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The Effects of Different Recovery Methods on Blood Pressure and Heart Rate Variability in Hearing-Impaired Athletes

Farklı Toparlanma Yöntemlerinin İşitme Engelli Sporcularda Kan Basıncı Ve Kalp Atım Hızı Değişkenliği Üzerine Etkileri

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THE EFFECTS OF DIFFERENT RECOVERY METHODS ON BLOOD PRESSURE AND HEART RATE VARIABILITY IN HEARING IMPAIRED ATHLETES

ABSTRACT

The aim of the present study was to determine the effects of foam roller (FR), dynamic stretching (DS), and passive recovery (PR) on blood pressure (BP) and heart rate variability (HRV) in hearing-impaired athletes after submaximal exercise. Twelve congenital (sensorineural) hearing impaired (>91dB) basketball players aged between 18-30 participated in the study voluntarily. Participants were randomly divided into 3 groups consisting of 4 subjects, and 3 different recovery methods after submaximal treadmill running exercises were performed in a cross-over design. BP and HRV parameters of the participants were measured at 4 different times, (i) pre-exercise, (ii) post-exercise, (ııı) during recovery, and (iv) after recovery. Data were analyzed with a two-way analysis of variance test for repeated measurements (3 groups x 4 times). There was a significant increase in RMSSD and HF compared to PR after the FR recovery and in 10-minute after recovery ($p<0.05$). There was a significant decrease in LF at 10 min after recovery exercise in FR compared to PR ($p<0.05$). No significant difference was found between DS and FR and between DS and PR in neither BP nor HRV parameters ($p>0.05$). The FR recovery method applied after submaximal exercise in hearing-impaired basketball players significantly improved HRV compared to PR. Performing FR recovery exercises in the post-exercise or post-competition period may positively affect HRV. FR exercise can be recommended to coaches and athletes as a method of recovery after post-submaximal exercises.

Keywords: *Blood Pressure, Cardiac Autonomic Modulation, Deaf, Recovery, Self-Myofascial Release.*

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FARKLI TOPARLANMA YÖNTEMLERİNİN İŞİTME ENGELLİ SPORCULARDA KAN BASINCI VE KALP ATIM HIZI DEĞİŞKENLİĞİ ÜZERİNE ETKİLERİ

ÖZ:

Bu çalışmanın amacı, işitme engelli sporcularda submaksimal egzersiz sonrası foam roller (FR), dinamik germe (DS) ve pasif toparlanmanın (PR) kan basıncı (BP) ve kalp hızı değişkenliği (HRV) üzerindeki etkilerini belirlemektir. Çalışmaya 18-

30 yaş arası 12 doğuştan (sensörinöral) işitme engelli (>91dB) basketbolcu gönüllü olarak katılmıştır. Katılımcılar rastgele 4 sporcudan oluşan 3 gruba ayrılmıştır. Katılımcılar çapraz desenli tasarımda (cross-over) koşu bandı üzerinde submaksimal koşu (%80) egzersizleri yapıtıktan sonra 3 farklı toparlanma yöntemi uygulamışıtır. Katılımcıların BP ve HRV parametreleri (i) egzersiz öncesi, (ii) egzersiz sonrası, (ııı) toparlanma egzersizi sırası ve (iv) toparlanma egzersizi 10dk sonrası olmak üzere 4 farklı zamanda ölçüldü. Veriler, tekrarlanan ölçümler (3 grup x 4 zaman) için iki yönlü bir varyans analizi testi ile analiz edilmiştir. FR toparlama egzersizi sonrası ve toparlanma egzersizinden 10 dakika sonra PR'ye kıyasla RMSSD ve HF'de anlamlı bir artış tespit edilmiştir ($p<0.05$). PR'ye kıyasla FR'de toparlanma egzersizinden 10 dakika sonra LF'de anlamlı bir azalma vardı ($p<0.05$). Ne BP ne de HRV parametrelerinde DS ile FR arasında ve DS ile PR arasında anlamlı fark bulunmamıştır ($p>0.05$). İşitme engelli basketbolcularda submaksimal egzersiz sonrası uygulanan FR toparlanma yöntemi, PR'ye kıyasla HRV'yi önemli ölçüde artırmıştır. Bulgularımıza göre egzersiz sonrası veya müsabaka sonrası dönemde FR toparlanma egzersizlerinin yapılması HRV'yi olumlu etkileyebilir. Antrenörlere ve sporculara post-submaksimal egzersizlerden sonra toparlanma yöntemi olarak FR egzersizi önerilebilir.

