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GUIDE FOR AUTHORS

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Cardiac specialized conduction system in competitive athletes

Francesca Latino[1], Domenico Tafuri[2], Filomena Mazzeo[3]

[1]*Department of Public Health, University of Naples Federico II, Italy*
[2]*Department of Sport Science and Wellness, University of Naples Parthenope, Italy*
[3]*Department of Science and Technology , University of Naples Parthenope, Italy*

Abstract. Competitive athletes are widely regarded as a special group of healthy individuals with a unique lifestyle who are seemingly invulnerable and often capable of extraordinary physical achievement.
Athlete's heart is generally regarded as a benign increase in cardiac mass, with specific circulatory and cardiac morphological alterations, that represents a physiological adaptation to systematic training. However, the clinical profile of athlete's heart has expanded considerably over the last several years as a result of greater accessibility to large populations of trained athletes studied systematically with, ECG, ambulatory Holter ECG monitoring, stress test, echocardiography and cardiac magnetic resonance. As a consequence, there is increasing recognition of the impact that prolonged conditioning has on cardiac remodeling, which may eventually mimic certain pathological conditions, such as Brugada syndrome, with the potential for sudden death or disease progression.
These findings indicate that atrioventricular conduction system abnormalities may play a fatal arrhythmogenic role and raise questions regarding the prevention of electrical instability in young people engaged in active sports. At last many drugs have been associated with adverse events in Brugada syndrome patients and have been indicated to provoke the characteristic Brugada syndrome-linked ECG abnormalities and/or (fatal) ventricular tachyarrhythmias.
Keywords: *atrioventricular conduction, sudden death, exercise, athletes*.

Introduction

The cardiovascular benefits of regular physical exercise have been well-documented, with overwhelming evidence from epidemiological and intervention studies, suggesting that cardiovascular disease is largely a disease associated with physical inactivity (1,2). Exercise plays a beneficial role in the prevention and treatment of cardiovascular disease, with an inverse and robust relationship between physical activity and mortality risk. With such overwhelming evidence to support the promotion of physical activity within the community, the competitive retirement or even death of an athletic individual due to a cardiac pathological mechanism is a tragic and highly publicised event (3,4).
Competitive athletes are widely regarded as a special subgroup of healthy individuals with a unique lifestyle who are seemingly invulnerable and often capable of extraordinary physical achievement.
The heart of trained athletes can have a variety of changes known as athlete's heart. Athlete's heart is generally regarded as a benign increase in cardiac mass, with specific circulatory and cardiac morphological alterations, and electrical changes that show up on an ECG, that represents a physiological adaptation to systematic training (5).
Syncope, defined as a transient loss of consciousness accompanied by loss of postural tone, is common in trained athletes. In a large cohort of Italian athletes, roughly 6% reported syncope in the prior 5 years (6,7).
The approach to the athletic patient with syncope begins with a detailed history, physical examination, and 12-lead ECG (8). The resting 12-lead ECG should be inspected for abnormalities of conduction - QT prolongation, pre-excitation, right bundle-branch block with early precordial ST elevation suggestive of Brugada syndrome (BrS) and structural heart disease - left bundle-branch block, LV hypertrophy with repolarization abnormalities, diffuse T-wave inversions (5).
Notable is the evidence that, many drugs have been reported to induce the type-1 BrS-ECG and/or (fatal) arrhythmias in BrS-patients.

Therefore, patients with BrS should be advised not to use these drugs or to use them only under controlled conditions (9).

Cardiac morfo-functional aspects in athlete's heart

The heart has an electrical conduction system makes of two nodes (special conduction cells) and a series of conduction pathways. The heart begins beating with an electrical impulse from the sinoatrial (SA) node. The SA node is the pacemaker of the heart, responsible for setting rate and rhythm and is located in the wall of the right atrium. The impulse spreads through the walls of the atria, causing them to contract. Then, the impulse moves through the atrioventricular (AV) node (a relay station) located at the junction between the atria and ventricles. As the impulse travels down the bundles, the ventricles contract and the cycles repeats itself, this cycle of atrial and ventricular contractions pumps blood of the heart to the rest of the body (6).

Resting and exercise heart rate are controlled by the sympathetic and parasympathetic nervous system. The sympathetic division of the autonomic nervous system prepares the body for physical activity by increasing heart rate, blood pressure and respiration. The sympathetic division also stimulates the release of glucose from the liver for energy. Once exercise begins, the sympathetic nervous system is activated and the heart rate rises quickly. Heart rate also rises by simply thinking about exercise, which is referred to as anticipatory heart rate response (10). The parasympathetic division helps to slow down heart rate and respiration. At rest, the heart is controlled by the parasympathetic division, which is why the average resting heart rate is 60 beats per minute or less. One of the explanations of why endurance athletes have such a low resting heart rate following training is due to increased parasympathetic response. During exercise, the release of epinephrine and norepinephrine stimulate receptors in the heart which causes heart rate to increase (5). Therefore, exercise acts as a trigger for lethal ventricular tachyarrhythmia, given the susceptibility imposed by underlying (and usually unsuspected) cardiac disease (8).

Recent data has documented an increased prevalence of supraventricular, complex ventricular and profound bradyarrhythmias in endurance-trained athletes, predominantly occurring in veteran athletes (11). Several forms of idiopathic ventricular arrhythmia have been identified in athletes which, by definition, originate in hearts without structural abnormalities. The clinical significance of these arrhythmias remains to be fully elucidated. Yet, in support of the potential pathological changes in the cardiac electrical activity, several studies have reported an incomplete reversal of left ventricular hypertrophy in retired elite athletes suggesting, in part, a pathological remodelling process (12,13).

Because of the heightened vagal tone that accompanies physical conditioning, trained athletes are known to commonly incur innocent arrhythmias and conduction alterations, such as sinus bradyarrhythmia, junctional rhythm, and first-degree or Wenckebach AV block (Mobitz type I). However, the application of ambulatory (Holter) ECG monitoring to trained athletes unexpectedly documented substantial ectopy with frequent premature beats and complex ventricular tachyarrhythmia (including couplets and bursts of nonsustained ventricular tachycardia) in many such individuals. These findings suggest that a variety of arrhythmias are part of the athlete's heart spectrum. Indeed, such rhythm disturbances have not been associated with adverse clinical events and are usually abolished or substantially reduced after relatively brief periods of deconditioning (as well as during physical training sessions and exercise testing). Even in athletes with heart disease, resolution of ventricular tachyarrhythmia with deconditioning is common and may represent a potential mechanism by which sudden death risk is reduced by withdrawal of these individuals from training and competition, in accord with consensus panel recommendations (14).

A few observational studies have reported mild-to-moderate postrace elevations in biochemical cardiac-specific markers (plasma cardiac troponin T and I) suggestive of transient myocardial injury in some participants after prolonged and strenuous endurance athletic events, such as triathlons and marathons (15,2). At present, there is no evidence that these subclinical findings are associated with permanent clinical consequences. Some studies have also identified transient and reversible systolic and diastolic dysfunction after extreme athletic events.

Although data defining the physiological and morphological adaptations of systematic training are considerable, it nevertheless remains

unresolved whether the current profile of athlete's heart can be extrapolated to all subgroups within this physically active and diverse population: those of different ages, sports disciplines, and racial or ethnic origin. Indeed, there are limited data defining the adaptations of athlete's heart in females, in modestly trained individuals in youth sports programs, and in blacks and other minorities (2).

In competitive athletes, the differential diagnosis between nonpathological cardiac changes associated with training (commonly referred to as "athlete's heart") and certain cardiac diseases with the potential for sudden death is an important and not uncommon clinical problem. Such crucial diagnostic distinctions most frequently involve Brugada syndrome, which is the most common cause of sudden death in young competitive athletes (3,4). Our awareness of this issue, as well as the parallel consideration of preparticipation athletic screening, has been heightened by several recent high-visibility catastrophies involving elite soccer, volleyball and basketball players who died suddenly and unexpectedly from cardiovascular disease (14).

The distinction between athlete's heart and cardiac disease has particularly important implications, because identification of cardiovascular disease in an athlete may be the basis for disqualification from competition in an effort to minimize risk. By the same token, the improper diagnosis of cardiac disease in an athlete may lead to unnecessary withdrawal from athletics, thereby depriving that individual of the varied benefits of sport (3, 2).

Nonetheless, he devastating impact of even relatively infrequent sudden deaths in young athletes offers justification for restriction from competition to reduce the risk related to silent and unsuspected cardiac disease. For athletes in whom cardiovascular disease has been identified (either by preparticipation screening or under other circumstances), important considerations arise with respect to the appropriate formulation of eligibility and disqualification decisions for competitive sports.

Recently, strict diagnostic criteria and risk stratification for the identification of high-risk patients with Brugada syndrome patients have been suggested. Thus, the diagnosis of Brugada syndrome can only be made on the basis of a typical ECG pattern and only a coved type ECG (Brugada type 1) is diagnostic of the disease and, if spontaneously occurring, apparently has a poorer prognosis (16,17). Although for European countries only scanty data exist as to the prevalence of the disease in the general population, the situation is even worse among endurance-trained athletes.

Recurrent exercise-related syncope in endurance-trained athletes is believed not to be associated with an adverse outcome, if structural abnormalities of the heart are absent. This, however, does not hold for syncope in individuals with Brugada syndrome, which is a potentially life threatening primary electrical disease. Individuals with a Brugada ECG and a history of syncope have a high risk for sudden cardiac arrest which amounts to 27% if they are inducible. In rare cases, syncope in Brugada syndrome may be due to a vasovagal mechanism (8).

Brugada syndrome

Brugada syndrome was first described in 1992 in a series of patients with sudden death who had similar, peculiar electrocardiogram abnormalities. It was later found that many of these patients had abnormal function of their sodium ion channels (3,4) .

Brugada syndrome is characterized by coved type ST- elevation in the right precordial leads (V1–V3) and increased risk of sudden death in the absence of structural heart disease.

ECG abnormalities constitute the hallmark of Brugada syndrome. They include repolarization and depolarization abnormalities in the absence of identifiable structural cardiac abnormalities or other conditions or agents known to lead to ST-segment elevation in the right precordial leads (10).

Three types of repolarization patterns are recognized (Fig. 1).

Type 1 is characterized by a prominent coved ST-segment elevation displaying J-wave amplitude or ST-segment elevation ≥2 mm or 0.2 mV at its peak followed by a negative T-wave, with little or no isoelectric separation (4,10).

Type 2 also has a high take-off ST-segment elevation, but in this case, J-wave amplitude (≥2 mm) gives rise to a gradually descending ST-segment elevation (remaining ≥1 mm above the baseline), followed by a positive or biphasic T-wave that results in a saddle back configuration (3,10).

Type 3 is a right precordial ST-segment elevation of <1 mm of saddle back type, coved type, or both, it presents also J-wave amplitude <2 mm.

It should be stressed that delineation of the *J* wave is sometimes tricky and that these descriptions are based on the correct placement of the precordial leads, although characteristic ECG features obtained with alternative placement of the right precordial leads in a superior intercostal space in individuals with high clinical suspicion may also disclose the presence of the arrhythmic substrate.

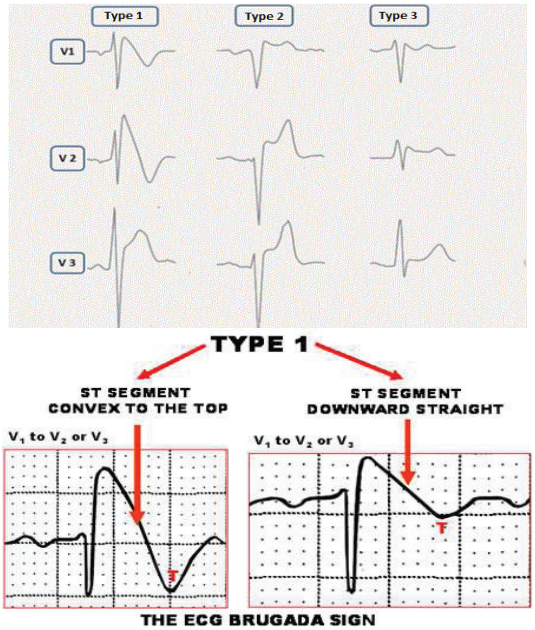

Figure 1. ECG pattern in Brugada syndrome

Brugada syndrome should be considered in the following cases:

- *Appearance of type 1*: ST-segment elevation (coved type) in more than one right precordial lead (V_1 to V_3), in the presence or absence of a sodium channel blocker, and one of the following likely indicates Brugada syndrome: documented ventricular fibrillation; self terminating polymorphic ventricular tachycardia; a family history of SCD (<45 years); coved type ECGs in family members; electrophysiological inducibility; syncope; or nocturnal agonal respiration. There should be no other factor(s) that can account for the ECG abnormality. The appearance of the ECG features without these clinical symptoms is referred to as an idiopathic Brugada ECG pattern (not Brugada syndrome) (13,18).
- *Appearance of type 2*: ST-segment elevation ("saddle-back type") in more than 1 right precordial lead under baseline conditions with conversion to type 1 after challenge with a sodium channel blocker is considered equivalent to case 1 above. A drug-induced ST-segment elevation to a value >2 mm should raise the possibility of Brugada syndrome when 1 or more clinical criteria are present. On the basis of our limited knowledge at present, a patient with a negative drug test (ie, no change in the ST-segment in response to a sodium channel blocker) is unlikely to have the Brugada syndrome; drug-induced ST elevation to <2 mm is considered inconclusive (19).
- *Appearance of type 3*: ST segment elevation in more than 1 lead under baseline conditions with conversion to type 1 after challenge with a sodium channel blocker is considered equivalent to case 1 above and should be screened accordingly. Drug-induced conversion of type 3 to type 2 ST-segment elevation is considered inconclusive (20).

Patients who do not fully fulfil the proposed criteria (eg, type 1 ECG with a J-wave amplitude of only 1mm), but who have one or more of the clinical criteria defined above, should be considered seriously. Most often, a drug challenge will disclose the diagnosis Brugada syndrome (3,6).

Particular problems exist in the pediatric population because of the lack of control data, the different chest morphology, and the age-dependent predominance of right ventricular forces. Typical ECG patterns, however, have been observed in small infants, where eventual lethal arrhythmias might actually resemble Sudden Infant Death syndrome. Hence, suspect symptoms with typical electrocardiographic features and/or a family history for sudden cardiac death, even at young age, should alert pediatricians to the possibility of Brugada syndrome (3,4).

Drugs and Bruganda syndrome patients

The presence of type-1 ECG has been linked to an increased risk for ventricular tachyarrhythmias, cardiac arrest and sudden death in Brugada syndrome patients (9). Importantly, many drugs have been reported to induce the type-1 ECG and/or (sometimes fatal) arrhythmias in Brugada syndrome patients. Therefore, it is necessary to advice patients with Brugada syndrome not to use these drugs, or to do so only in controlled conditions so that its potential pro-arrhythmic effect or the lack thereof can be documented and treated if necessary.

