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Effect of Leg Massage on Recovery from High Intensity Exercise on Football Players

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Abstract

The study was conducted on fifty two Punjabi University football probable preparing for inter university competition during their training camp held at the Punjabi University, Patiala campus in the years 2006 and 2007. The age range of the subjects was 18-25 years. The players were grouped into the three categories viz. massage group, active group & passive group. The massage group was administered effleurage & kneading massage on calf & hamstring & quadriceps regions of the leg. The active group of footballers was instructed to do a light intensity exercise of 30W during the recovery period of 15 minutes. The third group designated as the passive group was given no intervention during the recovery period. It is concluded from the present study that active and massage interventions applied during recovery following maximal exercise helps the footballers to recover better in terms of heart rate and blood pressure as compared to the passive mode of recovery. Football players exhibit significantly quicker heart rate recovery following leg massage as compared to active and passive mode of recovery. Active mode of recovery on the other hand is observed to help the footballers recover faster in terms of systolic blood pressure as compared to the passive and massage recovery intervention.

Key Words: Massage, Heart Rate, Blood Pressure, Footballers

Massage research has produced equivocal findings in recent years. Some athletes and physiotherapists support claims that massage can aid recovery and optimize performance; however, most of the evidence is anecdotal. Research in the field of sports massage has been flawed by many methodological variations and poor experimental control during the test phase including: inconsistent massage duration, no standardization of warm up, absence of a period of active recovery when comparing massage with other interventions, and often no standardization of physical activity performed preceding the massage. The literature does, to some extent, support psychological benefits from massage *(Hemmings et al, 2000),* but physiological and performance benefits have never been consistently observed. *Cafarelli & Flint (1992)* and *Tiidus (1997)* suggested that, in a practical setting, massage could show performance improvements, but lack of control would devalue the results. Beneficial effects of active recovery after intense exercise are well established *(Weltman, et al, 1979; Dodd et al, 1984 & Ahmadi et al, 1996)* research on the effect of massage on recovery of muscle function should include active recovery of some sort in all phases of the experimental design. To date, only one study has adopted this type of design in attempt to tease out any potential benefits of massage combined with active recovery versus active recovery alone or massage alone *(Monedero and Donne, 2000).* These findings indicate a beneficial effect of a 15 minute combined intervention, compared with active recovery or massage alone, on performance in repeated 5-minute cycle ergometer time trials. These data provide some evidence for the beneficial effect of massage when combined with a short active recovery process; however, the massage was short (7.5 minute), confined to the calf or hamstrings, and no indication of massage protocol or diet/activity control was provided. Furthermore, the main emphasis for an effect of massage in recovery from exercise is focused on improvements in blood flow and lactate clearance *(Cafferelli*

and Flint, 1992). Therefore it appears that there is a need for controlled study incorporating certain aspects of a practical setting (inclusion of a short active recovery period), a more suitable length of massage (20-30 minutes), and greater experimental control (preceding diet and exercise), to assess the potential benefits of massage on lactate clearance and subsequent high intensity exercise capacity/performance. Further more, the literature on the role of massage in increasing blood flow or lactate clearance is equivocal, *(Dolgener, and Morien, 1993; Shoemaker et al 1997; Martin et al 1998 & Monedero and Donne, 2000)* raising a question as to the precise role of massage in short-term recovery. Football playing requires short bursts of intermittent violent muscular actions. Trainers' emphasize on increasing the ability to recover quickly during training of foot ballers. Therefore, different recovery interventions are necessary for footballers to increase blood flow, induce changes in blood flow distribution and improve range of motion. These responses could enhance the clearance rate of Cretine Kinase from the muscle *(Ehlers et al 2002).* There fore the aim of this work was to compare the effects of different recovery interventions like leg massage, passive and active mode of recovery on certain common cardiovascular variables following high intensity cycle ergometer exercise in footballers.

Material & Method

The study was conducted on fifty two Punjabi University football probable preparing for inter university competition during their training camp held at the Punjabi University, Patiala campus in the years 2006 and 2007. The age range of the subjects was 18-25 years. As per the objective of the study, the players were grouped into the three categories viz. massage group, active group & passive group. The massage group was administered effleurage & kneading massage on calf & hamstring & quadriceps regions of the leg. This massage was given for first 3 minutes subsequent to the stoppage of exercise followed by no massage for next three minutes. This cycle was repeated in the subsequent phase of the remaining nine minutes of recovery. The active group of footballers was instructed to do a light intensity exercise of 30W during the recovery period of 15 minutes. The third group designated as the passive group was given no intervention during the recovery period. Mean characteristics of age, weight & height of the three groups are presented in table 1. Statistically speaking there is no difference in age, weight & height among the three groups.