Anahtar Kelimeler: *İşitme Engelliler, Kan Basıncı, Kardiyak Otonomik Modülasyon, Self-Miyofasyal Salınım, Toparlanma.*

INTRODUCTION

Some physical and physiological characteristics (muscular-cardiovascular endurance, neuromuscular system, rhythm, reaction, muscle coordination, balance, etc.) of hearing-impaired individuals are weaker than their healthy peers due to their disorders in the vestibular system (Melo et al., 2017). In this context, the most important parameter to be investigated in hearing-impaired athletes is the development of sportive performance (Jackson, 2006). One of the important criteria for developing and maintaining sports performance is determining the most appropriate recovery methods after exercise (Andersson et al., 2008). Recovery is the process of returning the body to its pre-exercise state physiologically or psychologically after any strenuous exercise (Kellmann et al., 2018). The main purpose of recovery exercises is to bring the athlete to the state before the exercise as soon as possible, to prevent performance decline, to increase performance, to increase high performance to continue, or to prepare the athlete for the next training or competition. If athletes train or compete without proper recovery, this may hinder their training adaptation or performance gains (Bishop, Jones, & Woods, 2008). Thanks to the recovery, the athlete maintains the balance between the training and tries to be protected from negative effects such as chronic fatigue, disability, etc. That's why it's important to follow an effective recovery prescription.

In recent years, heart rate variability (HRV) has been used as a tool to measure and evaluate autonomic nervous system (ANS) activity during exercise and recovery (Stanley, Peake, & Buchheit, 2013). HRV parameters, indicators of ANS activity, provide important information in maintaining homeostasis (Bastos et al., 2012). For example, sympathetic activity increases during exercise while parasympathetic activity decreases. There is a progressive parasympathetic reactivation with sympathetic withdrawal in the post-exercise period. The balance between sympathetic and parasympathetic activity reflects the restoration of cardiovascular homeostasis, an important component of autonomic and overall recovery. The increase in HRV after exercise is an important indicator of recovery (De Oliveira Ottone et al., 2014).

When the literature is examined, it is seen that many methods such as massage, cold or hot water therapy, vibration equipment, stretching, and foam roller (FR) exercises that affect the recovery process are applied (Chatzopoulos, Galazoulas, Patikas, & Kotzamanidis, 2014; De Oliveira Ottone et al., 2014; Kalén et al., 2017). In dynamic stretching (DS) exercise, the muscle is extended to the joint range of motion in a stretching position, and contraction and relaxation are performed with successive repetitions without stopping at the limit point (Sands et al., 2013). Some studies stated that DS increases performance by positively affecting maximum muscle strength, speed, balance, and vertical jump skills (Behm & Chaouachi, 2011; Chatzopoulos et al., 2014; Perrier, Pavol, & Hoffman, 2011). However, sports scientists and trainers have recently preferred FR exercises in the self-myofascial release technique as a popular recovery method (Healey, Hatfield, Blanpied, Dorfman, & Riebe, 2014). With this method, people put their own body on the FR and move inferiorly and superiorly, applying pressure to the fascia that is wrapped around the muscle, and this way, the fascia is loosened (Renan-Ordine, Alburquerque-Sendín, De Souza, Cleland, & Fernández-De-Las-Penas, 2011). Previous studies reported that the FR method increases sports performance, improves post-exercise recovery, develops flexibility, and balance skills, reduces muscle pain, and modulates the autonomic nervous system (Griefahn, Oehlmann, Zalpour, & von Piekartz, 2017; Healey et al., 2014; Kalén et al., 2017; Kim, Park, Goo, & Choi, 2014; Lastova, Nordvall, Walters-Edwards, Allnutt, & Wong, 2018). While recovery is achieved with increased muscle tension in the DS method, the muscle is relaxed by applying pressure in the FR method (Renan-Ordine et al., 2011).

