M</td>
<td>Soccer</td>
<td>None</td>
<td>No</td>
<td>None</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P4</td>
<td>15</td>
<td>M</td>
<td>Soccer/Swimming</td>
<td>LRP</td>
<td>No</td>
<td>DLD</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>P5</td>
<td>15</td>
<td>M</td>
<td>Soccer</td>
<td>None</td>
<td>No</td>
<td>None</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Abbreviations: PVCD: Paradoxical Vocal Cord Dysfunction; LCS: Liquid Cleaning Solution; DLD: Dry Laundry Detergent.
of up to 3% of intercollegiate athletes. Michaelis (2007) [13] reported that 8% of athletes screened for asthma at the 2004 Olympics suffered from PVCD. Rundell and Spiering (2003) [14] evaluated during exercise the breathing of 370 athletes with no breathing dysfunction diagnosis. They found that 5% of the athletes exhibited signs of PVCD. Powel et al (2000) [2] assessed 22 patients with PVCD aged 18 years and younger. Results of their study showed that 12 had significant sports’ stressors, nineteen had posterior laryngeal changes related to GERD, and twelve demonstrated abnormal true vocal cord adduction during quiet supraglottic anteroposterior construction and false vocal cord approximation during phonation. Other studies have suggested that PVCD is strictly a psychological disorder. For example, Leo and Konakanchi (1999) [15] reviewed 171 cases of PVCD from various reports and concluded that PVCD represents a psychological conversion reaction.

Primary results of Concurrent validity of the questionnaire using “hit rate” analysis is undergoing on a larger sample of participants. However, the initial cutoff score based on this pilot sample is over than 30 items. Sensitivity (i.e., percentage of truly PVCD, identified as such by the screening) was 90%. Specificity for this criterion (i.e., percentage of “truly” normal participants, identified as such by the screening) was 100%. However, best hit rate analysis is expected to be obtained after analyzing results from a larger sample. Specifically, the positive predictive value (percent failing the screen who tested as PVCD) and negative predictive value (percent passing the screen who tested as normal).

Based on results of this pilot study, it obvious that there is a need to investigate the prevalence of PVCD in young male athletes in Qatar. Specifically, those who experience occasional shortness of breathe during their regular sports activities. The next step in this project is to validate the “current trail version of symptom questionnaire” to assess its predictive and concurrent validity by examining correlation between score results of questionnaire and videolaryngoscopic findings in a larger cohort of athletes with probable diagnoses of PVCD. Future studies may investigate the evaluation of a therapeutic program that is based on laryngeal relaxation exercises for management of the symptoms of PVCD.

<table>
<thead>
<tr>
<th>Table 2: Videolaryngoscopic Findings for Five Participants.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Number</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>P1</td>
</tr>
<tr>
<td>P2</td>
</tr>
<tr>
<td>P3</td>
</tr>
<tr>
<td>P4</td>
</tr>
<tr>
<td>P5</td>
</tr>
</tbody>
</table>

Abbreviations: TVC: True Vocal Cord; FVC: False Vocal Cord

Figure 1 Paradoxical Vocal Cord Dysfunction during Inhalation.
CONCLUSION

Paradoxical vocal cord dysfunction has been considered an uncommon disorder in sports community. The primary findings of this study indicated the opposite. The findings showed the importance of identifying candidate patients by careful history taking that could be accomplished by a valid questionnaire. It also stresses the importance of fiberoptic findings in diagnostic process of PVCD. Fiberoptic laryngoscopy is the procedure of choice in diagnosing PVCD [11]. The results of this clinical-decision making could be more systematic through a systematic application of a standardized protocol with provocative testing. The research may lead to development of clinical assessment and therapeutic protocol for PVCD among athletes and increase sport community awareness of such disorder. This is the avenue we would like to pursue in the future with the ultimate goal of designing assessment and therapeutic protocols for voice-respiratory related disorders.

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REFERENCES

13. Michaels V. Breathing disorder can be difficult to detect. USA Today. 2007.