ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research

Vol. 06, Issue 07, pp.5081-5085, July, 2019

RESEARCH ARTICLE

THE EFFECT OF AEROBIC EXERCISE ON PORTAL VENOUS SYSTEM IN SPLENECOTMIZED PATIENTS

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ARTICLE INFO

Article History:

Received 05th April, 2019
Received in revised form
29th May, 2019
Accepted 28th June, 2019
Published online 31st July, 2019

Keywords:

Splenectomy, Aerobic exercise, Portal vein blood flow and Portal vein diameter.

ABSTRACT

Background: Splenectomy is a surgical intervention commonly performed at hospitals as a cause of splenic trauma. Aerobic exercise increases blood flow to contracting muscles, causes hypercoagulability and vasoconstriction in the splenic area, hence the portal vein diameter and blood flow velocity decrease. **Aim:** to study the effect of aerobic exercise on portal venous system in splenectomized patients. **Material and Methods:** Thirty adult male participated in this investigation were divided into two groups, control group received traditional treatment (encourage ROM, cough techniques and ambulation), study group received aerobic exercise (run for twenty minutes on treadmill at a velocity of 6km/h and ten –degree elevation for four weeks). We compared the white blood cells count, portal vein diameter, portal venous blood flow velocity and functional activities before and after exercise. **Results:** After exercise, the white blood cells count was significantly increased and portal vein diameter with portal venous blood flow were significantly reduced in study group($p<0.001$), but no statistically differences in two groups before and after exercise in functional activities. **Conclusion:** Aerobic exercise in splenectomized individuals cause decrease splenic blood flow which increase blood viscosity and decease portal vein diameter.

INTRODUCTION

There are several indications for splenectomy, traumatic injury was previously the leading indication for splenectomy, but with improved splenic preservation techniques, this is now second most common (35-40%), behind hematologic conditions (40-50%), with idiopathic thrombocytopenia purpura being most common, the splenectomized human population is usually young. Splenectomy is performed in two major clinical scenarios: trauma and hematologic disease. The spleen is one of the most frequently injured intra-peritoneal organs, and management of splenic injuries may require splenectomy or rarely splenorrhaphy. After splenectomy portal vein diameter does not change but splenic vein as a component of portal venous system become non-functional which decrease portal vein blood flow and portal vein diameter. The splenectomized human population is usually young and continues an active life in their post-operative period. Aerobic exercise increase blood flow to the contracting muscles while causing vasoconstriction in the splanchnic area lead to decrease porta vein blood flow, portal vein velocity and portal vein diameter.

SUBJECTS AND METHODS

This study was conducted in Al haram Hospital and El-kasr to investigate the effect of aerobic exercise on portal vein after splenectomy. Thirty male patients who had splenectomy was participated in the study.

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The experimental protocol was explained in details for every patient before starting the initial assessment, and a written consent form was signed by each patient before starting. The treated patients were instructed to report any side effects during the treatment sessions.

Subjects

Subjects were randomly divided into two equal groups, control group received traditional program(encourage ROM, ambulation and coughing techniques) and study group received aerobic exercise program (train to run for twenty minutes on treadmill at a velocity of 6 km/h and ten-degree elevation, 3times/weak for 4weeks). Using The Gerkin Protocol Start with warm-up: 3 mph at 0% incline for 3minutes, Continue with running at the same speed, but set incline at 2% for another 1minute, Continue running and increase speed by 0.5mph and incline by 2% every 1minute, Continue increasing efforts until reach 6mph and incline10%, then Cool down for 3 minutes at 3 mph speed and 0% incline).

Inclusive criteria

All patients were chosen according to the following criteria:

1. Age of patients from 25 to 45 years old.
2. suitable for exercise in cardiac and other aspects.
3. The patients participating in the study underwent splenectomy atleast6 months before the study from trauma.
4. Weight(kg):70-100
5. Height(cm):160-185.