In many studies, it is stated that both recovery methods have positive effects, but there is no study on which recovery method is more effective (Griefahn et al., 2017; Kalén et al., 2017; Lastova et al., 2018). In addition, there are studies examining the effect of static stretching exercise on HRV in the literature (Farinatti, Brandão, Soares, & Duarte, 2011; Silva et al., 2016), but as far as we know, there is no study on how DS exercise affects HRV during recovery. Therefore, determining the possible changes in blood pressure (BP) and HRV of different recovery exercises will enable us to understand better the exercise programs that hearing-impaired athletes will follow during the next training or post-competition recovery process. In the literature review, it is seen that there are studies on the psychosocial development of hearing impaired athletes, experimental research on improving sports performance is limited, and therefore there is a need for research on training science. The limited time between training or competitions increases the importance of recovery exercises in maintaining performance. It is thought that monitoring possible changes in BP and HRV after the main exercise or competition and revealing the outputs will contribute to selecting recovery training methods for hearing impaired athletes or trainers.

The aim of the present study was to determine the effects of the foam roller, dynamic stretching, and passive recovery after submaximal exercise on blood pressure and heart rate variability in hearing impaired basketball players. The study's main hypothesis is that the effects of FR exercises performed after exercise on BP and HRV will be more effective than DS and passive recovery (PR).

METHOD

Research Model

The research was carried out in the cross-over research model, which is one of the quantitative research methods. Participants visited the gym 4 times on non-consecutive days (at least 72 hours apart). Participants were randomly divided into 3 groups x 4 numbers. Before the trial, the exercises were introduced, and familiarization tests were carried out. In this process, the resting heart rates (HR) and maximum heart rates (HR_{max}) of the participants before starting the exercises were determined by the Bruce protocol (Foster et al., 1996). Then, heart rate ranges were determined according to the submaximal exercise intensity (80% of $HR_{max)}$ of the participants with the Karvonen method. The study was carried out during the time outside competition and training period of the participants. During the application process, the participants were asked to avoid physical activities that could affect the outcomes.

Universe-Sample

The universe of the research consists of all hearing impaired athletes who have been playing basketball for at least 2 years in Bursa. The sample consisted of 12 congenital (sensorineural) hearing impaired (>91dB) men aged between 18-30, who regularly play basketball in Bursa Yıldırım Deaf Sports Club. G*Power 3.1 software was used to calculate an adequate sample size. Assuming power = β 0.80, Error probability = α 0.05, Effect Size ES= f 0.40, the sample size was calculated as n=12, and the sample size was found to be sufficient to provide more than 80% of the statistical power (Beck, 2013). The exclusion criteria were i) any health problem that may pose a risk for the participant, ii) any health problem other than hearing impairment (metabolic disease, mental retardation, etc.), iii) medication affecting physiological functions, etc. iv) using stimulants (ergogenic supplements, etc.). Participants signed the informed consent form after being informed about the research procedure, requirements, benefits, and potential risks. This study was conducted following the Declaration of Helsinki and was approved by Bursa Uludağ University Clinical Research Ethics Committee (decision no: 2022-12/17).

Data Collection Tools

Body Composition: The participant's body weight and body mass indexes were analyzed with the TANITA BC-418MA (-0.50kg) Brand Segmental Body Analysis Monitor. The heights of the participants were measured by measuring the distance between the vertex of the head and the foot following a deep inspiration while the head was in the Frankfort plane.

Bruce Protocol: The test started on a professional treadmill (Valeo 7000a treadmill, France) with a 10% incline at 2.7 km/h. Speed and incline were increased every three minutes according to Bruce protocol. The test continued until the athlete could not continue the test, and HR_{max} was determined by monitoring HR with an HRV monitor throughout the test (Foster et al., 1996).

