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# Effect of Compression Modalities for Recovery on Wrestlers Biomarkers in One Day Tournament

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***Abstract***

*Aim: investigate the effect of different compression modalities as to recovery enhancement on some biomarkers in wrestlers.*

*Methods: Serum creatinine, lactic acid and glucose level were tested in elite wrestlers before match up, 3minuts post-match up and 19 minutes after applying recovery compression model.*

*Results: showed insignificant differences between pre-post 3min tests, among research groups due to sample equality, 3min and 19min post match up tests showed efficacy of compression technique in enhancing recovery in sake of 160/20 mmHg compression modality with enhancement percentage of 16.614% for serum creatinine, 43.214% for lactic acid and 22.505% for glucose level.*

*Conclusion: compression band with 160/20 mmHg exceeds recovery after match up*

***Keywords:*** *Compression modalities, recovery, wrestling, serum creatinine "SCR", lactic acid "LA", glucose level "GL"*

## Introduction

Fatigue has been investigated in different sports to theorize its classification. Mechanical fatigue can be realized as a decline in muscle strength or efficiency, psychological fatigue states tiredness, perception, and low cognitive function. The physiological fatigue occurs in insufficient blood flow to the working tissue and weakening muscle contraction. Fatigue also restrains nervous activation and metabolism some fatigue can be controlled by passive recovery, but muscular fatigue is complicated with extended effect (1-4), especially in the maximal power when measured immediately after the fatiguing performance (5-7). Scientists claim lactic acid production as prior factor of fatigue, resulting of severe exercise, but there is a growing interest of studying other metabolic byproducts causing fatigue (7,8). The impact of fatigue on athlete's achievement actuates scientists to monitor training loads, recovery duration and modality (1,9).

Proper recovery aims restoration of physiological and psychological excellence, so that the athlete can compete or continue training in an optimal level depending on the exercise nature.

Compression techniques of recovery vary in application and effect, Ischemic reconditioning (IPC) consists of repeated cycles of vascular occlusion with high pressure cuff applied on upper or lower limbs, followed by reperfusion in which pressure in the cuff is gradually released. IPC is known to improve vasodilation, oxygen utilization muscle function, and enhance exercise performance (10).

Compression garments are one of the recovery applications which apply a graduated compression on the limbs from proximal to distal. Compression pressure of a garment reduces the intramuscular space available for swelling and promotes stable alignment of muscle fibers (11,12).

IPC improves muscle blood flow, oxygen delivery which induces lactate removal from intra and extracellular formation during exercise (13-15).

Periodic cycles of ischemic compression followed by gradual reperfusion, enhance molecular, vascular adaptations and magnify muscular blood flow (16,17).

Compression technique used in recovery of post-exercise fatigue helps ceasing inflammatory responses, reduces

delayed onset muscle soreness and accelerates recovery process period (18,19).

High intensity exercise especially eccentric muscle contraction results high circulating creatinine (20), related to the athletes muscle size, fiber type, and exercising duration (21).

Hematological biomarkers have been proven validity for the quantifying and monitoring training load throughout a training period (22).

Whole blood or plasma creatinine and estimated glomerular filtration rate are particularly increased in strength sports, while creatinine kinase (CK) may be elevated during acute changes in training load, However the intra and inter-individual variations within the same or different seasons. The effect of exercise on biomarker levels have lack of reference values, as well as compression modality in post exercise recovery still a matter of study (23-25).

Wrestling is a part of poly-structural cyclic sports. Wrestling matches are classified as maximal and submaximal intensity performance. The energy expenditure in wrestling is very complex, that composed of anaerobic glycolytic pathways occurs during sudden, explosive throws or lifting (26).

From above reading; Varieties of compression modalities had been investigated as their effect in enhancing recovery, eliminating biomarkers of fatigue as serum creatinine, lactic acid and restoring glucose level, but never has a certain procedure in estimating pressure or location of the compression so the researchers aimed to establish a new compression modality and investigate its effect on serum creatinine, lactic acid clearance, and glucose level.