6. Gender: male.

Exclusive criteria: The patients with portal vein thrombosis, myelo-proliferative diseases, hemolytic and lymph proliferative disorders excluded from the study.

MATERIALS AND METHODS

Prior to the examination patients were asked to fast for at least 6-8 h, the subject arrived at the laboratory to examine white blood cells. The portal venous blood flow velocity and portal vein diameter examination was performed using a high-resolution real-time Doppler ultrasound scanner (GE logiq p5) with2-5 MHz curvilinear transducer at right of the midline subcostal or intercostal region in a supine position during breath-hold before exercise. The functional activities also measured before exercise through a patients answer many questions and do not skip any one. The subjects were trained to run on treadmill for 20minutes at a velocity of 6km/h and ten-degree elevation, 3 times/week for 4weeks. The analysis of white blood cells, portal vein blood flow velocity, portal vein diameter and functional activities measurements were performed after completion of exercise protocol.

Data analysis

Statistical analyses performed using SPSS (Statistical Packages for Social Sciences). Data expressed as mean ± standard deviation for metric variables. Comparison between the mean values of different variables pre and post treatment within group was performed using paired student t test. Comparison between the p-values of the different variables as regards post treatment in the two groups was performed using independent sample test.

RESULTS

Thirty patients selected and divided into two group with each group contain 15 male patients. The mean age is 34.13 ± 5.43 in control group and 32.53± 4.08 in study group as represented in Table (1), the mean weight is 82.33 ± 6.11 in control group and 79.93± 4.86 in study group as represented in Table (2) and the mean length is 174.46± 4.95in control group and 175.60± 4.45 in study group as represented in Table (3). Portal vein diameter distribution showed that the mean diameter is 10.88±1.05,10.88±1.05regarding Pre value, Post value in control group and 10.84± 0.95,9.52±1.01 regarding Pre value, Post value in study group as represented in Table (4), Fig (1), statistics of blood flow distribution showed that the mean blood flow is 803.93±121.47,803.93±121.47regarding Pre value, Post value in control group and 823.13± 84.34,596.86±92.04 regarding Pre value, Post value in study group as represented in Table (5), Fig (2) and the white blood cells distribution showed that the mean white blood cells are 9678.53±1337. 49, 9678.53±1337. 49 regarding Pre value, Post value in control group and 9267.60± 1418.14, 10389.8±1365.01 regarding Pre value, Post value in study group as represented in Table (6), Fig (3).

Paired sample test results showed that study group have significant difference(p-value<0.05) regarding portal vein diameter, portal vein blood flow and white blood cells values as shown in Table (7).

Table 1. Mean, SD & rang of age between two groups

	N	Minimum	Maximum	Mean	Std. Deviation
Age Control	15	26.00	43.00	34.1333	5.43621
Age Study	15	27.00	41.00	32.5333	4.08598

Table 2. Mean, SD & rang of weight between two groups

	N	Minimum	Maximum	Mean	Std. Deviation
Weight Control	15	72.00	90.00	82.3333	6.11400
Weight Study	15	71.00	87.00	79.9333	4.86190

Table 3. Mean, SD& rang of length between two groups

	N	Minimum	Maximum	Mean	Std. Deviation
Length Control	15	166.00	182.00	174.4667	4.95504
Length Stud	15	166.00	182.00	175.6000	4.45293

Table 4. Mean, SD & rang of pre portal vein diameter, post portal vein diameter between two groups

	N	Minimum	Maximum	Mean	Std. Deviation
pre Diameter control	15	9.36	12.73	10.8820	1.05182
post Diameter control	15	9.36	12.73	10.8820	1.05182
Pre Diameter Study	15	9.57	12.78	10.8460	.95070
Post Diameter study	15	8.15	11.47	9.5220	1.01597

Table 5. Mean, SD& rang of pre blood flow, post blood flow between two groups

	N	Minimum	Maximum	Mean	Std. Deviation
Pre Blood control	15	618.00	996.00	803.9333	121.47749
post Blood control	15	618.00	996.00	803.9333	121.47749
pre Blood Study	15	680.00	973.00	823.1333	84.34611
post Blood Study	15	389.00	723.00	596.8667	92.04569