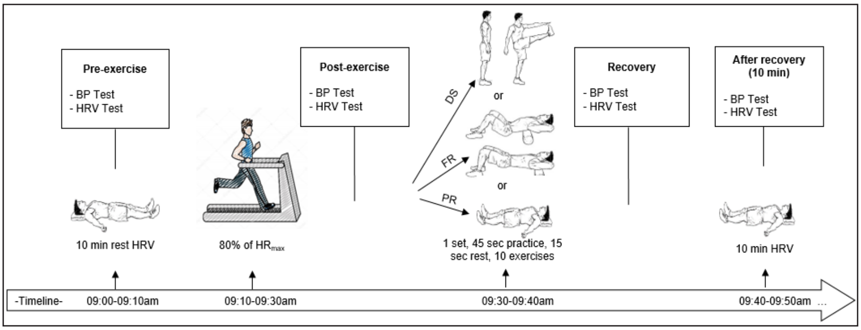
Blood Pressure: : Systolic (SBP) and diastolic blood pressure (DBP) were measured using an automated oscillometric device (Omron M2 HEM-7121-E, Kyoto, Japan). The equipment was automatically calibrated before each use. Measurements were made according to the recommendations of the American Heart Association (Pickering et al., 2005).

Heart Rate Variability: The tests were conducted in a quiet environment between 09:00 and 12:00. Room temperature was set at 20-24^0 and humidity at 30-45%. HRV was recorded with a heart rate monitor (Polar V800 watch, h-10 sensor, Finland) (Giles, Draper, & Neil, 2016).To estimate cardiac autonomic modulation, RMSSD, which predominantly gives information about the parasympathetic system in time domain measurements, HF measurements, which predominantly provide information about the parasympathetic system in frequency domain measurements, and LF measurements, which predominantly give information about the sympathetic nervous system in frequency domain measurements, were recorded. The data were evaluated in time and frequency domains using Kubios HRV analyzer software (Kuopio, Finland). The spectral analysis in the frequency domain was performed with the Fast Fourier transform algorithm. The power of the high (HF, 0.15–0.4 Hz) and low frequency (LF, 0.04– 0.15 Hz) bands were calculated in normalized units (n.u) (Malik, 1996)

Data Collection

The trials were carried out in the gym of Bursa Uludağ University Faculty of Sports Sciences. In each application, 2 participants took part at the same time. A total of 6 participants took part on the same day at one-hour intervals. Before the exercise, the participants' resting HRV was measured for 10 minutes in the supine position, and BP and HRV measurements were taken at the end of the 10 minutes. Then participants warmed up by jogging for 5 minutes and performing calisthenic exercises involving all body parts. Subsequently, each participant ran on the treadmill for 20 minutes at 80% of HR_{max}. HRV and BP of the participants were measured again within 1 minute after the running exercise was completed. Following the tests, 2 participants performed FR exercises including 7 muscle regions (gastrocnemius, tibialis anterior, iliotibial band, quadriceps, hamstrings, glutes, upper body) consisting of 10 exercises (shins, calves, It-band-right leg, It-band-left leg, hamstring, quadriceps, glutes, thoracic spine, rotator cuff-right side, rotator cuff-left side). Each exercise was applied for 1 set of 45 seconds, and 15 seconds of rests were given. FR exercise lasted a total of 10 minutes. Participants performed 15 repetitions in each exercise set, lasting 3 seconds (1.5 seconds inferior, 1.5 seconds superior) between the origo and insertion points of the target tissue. 2 participants performed the DS exercise with the same method, consisting of 10 exercises (vinyasa flow, inchworm, dynamic pigeon, leg swings, fire hydrant circles, leg crossovers, scorpion, page turns, frog walk-in and frog walk-in twist). The other 2 participants, as PR, remained on the rubber mat for 10 minutes in a supine position without moving. At the end of the recovery exercise, the participants' HRV and BP were measured again. All participants completed the applications on different days, including 3 recovery methods. FR exercises were performed on a medium hard-notched FR from Delta brand (14x33cm, FR3301, Istanbul, Turkey). The application procedure is shown in figure 1.

Fig 1. Application procedure.



