Impacts of Compound Liquid Supplement on the Sport Performance of Female Weightlifters

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Abstract

Discussion on the impacts of four compound water solutions of different compositions on the liquid retention rate, conformity of gastrointestinal tract, blood value and anaerobic power orally taken after severe dehydration of female weightlifters. Cross-over design method shall be adopted to respectively supplement low osmotic pressure electrolyte solution (HES), isometric pressure electrolyte solution (IES), sports beverage (SB) or water (W) equaling to 1.5 times of dehydrating amounts to 12 female weightlifters after they dehydrated by 2% of their weight, and to record related indexes of rehydration at the time of 30minutes, 60minutes and 90minutes and the indexes at the time after dehydration. Results showed that 1) At the time of 90 minutes of rehydration, the conformity of gastrointestinal tract after supplementing HES, IES and SB is significantly lower than supplementing W; 2) The blood glucose values of supplementing three solutions at the time of 60 minutes during rehydration period were significantly higher than that of W; 3) The serum potassium values of supplementing HES at the time of 120 minutes during rehydration period; and 4) There is no significant difference of the anaerobic power and liquid retention rate after supplementing the four solutions. The findings of this study revealed that weightlifters orally taking the four solutions after acute dehydration would not influence the anaerobic power after rehydration, but carbohydrate solutions and electrolyte solutions would result in better conformity of gastrointestinal tract with maintenance of blood glucose and blood electrolytic.

Keywords

Compound liquid supplement, liquid retention rate, conformity of gastrointestinal tract, and anaerobic power

1. Introduction

It is very common for players of weight hierarchical sports to lose weight before the competition, but after the acute dehydration of players, the sport performances of muscle strength, anaerobic power, and aerobic capacity would decrease significantly. Therefore, how to help players for rapid and effective rehydration before competition to achieve complete anaplerosis and reduce the impacts to sport performances from dehydration is one of the continuous concerning discussion topics of scholars[Hayes et al.,2010; Jones et al.,2008; Kraft et al., 2011; Merry et al., 2010]. The osmotic pressure and the content of carbohydrates of the liquids supplemented after dehydration would influence the water retention of kidney, so as to influence the effect of rehydration, therefore, the compositions of rehydration solution and the equilibrium condition of electrolyte and liquids after supplementation are the focuses during the research exploration of the discussion topic, therefore, rehydration rate, osmotic pressure and volume of blood, concentration of glucose, sodium, potassium, chloride are taken as the indexes for evaluating the hydration effect of the research[Park et al.,2012]. In addition, the taste and the conformity of gastrointestinal tract are also important factors influencing the supplementation willingness player, therefore, they are frequently discussed during the research of rehydration, and the solution with relatively low conformity of gastrointestinal tract after drinking is a relatively good choice for players. The research aims to discussing the effect of rehydration (including weight recovering and blood biochemical value) and sport performance (anaerobic power) for the severe and acute dehydration by orally taking compound water solutions of low osmotic pressure electrolyte solution (HES), isometric pressure electrolyte solution (IES) or sports beverage to provide references for hierarchal players after weighing.

2. Materials and methods

2.1 Materials

The experiment was performed with 12 female weightlifters in Chongqing Sport and Technology College with the average ages of 18.85±1.28, heights of 157.15±5.36cm and weights of 58.64±9.85kg.

2.2 Procedures and Methods of the Experiment

2.3 Experiment design

Cross-over experiment design was adopted; during the experiment, the participants of the experiment dehydrated 2% of their weights by the method of oven dehydration, and then took four solutions of HES (osmotic pressure: 269 mosm/L), IES (osmotic pressure: 295 mosm/L), SB (368 mosm/L) or water (W) equaling to 1.5 times of dehydrating amount. 4 weeks' interval was necessary for each experiment to guarantee that the physical conditions of participants were completely recovered. Therefore, the Wingate anaerobic tests were performed before dehydration and after rehydration as the basis of sport performance. Weights were measured and blood was collected during supplementation period to test concentrations of blood values of the water retention rate，osmotic pressure of blood, concentration of glucose, sodium, potassium, chloride as the evaluation indexes of rehydration efficiency. In order to apply the results of experiment into the weight lifting competition, experiment design and treatment in the mode of weighing for the research before 2 hours of the competition were performed based on the regulation of international weightlifting regulations. Liquid supplementation during experiment was completed after 1.5 hours of dehydration (30 minutes were reserved for warming up for the competition).