**Materials and Methods:**

Experimental method had been used to investigate the effect of three compression modalities on lactic acid clearance, serum creatinine and Glucose level in blood using pre- post-test.

**Samples:**

Twenty four elite wresters participated in this study aged between (18-23) weighted (82-87) from registered Egyptian federation players, sample divided in to 4 groups (control- experimental (Exp1)- experimental (Exp2)- experimental (Exp3), each group contain 6 players, 12 players intentionally played in each official weigh, Table (1) describing homogenous of the sample.

**Table (1)**
**Means, standard deviation and variance of sample groups in research variables**

| var | CONT | | | Exp1 | | | Exp2 | | | Exp3 | | | Hartly |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | ±SD | v | M | ±SD | v | M | ±SD | v | M | ±SD | v | |
| SCR | 1.080 | 1.175 | 0.044 | 1.130 | 1.115 | 0.015 | 1.093 | 1.095 | 0.021 | 1.092 | 1.100 | 0.032 | 2.976 |
| LA | 2.500 | 2.500 | 0.200 | 2.483 | 2.500 | 0.222 | 2.633 | 2.700 | 0.127 | 2.617 | 2.700 | 0.138 | 1.750 |
| GL | 128.500 | 128.500 | 19.500 | 127.333 | 128.000 | 11.467 | 127.167 | 126.500 | 47.367 | 128.833 | 129.000 | 25.367 | 4.131 |

Table (1) showed homogenous of research group where significance 4,5 F at 0.05 =13.7. Variance differences were insignificant according to Hartly test

**Measurements:**

Venous Blood samples were taken from players before playing the match, after playing the customized match as officially organized matches, with 3 minutes and 19 minutes with-without applying compression modality for post-match recovery. Measurements were serum creatinine, lactic acid and glucose. Samples preserved in acutainers, till sent to medical lab to be analyzed.

Serum creatinine "SCR":

Serum creatinine is one of health biomarkers which states athlete's responses to physical performance, especially in exhaustive performance that produces high loss of hydro electrolytes. High training workload and psychophysical stress from competitions may modify their homoeostasis, inducing apparently pathological biochemical and haematological values. Therefore definition of the behavior of creatinine (27,28), where exercise will acutely change serum creatinine level depending on the severity and duration of exercise, as well as on the age of athletes (29).

Serum creatinine concentrations higher than those measured in age matched sedentary subjects. This finding may be linked to the average higher muscle mass of athletes, because total muscle mass is the most important determinant of the creatinine pool size and of creatinine production (30). Exercise-induced changes in creatinine

levels which are transient and promptly normalize during recovery (29).

Lactic acid "LA":

Lactic acid is an important marker of fatigue (31-33), blood Lactate level directly after exercise varies depending on the time at which it was sampled,the mode of exercise and sample site. Blood samples are affected by recovery where lactate reading differs by time up to twenty-five minutes post exercise. Training has also proven to increase the rate at which lactate is removed after aerobic and anaerobic exercise (9,34).

Glucose "GL":

Physical training enhances insulin-stimulated glucose disposal in proportion to the improvement in physical fitness (35,36)

Physical training is known to improve insulin sensitivity, both immediately post-exercise and through multiple long-term adaptations in glucose transport and metabolism (37).

However in contrast, strenuous exercise is known to increase circulating concentrations of catecholamines, such as adrenalin and noradrenaline, to near pathological levels, resulting in hyperglycemia and hyper insulinemia post–intense exercise (38,39).

Lactic acid, Serum Creatinine and glucose level were investigated among several sports players, where little is known about their profile during a wrestling competition. Venues Blood samples were collected, maintained in acutainers, inside ice box till handled to medical lab of Tanta. Samples collected from arm vein where closer to active muscle in wrestling arm performances, referring to previous study of (Comeau et. al 2011) (40) that declared Sampling blood lactate from sites that are not close to the working muscle could result in inaccurate blood Lactate level due to the pooling of lactate in areas of inactive muscles.