Analysis of Data

Data analysis was made in SPSS Windows 23.0 (SPSS Inc, Chicago, USA) statistical program. Descriptive statistics were expressed as mean and standard deviation. The Shapiro Wilk test was used to verify the data normality and determined that the data were normally distributed. Data were analyzed by analysis of variance for repeated measures test (3 groups x 4 times). Bonferroni adjustment was made for pairwise comparisons. Cohen's d effect sizes were calculated for each outcome. Cohen's *d* classifications were <0.19=negligible effect; 0.20–0.49=small effect; 0.50– 0.79=moderate effect and >0.8=large effect. The significance level was accepted as $p<0.05$.

RESULTS

The age, body weight, body height, and BMI values of the participants (n=12) were determined as 25.3±4.3(years), 76.6±8.5(kg), 181.1±3.9(cm), 23.9±2.4(kg/m^2), respectively. The findings were presented in table 1 and figure 2 (SBP and DBP), figure 3 (RMSSD), figure 4 (HF) figure 5 (LF).

Cohen's *d* classifications were <0.19=negligible effect; 0.20–0.49=small effect; 0.50–0.79=moderate effect and >0.8=large effect. SBP, systolic blood pressure. DBP, diastolic blood pressure. RMSSD, the root of the mean of the square of the difference of the RR intervals. HF, high frequency. LF, low frequency. SD, standard deviation.

Table 1. Comparison of HRV and BP parameters within and between groups (n=12).

Variables		Pre-exercise(1) Mean±SD	Post-exercise(2) Mean±SD	Recovery(3) Mean±SD	After recovery(4) Mean±SD	P /Cohen's *d*
SBP	PR (a)	117.46±18.1	116.50±14.2	110.82±18.9	111.00±10.0	
	DS (b)	117.91±19.4	123.64±16.5	112.18±12.5	111.82±10.4	
	FR (c)	122.18±11.6	116.36±15.3	116.64±12.6	112.78±10.1	
DBP	PR (a)	75.91±13.2	76.55±10.2	71.36±8.3	77.36±8.4	
	DS (b)	80.36±12.0	76.27±7.5	74.46±11.7	77.00±15.9	
	FR (c)	80.72±9.5	73.46±8.7	72.64±8.2	76.91±9.1	
RMSSD	PR (a)	55.79±35.4	11.28±10.9	16.86±7.3	20.37±8.9	a1-a2 (0.001 /1.97) a1-a3 (0.003 / 1.72) a1-a4 (0.010 / 1.57) b1-b2 (0.001 / 2.04) c1-c2 (0.001 / 2.34) c1-c3 (0.041 / 1.41) a3-c3 (0.030 / -0.55) a4-c4 (0.049 / 0.70)
	DS (b)	57.27±45.3	11.26±15.2	25.97±22.5	27.19±9.3	
	FR (c)	61.06±33.7	8.34±7.1	29.34±15.4	36.25±17.8	
HF	PR (a)	74.29±11.4	39.67±15.5	56.84±13.4	61.00±16.5	a1-a2 (0.001 / 2.41) a1-a3 (0.025 / 1.21) a2-a3 (0.011 / -1.19) a2-a4 (0.004 / -1.48) b1-b2 (0.001 / 2.57) b2-b3 (0.013 / -1.95) b2-b4 (0.001 / -2.24) c1-c2 (0.001 / 2.46) c2-c3 (0.001 / -2.31) c2-c4 (0.001 / -2.48) a3-c3 (0.022 / -1.18) a4-c4 (0.026 / -1.06)
	DS (b)	73.36±16.8	36.46±11.9	64.56±13.0	68.63±18.7	
	FR (c)	76.01±14.7	40.62±17.1	73.86±9.5	76.26±10.7	
LF	PR (a)	38.40±12.7	60.57±17.1	41.28±11.6	41.69±12.8	a1-a2 (0.049 / -1.69) a2-a3 (0.001 / 1.47) a2-a4 (0.045 / 1.44) b1-b2 (0.003 / -1.75) b2-b3 (0.015 / 1.36) b2-b4 (0.001 / 1.68) c1-c2 (0.035 / -1.58) c2-c3 (0.022 / 1.41) c2-c4 (0.019 / 1.73) a4-c4 (0.038 / 0.68)
	DS (b)	36.62±13.5	59.67±8.3	41.74±11.4	37.64±8.5	
	FR (c)	34.79±9.2	55.57±20.7	37.00±8.1	32.81±17.0	

Cohen's d classifications were <0.19=negligible effect; 0.20–0.49=small effect; 0.50–0.79=moderate effect and >0.8=large effect. SBP, systolic blood pressure. DBP, diastolic blood pressure. RMSSD, the root of the mean of the square of the difference of the RR intervals. HF, high frequency. LF, low frequency. SD, standard deviation.