Table 1: Age, weight and height characteristics of three groups of footballers

		Age, Yrs		Weight, Kgs		Height, Meters	
Group	N	Mean	SD	Mean	SD	Mean	SD
Massage	13	19.77	1.83	64.00	5.39	1.72	0.05
Active	23	18.91	1.28	65.43	7.15	1.74	0.07
Passive	16	19.06	1.24	65.00	7.69	1.73	0.04

ANOVA	Statistical Comparison of age, weight and height of three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	6.37	2	3.19	1.58	0.22
	Within Groups	99.07	49	2.02		
	Total	105.44	51			
Height	Between Groups	0.01	2	0.00	0.85	0.44
	Within Groups	0.17	49	0.00		
	Total	0.18	51			
Weight	Between Groups	17.18	2	8.59	0.18	0.84
	Within Groups	2357.65	49	48.12		
	Total	2374.83	51			

Following cardiovascular parameters were measured in all the subjects at rest, during different progressive workloads and different stages of recovery.

- Heart rate in beats/min using Polar heart rate monitor

- Systolic & diastolic components of blood pressure by Ascultatory method using sphygmomanometer & stethoscope

All the subjects were administered progressive workloads on an electrically controlled bicycle ergometer starting from 50W and the load was then increased in steps of 25W every minute until the exhaustion of the subject. Each subject was asked to maintain the pedaling frequency at 60 rpm. After exhaustion, the recovery parameters in terms of heart rate and blood pressure were recorded at intervals of 1 minute for a total period of 15 minutes following maximal exercise for active and passive recovery groups where as for massage groups at interval of 3minute.

Result and Discussion

Table 2: Comparison of mean values of heart rate and blood pressure at rest of three groups of footballers

		Resting Heart Rate (RHR), Beats/Min.		Resting Systolic Blood Pressure (RSBP), mm Hg.		Resting Diastolic Blood Pressure, mm Hg.	
Group	N	Mean	SD	Mean	SD	Mean	SD
Massage	13	70.77	6.95	113.08	4.80	73.08	4.80
Active	23	69.13	7.03	113.04	4.70	73.04	4.70
Passive	16	73.00	6.66	114.06	5.54	73.75	5.00

ANOVA	Statistical Comparison of resting heart rate and blood pressure among three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
Resting heart rate	Between Groups	141.31	2	70.66	1.48	0.24
	Within Groups	2334.92	49	47.65		
	Total	2476.23	51			
Resting Systolic Blood Pressure	Between Groups	11.24	2	5.62	0.23	0.80
	Within Groups	1224.82	49	25.00		
	Total	1236.06	51			
Resting Diastolic Blood Pressure	Between Groups	5.35	2	2.68	0.12	0.89
	Within Groups	1138.88	49	23.24		
	Total	1144.23	51			

Age, weight and height characteristics of three groups of foot balers reveal non-significant differences (Table 1). Mean values of resting heart rate and blood pressure parameters of the three groups of football players are presented in (table 2). Statistically speaking no significant difference in the mean resting value of heart rate, systolic blood pressure and diastolic blood pressure have been observed in football players.

Table 3: Comparison of mean values of exercise heart rates during various workloads among three groups of footballers

	Group	N	Mean	SD
Exercise Heart Rate 50W, Beats/min	Massage	13	144.92	10.33
	Active Recovery	23	144.43	6.52
	Passive Recovery	16	146.31	11.43
Exercise Heart Rate 75W, Beats/min	Massage	13	159.38	10.34
	Active Recovery	23	157.00	6.44
	Passive Recovery	16	159.69	11.26
Exercise Heart Rate 100W, Beats/min	Massage	13	170.31	10.02
	Active Recovery	23	167.26	6.64
	Passive Recovery	16	168.00	10.24
Exercise Heart Rate 120W, Beats/min	Massage	13	177.38	10.02
	Active Recovery	23	177.00	8.06
	Passive Recovery	16	175.50	10.63
Exercise Heart Rate 150W, Beats/min	Massage	13	181.85	8.75
	Active Recovery	23	182.52	9.26
	Passive Recovery	16	179.06	10.29