**Main protocol:**

**Pilot study:** pilot study was carried out on 2 wrestlers to investigate the utility of the equipment and assistants needed, where the researchers decided to have two lab experts to ensure the blood collecting process speed.

**Main study:** Main experiment carried out in September 2018, and within two days. Customized match conditions as, morning breakfast 2 hours before experiment and contained (200ml orange juice- two bananas, cake slice), No further food supplies tell the end of the 19min post match test. 3 blood samples of 3cm (first thing in the morning before players wormed up, after 3min post match and 19min post match, with-without applying compression modality for recovery).

Players underwent wrestling matches with two rounds with 3 minutes each, intermittent rest of 30 seconds with confirmed condition manipulation of ( eliminating the shoulder touch down(OUTO touch), neglecting the score superiority(super URTY), matching underwent the whole timing of 6min with 30sec intermittent rest ). The international official (UWW) organized the first round matches 3-4 matches with intermitted rest between in international matches is 20 minutes. Every two groups wrestled each other randomly according to weight.

After 3min post match, players were classified into four groups, players of group (control) didn't apply any recovery method (passive recovery).

Group (Exp1) applied intermittent compression band (inflator cuff) for 14 minutes with interval 2minutes compression, then 2minutes release. Compression was 160 mm Hg (mercuric pressure), with gradual release up to 20 mm Hg

Previous studies varied in their compression pressure, compression sites, upper limb or lower limb, single or duple site occlusion and compression tactics.

(San Millán I., et al.) (41) used MMC devise on feet with intervals of pressure and gradual release, (Kraus A., et al. 2015) (42), used an automated inflatable cuff (E20 Rapid Cuff Inflator) four, 5 min episodes of RIPC treatment followed each by 5 min of reperfusion.

Group (Exp2) applied intermittent compression band (inflator cuff) for 14 minutes with interval 2 minutes compression, then 2minutes release. Compression was 120 mm Hg (mercuric pressure), with gradual release up to 20 mm Hg.

Group (Exp3) applied IPC device, arm cuff for 15 minutes.

Previous study of (Hanson E. 2013) (43) emphasized that using IPC for recovery was faster especially after a multitude of competition, (Jones M. 2016) (44) used graduated low-pressure 20:15:10 mmHg IPC use and graduated high-pressure 70:65:60 mmHg IPC. (Waller et al 2006) (45) Utilized the IPC as a recovery modality with graduated low-pressure (20 mmHg) IPC use, and graduated high-pressure (70 mmHg) IPC. (Winke M. and Williamson Sh. 2018) (46), also demonstrated intermittent pressure- release with 100 mmHg.

## Statistical procedures

Statistical analyses were performed using SPSS software. All data are reported as means, SD "standard deviation", ANOVA "analysis of variance", LSD "least significant differences" and enhancement percentage, were assumed at P<0.05. Experimental method four groups using 1pre test and 2 post tests.

## Results

Analytic treatment of research data resulted differences among the four research groups, table(2) represents the means, LSD and enhancement percentage of the pre- tests of the research variables" Serum Creatinine SCR", "Lactic acid LA" and "Glucose GL" of the four research groups "control cont.", " Experimental 1 Exp1", "Experimental 2 Exp2" and "Experimental 3 Exp3"