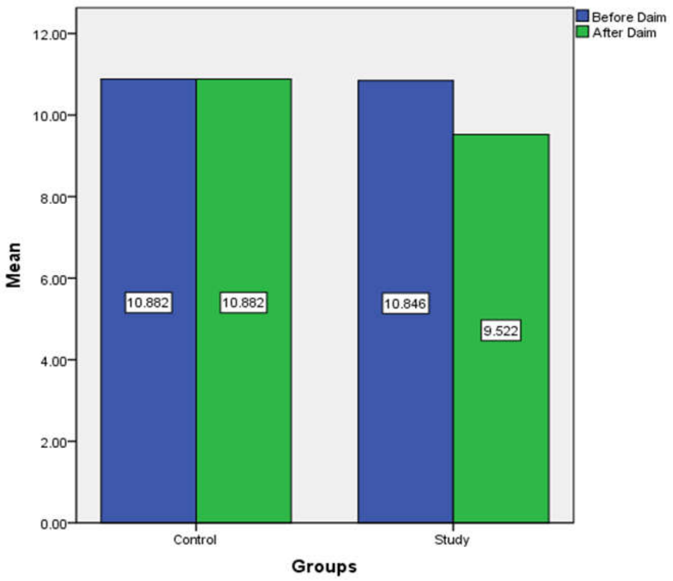

Fig. 1. PVD result compare before and after exercise

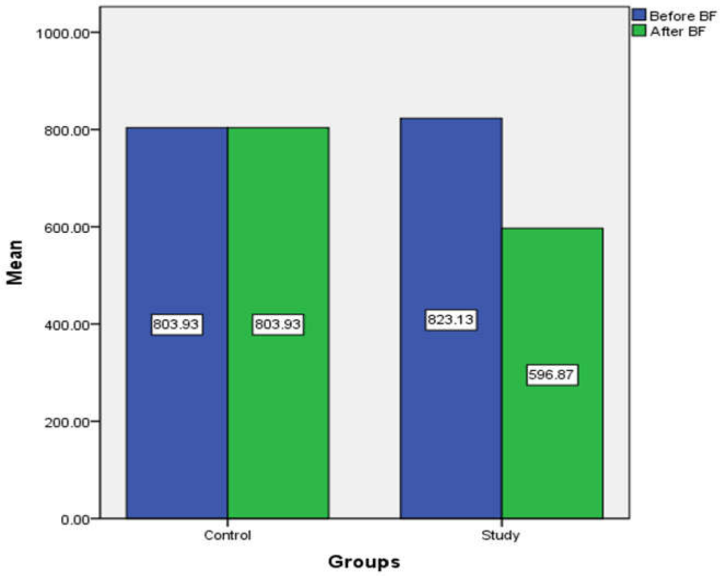

Fig. 2. BF compare result before and after exercise

Table 6. Mean, SD & rang of pre white blood cells, post white blood cells between two groups

	N	Minimum	Maximum	Mean	Std. Deviation
pre WBC control	15	7601	11857	9678.53	1337.495
post WBC control	15	7601	11857	9678.53	1337.495
pre WBC study	15	7555	11780	9267.60	1418.411
post WBC study	15	8650	12776	10389.87	1365.016