ANOVA	Statistical Comparison of exercise heart rates during various workloads among three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
Exercise Heart Rate 50W	Between Groups	34.05	2	17.02	0.20	0.82
	Within Groups	4176.01	49	85.23		
	Total	4210.06	51			
Exercise Heart Rate 75W	Between Groups	84.18	2	42.09	0.50	0.61
	Within Groups	4096.51	49	83.60		
	Total	4180.69	51			
Exercise Heart Rate 100W	Between Groups	78.55	2	39.27	0.51	0.60
	Within Groups	3749.20	49	76.51		
	Total	3827.75	51			
Exercise Heart Rate 125W	Between Groups	30.98	2	15.49	0.18	0.84
	Within Groups	4329.08	49	88.35		
	Total	4360.06	51			
Exercise Heart Rate 150W	Between Groups	118.30	2	59.15	0.66	0.52
	Within Groups	4394.37	49	89.68		
	Total	4512.67	51			

Table 4: Comparison of mean values of systolic blood pressure during various workloads among three groups of footballers

	Group	N	Mean	SD
Exercise Systolic Blood Pressure (EXSBP) 50W mm Hg	Massage	13	148.46	6.89
	Active Recovery	23	149.57	7.67
	Passive Recovery	16	151.88	9.11
Exercise Systolic Blood Pressure 75W mm Hg	Massage	13	167.69	8.57
	Active Recovery	23	165.22	7.15
	Passive Recovery	16	167.50	7.75
Exercise Systolic Blood Pressure 100W mm Hg	Massage	13	180.77	6.72
	Active Recovery	23	176.52	6.47
	Passive Recovery	16	179.06	5.54
Exercise Systolic Blood Pressure 125W mm Hg	Massage	13	191.54	6.25
	Active Recovery	23	188.26	4.42
	Passive Recovery	16	190.88	4.50
Exercise Systolic Blood Pressure 150W mm Hg	Massage	13	203.46	6.89
	Active Recovery	23	199.74	3.06
	Passive Recovery	16	200.75	4.04

ANOVA	Statistical Comparison of systolic blood pressure during various Workloads among three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
EXSBP 50W	Between Groups	91.37	2	45.68	0.72	0.49
	Within Groups	3108.63	49	63.44		
	Total	3200.00	51			
EXSBP 75W	Between Groups	72.24	2	36.12	0.61	0.55
	Within Groups	2904.68	49	59.28		
	Total	2976.92	51			
EXSBP 100W	Between Groups	161.07	2	80.54	2.05	0.14
	Within Groups	1924.98	49	39.29		
	Total	2086.06	51			
EXSBP 125W	Between Groups	111.89	2	55.95	2.28	0.11
	Within Groups	1203.42	49	24.56		
	Total	1315.31	51			
EXSBP 150W	Between Groups	116.32	2	58.16	2.79	0.07
	Within Groups	1020.67	49	20.83		
	Total	1136.98	51			

Graded exercise response of subjects in terms of their mean exercise heart rates and systolic blood pressure are observed to reveal increases in these parameters with increase in work intensity but intergroup comparison demonstrate no significant differences at various graded exercise intensities of work load as evaluated by analysis of variance (ANOVA) tests (Figure 1 & 2, Tables 3 & 4).

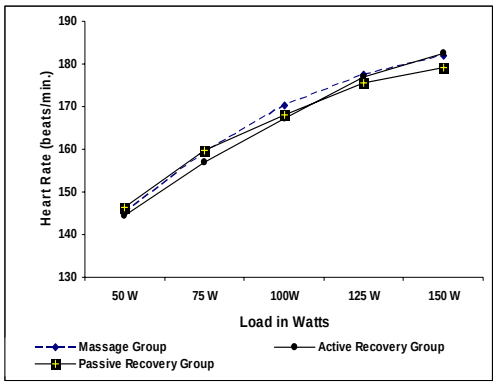

Figure 1: Heart Rate Response to Progressive Exercise in Football Players subjected to different Recovery Interventions