**Table (2)**
**Means, LSD and enhancement percentage of the pre-tests of the four research groups**

| No | var | cont | | | Exp1 | | | Exp2 | | | Exp3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SCR | LA | GL | SCR | LA | GL | SCR | LA | GL | SCR | LA | GL |
| means | Pre | 1.080 | 2.500 | 128.500 | 1.130 | 2.483 | 127.333 | 1.093 | 2.633 | 127.167 | 1.092 | 2.617 | 128.833 |
| | Post3min | 1.232 | 20.200 | 72.000 | 1.298 | 20.433 | 74.500 | 1.292 | 20.017 | 72.500 | 1.307 | 20.400 | 73.833 |
| | Post19min | 1.245 | 15.350 | 85.167 | 1.053 | 8.717 | 104.333 | 1.210 | 11.817 | 91.333 | 1.228 | 12.150 | 90.167 |
| LSD | | 0.216 | 1.899 | 6.642 | 0.127 | 1.039 | 4.776 | 0.129 | 1.863 | 5.607 | 0.170 | 2.053 | 4.905 |
| F | | 1.6329 | 210.573* | 179.842* | 8.8672* | 697.951* | 279.245* | 5.193* | 197.685* | 222.698* | 3.712* | 170.592* | 213.012* |
| P value | | 0.112 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Enhancement percentage | | pre | Post 3min | Post 19min | pre | Post 3min | Post 19min | pre | Post 3min | Post 19min | pre | Post 3min | Post 19min |
| SCR | pre | | 14.043 | 15.278 | | 14.897 | 6.814 | | 18.140 | 10.671 | | 19.695 | 12.519 |
| | Post 3min | | | 1.083 | | | 18.896 | | | 6.323 | | | 5.995 |
| | Post 19min | | | | | | | | | | | | |
| Lactic | pre | | 708.000 | 514.000 | | 722.819 | 251.007 | | 660.127 | 348.734 | | 679.618 | 364.331 |
| | Post 3min | | | 24.010 | | | 57.341 | | | 40.966 | | | 40.441 |
| | Post 19min | | | | | | | | | | | | |
| Glucose | pre | | 43.969 | 33.722 | | 41.492 | 18.063 | | 42.988 | 28.178 | | 42.691 | 30.013 |
| | Post 3min | | | 18.287 | | | 40.045 | | | 25.977 | | | 22.122 |
| | Post 19min | | | | | | | | | | | | |

**P value < 0.05, F value at 2,15 and significance 0.05=3.68**

**Table (3)**
**ANOVA, LSD and enhancement percentage of the post-tests among research four groups**

| Var | groups | Means | Enhancement perc. | | | | MD | | | | LSD | F | P Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cont. | Exp1 | Exp2 | Exp3 | Cont. | Exp1 | Exp2 | Exp3 | | | |
| SCR | Cont. | 1.245 | | 15.395 | 2.811 | 1.339 | | *0.192↑ | 0.035 | 0.017 | 0.114 | *5.477 | 0.001 |
| | Exp1 | 1.053 | | | 14.873 | 16.614 | | | *0.157→ | *0.175→ | | | |
| | Exp2 | 1.210 | | | | 1.515 | | | | 0.018 | | | |
| | Exp3 | 1.228 | | | | | | | | | | | |
| LA | Cont. | 15.350 | | 43.214 | 23.018 | 20.847 | | 6.633 | *3.533↑ | *3.200↑ | 0.580 | *189.888 | 0.00 |
| | Exp1 | 8.717 | | | 35.564 | 39.388 | | | *3.100→ | *3.433→ | | | |
| | Exp2 | 11.817 | | | | 2.821 | | | | 0.333 | | | |
| | Exp3 | 12.150 | | | | | | | | | | | |
| GL | Cont. | 85.167 | | 22.505 | 7.241 | 5.871 | | 19.167 | *6.167↑ | *5.000↑ | 3.886 | *38.469 | 0.00 |
| | Exp1 | 104.333 | | | 12.460 | 13.578 | | | *13.000→ | *14.167→ | | | |
| | Exp2 | 91.333 | | | | 1.277 | | | | 1.167 | | | |
| | Exp3 | 90.167 | | | | | | | | | | | |

**P value < 0.05, F value at 3,20 and significance 0.05=3.01**

## Discussion

Recent research aimed investigating different compression modalities on wrestler's recovery after customized wrestling match. Different compression modalities showed significant differences towards enhancement of post performance recovery, varied by the recovery procedure. Pre matching tests showed no differences owing to the homogeneity of the wrestler's performance level and BMI. 3minutes post match tests showed little differences with insignificance, thus for the previous reason. 19minutes post match tests taken after application of different recovery modalities, sowed varied readings with significant differences between experiment groups and control.