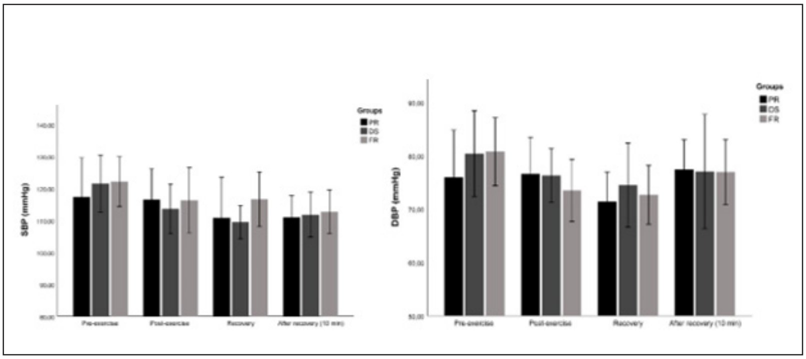


Fig. 2 shows the blood pressure parameters within and between groups. SBP, Systolic blood pressure. DBP, Diastolic blood pressure.

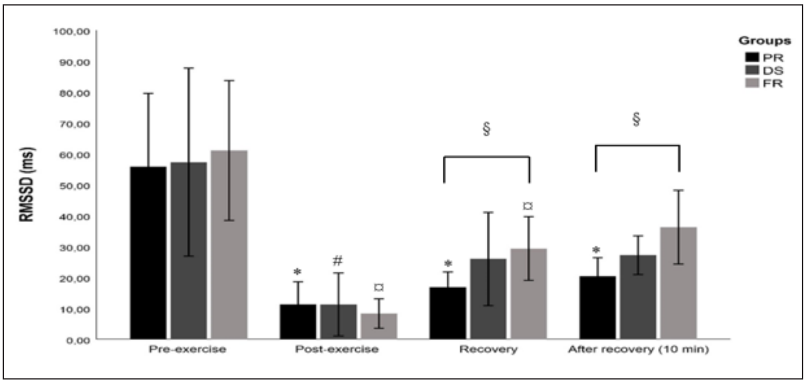


Fig. 3 shows the RMSSD within and between groups. RMSSD, the root of the mean of the square of the difference of the RR intervals. * There is a significant difference in passive recovery method compared to pre-exercise $p<0.05$. # There is a significant difference in dynamic stretching method compared to pre-exercise $p<0.05$. ¤ There is a significant difference in foam roller method compared to pre-exercise $p<0.05$. § Foam roller recovery method showed a significant increase after recovery and 10 minutes after recovery compared to passive recovery $p<0.05$.

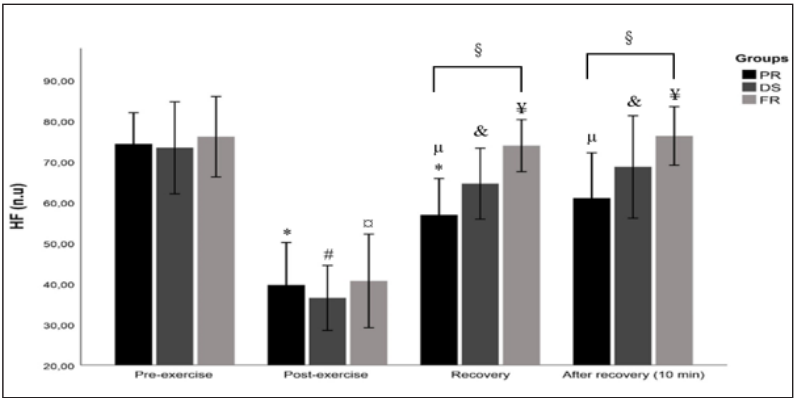


Fig. 4 shows the HF within and between groups. HF, high frequency. * There is a significant difference in passive recovery method compared to pre-exercise p<0.05. # There is a significant difference in dynamic stretching method compared to pre-exercise p<0.05. ¤ There is a significant difference in foam roller method compared to pre-exercise p<0.05. µ There is a significant difference in passive recovery method compared to post-exercise p<0.05. & There is a significant difference in dynamic stretching method compared to post-exercise p<0.05. ¥ There is a significant difference in foam roller method compared to post-exercise p<0.05. § Foam roller recovery method showed a significant increase compared to passive recovery after recovery and 10 minutes after recovery p<0.05.