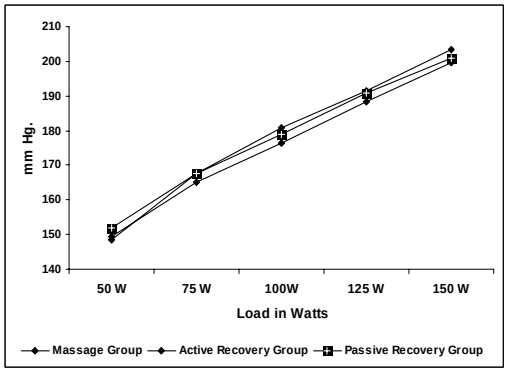

Figure 2: Systolic Blood Pressure Response to Progressive Exercise in Football Players subjected to different Recovery Interventions

Diastolic blood pressure on the other hand exhibit a different pattern of response that is at the initial exercise intensities no statistical significant difference is noticed between the three groups of foot ball players. However, group of foot ball players subjected to active mode of recovery demonstrate a significantly lower diastolic blood pressure in comparison to the other two groups at exercise intensity exceeding 100W (Figure 3 & table 5).

Table 5: Comparison of mean values of diastolic blood pressure during various workloads among three groups of footballers

	Group	N	Mean	SD
Exercise Diastolic Blood Pressure (EXDBP) 50W mm Hg	Massage	13	57.69	3.30
	Active Recovery	23	58.91	2.11
	Passive Recovery	16	58.75	2.89
EXDBP 75W mm Hg	Massage	13	55.00	4.08
	Active Recovery	23	57.17	3.64
	Passive Recovery	16	55.63	4.03
EXDBP 100W mm Hg	Massage	13	52.69	2.59
	Active Recovery	23	56.74	3.88
	Passive Recovery	16	54.06	4.55
EXDBP 125W mm Hg	Massage	13	51.92	3.25
	Active Recovery	23	56.09	4.25
	Passive Recovery	16	53.75	4.65
EXDBP 150W mm Hg	Massage	13	51.54	4.27
	Active Recovery	23	55.43	4.50
	Passive Recovery	16	53.44	5.39

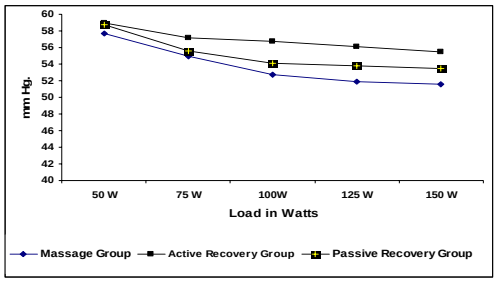

Figure 3: Diastolic Blood Pressure Response to Progressive Exercise in Football Players subjected to different Recovery Interventions

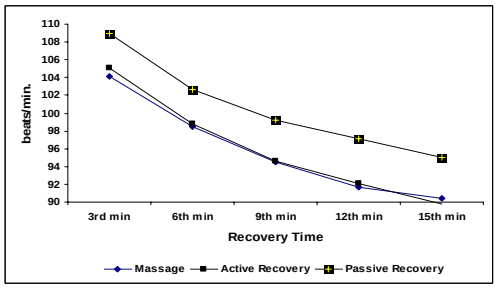

Figure 4 **: Heart Rate Response in Football Players subjected to different Recovery Interventions**

Recovery of the subjects in terms of heart rate and blood pressure have been explored with the employment of three interventions viz leg massage, active sum-maximal exercise (30W) and passive recovery methods. It is interesting to observe that recovery of heart rate was significantly faster in the football group to which leg massage was applied as compared to football players who were given the active and passive modes of recovery interventions (Figure 4 & table 6).

Table 6: Comparison of mean values of heart rate during different point of time of recovery following maximal exercise among three groups of footballers

	Group	N	Mean	SD
Recovery Heart Rate (RECHR) 3rd min Beats/min	Massage	13	104.15	4.71
	Active Recovery	23	105.13	5.69
	Passive Recovery	16	109.00	6.49
RECHR 6th min Beats/min	Massage	13	98.46	4.43
	Active Recovery	23	98.78	4.59
	Passive Recovery	16	102.63	5.51
RECHR 9th min Beats/min	Massage	13	94.46	4.29
	Active Recovery	23	94.57	4.14
	Passive Recovery	16	99.25	4.65
RECHR 12th min Beats/min	Massage	13	91.69	3.88
	Active Recovery	23	92.04	3.67
	Passive Recovery	16	97.13	3.77
RECHR 15th min Beats/min	Massage	13	90.38	4.11
	Active Recovery	23	89.74	3.28
	Passive Recovery	16	95.00	2.39