The concentration of serum creatinine is a reliable indicator of renal function in medicine research (30). Serum creatinine positively responses to physical exercise, and vary according to sample age, exercise intensity and duration (29).

In recent study Serum creatinine resulted dramatic increase in 3minutes post match test ranging 1.23-1.30 mg/dL. That may indicates subclinical muscle disease, where training loads may evidence through the onset of profound fatigue as in the study of (Brancaccio P., et al 2007) (47).

Our finding matched the study of (Papassotiriou I., et al 2018, Gill N. et al 2005) (48,49) that emphasized higher excretion of serum creatinine in 70% of the athletes according to athlete's body mass especially in wrestlers, while athletes with lower creatinine concentrations presumed albumin abnormality.

(Fragala M., et al 2017) (24) Proven that strength exercise was associated with higher levels of creatinine, where physical performance compels athlete's muscles to process high amounts of creatine which produce higher levels of serum creatinine.

19minutes post match creatinine test, after applying 3 different recovery modality, results among groups showed insignificant differences between (cont.) and (exp3) group which declares compression modality of (IPC) was little influence than passive recovery, significant differences between exp(1,2) and (cont.) groups differed according to the recovery modality, with recovery of creatinine clearance in sake of the (exp1) with mean (1.03 mg/dL), showing the superiority of (160/20 mm Hg) compression modality. (Exp2) with (140/20 mm Hg) modality showed significant difference to (cont.) group and with (exp1) in sake of (exp1), Where enhancement percentages were (16.614 %, 15.395% and 14.873%) between (exp1, epr2 and exp3) respectively.

Creatinine clearance after match up in wrestling in essential for wrestlers to continue match up in preparation phase or in finals, using recovery modality to shorten the recovery period.

Our finding matching the studies of (Papassotiriou I. and Nifli A. 2018, Brancaccio P 2007, Fallon KE, et al 1999, Hortobagyi T., et al 1989) (47,49-51) that resting creatinine levels are higher in athletes especially wrestlers.

Creatinine clearance induced by using compression modality which previously studied in studies of (Comerota A. and Aziz F. 2009, Chase J., et al 2017, Deschênes P., et al 2017,Lopes T., et al 2018, Thorpe R. 2017)(9,52-55) emphasizing on the validity of compression modalities in enhancing limb vasculature, blood circulation, oxidation and post exercise recovery.

Lactic acid is the product of the anaerobic breakdown of glucose in tissues. While earlier research demonstrated that lactate was a waste product and a cause of acidosis, new findings have shown that lactate not only does not cause acidosis (56) but it is also a very useful carbohydrate in times of increased energy demand (57). Competitive fight particularly depends on the capacity of maximum mobilization of anaerobic lactic energy (58). The anaerobic system provides the short, quick bursts of maximal power during the match while the aerobic system contributes to the wrestler's ability to sustain effort for the duration of the match (59).

Pre match up lactic acid test was normal range for all research groups with range of "1.9-3.0" mmol·L. Recent data matched the studies of (Kraemer et al., 2001; Mahdi, 2007) (33,60) showed resting state lactate concentrations before warm up between 1.7 mmol·L -1 to 2.6 mmol·L -1.

3 minutes post match up, lactate test was raised for all research groups, due to the anaerobic nature of wrestling match performance. Readings differences were insignificant among groups as the likelihood of training experience, readings ranged "20.017-20.433 mmol·L", matching the study of (Karninčić H., et al 2009, Utter A. et al 2002) (34,61) were post match test ranged "17.1 to 20.0 mmol·L".