This advice is also acknowledged in the latest guidelines for the treatment of inheritable arrhythmia syndromes (9).
Drugs are divided into four lists: drugs to be avoided, drugs preferentially avoided, potential anti-arrhythmic drugs, diagnostic drugs (9, 21).

Drugs to be avoided (Tab. 1). The following drugs have been associated with arrhythmias and the typical (type-1) Brugada Syndrome ECG. It should be seriously considered to advise patients with Brugada syndrome to avoid these drugs or to use these drugs only after extensive consideration and/or in controlled conditions (9, 22).

Table 1**.** Drugs to be avoided in Brugada syndrome

ANTIARRHYTHMIC DRUGS	PSYCHOTROPIC DRUGS	ANESTHETICS/ ANALGESICS	OTHER SUBSTANCES
Ajmaline	Amitriptyline	Bupivacaine	Acetylcholine
Flecainide	Clomipramine	Procaine	Alcohol (toxicity)
Pilsicainide	Desipramine	Propofol	Cocaine
Procainamide	Lithium		Ergonovine
Propafenone	Loxapine		
	Nortriptyline		
	Oxcarbazepine		
	Trifluoperazine		

Drugs preferentially avoided (Tab. 2). The following drugs have been associated with the typical (type-1) Brugada Syndrome ECG. However, there is (yet) no substantial evidence that these drugs can, in addition to the ECG phenotype, also cause malignant arrhythmias. Furthermore, list include drugs for which there is only experimental evidence (*in-vivo* or *in-vitro*) that suggests a possible deleterious effect in Brugada syndrome. However, as mentioned earlier this deleterious effect has not been documented clearly and some patients may benefit from these drugs for other reasons. Nevertheless, it should be considered to advice patients with Brugada syndrome to avoid these drugs or to use these drugs only after extensive consideration and/or in controlled conditions (9,23).

Table 2. Drugs preferentially avoided in Brugada syndrome

ANTIARRHYTHMIC DRUGS	PSYCHOTROPIC DRUGS	ANESTHETICS/ ANALGESICS	OTHER SUBSTANCES
Amiodarone	Carbamazepine	Ketamine	Dimenhydrinate
Cibenzoline	Clothiapine	Tramadol	Diphenhydramine
Disopyramide	Cyamemazine		Edrophonium
Lidocaine	Dosulepine		Indapamide
Propranolol	Doxepin		Metoclopramide
Verapamil	Fluoxetine		Terfenadine/
Vernakalant	Fluvoxamine		Fexofenadine
	Imipramine		
	Lamotrigine		
	Maprotiline		
	Paroxetine		
	Perphenazine		
	Phenytoin		
	Thioridazine		

Potential anti-arrhythmic drugs (Tab. 3). The following drugs have been described in case reports or relatively small series as potential antiarrhythmic drugs in Brugada syndrome patients. Utmost care should be taken when using these drugs in the acute or chronic setting in Brugada syndrome patients (24). None of these drugs have proofed to completely prevent arrhythmias, some drugs have not been tested to an appreciable extent in Brugada syndrome patients and some drugs may have unacceptable side-effects.

Preferably only (severely) symptomatic or otherwise high-risk patients in the absence of provoking drugs may be candidates for chronic therapeutic treatment in an experienced medical center. Currently, quinidine seems to be the treatment of choice for chronic therapy. As mentioned earlier, avoidance of provocative drugs/substances and timely treatment of fever is probably the most effective and safe treatment in many Brugada syndrome patients. However, some Brugada syndrome patients may (only) be appropriately treated with an implantable cardioverter defibrillator.

Table 3. Potential anti-arrhythmic drugs in Brugada syndrome

Cilostazol
Isoproterenol
Isoprenaline
Orciprenaline
Quinidine

Diagnostic drugs (Tab. 4). These sodium channel blocking drugs are used to test for Brugada Syndrome in patients suspected of Brugada Syndrome but without a spontaneous type-1 Brugada ECG. Tests should always be performed under continuous ECG monitoring and controlled conditions. Drug administration during the tests differs per drug used but regularly the drug is administred in 5 to 10 minutes either continuously or in 1 minute intervals untill a diagnostic ECG, arrhythmias, excessive conduction abnormalities or maximal dose are reached. Post-test monitoring depends on the half life of the chosen drug (ajmaline several minutes, flecainide 20 hours, procainamide 3-4 hours), and is recommended untill the ECG has returned to baseline conditions (25, 26).

Table 3. Diagnostic drugs in Brugada syndrome

Ajmaline
Flecainide
Pilsicainide
Procainamide

Closing remarks

In competitive athletes, the differential diagnosis between nonpathological cardiac changes associated with training (commonly referred to as "athlete's heart") and certain cardiac diseases with the potential for sudden death is an important and not uncommon clinical problem. Such crucial diagnostic distinctions most frequently involve the Brugada syndrome, which is the most common cause of sudden death in competitive athletes (1,28).

The distinction between athlete's heart and cardiac disease has particularly important implications, because identification of cardiovascular disease in an athlete may be the basis for disqualification from competition in an effort to minimize risk.

Because of the wide variety of ECG alterations present in both athletes without cardiovascular disease and patients with Brugada syndrome, the 12-lead ECG is particularly useful in distinguishing between these two entities (4).

The majority of sudden deaths in athletes occur in the context of underlying inherited or genetic cardiac disorders. The evaluation of every athlete regarding underlying cardiac disease is impractical and therefore needs to be targeted at those who are at a higher risk (29).

A practical approach would be to channel efforts towards athletes with cardiac symptoms, those with a family history of inherited cardiac disease, and those with a family history of premature sudden death[14]. There are potential pitfalls in the evaluation of young athletes using non-invasive tests when making the distinction between physiological adaptations to exercise and cardiac pathology (30).

The fitness of patients with Brugada syndrome to indulge in sporting activities is a practical cardiology problem. The major risk is sudden death, therefore signing a fitness certificate engages the clinician's responsibility. Non invasive complementary examinations are useful and important for maintaining the health of the athletes (31).

Therefore, one of the crucial activity of sport physician is the certification of medical fitness for athletes with Brugada syndrome. The certification must be based on knowledge of sport competive athletes conditions, knowledge of health risks and on results of medical examinations (32).

Physicians evaluating young athletes need to be aware of the spectrum of physiological adaptations and to be familiar with conditions responsible for sudden death in this population.

It is concluded that Brugada syndrome contra-indicates competitive sports in most cases. Games played outside competitions remain possible just in the absence of symptoms or just when the arrhythmias are well controlled by medical treatment (33).

Asymptomatic athletes without a spontaneously occurring type 1 Brugada ECG and with a negative family history form the lowest risk category and could be considered just for noncompetitive sport (1).

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Corresponding author
Filomena Mazzeo
Department of Science and Technology
University of Naples Parthenope, Italy
Phone: +39 0815474973
E-mail: *filomena.mazzeo@uniparthenope.it*

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Analysis of pain threshold and tolerance of super league soccer players

Recep Lokmaoğlu[1], Nesrin Yağcı[2], Uğur Cavlak[2]
[1]*Bursaspor Club*
[2]*Pamukkale University, School of Physical Therapy and Rehabilitation, Denizli, Turkey*

Abstract. The aim of this study is to measure pain threshold and pain tolerance in male soccer players playing in super league and to compare with sedentary healthy male subjects. *Materials and Methods*. Thirty-seven male soccer players playing in Denizlispor Club aged 19-32 years an twenty-four sedentary healthy male subjects were included in this study. Pain threshold and pain tolerance were measured from both right and left side upper and lower extremities. In this study, it was used experimental pain by electrical stimulation to measure pain threshold and tolerance. Body Mass Index (BMI) score was calculated for each subject. *Results*. Pain threshold values of the soccer players were found to be lower than sedentary subjects, pain tolerance of the soccer players was found to be higher than sedentary subjects (p=0.0001). *Conclusion*. The results obtained from this study indicate that soccer players had lower pain threshold compared with sedentary subjects; however, pain tolerance of the soccer players was higher.
Key words: *soccer, experimental pain, pain threshold, pain tolerance*.

Introduction

Pain is accepted as an unpleasant sensation generally occurring as a response to tissue damage and that results in the motivation and awareness to avoid the stimulus that causes it. According to Melzack, pain is a multidimensional, unpleasant sensory and emotional experience (1).

Although assessment of pain is fairly easy, it is subjective because it changes from person to person. Perception of pain is directly related with pain threshold and tolerance.

One of the methods used in assessing pain is electrical stimulation. Due to its easy application and control, this method can be used on cutaneal, deep somatic and visceral zones.

Pain threshold and tolerance values can be measured physically by means of electrical stimulation. Defined and obtained threshold values are controlled with the occurrence of pricking sense (2).

In sports, pain is an important concept and determines athletes' performance and professional future. Pain is defined as the most serious symptom restricting skill in both individual and team sports requiring high performance (3). It was determined that the cardiovascular systems of professional athletes are constantly stimulated at high levels and that their pain tolerances are higher (4,5). In the study Ord and Gijsbers conducted, while no difference could be found between the pain threshold values of athletes and sedentary individuals subjected to ischemic pain, pain tolerances of the athletes were determined to be higher (6).

Our study was planned for the purpose of examining pain threshold and pain tolerance by means of inducing experimental pain to male soccer players playing in one of the professional Turkish leagues, and to compare these with those of sedentary male subjects.

Material and Method

37 male professional soccer players aged between 18 and 32 years of age and playing in the team Denizlispor in the PTT League 1, and 24 healthy, sedentary male subjects aged between 19 and 32 years of age were included in the scope of the study. Before performing the tests, all participants were informed concerning the study; their oral and written consents were obtained and approved by the Institute of Medical Sciences of Pamukkale University. The study was conducted in compliance with the principles of the Helsinki Declaration. Study groups were formed as follows: Soccer Player - 37 professional male soccer players playing in the Turkish professional league 1; Control -24 healthy sedentary male subjects that do not participate in any sports, be it amateur or professional.

Measurements Procedures. A form to record the socio-demographic characteristics of the cases was prepared. In this assessment, ages, heights, body weights, body mass index (BMI) and body fat percentages of the participants were recorded.
Body mass index (BMI) was calculated for the purpose of assessing body composition. It was obtained by dividing body weight in kilogram to the square of height in meter (kg/m^2) (7). Body weights were measured on a weighing scale, with the participants without shoes and with underwear. Heights were measured with a tape measure, again while the participants did not wear shoes. While those that have a Body Mass Index (BMI) between 18,5 and 24,9 were grouped as normal weighted, the participants with BMI values between 25 and 29,9 were grouped as overweight.
Measurements of pain threshold and tolerance were carried out by applying experimental pain through electrical stimulation (8). For the determination of pain threshold and tolerance Endomed 982 (Enraf Nonius Company) device was used. For assessment, the device was adjusted to induce square galvanic current at 166 Hz frequency with 1 msec. stimulation and 5 msec. monitoring. In the application a 6 x 8 cm. carbonized electrode was used as the passive electrode while a pen electrode was used as the active electrode (Figure 1).

Figure 1. Endomed 982 device just used to test the pain threshold and pain tolerance

The measurements were carried out at a fixed room temperature of 18-22 ˚C, at sitting position for upper extremity with elbow flexion 90° and the forearm at neutral position between pronation supination. Passive electrode was positioned on the radial side of the forearm proximal, while the active electrode was positioned on the radius distal end. For lower extremity, the measurements were carried out at lying position, with the extremity supported by a pillow and electrodes connected on peroneal nerve line. Before the measurements, the participants were asked to state when they feel pain the first time, explained that it will get stronger and that they are expected to state when it becomes intolerable. The current was applied by increasing it gradually. The points where the pain was felt for the first time were recorded as pain threshold, while the points where it becomes unbearable were recorded as pain tolerance in Ampere (mA). Measurements were repeated three times by the same physiotherapist and the mean of the 3 values obtained were calculated.
Statistical Analysis. Mean values and standard deviations were calculated for all variables. Each parameter was examined for normality using the Kolmogorov-Smirnov test. Comparisons between groups' pain threshold and tolerances were performed using two independent sample t-tests. Comparison of the pain threshold and tolerance between groups according to the BMI, pain perception results was performed using Mann-Whitney U test. The alpha level of statistical significance was set at $p<0.05$ for all statistical tests (9).

Results

A total of 61 individuals were included in the study. Descriptive data of the participants and their comparisons are presented in Table 1. There was no statistically significant difference between the age, height and weight averages of the two groups and a homogenous distribution is observed among the groups ($p>0.05$). BMI values of the control group were found out to be higher than those of the soccer players ($p=0.003$).

Table 1. Descriptive data of the groups

Variables	Soccer players (n=37) Mean ± SD	Control group (n=24) Mean ± SD	p^*
Age (year)	24.18± 4.03	24.20±3.48	0.985
Height (cm)	180.03±0.06	177.01±0.05	0.068
Weight (kg)	76.18±6.59	77.55±8.21	0.491
BMI (kg/ m²)	23.26±1.36	24.49±1.67	0.003

**Two Independence Sample t-test, SD: Standard deviation*

Comparison of the Pain Thresholds and Pain Tolerances of the Groups. The right and left upper extremity pain thresholds and right and left lower extremity pain thresholds of the soccer players were found out to be lower than those of the control group and the difference was determined to be statistically significant (p=0.0001). On the other hand, the lower extremity pain tolerance and upper extremity pain tolerance of the soccer players were found out to be higher than the control group and the difference was determined to be highly significant (p=0.0001) (Figure 2).

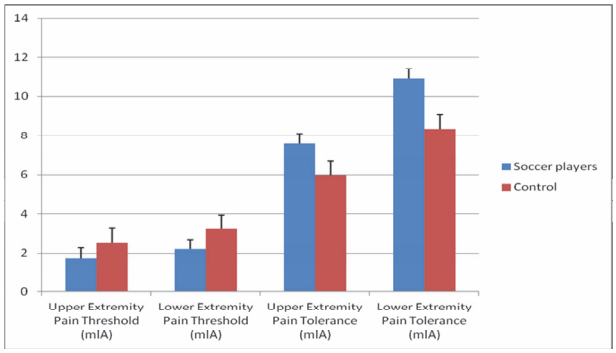

Figure 2. Comparing the pain threshold and pain tolerance of the groups

Discussion

The study demonstrated that, in comparison with sedentary individuals, professional soccer players have lower pain thresholds and higher pain tolerances.

Pain is an important symptom mechanism providing information on injuries. Particularly in contact sports, it is a factor that determines where the athletes should stop and therefore prevents further injuries (10). In the study conducted by Prokop, pain is defined as the most serious symptom restricting skill in both individual and team sports requiring high performance (3). Athletes involved in contact sports have lower pain perception and higher pain tolerance. This is generally attributed with pain desensitization of athletes due to physical contact (10). Sensitivity to pain affects athletes' motivations and performances (11). There are many factors affecting pain tolerance such as age, gender, type of sports, content of exercises, stress, anxiety, personality and cultural background (12-14). Conducted studies also report that pain threshold and tolerance are also affected by the length of the sports contest (15,16).