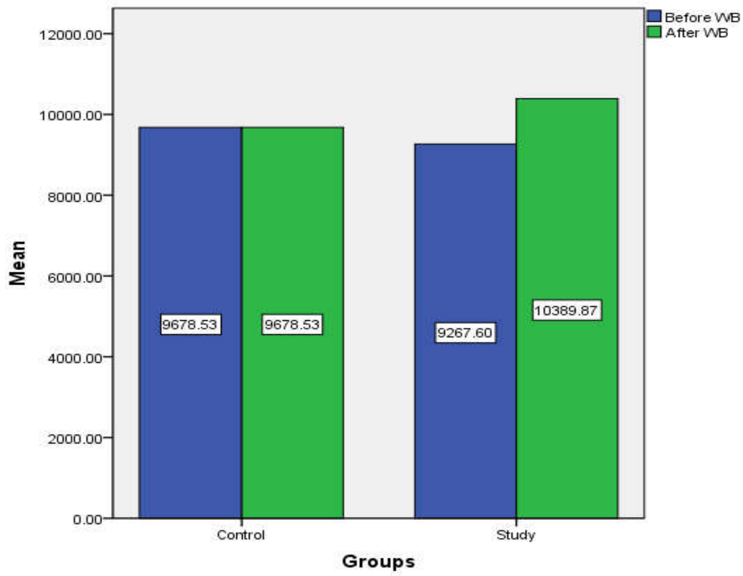

Fig. 3. WBC compare result before and after exercise

Table 7. Paired test statistics of PVD, BF&WBC

Paired Samples Test							
		Paired Differences			T value	Df	Sig(p value)
		Mean	Std. Deviation	Std. Error Mean			
Pair 2	Pre Diameter Study - Post Diameter study	1.32400	.34394	.08881	14.909	14	.000
		Paired Differences			T value	Df	Sig(p value)
		Mean	Std. Deviation	Std. Error Mean			
Pair 2	pre Blood Study - post Blood Study	226.26667	38.49947	9.94052	22.762	14	.000
		Paired Differences			T value	Df	Sig(p value)
		Mean	Std. Deviation	Std. Error Mean			
Pair 2	pre WBCs study - post WBCs study	-1122.267-	293.429	75.763	-14.813-	14	.000

DISCUSSION

The results of this study came in agreement with the (Ozban, 2012) portal vein diameter does not change after splenectomy but while being a component of portal venous system, the splenic vein becomes nonfunctional and the portal venous blood flow significantly decreases, changes also the quantity and quality of the immune system cells. Investigated the effect of exercise on portal venous blood flow in healthy men while the portal vein diameter, cross-sectional area and blood flow rates were found significantly decreased after exercise. found the gastrointestinal symptoms to increase in individuals who had regular sportive activity, especially marathon runners. They suggested some possible reasons including the decrease in splanchnic blood flow, changes in the levels of prostaglandins and other gastrointestinal hormones that could be affected by exerciseWe also determined that the velocity of portal venous blood flow and portal vein discharge decreased after exercise in both splenectomized and healthy subjects. At the sametime we showed that rather than the control group, the splenectomized group showed a significant decrease in portal blood flow rates (Rao, 2004). It is clear that exercise does not alter only the portal blood flow, but it changes also the quantity and quality of the immune system cells with tissue destruction and production of stress hormones. As opposed to regular and mild exercises which decrease the infection rates when compared to sedentary life style, severe exercises cause immunologic disorders. showed that severe exercise caused tissue destruction; therefor stress hormones were secreted thus altering the levels of various immunologic cells and functions. Depending especially on their intensity and duration, acute exercises increase the leukocyte counts (particularly those of lymphocytes and neutrophils), raise many inflammatory cytokines affecting the functions of leukocytes (TNF-alfa, IL-1beta), and increase anti-inflammatory cytokines (IL-6, IL-10) and acute phase reactants (CRP) (Natela, 2003). We did not identify any differences between splenectomized and healthy groups in respect to levels of leukocyte but we showed a statistically significant increase in leukocyte counts after exercise. It is known that blood viscosity may cause thrombosis and thromboembolic complications showed that blood components could affect the whole blood viscosity. Therefor leukocytosis especially in splenectomized adults may cause thrombosis resulting in portal vein thrombosis (Ho, 2004). Analyzed the effect of age and sex on the levels of leukocytes after exercise.