19minutes post match up, lactic acid test, varied in the four research groups with minimal insignificant change in (cont) group where passive recovery didn't record lactate clearance matching the study of (Jemni M. 2003)(62)

Significant differences among the experimental groups. Compression modalities showed remarkable attitude in lactate recovery with enhancement percentage of (43.214, 39.388, 35.564) between (exp1, exp2, exp3) respectively. Highest enhancement was in sake of (exp1) with mean of (8.717 mmol·L) emphasizing on the role of intermittent compression pressure in lactate recovery. Our finding matches the studies of (Hanson E. et al 2013, Barbas I. et al 2011, Sharma L. and Verma S. 2017, Baker S. and King N. 1991) (43,63-65).

Glucose is a master nutrient of body organs especially organs of nervous system, insulin and glucagon hormones are the moderators of blood glucose "hyperglycemic and hypoglycemic actions" to normal range in order to keep body systems out of danger (66).

3 minutes post match up, glucose test recorded high reduction in all research groups, due to the high anaerobic exertion of wrestling match performance. Readings differences were insignificant among groups as the likelihood of training experience, readings ranged "72-74.5mg/dl" where Reductions in blood glucose levels have been associated with fatigue matching the studies of (Abernethy P. and Eden B. 1992, Costill DL and Hargreaves M. 1990, Goodwin M. 2010) (37,67,68)

19 minutes post match up, glucose test, recorded high increase in glucose level, matching the study of (Hermansen L. et al 1970) (69) which emphasized the great increase in glucose level responding to maximal exercise performance. That increase in blood glucose deduced in the study of (Coker RH and Kjaer M. 2005) (70) to be an immediate release of glucose from the liver.

Glucose increase varied in the four research groups enhancement percentage of (22.50, 13.578, 12.460) between (exp1, exp2, exp3) respectively with high significance in sake of (exp1) with mean (104.333 mg/dl) showing the efficacy of the compression modalities in increasing the muscle blood pooling, matching the study of (Goodwin M. 2010, Khayat ZA et al 2002, Richter EA et al 2002) (68,71,72) that exercise and hypoxia (resembled in occlusion procedure in recent study) induce glucose increase.

Exhaustive bout of wrestling performance represented in recent customized match and hyperemic effect of occlusion- perfusion, recovery modality coincided with the previous finding of (Flunkey JD et al 1994, Henriksson J. 1995) (73,74) where the reduction in muscle glycogen is an important factor of increasing insulin sensitivity in the post exercise.

In (Adams P. 2015) (75) study declared that the high increase in blood glucose lasts up to 1 hour Leading to Plasma insulin levels rise, correcting the glucose level and restoring muscle glycogen.

The recovery modalities applied in recent study proved their effectiveness in recovery improvement especially with the dietary restriction condition. The utilization of these different modalities differs by the compression pressure level and the technique of inflation-deflation sequence. The idea of these modalities depends on manipulating blood flow speed and volume, flushing out muscles fatigue products as lactic acid which examined in this research and enhance recovery especially in wrestling matches where multiple performances exerted. These kinds of compression modalities had been used in BFR

training technique where manipulating blood flow, increase anaerobic function of muscles and enhance rehabilitation, as in studies of (Kraus A. et al 2015, McNeil C. 2015, Slysz J 2016, Hughes L. 2017, Ghoraba M. et al 2017) (42,76-79)

## Conclusion

Compression modalities used in post exercise recovery with different pressure level and technique as used in this study showing superiority of high pressure with 160-20 mmHg which accelerated recovery time due to its hyperemic effect of the perfusion. This technique should be used in regard to the athletes muscularity and blood pressure "systolic and diastolic numbers" with high concern to nerves safety as (Tschakovsky et al., 2004) (80) regarded that peripheral nervous system likely played a role in vasodilation along with compression effect of increasing oxygenation. however (Labropoulos, N. et al., 2010) (81) emphasized that higher pressure produced a greater increase in blood flow as well as quicker acceleration of blood flow, there isn't fixed value for compression level so far and it is still a matter of research.

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