ANOVA	Statistical Comparison of recovery heart rates during different Point of time of recovery among three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
RECHR 3rd min	Between Groups	205.4	2	102.7	3.1	**0.05**
	Within Groups	1610.3	49	32.9		
	Total	1815.7	51			
RECHR 6th min	Between Groups	174.4	2	87.2	3.7	**0.03**
	Within Groups	1154.9	49	23.6		
	Total	1329.3	51			
RECHR 9min	Between Groups	247.1	2	123.6	6.6	**0.00**
	Within Groups	923.9	49	18.9		
	Total	1171.0	51			
RECHR 12th min	Between Groups	301.5	2	150.8	10.7	**0.00**
	Within Groups	691.5	49	14.1		
	Total	993.0	51			
RECHR 15th min	Between Groups	283.5	2	141.7	13.2	**0.00**
	Within Groups	525.5	49	10.7		
	Total	809.0	51			

Scheffe Post Hoc Test Comparisons

Parameter	Group 1	Group 2	Mean Difference (Group 1- Group 2)	Standard Error	Sig
RECHR 3rd min	Massage	Active	-0.98	1.99	0.89
		Passive	-4.85	2.14	0.09
	Active	Massage	0.98	1.99	0.89
		Passive	-3.87	1.87	0.13
	Passive	Massage	4.85	2.14	0.09
		Active	3.87	1.87	0.13
RECHR 6th min	Massage	Active	-0.32	1.68	0.98
		Passive	-4.16	1.81	0.08
	Active	Massage	0.32	1.68	0.98
		Passive	-3.84	1.58	0.06
	Passive	Massage	4.16	1.81	0.08
		Active	3.84	1.58	0.06
RECHR 9th min	Massage	Active	-0.10	1.51	1.00
		Passive	-4.79	1.62	**0.02**
	Active	Massage	0.10	1.51	1.00
		Passive	-4.68	1.41	**0.01**
	Passive	Massage	4.79	1.62	**0.02**
		Active	4.68	1.41	**0.01**
RECHR 12th min	Massage	Active	-0.35	1.30	0.96
		Passive	-5.43	1.40	**0.00**
	Active	Massage	0.35	1.30	0.96
		Passive	-5.08	1.22	**0.00**
	Passive	Massage	5.43	1.40	**0.00**
		Active	5.08	1.22	**0.00**
RECHR 15th min	Massage	Active	0.65	1.14	0.85
		Passive	-4.62	1.22	**0.00**
	Active	Massage	-0.65	1.14	0.85
		Passive	-5.26	1.07	**0.00**
	Passive	Massage	4.62	1.22	**0.00**
		Active	5.26	1.07	**0.00**

It is pertinent to mention here that the differences related to heart rate recovery assume statistically significant proportion during the later past of recovery i.e. from 9-15 minute of recovery following maximal exercise. In case of recovery of systolic blood pressure, the picture is different in the sense that foot ball players who were given sum-maximal exercise during recovery (active group) demonstrated significantly lower blood pressure as compared to those footballers who were given leg massage or passive mode of recovery intervention (fig 5 & table 7).

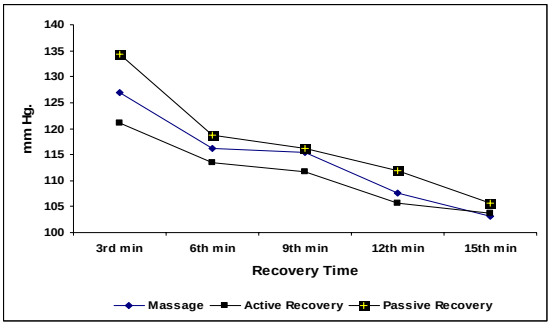

Figure 5 Systolic Blood Pressure Response in Football Players subjected to different Recovery Interventions

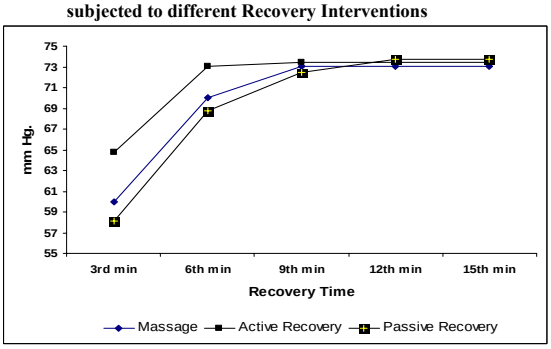

Figure 6 Diastolic Blood Pressure Response in Football Players subjected to different Recovery Interventions