Soccer is contact sports and matches are 90 minutes long. Training periods with intense exercises are made for preparation before matches (17). Also, the most frequent injuries occur in soccer (18-20). Since the work load peaks of soccer players are mostly on lower extremities, also muscle pains are found more intensely on lower extremities (21,22). Soccer players push their maximum physical limits during trainings and matches. This in turn enhances muscle strength of the body and particularly of the lower extremity. In soccer matches, who require durability, endurance and agility, work load of the first half is higher than that in the second half. Accordingly blood lactate levels are found out to be higher during the first halves, and particularly higher in forward players in comparison with mid-fielders and defense players (23,24). Regularly conducted physical activities affect pain perception of athletes (13). It is reported in conducted studies that the pain tolerances of athletes are typically higher than that of sedentary individuals (25-28).

In a comparative study conducted on several branches of sports, it was reported that athletes' capability to tolerate pain is higher than sedentary individuals (8). In our study it was determined that pain tolerance of soccer players at lower and upper extremities is higher than sedentary individuals. This finding indicates that in contact sports such as soccer, the fact that professional athletes are subjected to painful stimulants in every match causes their pain tolerances to increase.

Pain threshold is the key to the success of athletes particularly competing in sports branches that require high endurance (29).

In controlled studies conducted on pain threshold of athletes it was determined that the contests reduce pain threshold (30,31).

One of the factors affecting pain threshold is the aerobic exercises. It is stated in the literature that pain threshold and resistance particularly of the exercised muscles increase and strengthening exercises do not affect pain threshold (32-34).

Soccer is a branch of sports with aerobic and anaerobic loads. While trainings intended to increase anaerobic capacity are carried out for higher speed and strength, also trainings intended to increase aerobic capacity are conducted in order to enhance endurance and ensure that the player can stay on the field for 90 minutes (35-38).

Also special exercises for strengthening the body and the lower extremity are carried out in soccer trainings. As a result of these exercises hypertrophy of muscles takes place. Volume of the blood reaching the muscles was increased by

30 to 40 times. Fibril number, diameter and ATP concentration increase.

In consequence of the loads introduced with strength building exercises, muscle contraction rate increases and stimulability of motor units rises (39,40).

By means of the experimentally induced pain on the motor units of muscles through electrical stimulation, in our study the pain threshold of upper and lower extremity of soccer players was found out to be lower than sedentary individuals. This may be explained in the way that, in consequence of intense aerobic and anaerobic trainings soccer players carry out, the hypertrophy in their muscles responds to electrical stimulants rather quickly and by activating several motor units.

Our study proves that pain perception of professional soccer players is different than that of sedentary people. Understanding pain perception without sportive injuries will be helpful in the interpretation of functional pain mechanisms and in creating the proper treatment plans.

Declaration of conflicting interests

This study was presented at the 7th European Congress on Pain, Hamburg, Germany, September, 2011. The authors declared no conflicts of interest with respect to authorship and/or publication of this article.

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Corresponding author
Uğur Cavlak
Pamukkale University
School of Physical Therapy and Rehabilitation,
Denizli, Turkey
Phone: +90 258 2962301
E-mail: *ucavlak@yahoo.com*

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Exhaled nitric oxide in athletes admitted to a pediatric department

Radu Diaconu[1], Dragos Valceanu[2], Carmen Diaconu [3]

[1] *Pediatrics Department, University of Medicine and Pharmacy, Craiova, Romania*
[2]*Filantropia Municipal Hospital, Craiova, Romania*
[3]*Sports Medicine Department, Emergency Clinical Hospital, Craiova, Romania*

Abstract. Fractional exhaled nitric oxide (FeNO) is the most accessible marker of bronchial inflammation, and may be a useful tool in sports medicine. The aim of our study was to evaluate the bronchial inflammation in the pediatric athletes admitted to our department and to correlate it to the atopic status and type of sport. Methods. We enrolled 127 athletes from our region and compared them with 100 control children without competitive background. We performed clinical examination, followed by FeNO testing and pulmonary function test (spirometry). Results. The spirometric data showed no difference between groups. FeNO levels were higher in the study group 16.05± 8.97 ppB, versus 13.02 ± 9.40 ppB in controls, p = 0.014 (t test). The stratified analysis showed increased FeNO in children practicing indoor compared to outdoor sports, especially in those without history of allergy. Conclusion. Practicing indoor sports seemed to be related to a higher level of exhaled nitric oxide which is already known as a predictor for atopic diseases (mainly asthma).
Key words: *exhaled nitric oxide, sports, children*.

Introduction

First discovered by Joseph Priestley in 1772, the nitric oxide (NO) is a "wonder molecule" which participates in the function of all main organ systems of the human body.

The measurement of exhaled mediators is one of the tools used in monitoring specific diseases as asthma, interstitial lung disease or chronic obstructive pulmonary disease. The fractional exhaled nitric oxide (FeNO) seems to be the most accessible due to the development in the last two decades of a whole range of fixed or portable dedicated devices (1). Since 2005, a joint statement (2) was issued by American Thoracic Society and European Respiratory Society, regarding the measurement of nitric oxide in humans.

The factors influencing the FeNO values are extremely different, some of them being non-disease related (age, sex, respiratory maneuvers, smoking, beverages and/or foods, circadian rhythm, et al.). There are also many studies regarding the effect of the physical exercise on NO values (3-5). The early data showed a decrease of FeNO levels during the effort, although other authors reported stable values after exercise.

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Sports medicine professionals are also interested in FeNO measurements taking into account the high prevalence of asthma in elite athletes and the effort induced type of the disease (6-9). The exposure to extreme weather conditions (cold air, high temperatures) or the contact with various irritants and allergens are the main triggers in developing asthma (10, 11).

The aim of this study was to evaluate the bronchial inflammation in pediatric athletes from our region and to correlate it with the atopic status and type of sport. Children with no athletic background were used as controls. The age group ranged between 6 and 12 years, due to the limitations imposed by the FeNO levels according to the latest recommendations.

Material and Method

We enrolled 227 consecutive children admitted to the Department of Pediatrics and the Department of Sports Medicine during a 12 months period. The study group comprised 127 athletes from Oltenia Region.

The control group had 100 healthy children not involved in professional sports. The children completed a health questionnaire, clinical examination, spirometry and FeNO measurement.
The spirometric evaluation was carried out according to the American Thoracic Society (ATS) and the European Respiratory Society (ERS) recommendations (12) using a Vitalograph Compact desktop spirometer (Vitalograph, Great Britain).
We determined the forced expiratory volume per one second (FEV_1), forced vital capacity (FVC) and maximal respiratory flows at various lung volumes. The results are displayed as the ratio between the measured and the predicted values.
The FeNO measurements were made before the spirometry, according to the ATS guidelines. The device used was the Nitric Oxide Analyser (NIOX MINO, Aerocrine, Solna, Sweden).
The patients inhaled using the mouth piece, then exhaled from total lung capacity to residual volume at an expiratory flow rate of 50 ml/second using the provided monitor and a mirror. The FeNO value was determined on the plateau of the exhaled nitric oxide graph. The elevated FeNO levels were defined as values higher than 25 ppb (parts per billion) according to the available data (13).
Statistical Analysis. Descriptive statistics are expressed as mean and standard deviation (SD). Statistical significance was determined as $p < 0.05$. FENO values were expressed in ppb (parts per billion) and were considered normal if results were below 20 ppb. Differences in FENO values in each group were studied using t test. A value of $p < 0.05$ was considered significant.

Results

The main groups characteristics are presented in Table I. The pediatric athletes admitted had a minimum 12 months competitive experience. 22 cases reported allergic diseases (atopic dermatitis, eczema, atopic rhinitis, atopic conjunctivitis, and/or asthma).
Our pediatric department deals mainly with pneumological cases, thus 28% of our controls reported at list one atopic disease. 83 athletes were involved in indoor sports (basketball, voleyball, martial arts, fencing, judo). 44 cases practiced outdoor sports (football and track and field).

The spirometric evaluation showed similar values in controls and study group. Most of the children showed normal or slightly reduced values of the main spirometric indices. There was no statistical significant difference between indoor or outdoor sports. The means as percent of the predicted values adjusted for age, height, gender are presented in table II.

Table I. Main groups structure

	Study group (n = 127)	**Controls (n = 100)**
Male:female, n	68:59	53:47
Age, mean (range), yrs	8.21 (6-12)	8.49 (6-12)
Competitive experience, mean (range), yrs	2.32 (1-7)	NA
Self-reported allergy: yes/no, n	22/115	28/82
Indoor/outdoor sport, n	83/44	NA

Table II. Spirometric evaluation

Mean (% of predicted value)	**Study group (n = 127)**		**Controls (n = 100)**
	Indoor	***Outdoor***	
FVC	89.4	92.1	87.5
FEV1	87.8	89.2	83.4
PEF	83.2	81.1	87.4
FEF_{25-75}	79.2	84.5	82.9

After the clinical examination, the subjects were consecutive tested for exhaled nitric oxide, before pulmonary function tests.
The children involved in various sports showed increased values of FeNO. The mean ± SD in study group was 16.05±8.97 ppB versus 13.02±9.40 ppB in controls, p=0.014 (t test), as showed in Figure 1. The proportion of self reported allergy was higher in the control group (28% vs. 16.05%), yet the bronchial inflammation seemed to be more elevated in the study group.

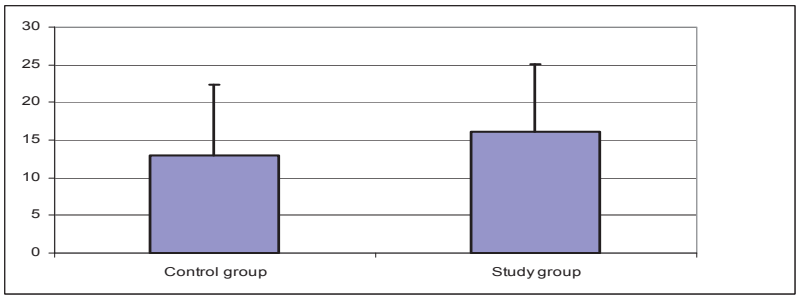

Figure 1. FeNO values (Mean ± SD) between groups

We performed a stratified analysis of the athletes group based on type of sport (indoor vs. outdoor) and self reported allergy (Figure 2). Outdoor athletes had FeNO levels similar to controls: mean ± SD = 11.81 ± 6.87 ppB, p = 0.39, thus the statistical difference between our main groups was due to the athletes practicing indoor sports: mean ± SD = 18.30 ± 9.19 ppB, p = 0.0018 (vs. controls). Also, only 5 outdoor athletes reported allergy, vs. 16 indoor: p = 0.12 (chi square), RR = 1.69 (0.66-4.32).

The FeNO levels were elevated in athletes practicing indoor sports regardless the atopic status. Our study lots allowed us to perform t test between "out normal" and "ind normal" subgroups and the result was statistically significant (0.00015).

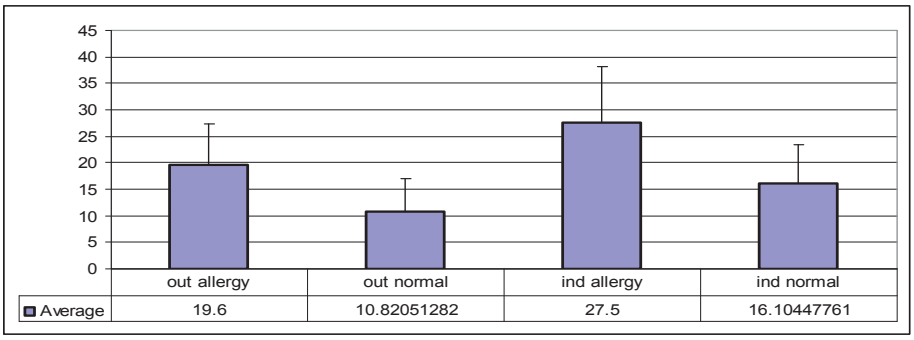

Figure 2. FeNO values (Mean ± SD) stratified by type of sport and allergy
out allergy - athletes practicing outdoor sports self reporting allergy; out normal - athletes practicing outdoor sport without known allergy; ind allergy - athletes practicing indoor sports self reporting allergy; ind normal - athletes practicing indoor sports without known allergy

Conclusions and discussions

The presence of atopic disease among athletes is a certitude. The data recorded from clinical history and spirometric evaluation doesn't always match the FeNO findings. In our cases the pulmonary function tests showed similar values between groups.

Although the proportion of self reported atopy was higher in the control group (due to the pneumological interest in our pediatric department), the FeNO levels recorded during the study were elevated mostly in the athletes group. Children practicing indoor sports seemed to have a higher level of exhaled nitric oxide, regardless the presence or absence of self reported atopy.

There was no statistical significant difference between the outdoor group and the controls, thus we suppose that the environmental factors have a primary role in bronchial inflammation. Children practicing indoor sports self reported allergy in greater proportion compared to the outdoor athletes. Yet, we didn't reach the statistical significance, probably because our subgroups were too small - further research is needed.

Researching for the exhaled nitric oxide may be one of the tools which can help the sports

medicine professionals to identify athletes at risk for developing alergic diseases (mainly asthma). Higher FeNO levels associated with indoor sports may add a new environmental factor in the complex etiology of sport related asthma. Monitoring bronchial inflammation (especially with portable devices - already relatively accessible) will help predicting athletes at risk for developing asthma and allow early interventions for prophylaxis and treatment.

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Corresponding author
Radu Diaconu
Pediatrics Department, University of Medicine and Pharmacy, Craiova, Romania
Phone: +400723524392
E-mail: *raduteodiaconu@yahoo.com*

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The effect of 8 weeks of training endurance and curcumin supplementation on VEGF levels in the liver rats exposed to lead acetate

Shadmehr Mirdar[1], Rahman Aziz[1], Ehsan Arabzadeh[1], Mehdi Hedayatii[2]

[1]*Department of Exercise Physiology, Faculty of Physical Education and Sport Sciences, University of Mazandaran , Iran*
[2]*Shahid Beheshti University of Medical Science, Iran*

Abstract. Vascular endothelial growth factor (VEGF) plays an important role in physiologic and pathophysiological angiogenesis.The aim of this study was to investigate the effects of eight weeks of endurance training and curcumin supplementation on VEGF levels in the liver of rats that were exposed to lead acetate. In order to assess the effects of lead, regular endurance exercise and curcumin supplementation on VEGF protein on the liver tissue, 60 male Wistar rats were classified randomly in to 6 groups. These groups are consisted of 2 control group, base and vehicle, two training groups included training + lead and training + curcumin+ lead and two non-exercise groups included curcumin + lead and lead group. Exercise training program for training groups consisted of running on a treadmill without slope for 25-64 minutes with velocity that starts with 15 meters per minute and was increased to 22 meters per minute and was administered for 8 weeks. Measurement was performed by VEGF ELISA kit. The result was assessed using Kolmogorov-Smirnov test, ANOVA and independent t-test and LSD at $p<0.05$. The results showed that the intraperitoneal injections lead to increased levels of lead in the lead group, while the VEGF levels only significantly decrease in the Curcumin + lead groups, compared with other groups($P<0.001$). Findings from this study showed that a healthy lifestyle includes the use of anti-oxidation supplements with regular endurance exercise may have beneficial effects in preventing oxidative damage caused by lead.
Key words: *vascular endothelial growth factor, lead, curcumin, exercise*.