The latter factors were found to increase the leukocyte counts after exercise in all groups (Timmons, 2006). Splanchnic blood flow decreases during long-duration exercise. Pulsed-Doppler ultrasonography has revealed the nature of this change in human subjects. Cycling at 40–75% of maximum oxygen consumption (VO2max) for 15 and 120 min was found to decrease the blood flow in the CA and SMA by roughly 30% and 50%, respectively11-13). However, lower-intensity exercise at 40 watts for 4 min did not affect the blood flow in the SMA (Naoyuki Hayashi, 2012). Exercise promotes marked hemodynamic and humoral changes characterized by an increase in cardiac output, a redistribution of blood flow to muscular territories under activity, and an increase in sympatho adrenergic activity. also, increased arterial pressure and cardiac output and decreased systemic vascular resistance. which lead to a significant reduction in hepatic blood flow (from 1291 +/- 216 to 1034 +/- 152 mL-min-1; $P < 0.05$). All of these changes were intensified at 50% of target workload. The present study shows that moderate exercise increases portal pressure and may therefore increase the risk of variceal bleeding in patients with esophageal varices (Knight, 2017). All studies included a 30 min rest period prior to undertaking exercise after meal ingestion. Both Waaler and Perko found that the reduction in SMA flow was less marked when exercising in the fed state compared with fasting. However, a further two studies, both conducted by the same group, found the opposite: SMA flow was reduced in exercise undertaken in both the fasting and fed state. Eriksen found a moderate increase in SMA flow during exercise, but flow was unchanged in the fed state. Finally, Qamar reported a fall in SMA blood flow during exercise in the fasting state but an increase with exercise following meal ingestion (Knight, 2017) found a similar trend in mesenteric haemodynamics when measuring abdominal blood flow in response to 12 min of ergometer cycling in healthy volunteers. At 30% VO_2max, blood flow was slightly increased, while at 50% VO_2max it was reduced by one-third and at 85% VO_2max by 89%. Blood flow in this study was calculated by subtracting flow in the proximal right femoral artery from that in the abdominal aorta superior to the coeliac axis. While this indirect measure of mesenteric flow produces an estimation of SMA flow in contrast with other more direct measures, the results are similar, demonstrating clearly the compensatory decrease in SMA flow to facilitate redistribution of cardiac output as intensity rose (Osada, 2012) recorded measurements between 15 and 30 min and again at approximately 40 min following 60 min of ergometer cycling. Subjects were resting in the supine position during this time. The delay between cessation of exercise and measurement of SMA flow means that haemodynamics in the immediate period following exercise are not captured. The resulting data are likely to reflect recovery of the splanchnic circulation following exercise rather than adaptations in the acute phase. also measured the resistance index of the SMA in response to 4 min of ergometer cycling in a separate study. Measurements were taken at 14 points during exercise and at 6 points in the first 3 min following exercise. The findings were similar: the resistance index of the SMA was essentially unchanged. These studies contrast both in their methodology and in the timing and calculation of SMA flow, with the former using indirect measures. The consistency of the finding of unchanged flow does suggest that timing alone cannot explain this. The much shorter duration of exercise coupled with the low intensity in the latter study could contribute to this finding (Endo, 2012).

The only disagree study (Eriksen, 1994), reported increased SMA flow during exercise. Flow was measured before, during and after exercise consisting of semi-supine cycling at 50–65 and 150–200 W for 4 min each. Interestingly, their finding of increased SMA flow following exercise in the fasting state is to our knowledge unique. This has not been previously recorded in fasting exercise, only in postprandial exercise. This study was small, with only five participants. Measurements were taken in the final 2 min of the resting, exercise and recovery phases. SMA conductance fell during exercise in the postprandial state, but flow rates were maintained at pre-exercise levels despite this. The authors suggested the short duration of exercise and submaximal intensity may account for their findings. In conclusion, during exercise the rate of blood flow to the muscles andblood viscosity increase, while the splanchnic area reacts by vasoconstriction. All these factors cause a decrease in portal veindiameter, blood flow and increase white blood cells. Exercise in splenectomized individuals can cause serious problems such as decrease in splanchnic blood flow and increase in blood viscosity.

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