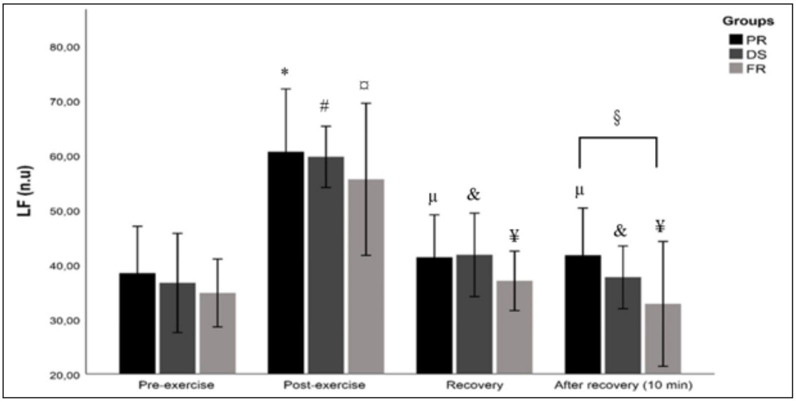


Fig. 5 shows the LF within and between groups. LF, low frequency. * There is a significant difference in passive recovery method compared to pre-exercise p<0.05. # There is a significant difference in dynamic stretching method compared to pre-exercise p<0.05. ¤ There is a significant difference in foam roller method compared to pre-exercise p<0.05. µ There is a significant difference in passive recovery method compared to post-exercise p<0.05. & There is a significant difference in dynamic stretching method compared to post-exercise p<0.05. ¥ There is a significant difference in foam roller method compared to post-exercise p<0.05. § Foam roller recovery method showed a significant increase in 10 minutes after recovery compared to passive recovery p<0.05.

DISCUSSION

In the present study, the effects of different recovery methods after exercise on BP and HRV in deaf athletes were investigated. Main findings; i) there was a significant increase in RMSSD and HF in FR exercise compared to PR during recovery and 10 minutes after recovery, ii) a significant decrease was found in HF in FR exercise compared to PR 10 minutes after recovery, iii) there was no significant difference between exercises in SBP and DBP, iv) there was no significant difference between FR and DS and between DS and PR. The obtained findings confirmed the hypothesis of our study.

Lastova et al. (2018) reported that, after 15 minutes of foam roller exercise involving 7 muscle areas, a significant difference was found in RMSSD according to the resting value, but there was no significant difference compared to the control group. However, a significant increase in HF was reported compared to the control group and a significant decrease in LF during the recovery period after exercise. In another study, it was reported that BP and HRV parameters returned to pre-exercise levels more quickly and parasympathetic activity recovered more rapidly compared to the control group after 40 min of myofascial relaxation massage applied after the Wingate test (30-sec protocol), which was repeated 3 times (Arroyo-Morales et al., 2008). It has been reported that 2-week self-myofascial massage applied to the neck and back muscles with a baseball in patients with myofascial pain dysfunction syndrome causes an increase in HF power (Chan et al., 2015). Our study observed significant improvement in HRV parameters of FR exercise applied after submaximal exercise compared to the control group. It is argued that FR reduces blood lactate and edema by increasing blood flow and increasing the amount of oxygen in the muscle (Pearcey et al., 2015). A previous study found a significant increase of 73.6% in blood flow (1 min) after FR and 52.7% after 30 min (Hotfiel et al., 2017). Changes in tissue blood circulation due to mechanical stress during and after FR may cause the release of vasoactive substances such as nitric oxide (NO), which plays an important role in regulating vasoconstriction and dilation (Hotfiel et al., 2017). Several research findings suggest that NO may play an important role in increasing parasympathetic activity and decreasing sympathetic activity (Conlon, Collins, & Kidd, 1996; Hotfiel et al., 2017; Okamoto, Masuhara, & Ikuta, 2014). In another study, a statistically significant increase in plasma NO concentration was observed after FR, and it was reported that FR reduced arterial stiffness and improved vascular endothelial function (Okamoto et al., 2014). However, D'Amico et al. (2020) reported that the foam roller exercise applied after 40 sets x 15m sprints was similar to the control group in RMSSD. Factors such as differences in FR types used in FR exercise (hardness level on the roles, etc.), application times, and tempo may affect the results. In addition, foam roller can increase blood circulation and venous return due to the number of muscle areas to which it is applied and the mechanical pressure on the tissues acting on more muscle surface. This may positively affect cardiovascular recovery.