Introduction

Nowadays with the advancement of technology and industrialized societies, air pollution has risen sharply in many major cities. Air pollutants are one of the biggest factors threatening the health. Lead is one of the most abundant pollutants elements, element that is heterogeneous tissue that was not like other essential elements such as zinc and selenium, and is poisonous to the body tissues. Increased amount of this element in the blood, lead to various diseases of liver, kidney, cardiovascular, respiratory, infectious, neurological and cancer (1-3). Studies have been shown that lead causes the formation of free radicals, disrupt oxidation/anti-oxidation stability and thereby changing in antioxidant properties in the body's immune system(4, 5). Wang et al (2007) assessed oxidative stress induced by lead on the liver. They reported that exposure to lead acetate, cause oxidative stress in the liver and this oxidative stress caused a significant decrease in hemoglobin, catalase and glutathione peroxidase in the liver. They also reported that significant damage in DNA and liver cell apoptosis were observed (6). Ahmed Hossain and colleagues stated that one of the factors that interfere with vascular endothelial growth factor (VEGF) work and thereby causing damage to capillary dysfunction related to brain damage is due to lead contamination (7).

VEGF is one of the key regulators of angiogenesis. In several studies, researchers concluded that increased VEGF expression occurs in various cases such as oxidative stress and hypoxia (8). Lead by creating oxidative stress and production of free radicals, can affect various organs (1, 9). Oxidative stress by reactive oxygen spice (ROS), stimulates VEGF expression in vivo and in vitro (1). This increase in VEGF is influenced by incremental adjustments Hypoxia inducible factor-1α (HIF-1α) due to ROS (10).

On the other hand, physical activity is among the factors that affects the amount of VEGF (11).
Several methods have been studied to counteract or minimize the detrimental effects of lead. One of the approaches noted about paying attention to nutrition and food specialty anti-oxidations (1, 9). Turmeric is one of this food, and more specifically, curcumin that is one of Turmeric elements. This herb has been used greatly in traditional medicine for blood purification, digestion, high cholesterol, inflammatory conditions and is used to protect the liver (12, 13). It is Shown that curcumin as an anti-oxidation substance, prevent from oxidative stress in rat liver and inhibit lipid peroxidation and protein oxidation (14). Hatcher and colleagues showed that curcumin in cerebrospinal fluid has higher antioxidant activity than □-tocopherol. In this research indicated that curcumin inhibited the growth fibroblasts factor and VEGF in production new vessels (15).
In addition to antioxidant effects of exercise training in reducing the harmful effects of lead on VEGF, this seems to be as a low-cost but effective way. VEGF response to acute exercise is low in human skeletal muscle. By increasing Aerobic capacity of skeletal muscle, redox potential, capillary property, or increased blood flow in arteries has been observed after 8 weeks of endurance training (16). In addition to the production of free radicals during exercise, more distribution of blood flow to active muscles for more muscle work causes organs such as the liver, kidneys and intestines to experience a hypoxic environment. Hypoxia and oxidative stress induced by exercise maybe has a mutually inhibitory or irritation effects in VEGF production (17). Researcher believe that the effect of endurance training on mitochondria and oxidative stress in liver during endurance exercises causes fatigue due to mitochondrial dysfunction and oxidative stress. On other hand, the use of supplements may play a reducing role on these negative effects(18). As a result, choose the right training model with herbal supplement maybe effective on the adjustment mechanisms that threat the health.
According to the above points and the interaction of oxidative stress by lead acetate and their possible role in VEGF stimulation and also the anti-oxidation role of curcumin and regular exercise in relation to metabolic role of liver, the present study attempted to assess the above questions and manner of effectiveness of the independent variables on the VEGF.

Material and Method

This research was experimental research. The study subjects were 60 male Wistar rats that were kept in a standard environment. After transferring to the laboratory environment and familiarity with the new environment and how to exercise by treadmill, all the rats were classified randomly in two control groups, base and vehicle, two training groups included training + lead and training + curcumin+ lead and two non-exercise groups included curcumin + lead and lead group So, that each group contains 10 rats, respectively.
To provide lead acetate, firstly 2 g of lead acetate were weighted by a balance with the accuracy of 0/0001 and placed in a graduated container and then gradually the volume of the solution was diluted with distilled water to 100 cc to provide one gram solution of curcumin in the curcumin powder weighing scales manufactured by Sigma Germany and was placed in a graduated container. Then one cc of absolute alcohol (ml) was added and the vehicle curcumin (ethyl oleat) was brought to a volume of 100 cc.
Acetate was injected intraperitoneally 20 mg per kg of body weight in a period of three days a week for 8 weeks into all groups except the control group. Meanwhile, the simultaneous injection of lead acetate into group exercise, supplements, curcumin, combined (training + curcumin) and leads to a control group of 30 mg curcumin vehicle (ethyl oleat) per kg of body weight intraperitoneally were injected three days a week for 8 weeks. In addition, curcumin also intraperitoneally, and a solution of ethyl oleat in doses of 30 mg per kg of body weight were injected to the curcumin and combined groups three times per week for 8 weeks (19).
The familiarization program included five sessions of walking and running at a speed of 5 to 8 $m \cdot min^{-1}$ and a slope of zero percent for 5 to 10 min. The training program for the exercise and combination groups (endurance training + curcumin) involved running on a treadmill with no incline was specific for rodent with the overload principle and the training was performed progressively for 64-25 min at a speed of 22-15 $m \cdot min^{-1}$. This program was performed during 5 sessions per week for 8 weeks. At the beginning of each training session, to warm up, the subjects ran for 3 min at a speed of 7 $m \cdot min^{-1}$ and then, in

order to achieve the desired rate per minute, the speed of the treadmill was increased to 2 m·min^{-1}. At the end of each training session, to cool down the body, the speed of treadmill was decreased reversely until reaching the initial speed. The training program was performed on the treadmill without slope.

All the groups with the same and basis conditions (24 hours after the last training session for training groups and 24 hours after the last injection curcumin (curcumin, acetate or vehicle curcumin), were anesthetized completely equally with the solution of ketamine – xylazine (with injection of ketamine and xylazine solution of 3 units) with broke 5 to 2 and were killed with a guillotine. Then, the liver was removed using a surgical blade, and the balance sartorius: BI 1500 with a precision of 0.001was weighed. The tissues were removed by surgical blade and were placed in the special tubes, and then, immediately they were placed in liquid nitrogen and then for kept was taken in a freezer at - 70 ° C. VEGF was measured by Rat VEGF, CUSABIO BIOTECH, Wuhan ELISA kit. For this purpose, the tissues were powdered by using liquid nitrogen and then they were centrifuged in the homogenized buffer solution for 10 minutes. The obtained solution was transferred to the laboratory by using dry ice to determine the needed index. To measure the levels of malondialdehyde (MDA) and total anti-oxidation capacity (TAC) Thiobarbituric acid and FRAP methods were used, respectively. Data analysis using Kalmogorov - Smirnov test, ANOVA and LSD post hoc test was used to assess differences between groups. In these studies, the $p \leq 0.05$ was used to reject the null hypothesis.

Results

The table 1 shows the TAC and MDA blood levels and the table 1 shows the changes in vascular endothelial growth factor in rats exposed to lead acetate groups. The weight (micromoles per milliliter) of each evaluated group was as follows: based groups = 333±25, vehicle group = 323±34, group training + lead= 314±20, lead + curcumin group= 284±43, lead + training + curcumin group= 331±24 and lead=317±22. As can be seen, the mean body weight in biopsy in the training group + curcumin + lead is further in comparison with the other groups, except the base, and compared with the base was only less than 2 g.

Table 1: The mean and standard deviation of total TAC and MDA (micromoles per milliliter) in different groups

Groups / index	base	vehicle	lead	training+ lead	curcumin + lead	training+ curcumin+ lead
TAC	392.8±11.4	385.7±8.8	279.8±18.3	411.7±13.8	7143±14.8	450.3±19.7
MDA	24.9±4.1	26.8±2.8	46.7±9.2	18.4±3.2	35.8±6.4	13.4±5.2

The average TAC in lead + training + curcumin group was more compared to the baselines, vehicle s, lead, train + lead and lead + curcumin. Average TAC of the lead group compared to the baselines, exercise + lead, curcumin + lead, training + curcumin + lead shows the reduction of 28/76, 23/03, 23/02, 37/86 percent, respectively. Also, the mean TAC in subjects with exercise + lead, curcumin + lead, and training + curcumin + lead group increased compared to the baseline to 4/81, 4/80, 14/54 percent.

The results of table I show that the mean of serum MDA in the group of training + supplements + lead is less than that of other groups.

The mean of serum MDA lead group had an increase about 84/44, 159/29, 28/63 and 244/89 percent in comparison with base, training + lead, curcumin+ lead and training + curcumin+ lead groups, respectively. Also, the mean of MDA subjects groups of training + lead and training + curcumin+ lead decreased to 26/30 46/52 percent compared to the baseline group and this ratio had a decrease to 43/40% in curcumin group.

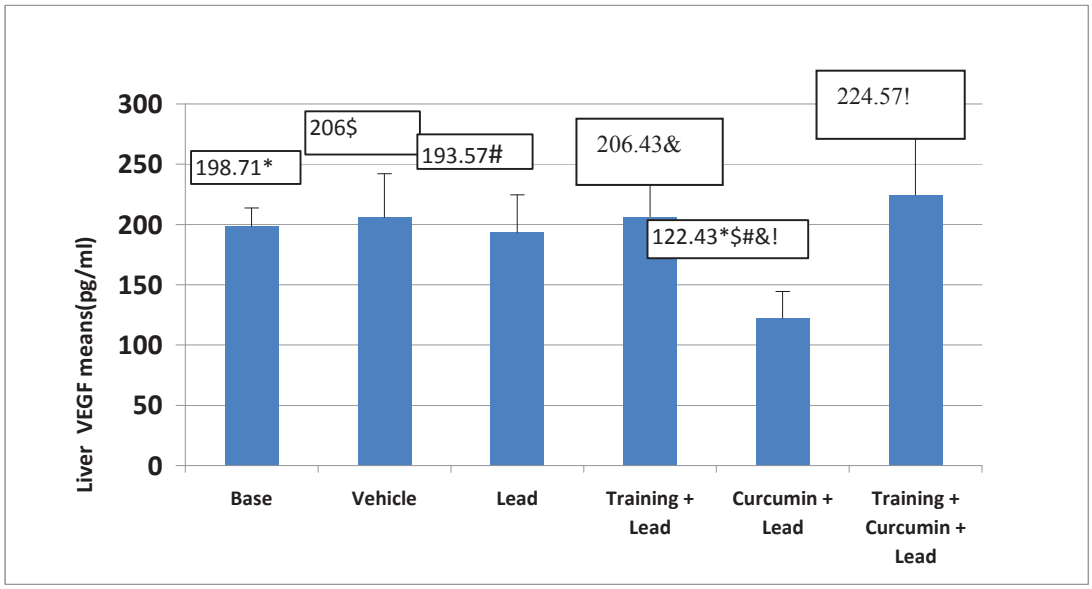

Figure 1. Effect of training and curcumin supplementation on the liver VEGF in of rats exposed to lead
*، $، #، &، ! significant compared with curcumin + lead.

According to the obtained value of F (6/636) resulted from the one-way ANOVA, there was a significant difference between VEGF levels in the liver of different groups after 8 weeks of endurance training, curcumin supplementation or a combination of exercise, and supplementation. So that the data in figure 1 show that chronic exposure to high levels of lead acetate significantly reduced VEGF level in curcumin + lead group compared with other groups ($p \leq 0.05$).

Discussion

VEGF is one of the key regulators of angiogenesis. In several studies, researchers concluded the increased expression of VEGF was caused by many different things including hypoxia and oxidative stress and curcumin has Inhibitory effect on this factor (8, 15). Consequently, the aim of this study was to examine the effect of eight weeks of endurance training, curcumin consumption and a combination of both on VEGF changes in liver male Wistar rats were exposed to lead acetate. Several studies have shown that different doses lead to different responses to oxidative stress in the structural part of the body and result to some injuries to the lungs, liver, testis, cardiovascular (20). Also, it has been shown that in vivo and vitro, ROS stimulated VEGF expression (10). This study found that intra-peritoneal injection of 20 mg per kg body weight of lead acetate for 8 weeks significantly increased blood lead levels in the lead group compared to the other groups. And this increase, in turn, increase the index of oxidant MDA that was increased in oxidative stress, It seems that this increase also increases expression of VEGF and decreases TAC, this result is aligned with the majority of studies.

Studies indicate the stimulation of ROS by lead and the next empty defense anti-oxidation cell can lead to imbalanced oxidative/antioxidative tissue that is exposed to lead (21). For this reason, in the present study, anti-oxidation effect of curcumin supplementation on lead-induced changes in markers associated with oxidative damage were investigated. Descriptive data obtained from various groups serum MDA in the present study expression increases levels of MDA in the lead group. While the mean serum MDA in training + curcumin+ lead group is lower than the other groups. That indicating a decline in the index MDA-oxidant with use of training and supplement. That correspond with previous studies on the effects of anti-oxidative agents on oxidative parameters. Also the mean MDA subjects training + lead and training + curcumin+ lead groups reduction compared to the base group and increased in curcumin+ lead and lead groups. That, this increase may indicate that oxidative damage is caused by lead and it can be stated that one reason for the increase in VEGF in lead group increased in MDA levels caused oxidative stress by lead. The findings Lzuta et al (2010) also represent the same ways of this topic.

The study that they did on diabetic patients expressed oxidative stress and ROS play an important role in the regulation of angiogenesis by increasing VEGF expression in vitro and in vivo (22). TAC measured in the present study suggests that the mean TAC in training + curcumin+ lead groups is higher than the other groups. Reduction in average TAC of the lead group in comparison with base, training + lead, curcumin+ lead and training + curcumin+ lead which implies deleterious effects of lead on reducing the anti-oxidation factor and increased oxidative factors. The mean TAC in subjects training + lead, curcumin+ lead and training + curcumin+ lead groups was Increased compared to base group that indicating the positive effects of exercise, curcumin and combining training and curcumin increase TAC and decrease the deleterious effects of lead on anti-oxidation agents.