Table 7: Comparison of mean values of systolic blood pressure during different point of time of recovery following maximal exercise among three groups of footballers

	Group	N	Mean	SD
Recovery Systolic Blood Pressure (RECSBP) 3rd min	Massage	13	126.92	3.84
	Active Recovery	23	121.09	4.25
	Passive Recovery	16	134.38	5.12
RECSBP 6th min	Massage	13	116.15	5.06
	Active Recovery	23	113.48	4.87
	Passive Recovery	16	118.75	3.42
RECSBP 9th min	Massage	13	115.38	5.19
	Active Recovery	23	111.74	6.50
	Passive Recovery	16	116.25	5.00
RECSBP 12th min	Massage	13	107.69	4.39
	Active Recovery	23	105.65	5.90
	Passive Recovery	16	111.88	4.03
RECSBP 15th min	Massage	13	103.08	4.80
	Active Recovery	23	103.70	4.58
	Passive Recovery	16	105.63	5.12

ANOVA	Statistical Comparison of recovery of systolic blood pressure during different point of time of recovery among three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
RECSBP 3rd min	Between Groups	1667.56	2	833.78	42.18	**0.00**
	Within Groups	968.50	49	19.77		
	Total	2636.06	51			
RECSBP 6th min	Between Groups	264.80	2	132.40	6.46	**0.00**
	Within Groups	1004.43	49	20.50		
	Total	1269.23	51			
RECSBP 9th min	Between Groups	223.41	2	111.71	3.36	**0.04**
	Within Groups	1628.51	49	33.24		
	Total	1851.92	51			
RECSBP 12th min	Between Groups	367.96	2	183.98	7.27	**0.00**
	Within Groups	1239.74	49	25.30		
	Total	1607.69	51			
RECSBP 15th min	Between Groups	54.52	2	27.26	1.18	0.32
	Within Groups	1131.54	49	23.09		
	Total	1186.06	51			

Schaeffe Post Hoc Test Comparisons

Parameter	Group 1	Group 2	Mean Difference (Group 1- Group 2)	Standard Error	Significance
RECSBP 3rd min	Massage	Active	5.84	1.54	**0.00**
		Passive	-7.45	1.66	**0.00**
	Active	Massage	-5.84	1.54	**0.00**
		Passive	-13.29	1.45	**0.00**
	Passive	Massage	7.45	1.66	**0.00**
		Active	13.29	1.45	**0.00**
RECSBP 6th min	Massage	Active	2.68	1.57	0.24
		Passive	-2.60	1.69	0.32
	Active	Massage	-2.68	1.57	0.24
		Passive	-5.27	1.47	**0.00**
	Passive	Massage	2.60	1.69	0.32
		Active	5.27	1.47	**0.00**
RECSBP 9th min	Massage	Active	3.65	2.00	0.20
		Passive	-0.87	2.15	0.92
	Active	Massage	-3.65	2.00	0.20
		Passive	-4.51	1.88	0.07
	Passive	Massage	0.87	2.15	0.92
		Active	4.51	1.88	0.07
RECSBP 12th min	Massage	Active	2.04	1.75	0.51
		Passive	-4.18	1.88	0.09
	Active	Massage	-2.04	1.75	0.51
		Passive	-6.22	1.64	**0.00**
	Passive	Massage	4.18	1.88	0.09
		Active	6.22	1.64	**0.00**

Recovery in case of diastolic blood pressure in general reveal no statistical difference among the three groups of footballers except the massage group where the diastolic blood pressure was observed to remain significantly lower in comparison to the active and passive groups (table 8).