In the present study, no significant difference was found in HRV parameters after dynamic stretching exercise compared to both FR and PR. As far as we know, there is no study examining the effect of DS as a recovery method after exercise on HRV. Ujikawa et al. (2020) stated an increase in LF/HF and a decrease in HF compared to static stretching after DS was applied as a warming up. The researchers noted that the sympathetic system was dominant as the exercise load increased and suggested that the difference between the groups was because DS included more exercise load than static stretching. In young men with low flexibility, SDNN and RMSSD were significantly increased 30 minutes after exercise consisting of 3 active static stretching movements (3 sets x 30s) involving the trunk and hamstring region (Farinatti et al., 2011). In another study, it was reported that there was no significant difference in the HRV parameters of the 20-minute static stretching of the chest area, consisting of 2x30 seconds, performed with trained men compared to the control group (Silva et al., 2016). Different results have been revealed in the applied stretching methods. A review study reported that dynamic stretching lasting longer than 90 s had a greater increase in some performance parameters (force, isokinetic power, etc.) compared to shorter stretching times (Behm & Chaouachi, 2011). In our study, each stretching movement took 1 set and 45 seconds. Dynamic stretching time may have been limited in affecting HRV and BP parameters.

In this study, no significant difference was found between the groups in SBP and DBP parameters. Lastova et al. (2018) found a significant decrease in SBP and DBP in the recovery period (about 30 minutes) after acute FR exercise compared to the control group. One study reported that the change in BP values after acute exercise was similar to that in resting conditions after eight weeks of regular aerobic exercise (Liu, Goodman, Nolan, Lacombe, & Thomas, 2012). Adapting the subjects in our study to regular exercise (2 years) may have reduced the effects of acute training on BP parameters. Recovery manipulations (type of exercise, intensity, duration, etc.) can affect the magnitude and duration of BP parameters. There were some limitations in this study. Firstly, hearing and female athletes were omitted. Secondly, the effects of only three recovery methods among many recovery methods applied in the field of sports science were examined. Finally, the effects of exercises on HRV and BP parameters were examined, and other parameters were not evaluated (e.g., NO).

CONCLUSION

As a result, the FR recovery method applied after submaximal exercise in deaf basketball players significantly improved HRV compared to PR. However, there was no difference between FR and DS methods in HRV and BP. In DS, the findings were similar between recovery methods. Performing FR recovery exercises in the post-exercise or post-competition period may positively increase HRV. FR exercise can be recommended to coaches and athletes as a method of post-submaximal exercise recovery. In future studies, HRV parameters can be followed for a longer time (e.g., up to 60 minutes) after the recovery exercise, and the effects of different recovery methods can be examined.

Conflict of Interest Statement

There is no personal or financial conflict of interest between the authors of the article within the scope of the study.

Yazar Katkı Oranları:

Çalışmanın Tasarlanması (Design of Study) : AKG (%40), HT (%40), RA (%10), ŞŞ (%10)

Veri Toplanması (Data Acquisition) : AKG (%50), HT (%50)

Veri Analizi (Data Analysis) : AKG (%50) RA (%25), ŞŞ (%25

Makalenin Yazımı (Writing up) : AKG (%25), HT (%25), RA (%25), ŞŞ (%25)

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