Appears that endurance training inhibits the effects of oxidative stress, and thus it can be expected that the combination of exercise will lead to reduced VEGF. The study found that exercise increases the levels of TAC and this increase; indicate the reduction of effect of endurance training on oxidative lead. In fact, regular physical exercise, increase the ability of the body's anti-oxidation systems and protection of the body against on the effects of free radical damage that is increased in the exercise (23). The result of this study shows that in the liver tissue, VEGF has been reduced due to training and lead compounds. Hence, it can be said that 8 weeks of endurance training able to prevent the increase in VEGF with inhibits the effect of lead toxic and its oxidative stress. Studies show that with perform endurance training also could increase VEGF activity. Kraus et al (2004) in a cross-sectional study that performed in response plasma VEGF to relative amount of overload in the endurance training, expressed that increase in the VEGF is seen alone in the endurance training, and no change show in VEGF by short-term training that was done with this training (11).

In liver tissue, curcumin supplementation could reduce VEGF activity by inhibition in the lead and that's oxidative stress. Also the MDA and TAC data has been shown the same results in the current study. Since the reactive oxygen radicals such as superoxide anions and hydroxyl radicals play a role in making the oxidative damage, so the cleaning these factors are useful in the prevention of various diseases like that cancer. Anti-oxidation effects of curcumin has been established to inactivate free radicals, however, these effects are often related to dose and environmental conditions (24, 25). Indeed curcumin as an anti-oxidative factor, inhibited the oxidative stress induced by lead acetate. Shang and colleagues (2010) showed that curcumin can be used as a powerful anti-oxidation factor against oxidative stress and its effects (26). The results showed that VEGF levels in lead + curcumin group were significantly decreased in relation to other groups, that expressed reducing effects of curcumin in the VEGF created by lead. Also increase in VEGF was not observed in the other groups. Thus it can be expressed that curcumin and training can avoid from increase in levels of VEGF induced by oxidative stress resulting from lead contamination.

Patra and colleagues (2011), in review the oxidative stress induced by lead and cadmium on health, revealed that these factors most of its negative impact have on lung tissues, brain, liver, kidneys and testes (27).

Studies show that VEGF is a key factor in angiogenesis during endurance exercise and its presence is essential for the different adaptation (11, 23). On the other hand, in conditions of oxidative stress, have positive contributions to the development of tumors and to promote the growth of tumors (28). Therefore, VEGF response appropriate with tissue situations may stimuli in the tissue functional, in order to accommodate the appropriate functional, useful in that case, or in pathological conditions may have a different role and its role has changed and is harmful to the body. The results of this study showed that the use of curcumin and regular endurance exercise can inhibit the effects of lead exposure. However, disorders of lead, leaves to harmful effects and can be used curcumin and regular exercise as an effective strategy against the effects and pollution from lead. Meanwhile, because this study, was down as the first study that investigate the VEGF changes during 8 weeks of endurance training in rats in both curcumin and consumed acetate, to clarify the results and the reasons for its needed more research, particularly on human samples.

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Corresponding author
Shadmehr Mirdar
Department of Exercise Physiology
Faculty of Physical Education and Sport Sciences
University of Mazandaran
Beheshti St, Babolsar, Iran.
Phone: +98- 112-5244705
E-mail: *Shadmehr.mirdar@gmail.com*

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Effects of short rest periods on neuromuscular responses to resistance exercise in trained men

Mohammadi Sajad[1], Damirchi Arsalan[1], Ahmadi Rahmat[2]

[1]*Department of Physical Education & Sport Sciences, Rasht, Iran*
[2]*Department of Physical Education & Sport Sciences, Guilan University, Rasht, Iran*

Abstract. The present study examined the effect of three different rest intervals in resistance training (RE) on neuromuscular responses. *Method.* Twelve healthy trained males of students of Guilan University (mean age 21.67±2.309 years, weight 65.067±7.14 kg and height 171.17±7.030 cm) voluntarily participated in the study. Subjects at three separate sessions of an RE protocol were assigned in a random order a rest interval of 60s (P60), 90s (P90) or 120s (P120) between sets. The RE session consisted of 4 sets of knee extension to failure using 80% of 1 maximum repetition. Integrated electromyography (IEMG) right femoral muscle was recorded before and immediately after exercise protocols, also was calculated training volume in all rest intervals. Statistical evaluation of the data was accomplished by a repeated measures analysis of variance. *Result.* The results showed no significant difference in values of IEMG between the rest intervals $p \leq 0/45$, but after the training values of IEMG were significantly decrease in all rest intervals $p \leq 0.001$. Training volume performed in P90 and P120 significantly greater than P60 $p \leq 0.001$ but there was no significant difference between P90 and P120 $p \leq 0.99$. *Conclusion.* It is concluded that all three rest intervals caused fatigue and decreased IEMG values but decreased IEMG values in rest interval of 60s more than 90s and 120s, respectively.
Key word: *resistance training, rest interval, electromyography, fatigue*.

Introduction

Designing resistance training programs is a complex process that must be combined with a number of key variables and acute exercise. Usually, rest intervals between sets based on the goal of the exercise is prescribed, but may be altered by many factors. Rest intervals between sets should be sufficient to recover energy (1). Electrical characteristics of muscles are measurable by electromyography (EMG). Integrate Electromyography (IEMG), reached all impulses to the muscle and shows the level of neural activity of muscle (2). Studies reported that high-intensity exercise can lead to increased activation of neuromuscular and create maximal activity of EMG. Most failure resistance training program in the short term is leading to a significant reduction in IEMG values. Acute decrease in this variable indicates that the training program leads to most fatigue and consequently reduction recruitment of motor units. Rooney et al (1994) found that protocols that produced greater levels of volitional fatigue were more effective in improving strength than protocols that produced less fatigue with the same time under tension (3). It is also shown that the training volume effective on neural responses, hypertrophy, metabolic and hormonal and the subsequent adaptations to resistance training (4).

It was speculated that during resistance training to failure or substantial levels of fatigue, active motor units fatigue and their contribution to the generation of force is reduced. Consequently, motor units that were previously inactive are now recruited to assist in maintaining the necessary force output.

Several studies have shown that training with loads of 80 to 85%RM (maximum repetition) has very effective for increasing maximal dynamic strength (5).

Some studies used from parameters of the EMG to evaluation acute responses neuromuscular and fatigue in rest interval between sets. Of course, these studies were different in training load, rest intervals between sets and training methods (5-7).

Benson and et al (2006) investigated acute neuromuscular responses during resistance exercise training with different loads. Subjects experienced in weight training completed two different weight training protocols involving a single elbow flexion exercise. One protocol required the subjects to perform each set to failure using 100% 10 RM load whereas the second protocol required the subjects to perform 10 repetitions for the first two sets using 90% 10 RM load and only go to failure on the third set. Subjects were able to perform a significantly greater volume of work in the 90% 10 RM protocol compared to the 100% 10 RM protocol. Both protocols elicited similar cumulative levels of fatigue as reflected by a decrease in IEMG. McCauley and et al (2009) examined the acute neuromuscular responses to hypertrophy, strength and power training. The results showed that the values IEMG significantly decreased in both protocols hypertrophy and strength (10). Rahimi and et al (2010) examined the effect of short rest intervals on training volume in trained man. Results showed that despite the training volume performed at 90 and 120s higher than 60s rest interval but there was no significant difference between groups (7). Bottaro and et al (2007) examined the effect of rest interval between sets on training volume of resistance training performed in trained women. The results showed that the volume of training performed rest interval 30 seconds significantly less than the rest intervals of 60 and 120s but there was no significant difference between the rest intervals of 60 and 120 s (6). Due to that the EMG parameters are accurate assessment of neuromuscular responses and the conflicting results reported of training volume in short rest intervals between sets; So, the aim of the present study was the examination of acute neuromuscular responses in an resistance training protocol to failure with 80% of 1RM load and very short different rest intervals of 60, 90, and 120 seconds between sets.

Material and Method

Twelve college-aged males with at least 1 year of experience in weight training volunteered as subjects for the study. Mean (±SD) age, height, weight and knee extension 1 RM of the participants were 21.6±2.3 years, 171.1±7.3 cm, 65±3.3 kg, 43.3±9.6 kg, respectively. The subjects had primarily utilized training loads of 80% 1RM and, therefore, were accustomed to the loads used in the present study. All procedures were approved by the institution's ethics committee and informed consent was obtained for each participant.

The subjects were familiarized with the experimental testing procedures during a control day about 1 week before the actual measurements. Resistance load verification for the experimental knee extension was also determined. All the subjects went through 3 strength exercise trials of different rest intervals between sets. The strength exercises lasted from 09:00 to 11:00 hours and to avoid any potential carry-over effects and threats of internal validity, each of the 3 protocols was performed in a counterbalance order by all 12 participants. At least 48 hours but not more than 72 hours of recovery time was allowed between each training session. Subjects were assigned in a random order at a rest interval of 60s (P60), 90s (P90), or 120 s (P120) between sets. The resistance exercise session consisted of 4 sets of knee extension to failure using 80% of 1RM with 4-minute recovery between the exercises. Maximal isometric strength and EMG were assessed pre- and post-protocols.

Training program. The participants came to the physiology laboratory at Guilan University a four times. Prior to familiarization and three testing procedures. All four days, participants warmed up on a cycle ergometer for five minutes. Immediately following warm-up sat on knee extension in a comfortable upright seated position. Straps were used to secure the thigh, pelvis and trunk to prevent extraneous body movement. The axis of knee extension machine was aligned with the axis of rotation of the right knee joint. Arms were placed across the chest with hands grasping the straps. For warm-up participants performed three submaximal (50% of 1RM) knee extension repetition. Approximately 1 week after the familiarization in first session participants in three rest intervals randomly performed four sets knee extension to failure with 80% 1RM. Participants were given verbal encouragement in an attempt to achieve maximal effort and they were instructed to exhale during the contraction. The total volume of the exercise that was used in the study has been applied previously in study for trained man (5). Integrated electromyography (IEMG) right femoral muscle were recorded before and immediately after exercise protocols. Approximately 2 days after the first session and 2 days after the second session the procedure of the

first session was repeated. The rest interval between the sets was 60, 90 and 120s and was randomly assigned on testing of the first, second and third session.

EMG records. Silver chloride electrode leads were applied to the belly of the right rectus femurs muscle of each subject. A 20-mm distance and a bipolar configuration between the centers of electrodes were used to help minimize cross-talk among synergistic and antagonistic muscle groups. Prior to positioning the recording electrodes, the placement areas were abraded and then scrubbed of dead skin cells with an alcohol-soaked pad prior to electrode application. Electrodes were attached with double adhesive bands and conductive gel placed in the center region of the electrode. A ground electrode was then placed on the patellar knee. Following electrode placement, each electrode was traced with a permanent marker to ensure consistent placement for each session. The EMG signal was recorded at 1000 Hz (Muscle Tester ME3000P8). Electrical activity of the knee extension was measured during the pre and post-protocol MVIC. Following raw data collection, all data were stored and later analyzed using the Megavin EMG software package. A 3-s segment of the recorded EMG signal, beginning 1 s after the onset of the MVIC, was processed. For analysis the raw EMG signals were rectified and integrated. Integrated EMG (IEMG) recording were determined.

Statistical Analyses. Statistical evaluation of the data was accomplished by a repeated-measures analysis of variance. In the event of a significant F ratio, least significant difference post hoc tests were used for pairwise comparisons. A criterion *a* level of $p \leq 0.05$ was used to determine statistical significance. All data are reported as mean ± SD.

Result

Training volume was significantly different between different rest intervals. Training volume in rest intervals 90 (1303kg) and 120 sec (1326kg) significantly greater than the rest interval of 60s (1133kg), respectively. But there was no significant difference between rest intervals 90 and 120s (Figure 1) ($p \leq 0.05$). There was no initial difference between the three rest intervals for IEMG ($p \leq 0.05$). Significant decreases ($p \leq 0.05$) were found from pre- to post-protocol for the all three rest intervals (Table 1).

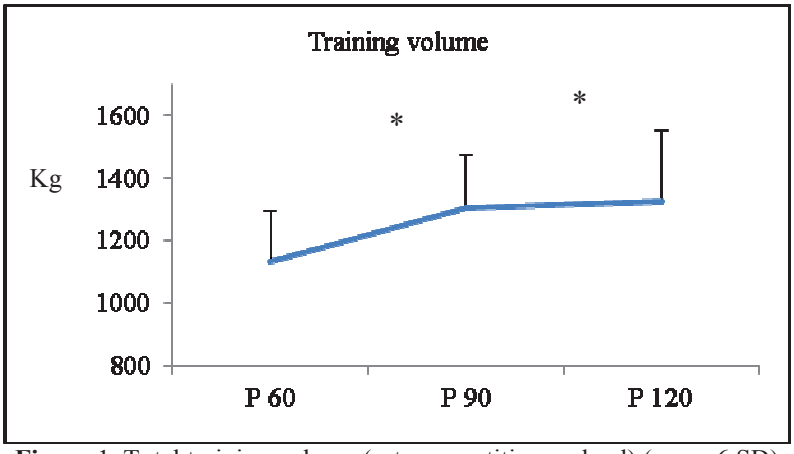

Figure 1. Total training volume (sets × repetitions × load) (mean 6 SD) during 3 resistance exercise protocols in knee extension
** represents significant differences by P 60 (p < 0.01*

Table 1. Mean (S.D.) Training volume (kg), IEMG (µV) in response to the performance of three rest intervals of knee extension

	Rest intervals		
IEMG	**P60**	**P90**	**P120**
pre	1634±85	1654±70	1561±59
post	1278±75*	1348±62*	1402±53*

Total training volume = sets × repetitions × load
** represents significant between three rest intervals from pre- to post-protocol (p≤ 0.05)*

Discussion

EMG shows the electrical characteristics of muscle and often is used neuron drive control. There are significant relationship between surface EMG amplitude and total active motor units. During several studies found that high-intensity resistance training increased IEMG, while the reduction in IEMG observed in detraining and low intensity training. Most failure resistance training program in the short term is leading to a significant reduction in IEMG values. Acute decrease in this variable indicates that the training program leads to most fatigue and consequently reduction recruitment of motor units. IEMG analysis allows us to determine the active motor units. Muscle electrical activity may be reflect central activation or neural components for force generation. Decrease in IEMG is sample of changes in force and may be due to a decrease in neural activation (11). The available documents indicate that IEMG reports accurate information about force generation and motor units, Therefore, in this study, the EMG is used to determine neuromuscular responses. The results showed that the IEMG values after the training was significant decrease in all the rest intervals of 60, 90 or 120 seconds.