Table 8: Comparison of mean values of diastolic blood pressure during different point of time of recovery following maximal exercise among three groups of footballers

	Group	N	Mean	SD
Recovery Diastolic Blood Pressure (RECDBP) 3rd min	Massage	13	60.00	0.00
	Active Recovery	23	64.78	5.11
	Passive Recovery	16	58.13	3.59
RECDBP 6th min	Massage	13	70.00	0.00
	Active Recovery	23	73.04	4.70
	Passive Recovery	16	68.75	8.85
RECDBP 9th min	Massage	13	73.08	4.80
	Active Recovery	23	73.48	4.87
	Passive Recovery	16	72.50	6.83
RECDBP 12th min	Massage	13	73.08	4.80
	Active Recovery	23	73.48	4.87
	Passive Recovery	16	73.75	5.00
RECDBP 15th min	Massage	13	73.08	4.80
	Active Recovery	23	73.48	4.87
	Passive Recovery	16	73.75	5.00

ANOVA	Statistical Comparison of recovery of diastolic blood pressure during different point of time of recovery among three groups of footballers					
		Sum of Squares	df	Mean Square	F	Sig.
RECDBP 3min	Between Groups	**459.26**	2	229.63	14.66	**0.00**
	Within Groups	767.66	49	15.67		
	Total	1226.92	51			
RECDBP 6min	Between Groups	189.97	2	94.98	2.80	0.07
	Within Groups	1661.96	49	33.92		
	Total	1851.92	51			
RECDBP 9min	Between Groups	9.03	2	4.52	0.15	0.86
	Within Groups	1498.66	49	30.59		
	Total	1507.69	51			
RECDBP 12min	Between Groups	3.26	2	1.63	0.07	0.93
	Within Groups	1173.66	49	23.95		
	Total	1176.92	51			
RECDBP 15min	Between Groups	3.26	2	1.63	0.07	0.93
	Within Groups	1173.66	49	23.95		
	Total	1176.92	51			

Scheffe Post Hoc Test Comparisons

Parameter	Group 1	Group 2	Mean Difference (Group 1- Group 2)	Standard Error	Sig
RECDBP 3rd min	Massage	Active	-4.78	1.37	**0.00**
		Passive	1.88	1.48	0.45
	Active	Massage	4.78	1.37	**0.00**
		Passive	6.66	1.29	**0.00**
	Passive	Massage	-1.88	1.48	0.45
		Active	-6.66	1.29	**0.00**

The findings of the study reveal that massage and active modes of interventions during following maximal exercise helps the footballers to attend the physiological restoration more quickly and faster as compared to passive mode of recovery.

An active recovery (i.e. 30- 40% of VO_2 max.) has been shown by many investigators to promote faster clearance of blood lactate when undertaken after high- intensity exercise *(Thiriet, et al, 1993, Billat, 2001).* Further more an active recovery has also been reported to improve power output recovery during subsequent exercise bout in most studies *(Thiriet et al, 1993; Bogdanis et al, 1995; Connolly et al, 2003).* According to *Poliner et al (1993)*, left ventricular end-diastolic volume increases largely because of the return of blood to the heart by the active muscle pump and the increased sympathetic out flow to the veins causing vasoconstriction and augmenting venous return. Left ventricular end-systolic volume decrease because of augmented contractility of the heart, which eject more blood from the ventricle and leaves less in the ventricle. As per this notion, the systolic blood pressure during active recovery should exhibit higher values as compared to other modes of exercise interventions. But in the present study the results are contrary indicating that systolic blood pressure tends to remain significantly lower during active mode of recovery in comparison to the passive and massage intervention groups. The probable reason may be long duration of very low intensity of exercise load of 30W given to the subjects during recovery as compared to other studies where the load was 30 to 40% of their VO_2 max and for short duration.

Massage intervention during recovery was observed to successfully keep the diastolic blood pressure significantly lower in footballers as compared to other modes of recovery intervention. Diastolic blood pressure is the outcome of the balance of vasodilatation in the vasculature of the active muscle and vasoconstriction in other vascular beds. It is visualized that massage applied to the leg region may have resulted in opening of more vascular beds and thus favored vasodilatation resulting in lowering of diastolic blood pressure. In addition the application of leg massage may have contributed to increase in temperature causing dilatation of skin vessels and decrease in resistance to blood flow.

Conclusion

It is concluded from the present study that active and massage interventions applied during recovery following maximal exercise helps the footballers to recover better in terms of heart rate and blood pressure as compared to the passive mode of recovery. Football players exhibit significantly quicker heart rate recovery following leg massage as compared to active and passive mode of recovery. Active mode of recovery on the other hand is observed to help the footballers recover faster in terms of systolic blood pressure as compared to the

passive and massage recovery intervention.

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