Benson and et al (2006) investigated acute neuromuscular responses during resistance exercise training with different loads. Subjects performed two different protocols of elbow flexion in three sets by 10 repetitions and 3 minutes of rest intervals between sets. The results showed that IEMG values in both protocols after the training has decreased significantly compared to before training (5). Bhem et al (2002) determine differences in muscle activation between resistance training. The results showed that IEMG values in recovery time of 30 seconds, 1, and 2 min was significantly lower than the pre-test (12). But Soylu and et al (2010) reported that during of contraction has increased the values IEMG. Possibly because of differences in results with the present study was their training protocol. Soylu and et al (2010) from subjects asked to hold for 8 seconds maximum voluntary contraction and simultaneously IEMG values were recorded. Whereas before it there was no resistance training that cause fatigue. In fact, closer examination of individual data in the present study indicated that, although all subjects demonstrated reduced force generation following resistance exercise protocols, but studies show that Individual differences such as training status, fiber type, activation patterns and genetic response to training could account for the variability in the IEMG. Possibly present protocol caused reduce motor units during contraction and decrease in firing frequency active units and because resistance training to failure or substantial levels of fatigue, active motor units fatigue and their contribution is reduced to generation of force.

Reported that the training volume effective on neural responses, hypertrophy, metabolic and hormonal and the subsequent adaptations to resistance training (4). Performing fewer repetitions by using moderate to large number of sets have been introduced as a low-volume programs. Use of medium to heavy loads, moderate to high repetitions and multiple sets of each exercise generally are considered as high-volume programs. Comparing the results of this study showed that training volume performed in P90 and P120 significantly greater than P60, but there was no significant difference between 90 and P120.

This finding was agree with results of the researchers such as Willardson and Burkett, Simao, Ratamess, Senna and Miranda (14-18). But with results of Rahimi et al (2010) and Bottero and et al (2007) are inconsistent (6-7). Rahimi and et al (2010) examined the effect of short rest intervals on training volume in trained man. Results showed that despite the training volume performed at 90 and 120s higher than 60s rest interval but there was no significant difference between groups (7). Probably reason of different results of this study with Rahimi et al (2010) is the amount of training load, Because training load in the present study was 80% 1RM Whereas Rahimi and et al (2010) had used 85% 1RM of your protocol. Bottaro and et al (2007) examined the effect of rest interval between sets on training volume of resistance training performed in trained women. The results showed that the volume of training performed rest interval 30 seconds significantly less than the rest intervals of 60 and 120s but there was no significant difference between the rest intervals of 60 and 120s (6). Probably reason of different results of this study with Bottaro and et al (2007) is the amount of training load and sex subjects. Because Bottaro et al (2007) were used trained female and 10RM load training whereas present study was

used trained male subjects and 80% 1RM training load. Probably differences in the training volume due to different rest intervals has been in the present study. Because the long rest interval caused more recovery energy sources and neuromuscular and increased metabolic excretion. These factors allowed the muscles able to perform higher training volumes in 90 and 120s than 60s rest interval. It is recommended that athletes for perform higher training volumes increase their rest intervals.

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Corresponding author
Sajad Mohammadi
Department of Physical Education and Sport Sciences
Guilan University, Faculty of Sport Science and Physical Education,
Rasht, Iran
E-mail: *sajadmohammadi92@gmail.com*, *damirchi@guilan.ac.ir*

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Development of a new motor development evaluation scale for cerebral palsy diagnosed children (SED-PCI): Phase II — practical application

Zăvăleanu Mihaela, Roşulescu Eugenia, Vasilescu Mirela
Kinetotherapy and Sports Medicine Department, Faculty of Physical Education and Sports, University of Craiova, Romania

Abstract. The aim of our study is to establish the validity of scale SED-PCI (*Development Evaluation Scale for Infantile Cerebral Palsy)* for measuring and quantification of motor development in children with cerebral palsy. We describe the process to verify the items of scale to evaluate child's motor behaviour and performance. The scale desires to be a specific observational instrument with practical application on Romanian particularities of CP case. We used to demonstrate the validity of SED-PCI a comparative research with GMFM and GMFCS scales on 75 cerebral palsied children. The findings showed us a proper correlation with the mentioned scales which means that our scale is a useful instrument to describe the development for this type of pathology at different years of age. This instrument adapt easily to evaluation program's needs, that are culturally sensitive in a particular region and ethnic group, and is intended to be useful in community-based programs which usually have limited resources and depend on the efforts of parents and personnel who have little formal or specialized training.
Key words: *cerebral palsy, evaluation, development, motor behaviour*.

Introduction

Among the childhood disabilities, cerebral palsy is, even today, the most encountered and even so the understanding of the treatment is still in a working process around the world. Specialist from different medical school and countries based their work and management of treatment on the local material possibilities, traditions regarding the child growth and development, also on the latest informations and access to those. In Romania, sadly there are some discrepancy among the available therapies in our country due to the lack of economic background and due to the society believes (specially around the year '89-90') that was underline the fact that a disable person is a shame for the family and the society, a society that need only perfect individuals. Those traditional believes only accentuated the gap between the European, Australian or USA's way of understanding and view of child disabilities and the Romanian management of cerebral palsy (CP).
In the last years, we notice a changings that are beneficial for everybody: patient, parents, caregivers, medical team, teachers, and whole society.
The work for the doctoral thesis with the theme *"Clinical-functional evaluation and the rehabilitation of cerebral pals"* underlined for us the lack of information transfer available in Romanian language, regarding this disability. Also, the work for the thesis underline the lack of and available evaluation methods, scales in Romanian language based on our medical and cultural tradition, on ethical and cultural principals, that can enhance the early recognition of the babies with neuro-motor disabilities or cerebral palsy.
The early recognition means an early intervention and studies from around the world underline the fact that the early therapy will be more successful for the rehabilitation and for the child/family wellbeing in society and in the future.
In population-based studies from around the world report prevalence estimates of CP ranging from 1.5 to more than 4/1,000 live births or children of a defined age range (1,2), but in Romania we don't have official statistics, we don't have also a Romanian nation registry for the disabilities so the work in this field is sometimes under financed.
The Romanian clinicians need instruments for a better appreciation of the major developmental disabilities and delay for early childhood years in order to treat and establish the intervention therapy.

The field of health promotion and disease prevention is moving toward the goal of implementing evidence-based interventions that have been rigorously evaluated and found to be both efficacious and effective (3). The contemporary medicine address the subject's diagnosis by using simple evaluation scales like GMFM, GMFCS that were translated in Romanian inside the above mentioned thesis.

The normal development of the human brain trails expectable patterns that are determined intrinsically (4).

The studies also talk about the *windows of opportunity for the brain* (5), time windows when the brain is more susceptible to the rehabilitation intervention that can/try to restore a function and can help the child to obtain a proper motor development like a future society adult member.

The quality of all movements is the aim of all therapeutic intervention for the child with a neuro-motor problem or with CP. The motor performance in static or dynamic performances, for the gross and fine activities require an examination and objective evaluations, also it must have other characteristic like to be facile implemented, available in any medical place, easy to be learn by the medical staff, physiotherapist or caregivers or family child, must be usefully in diagnosis and therapy management.

In Romania, the diagnosis orientation and periodic evaluation of the cerebral palsy child status can be very expensive, not so easy to attaint by the family and the scale we propose came in meeting of this desire with minor resources for all.

Many neurodevelopmental assessment tools have been developed and may be either comprehensive or screening tools, or aimed to assess a specific area of function e.g. (6). Our scale meant also to underline the baby with risk for cerebral palsy and/or with delay in motor acquisition area in order to apply effective early therapy management strategies for the child.

We did not found a validated evaluation instrument of neuro-motor development in Romanian language to be used for the statistical work of our study. For the validity of the scale we compare the results of SED-PCI with the results after applying two other different scales, validated abroad, that we translate in Romanian.

Today different scale are available and used in medical rehabilitation of cerebral palsy for clinical and research evaluations, like: *GMFM, GMFCS, MACS, BFMFC*. GMFM (Gross Motor Function Measure) is an well-known test in order to determine the gross motor functions of children (7). GMFCS (Gross Motor Function Classification System) is a classification system for the level of gross motor competence (sitting position, upright standing position, walking, etc) achieved by children of different age groups with CP (7, 8). It is an extremely useful tool to assess the measurement of disability and the level of autonomy achieved by the child, but it does not offer insight into the way a specific perceptive-motor function is organized and, therefore, it does not provide prognostic and rehabilitation orientation (9). More recently, similar classification systems were proposed based on manipulation function, i.e. BFMFC (Bimanual Fine Manipulation Functional Classification) (10), and MACS (Manual Ability Classification System) (11).

After defining the *Development Evaluation Scale for Infantile Cerebral Palsy (SED-PCI),* like we present in the previous article (4), we established the instrumentation and procedures of practical application.

This instrument adapt easily to evaluation program needs that are culturally sensitive in a particular region and ethnic group, and are intended to be useful in community-based programs which usually have limited resources and depend on the efforts of parents and personnel who have little formal training (4). Identification of abnormalities or delays of neuro-motor development should be the primary goal in order to diagnose and apply rehabilitation therapy in order to have a normal healthy child and a happy normal adult.

Material and Method

Aim of the study was to assess the reliability application of the SED-PCI as an instrument to predict neurodevelopmental outcomes in children, by comparing the scores as assessed using the SED-PCI, to the developmental scores as assessed by the standard scales GMFM and GMFCS, thereby to determine whether the SED-PCI has any value in clinical practice.

The SED-PCI performed at a young age of children with risk of cerebral palsy, with CP or with neuro-motor delay, will reliably predict the neurodevelopmental result, or alternatively the SED-PCI will not reliably predict the neurodevelopmental result.

Primary objective of this study was to demonstrate whether the SED-PCI performed at the child is a reliable predictor of the neurodevelopmental status as measured by the GMFM or GMFCS. The secondary objective - to determine if the SED-PCI has value in clinical practice and future research.

Inclusion criteria of subjects in the research group was the ethical issues regarding the involvement of subjects in a research study that apply to adults also apply to children although there are some additional specific concerns regarding the fact that the parents/caregivers decide the participation to the study or not.

The children parents and caregiver were informed about the purpose of the study and after they accept the evaluations and signed a consent the child was include in our study. We collected data from the children with cerebral palsy or neuro-motor delay that have follow an rehabilitation therapy program across our town or demand an examination for their problems, in different medical rehabilitation centers and in a private medical clinic from Craiova, Romania.

Exclusion criteria: children whose parents are not interested to participate; in some situation (4 cases), the results for all parameters were not entirely obtained, so the cases were not included in our analysis.

Assessments and data collection: Each assessment was performed by a single examiner. Data from patient was recorded on a special data sheet. This was transferred to a data base on a private computer.

SED-PCI Scale is quick and easy to administer. The SED-PCI assesses the basic areas of child development: Gross Motor, Fine Motor, listing items from 1–5 years. The SED-PCI takes approximately 10 minutes to perform and requires minimal devices. SED-PCI enables the examiner to ascertain the developmental age equivalent of the child. The quotients give an indication of the severity of the disability. The use also allows permit us the comparison of results in testing the same child with two different functional scales; and enables the calculation of mean scores when comparing different results.

GMFM - Gross Motor Function Measure. The items of the GMFM scale include the movements that challenge the balance and necessity transition from a posture to another by the distribution of weight. The five section evaluated by GMFM are A (lying & rolling), B (sitting), C (crawling & kneeling), D (standing), E (walking, running & jumping) (7). It is a criterion-referenced test: evaluates performance of motor skills on that day; useful for comparison over time. It measures how much of a task the child can accomplish, rather than how well the task is completed (quantity, not movement quality) (8). The GMFM score is represented by an ordinary scale with four points from 0 to 3, a percentage score is calculated because all the five sections have the same number of items. The medium percentage scale score for all five sections offer to the therapist the final percentage score (7). The GMFM authors affirm that the validity of GMFM it is not altered if the dimensions are used separately by the scale like a whole. A greater score indicate a better gross motor function (12).

GMFCS - Gross Motor Function Classification System. The GMFCS is a 5 level classification system that describes the gross motor function of children and youth with cerebral palsy on the basis of their self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility (3). Distinctions between levels are based on functional abilities, the need for assistive technology, including hand-held mobility devices (walkers, crutches, or canes) or wheeled mobility, and to a much lesser extent, quality of movement (13-15). The focus of the GMFCS is on determining which level best represents the child's or youth's present abilities and limitations in gross motor function. Emphasis is on usual performance in home, school, and community settings (i.e., what they do), rather than what they are known to be able to do at their best (capability). It is therefore important to classify current performance in gross motor function and not to include judgments about the quality of movement or prognosis for improvement (13-15).

Criteria for validation research. A well-designed intervention study includes optimal sampling techniques, data analysis using appropriate statistical methods, steps to enhance internal and external validity, and psychometrically sound assessment instruments (16). The clinical works combine a lot of different situation that must congregate into results that can be valid or not, that can bring in time some positive results or maybe not. All the research phases must be followed. The standardization in the research field is the guarantee for validity and security of

research work. Thus, the theorization would not be an end but a means (17). A research must integrate into the conceptualization of investigation process and must clearly explain the means that are intend to be used, follow to an inductive reasoning that is the base of this work. The global validity of the research seems to necessitate the implementation of different types of validity; the validity of the methodology, the validity of the measuring instrument, the internal validity of the results and the external validity (18). According to Thiétart [19], the type of knowledge that the researcher wishes to obtain depends on the kind of reality that he wishes to study, the type of relationship between the subject/object and the vision of the social world that the researcher has.

Our research was based on those criteria, perception; our research method in order to. The flux of informations must be systemized in a valid and systematic way.

Results

Participants data and characteristics. 75 children (40 boys and 35 girls) met our criteria and were included in the study, their demographic and clinical data are shown below (table I and II). The average age of children with CP in the study group was 4.45 years (95% CI 70.55 to 83.73), with a range between 1 and 12.

60/75 (78%) of subjects with PC studied were from urban areas, 15 (22%) from rural areas around Craiova. This prevalence of PC is different between the two areas, probably due to low addressability rural families to specialized rehabilitation services usually located in big cities, because of financial chances, parents knowledge regarding the appropriate treatment for their child.

Table I. Sex ratio in the study group

Subjects	**Number (%) subjects**
girls	40 (53,3%)
boys	35 (46,6%)
TOTAL	75 (100%)

Tabel II. Distribution according to the age in the study group

Age (years)	**Number (%) subjects**
1-2	9 (12%)
2-4	18 (24%)
4-6	23 (30,6%)
6-12	25 (33,3%)
TOTAL	75 (100%)

Average age =4.45 years; Min age=1 years; Max age=12 years

Table III. The distribution of different forms of CP in the study group

Reserch group	**Number(%)subjects**
Spastic hemiplegia	25 (33,3%)
Tetraplegia	15 (20%)
Paraplegia	25 (33,3%)
Diskinezia	7 (9,3%)
Ataxia	5 (6,6%)
TOTAL	75 (100%)

Children classification based on functional level of GMFCS

Using the functional scale classification system of gross motor function (GMFCS) used for individuals with PC based on functional mobility or limitation, the classification of the 75 children investigated was presented in Table IV. Functional classification regarding the ambulation, level I and II of the GMFCS scale was obtained for 17 (22,6%) and 23 (30,6%) children, those present functional walking without limitations. For 15 (20%) of the children from the studied group walking using a walking device (GMFCS level III), and the remaining 11 children (14,6%) and 9 (12%) were classified as Level IV and V, showing severe impairment of gait and functional activity.

Table IV. Distribution according to the GMFCS functional level in the stdied group

Functional level	Number (procent) subjects
I - Walks without Limitations	17 (22,6%)
II - Walks with Limitations	23 (30,6%)
III - Walks Using a Hand-Held Mobility Device	15 (20%)
IV - Self-Mobility with Limitations; May Use Powered Mobility	11 (14,6%)
V- Transported in a Manual Wheelchair	9 (12%)
TOTAL	81 (100%)

Table 6. The distribution by % of sections GMFM score and by clinical form for the subjects investigated

Reserch group	Number (procent) subjects	Scor GMFM* - SECTION** - Mediana (percentiles 25-75%)					Total GMFM score	
		A	B	C	D	E	Mean (min-max)	Median (percentiles 25-75%)
CP spastic	66 (88%)	86 (78-90)	53 (32-63)	60 (29-76)	36 (3-46)	11 (0-15)	44 (0.4 – 80)	50 (28 – 60)
CP diskinetic	5 (6,6%)	75 (19-95)	32 (7-63)	26 (0-71)	25 (0-46)	0 (0-18)	34 (0.4 – 83)	27 (5 – 59)
CP ataxic	4 (3,3%)	100 (94-100)	78 (67-80)	88 (81-95)	56 (49-72)	21 (15-21)	66 (49 – 75)	69 (61 –75)
TOTAL	75 (100%)	86 (78-94)	53 (32-67)	60 (29-81)	36 (3-49)	11 (0-17)	44 (0.4 – 83)	50 (27 –61)

Concurrent validity. The score obtained for the impact dimension of the SED-PCI was highly correlated with the GMFM or GMFCS score (Spearman's correlation coefficient, $r = 0.72$, $p = 0.0001$).

Construction validity and internal reliability of final questionnaire. All items were better correlated with their own dimension than with other dimensions, indicating excellent discriminant validity, and all met the convergent validity criterion with their dimension (correlation coefficient 0.4).

Clinical validity. Hypotheses enabling verification of the clinical validity of the questionnaire were tested. The patient with tetraplegia reported that they were more affected in the neuro-motor area than the patients with hemiplegia ($p < 0.05$).

Discussion

Specialists working in neuro-motor development area should consider the use of a variety of standardized tests and scales in their clinical practice. Assessment for treatment management or for the evaluation of therapy results and brain maturation for children with disabilities should not be based solely on developmental skills.

The criteria used to make judgments of research quality and rigorous differ between paradigms of knowledge.

Whereas positivist research emphasizes validity and reliability – ensured through careful study design, tool development, data collection and appropriate statistical analysis – relativist research considers the trustworthiness of the analysis – whether it is widely recognized to have value beyond the particular examples considered (20).

Evaluation scales can be the most used method of data collection in field of research and can easily orientate the objectives and management of the treatment for the cerebral palsied child. Problems with the reliability and validity of measures used on questionnaires has often led to difficulties in interpreting the results of field research.

Bland JM and Altman DG in a 2002 article talk about the quality of validating scales and indexes, pointing some quantities that even more difficult to measure and evaluate (21). Also, the article point an important question: Our scale may look right and cover the right things, but what other evidence can we bring to the question of validity? (21). The next question in the article being if it the items which together compose the scale are related to one another: does the scale have internal consistency (21).

We consider that the items of SED-PCI really measure the thing for what it has being conceive, the evaluation of neuromotor development depending on the age of the child. Highly correlated items in a scale may make the scale over-long and may lead to some aspects being over emphasized, impairing the content validity. A handy summary measure for this feature is Cronbach's alpha (22).

The work of obtaining data underlines the fact that some factors can affect the results, and the conceptual validity, predictive validity, for example to the new environments for the child.

The idea of this research starts from the desire to produce knowledge in the field of child neuro-motor development, the knowledge, that we realize when we work in our previous researches, which is lacking in Romania comparing with other countries. The researcher and clinician must guide their work with the patient following some clear management steps, the clinical evaluation being almost the capital one. Systematic construction of a research device implies very much work, especially in the clinical field area, much work with the patient.

Conclusions

Development of a valid and reliable questionnaire involves quite a lot of working steps. This article describes the sequential steps involved in the testing of questionnaires used for data collection.

This scale has proven its practical utility since: allow an evaluation of development in function of age, and permit underline the solid and delicate points of the child, in all the gross and fine motor area; permit the follow-up of the development acquisitions; allow the parents/caregivers to follow in a pragmatic way the development of child.

The findings showed us a proper correlation with the mentioned scales which means that our scale is a useful instrument to describe the development for this type of pathology at different years of age. This instrument adapt easily to evaluation program's needs, that are culturally sensitive in a particular region and ethnic group, and is intended to be useful in community-based programs which usually have limited resources and depend on the efforts of parents and personnel who have little formal or specialized training.

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Corresponding author
Zavaleanu Mihaela
Department of Kinetotherapy and Sports Medicine
Faculty of Physical Education and Sports,
University of Craiova, Romania
E-mail: *mihaela.efs@gmail.com*

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Postural stability in children with Down syndrome

Bahiraei Saied, Daneshmandi Hassan, Behdost Mohammad Reza

Department of Physical Education and Sport Sciences, Faculty of Sport Science and Physical Education, University of Guilan, Rasht, Iran

Abstract. The purpose of this study to evaluate the postural balance using the Biodex Balance System (BBS) in children with Down syndrome (DS). *Material and Method*. The study involving 30 male subjects with DS (mean age: 15.02±2.07 years, mean body weight: 61.63±12.80 kg, mean height: 155.00±10.65cm, body mass index (BMI): 25.85± 4.21) and 25 Non-DS male subjects (mean age: 15.04±2.13 years, mean body weight: 56.24±12.01, mean height: 164.36±11.42, body mass index (BMI):20.72±3.58). Independent *t* test was also used to determine any difference in balance scores between DS patients and healthy. Medial–lateral stability index (MLSI), anterior–posterior stability index (APSI) and an overall stability index (OSI) were measured in two measurement sessions using the Biodex Balance System. Balance was measured in four conditions: bilateral and unilateral stance with eyes open and eyes closed, over a period of 20s. *Result*. The Bland-Altman plot of agreement in balance scores between tests and retests demonstrated good agreement. A significant difference was found in OSI, APSI, and MLSI between subjects with DS and healthy. *Conclusion*. This study finds that subjects with Down syndrome included in this research demonstrate that deficits in postural control system that may provide a partial explanation for function balance problems that are common in these subjects. However, no significant difference was detected in APSI (SLEO) between two groups this study finds that subjects with Down syndrome included in this research demonstrate that deficits in postural control system that may provide a partial explanation for function balance problems that are common in these subjects.
Key word: *posture, balance measurements, Down syndrome*.

Introduction

Down Syndrome (DS) was clinically described for the first time by English physician John Langdon Down in 1866, but it was not until 1959 that French geneticist Jerome Lejeune identified its causes. DS is the most common of all genetic syndromes1 and it is caused by chromosomal changes, in this case the trisomy of the 21st chromosome pair, resulting in physical and mental changes (1, 2). This syndrome has been studied by several researchers and, with regard to aspects of child development; they have found that children with DS have a delay in motor skill development, indicating that these skills emerge at a different time compared to children with healthy development (3, 4). Dynamic motor dysfunction is widespread among individuals with DS. It includes longer motion and reaction times, balance and postural deficits and co-contraction of agonist and antagonist muscle pairs (5, 6).

Some of the aspects are considered as causes of acquisition delay for motor skills in DS children. The main causes of these differences include an exacerbated weakness in the joints, muscle weakness, sensory-motor abilities, cerebellar hypoplasia, and hypertonia (7, 8). Dysfunctions in the postural control are often described in DS children and associated with motor coordination difficulties, problems with sensory-motor integration or simply with awkward movements. Movements are considered awkward when the individuals are slow to adapt to a task and to changing conditions in the environment or are less capable of making anticipatory postural adjustments (7, 9).

To maintain balance in any posture, the human body must receive information about its position in space and about the environment. The body receives this information through the neural system, which integrates the sensory information to access the position and the movement of the body in space, and the musculoskeletal system, which generates forces to control the position of the body, known as postural control system (10, 11).

Postural control has two behavioral aims: orientation and postural balance. Postural orientation is the positioning and alignment of body segments in relation to one another and in relation to the environment. Postural balance is the state of equilibrium between all the forces that act on the body to maintain the desired position and orientation (12). To ensure that the postural control system achieves both behavioral objectives, namely orientation and postural balance, two elements are necessary: perception (the integration of the sensory information to analyze the position and the movement of the body in space) and action (the capacity to produce forces to control the body's positioning systems). Thus, postural control requires a continuous interaction between the musculoskeletal and the neural systems (11, 13). The Biodex Balance System (BBS; Biodex Inc.) has been used to evaluate postural balance in recent years (14, 15). The BBS is a multiaxial device that objectively measures and records an individual's ability to stabilize the involved joint under dynamic stress. It uses a circular platform that is free to move in the anterior–posterior and medial–lateral axes simultaneously (15). The BBS allows up to 20° of foot platform tilt, which permits the ankle joint mechanoreceptors to be stimulated maximally. The BBS measures, in degrees, the tilt about each axis during dynamic conditions and calculates a medial–lateral stability index (MLSI), anterior–posterior stability index (APSI), and an overall stability index (OSI). These indexes represent fluctuations around a zero point established prior to testing when the platform is stable (15). For example, an OSI of 5° would be interpreted to mean that on average, the displacement from center is 5°. Rast and Harris (1985) emphasized the importance of early postural reactions for the development of a balance Strategy, which ensures the automatic stability of the head, trunk, and extremities and makes normal movement and transfer of weight possible. The authors, on the basis of their comparison between control and DS children, concluded that postural reactions in the group of children with DS developed later and that children with DS demonstrated less variation in postural reactions: they develop only those reactions that are necessary to achieve a particular motor phase. The postural control was evaluated in literature only in few studies. In particular Nakagawa et al (16) hypothesized that hypotonia cause's compensatory foot positioning in standing in people with DS. They found that adults with DS stood with (i) forward displacement of the Centre of pressure, (ii) no lateral weight loading on either foot, and (iii) abnormal ankle eversion posturing.

Although these and other studies accurately describe the behavioral deficits and delays in children with DS, few studies have explored the specific motor control deficits that could underline postural instability and subsequent developmental delay in motor coordination.

For this reasons this study started from the needing to deeply evaluate the standing balance and postural control of patients with DS compared to subjects without pathologies.

The purpose of this study was to evaluate the reliability of dynamic standing balance in children with DS and healthy children using BBS and to compare the balance indices between two groups. And aim of this research is to quantify the abnormalities in the automatic postural control system in patients with DS in order to organize better rehabilitative treatments based on these findings.

Materials and methods

A sample of 55 children (30males, aged between 12-20 years) with DS and children healthy were recruited from different schools and institutions Tehran (Iran).

The study used a Quasi-experimental research, and subjects were randomly selected. An age control group (CG) composed of 25 participants (25 males) without DS was also recruited. Inclusion criteria for the DS group (DSG) subjects were: the presence of trisomy 21; the absence of any gross visual or organic defect and independence in stance and ambulation.

All participants without DS were healthy, without signs of any orthopedic or neurological disorders, impairment of somatosensory activity, hearing, vestibular or uncorrected visual functions and free of medications for at least 3 months before the beginning of the study.

Full clinical history, including illnesses or surgical interventions and stays in a hospital, was collected for all individuals.

Both parents and children were informed about the aims and procedures, as well as possible risks and benefits, of the study. Written informed consent was obtained from all the subjects included and from their parents or guardians.

Balance assessment. The BBS was used to measure balance and postural stability under dynamic stress (BBS; Biodex Inc., Shirley NY). As noted, the BBS uses a circular platform that is free to move in the anterior–posterior and medial - lateral axes simultaneously.

The BBS allows up to 20° of foot platform tilt and calculates three separate measures: MLSI, APSI and OSI. A high score in the for example, OSI, indicates poor balance. The OSI score is believed to be the best indicator of the overall ability of the patient to balance the platform.

The stability of the platform can be varied by adjusting the level of resistance given by the springs under the platform. The platform stability ranges from 1–8, with 1 representing the greatest instability.

The lower the resistance level the less stable the platform **(**15, 17**).** In this study, we assessed bilateral and unilateral stance both with eyes open and eyes closed with the BBS over a period of 20s.

Stability levels were changed from level 6 to level 3 and from level 8 to level 4 for bilateral and unilateral stance assessment respectively, and subjects were instructed to maintain their center of pressure in the smallest concentric rings (balance zones) of the BBS monitor, named a zone.

All subjects in two groups were right leg dominant and right leg was used for stability scores in unilateral stance. To begin, participants stood on the BBS's locked platform.

To assess the foot position coordinates and establish the subjects' ideal foot positioning for testing, the stability platform was unlocked to allow motion.

Participants were instructed to adjust the position of the foot until they found a position at which they could maintain platform stability. The platform was then locked. Foot position coordinates were constant throughout the test session.

Next, testing began as the platform was released for a 20s trial and participants were asked to maintain an upright standing position on their limb/limbs.

For the trial to be complete, balance needed to be maintained for 20 sec **(**18, 19**).** All participants were trained 1 min for adaptation to the machine, following which three practice trials, to reduce any learning effects, and three test evaluations were performed in each measurement session.

A mean score was calculated from the three trials. As noted, balance was measured in four conditions: bilateral and unilateral stance with eyes open and eyes closed.

The tester undertook the balance test in each condition in random order and not in specified in subjects.

Data Analysis. The intraclass correlation coefficient (ICC), two way mixed effect model, was used to assess intra-tester reliability of the measurement for dynamic standing balance in patients with DS and healthy.

We calculated the ICC (3, 1), because only one judge evaluated the same population of subjects. The 95% limits of agreements method of reliability assessment providing upper and lower limits for variation with a confidence level of 95% was measured by plotting a Bland-Altman plot to assess absolute reliability.

Independent t–test was also used to determine any difference in balance scores between DS patients and healthy.

Result

30 male patients with DS (mean age: 15.02±2.07 years, mean body weight: 61.63±12.80 kg, mean height: 155.00±10.65cm, body mass index (BMI): 25.85± 4.21) participated in this study.

Statistical analysis (independent t-test) revealed no significant difference in age ($p = 0.86$), weight ($p = 0.84$) and height ($P = 0.85$) between two groups.

Table I presents the intraclass correlation coefficient (ICC) for each index in different test position.

All ICC values were greater than 0.90 and 0.85 in healthy subjects and those with DS, respectively. (Table I).

The Bland-Altman plot of agreement in balance scores between tests and retests demonstrated good agreement between test and retest. Independent t-test showed significant difference in the OSI ($P \leq 0.001$) and MLSI ($p \leq 0.001 = 0.25$) in four test conditions between subjects with DS and healthy.

Our data, however, showed no significant difference in APSI (SLEO) between two groups (Table II).

Table I. Intraclass correlation coefficient values for Reliability for the balance test measurements

Condition SLEO	Stability Indices	With DS N= 20ICC (3,1)	Without DS (healthy) N= 20ICC (3,1)
	OSI	0.96	0.92
SLEC	OSI	0.97	0.96
DLEO	OSI	0.98	0.95
DLEC	OSI	0.94	0.94
	APSI	0.94	0.92
	MLSI	0.91	0.88
	APSI	0.97	0.94
	MLSI	0.95	0.89
	APSI	0.97	0.89
	MLSI	0.92	0.91
	APSI	0.95	0.94
	MLSI	0.93	0.94

ICC = Intraclass Correlation Coefficient, DS: Down syndrome, OSI: Overall Stability Index, APSI: Anterior – Posterior Stability Index, MLSI: medial–lateral stability index, DLEO: Double Leg Eyes Open, DLEC: Double Leg Eyes Closed SLEO: Single Leg Eyes Open, SLEC: Single Leg Eyes Closed

Table II. Balance test measurements in four conditions between subjects with DS and healthy

Condition	Stability Indices	Without DS (N=20) Mean	SD	With DS (N=20) Mean	SD	t test	p-value
DLEO	OSI	3/12	0/76	5/5	1/06	11/89	≤0.0001*
	APSI	2/64	0/83	4/6	1/07	13/19	≤0.0001*
	MLSI	2/55	0/78	4/5	0/98	15/91	≤0.0001*
DLEC	OSI	7/96	0/97	10/44	1/03	10/53	≤0.0001*
	APSI	8/8	1/1	9/26	1/2	5/06	≤0.0001*
	MLSI	5/84	1/05	9/1	0/78	12/82	≤0.0001*
SLEO	OSI	2/43	0/74	4/8	0/94	18/86	≤0.0001*
	APSI	3/93	1/3	3/82	1/32	-1/47	**0.158**
	MLSI	1/96	0/68	3/5	0/78	9/40	≤0.0001*
SLEC	OSI	4/7	1/26	6/97	1/09	14/38	≤0.0001*
	APSI	5/04	0/84	6/29	1/17	5/40	≤0.0001*
	MLSI	3/63	0/94	5/2	0/75	7/87	≤0.0001*

DS: Down syndrome, OSI: Overall Stability Index APSI: Anterior–Posterior Stability Index, MLSI: Medial–Lateral Stability Index DLEO: Double Leg Eyes Open, DLEC: Double Leg Eyes Closed SLEO: Single Leg Eyes Open, SLEC: Single Leg Eyes Closed

Discussion

Our data indicate a high reliability in balance test indices measured by using BBS (OSI, APSI, MLSI) both in subjects with DS and healthy (Table I). This finding is in accordance with other studies showing good reliability for using BBS to assess postural balance in healthy subjects (20, 21). The BBS was shown to be reliable in several previous studies. Pincivero et al. found the BBS to be a reliable assessment device across multiple test trials (20 sec) in healthy college students (N = 20). At Level 2 resistances (out of 8 possible), the ICC for the OSI measures was 0.60 for testing on the dominant and the non-dominant limb (21). At Level 8, the ICC was 0.95 for the dominant limb, and 0.87 for the no dominant limb. Pincivero et al. recommended two practice trials (21). With respect to the other two indexes available when using the BBS (MLSI and APSI), Schmitz and Arnold (22) found with a decreasing stability protocol (from Level 8 to Level 1 over 30 sec; N = 19), intratester reliability of 0.80 for the APSI and 0.43 for the MLSI.21 The intra-tester reliability was reported as 0.82 for the OSI. Schmitz and Arnold concluded that the over-all stability index measures were the most reliable. Reliability estimates obtained in this study for the OSI measures were higher than those reported by Pincivero et al (21). The high reliability estimates of the OSI measures was found in this study, supports the conclusion drawn by Schmitz and

Arnold (22) that the overall stability index measures may be more reliable than the other two indexes. The more important observation, however, was that for the protocol of two test trials, all of the measures provided by the BBS had similar and good, reliability estimates. However, the significance of this study was assessing the reliability of BBS to assess postural control both in subjects with DS and healthy. We found that BBS is reliable for postural balance assessment is DS and could be used in studies assess balance in these patients. The results of this study showed a significant difference in the OSI, APSI and MLSI between subjects with DS and healthy. Our data, however, showed no significant difference in APSI (SLEO) between two groups (Table II). Adoracio´n Villarroya et al Compared Static standing balance in adolescent's aged 10–19 years with Down syndrome. Static-standing-balance under four conditions (C1: open eyes/ fixed-foot-support; C2: closed eyes/fixed-foot-support; C3: open-eyes/compliant foot- support; closed eyes/compliant-foot-support) was examined by means of time and frequency Postural-Parameters (PPs). Mean values of time PPs were higher in both groups on compliant-foot-support (with open and closed eyes) than on fixed-foot-support. Ratios C2/C1 were significantly lower in DSG than in CG; ratios C3/C1 presented higher values in DSG than in CG, with significant differences in length path and RMS-velocity; there were no differences in ratios C4/C1. Which is in accordance with the results of the present study (23). Vuillerme et al obtained the same conclusion as we did in their group of adolescents with DS. However, these last authors found a similar behavior in their two groups of adolescents, with and without DS, under both conditions: no differences in the COP range, although a higher COP mean velocity with closed eyes (24). Galli et al did not report any differences between open and closed eyes, either in their group of young adults with DS (mean age-18.7 years) or in their CG (25). Kokubun et al compared balance with unilateral support in DS children to that of children with other kinds of mental impairment. The authors observed that the frequencies of sway waves were higher in children with DS, suggesting that higher frequencies of sway wave may be related to muscle hypotonia (26).

Conclusions

The findings of this study showed high reliability for the Biodex Balance System to evaluate dynamic postural balance in subjects with Down syndrome and healthy. It seems that medial–lateral stability index (MLSI), anterior–posterior stability index (APSI) and an overall stability index (OSI) significantly differ between subjects with Down syndrome and healthy. However, there is no significant difference in APSI (SLEO) between the DS patients and those healthy.

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Corresponding author
Bahiraei Saied
Department of Physical Education and Sport Sciences,
Faculty of Sport Science and Physical Education,
University of Guilan, Rasht, Iran
E-mail: physiourja@gmail.com

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Immediate effects of kinesio tape on acute hamstring strain; case report

Senem Güner, Serap Alsancak

Ankara University School of Health Care Professions Department of Prosthetics and Orthotics Ankara, Turkey

Abstract
To determine the immediate effects of applied kinesio tape on kinematics and spatiotemporal gait parameters of acute hamstring strain injury. A 19 year old male football player presented to sports medicine clinic with complaints of left knee hamstring strain. Three dimensional gait analyses were done after application of kinesio tape on patient. The taped condition in knee total excursion was nearly 5 degrees higher than the untaped condition in the left knee kinematics results. Especially, increased knee flexion of nearly 10 degrees in terminal swing phase that activated hamstring muscles in gait cycle. Cadence was clinically increased taped condition. Our report results demonstrated kinesio taping increased knee flexion ROM apply on hamstring muscle strain, thus a positive effect on muscle activation.
Key Words: *taping, knee flexion, hamstring strain*.

Introduction

Acute hamstring strain injury is known as the second-most common injury in track and field, soccer, rugby and football (1,2,10,13,16). This injury type consists of the biceps femoris and along an intramuscular tendon and in the adjacent muscle fibers. Injuries generally occur in the semimembranosus along the proximal free tendon (3,4,13). Kinesio tape (KT) is being widely used to prevent injuries to athletes, for rehabilitation and also to treat several musculoskeletal disorders (14,15).

Kinesio tape was developed in 1970s by Dr. Kenzo Kase. This alternative taping technique, theorized by Kase, had been suggested to introduce the beneficial effects of the tapes including effects on strength, control and performance, as well as reduction in pain, prevention of injury, inhabitation and facilitation of motor activity, improvement of a variety of physiological problems, including the range of motion, based on the functions of the tape (6,9,12) KT mechanism, by which KT exerts its hypothesized effects, has not clearly demonstrated the effectiveness of its methodology yet. KT has been show to support muscle movement, relieve abnormal feeling or pain on the skin. Mori et al suggested that KT normalizes muscle function (11). Kase et al believed that the stretch rate and width of the KT affected the facia and flow of lymph fluid (9). Kinesio taping reduced cervical pain and increased range of motion (ROM) 24 hours following whiplash injury (5). Slupik et al showed a preliminary effect on quadriceps peak torque and electromyographic activity in healthy subjects (14).

The primary objective of this report was to determine the immediate effects of KT on knee kinematics gait cycle in individuals with unilateral hamstring strain. The case report will demonstrate the use of elastic KT for control of pain and improvement of hamstring muscle contraction in early effects of hamstring strain.

Case Report

The patients was a 19 year old male (weight 72 kg, height 1.70 m) nonprofessional football player who suffered an acute left knee hamstring strain while football playing. The mechanism of injury was an end-range hip flexion with knee extension stretching movement. Clinical examination of the patient with an acute hamstring strain was demonstrated by altered gait mechanics, local tenderness to palpation at the side of injury, pain with resisted knee flexion and or hip extension

with knee extension (10,16). He was assessed one day after injury.

The physiotherapist used KT in a configuration to facilitate the hamstring contraction and to decrease pain. The KT is very different from elastic tape, which is manufactured with special weave and viscosity, with more expanded elasticity and a minimization of skin discomfort. A blue 5 cm wide Kinesio® Tex Tape (Kinesio Holding Company Albuquerque, NM) was applied to the hamstring using the X-shaped technique. The tape technique was placed hip flexion and knee extension and then application of semimembranosus, semitendinosus muscle and the lateral strip on the femoral biceps, maintaining the original 10% tape prestretching (Figure 1).

Figure 1. Elastic kinesio taping of hamstring muscle

Patient barefoot walking was recorded without taping and immediately after taping. Three dimensional kinematics and kinetics analysis was recorded on the patient in the gait laboratory.

Three dimensional gait analyses were done in Motion Analysis Laboratory via Vicon motion analyses system (Vicon Nexus, Oxford Metrics, Oxford, UK) with six infrared cameras at 240 Hz. The standard Plug-in Gait marker set was used. Before data collection, each camera and force plate was calibrated. Data were collected after several practice trials, both on kinesio taping and without kinesio taping at knee. The average of three trials for each walking condition was calculated.

A significant difference was identified for knee flexion/extension ROM and cadence. The taped condition in knee total excursion was nearly 5 degrees higher than the untaped condition in the left knee kinematics results. Especially, increased knee flexion degree nearly 10 degrees in terminal swing phase that is activated hamstring muscles in gait cycle. Cadence was clinically increased taped condition (Figure 2 and 3, Table 1,).

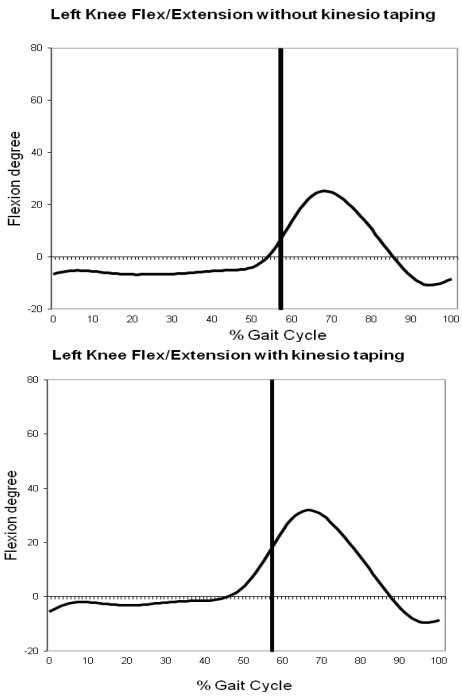

Figure 2. Gait cycle

Table 1. Evaluation of comparison of hip and knee flexion/extension ROM, cadence, walking speed
KT- kinesio taping

Kinematics and Spatiotemporal Parameters	LEFT Without KT	LEFT With KT	RIGHT Without KT	RIGHT With KT
Hip Flexion/Extension ROM throughout gait cycle (°)	26.3	26.6	38.79	38.42
Knee Flexion/Extion ROM throughout gait cycle (°)	6.07	41.37	58.19	62.2
Cadance (steps/min)	93.7	99.1	91.6	90.2
Walking Speed (m/s)	0.85	0.84	0.82	0.78

Discussion

Results of the case report suggest that KT may increase active ROM of knee hamstring strain. One suggested mechanism for the effect of KT on active range of motion is an increased blood circulation in the taped area and this physiological change may affect the muscle and myofascial functions that increased ROM within the muscle (17). The possible increase in blood circulation is theorized to affect muscle function, and application of KT may apply pressure to the skin or stretch skin, and this external load may stimulate cutaneous mechanoreceptors and as a result impact knee flexion/extension ROM. Mechanical load on muscle may increase muscle excitability. An additional theory is that fear of movement is related to pain intensity in patient and thus the application of KT provides sensory feedback and so increases ROM (5). KT was used to correct biomechanical movements, so allowing them to create more power through their movements and effectively improve their performance. Hsu et al assessed the effect of KT on shoulder kinematics in baseball players with shoulder impingement syndrome. The KT group had statistically significant improvements in scapular orientations compared with the placebo group (7). Slupik et al investigated a 54% increase in muscle activity of the vastus medialis muscle 24 hours after application of KT (14). Karatas et al reported that kinesio taping would be an effective method for reducing neck and low back pain and improving functional performance (8). Our report results demonstrated kinesio taping increased knee flexion ROM when applied to hamstring muscle strain, thus had a positive effect on muscle active assistive direction.

Use of KT relaxes the injured muscles and increases circulation to the area, as well as providing significant pain relief and physiological change in the region. Our suggestion is to combine KT with light progressive stretching activity, icing after activity and appropriate rest in order to speed healing in hamstring injury rehabilitation.

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Corresponding author
Senem Güner
Ankara University
School of Health Care Professions
Department of Prosthetics and Orthotics,
Ankara, Turkey
Phone: +0903123573242
E-mail: *sguner@ankara.edu.tr*

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