2.4 Experiment procedures

1) Participants of the experiment drank at least 480mL water after the dinner the day before the experiment, and the participants took the standard breakfast (the proportion of carbohydrate, protein and fat are 63%-67%, 10%-13% and 20%-26% respectively) of 7kcal/kg on the day of the experiment and 240mL water (to guarantee sufficient water in body), 60 minutes of rest was also necessary before the experiment.

2) Weights were measured after urine was released before dehydration, 10mL blood were extracted from the vein before the elbow of the weak hand with stuck needle, then performed the Wingate anaerobic tests by pedaling cycle ergometer.

3) After anaerobic power test was completed, 2% of their weights were dehydrated by the method of oven dehydration. Weights were measured and 10mL blood were drawn immediately after the dehydration, then the supplementation of solutions was performed with the supplementation volume of 37.5% of losing weight, the supplementation time were the time immediately after dehydration and 30 minutes, 60minutes and 90minutes of rehydration.

4)Weights were measured before each liquid supplementation and 120 minutes after the rehydration, liquid retention rate = ([weights at various time point – weight at the former time point] ×100% ／ liquid volume taken in)[6]; and scores of conscientious conformities of gastrointestinal tract were recorded (based on the self-perception, the score range is 1-4 point, 1 for pretty comfortable, 2 for comfortable, 3 for a little uncomfortable and 4 for uncomfortable).

2.5 Mathematical Statistics

Differences of various values between the same time point and different experiment treatments were verified by repeatedly measuring one-way ANOVA; significance level of all statistical magnitude was set asα=0.05.

3. Results and discussion

3.1 Liquid Retention Rate and Conformity of Gastrointestinal Tract

Table 1 shows: scores of liquid retention rate and conformity of gastrointestinal tract after supplementing four solutions of HES, IES, SB and W after dehydration of participants. 1) There was no significant difference among the liquid retention rates by four treatments at the same time point; 2) As for the conformity of gastrointestinal tract, when RE-90, the scores of conformity of gastrointestinal tract for supplementing HES, IES and SB were significantly lower than that for supplementing W (2.95±0.69, 2.78±0.95, 2.67±0.71 respectively for 3.83±0.75, P＜0.05).

Table 1 Statistic of Liquid Retention Rates and Conformities of Gastrointestinal Tract at Various Time Points before Dehydration and after Rehydration by Supplementing Different Liquids

Variables	HES(a)	IES(b)	SB(c)	W(d)	Multi-comparison
Liquid retention rate %					
RE-30	90.32±11.65	88.32±8.24	89.56±14.65	87.87±8.58	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-60	93.78±5.58	91.36±11.21	95.25±13.14	94.11±12.17	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-90	80.25±21.15	82.11±15.23	85.36±7.95	84.58±11.26	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-120	81.14±27.21	83.14±26.12	80.15±25.14	83.19±18.56	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Score of conformity of gastrointestinal tract					
RE-0	2.37±0.75	2.57±0.87	2.38±0.97	2.45±0.86	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-30	2.01±0.71	2.08±0.690	1.89±0.77	2.11±0.86	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-60	2.44±0.74	2.48±0.71	2.27±0.59	2.65±0.74	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-90	2.87±0.63	2.79±0.89	2.66±0.75	3.83±0.75	P_{ad}^{**}; P_{bd}^{**}; P_{cd}^{**} P_{ab}; P_{ac} P_{bc}
RE-120	2.79±0.61	2.68±0.85	2.59±0.68	2.84±0.73	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}

Notes: HES = low osmotic pressure electrolyte solution; IES = isometric pressure electrolyte solution; SB = sports beverage; W = water RE-30: rehydration for 30min; words in the following tables have the same meaning

3.2 Blood Value

Table 2 shows: blood glucose of RE-0, RE-60 and RE-120 and the values of electrolytes of sodium, potassium, chloride in blood and osmotic pressure before supplementing the four solutions of HES, IES, SB and W.

1) As for the part of blood glucose, at the time of RE-60, the concentration of blood glucose of supplementation of HES, IES and SB were significantly higher than that of W (5.98±1.89mmol/L, 6.6±1.63 mmol/L, 7.57±2.32 mmol/L respectively for 4.58±0.87 mmol/L, P＜0.05), and the indexes of group IES and SB were significantly higher than group HES.

2) As for the aspect of potassium concentration, at the time of RE-120, the potassium concentration of supplementation of HES and IES were significantly higher than those of SB and W (4.32±0.57 mEq/L, 4.16±0.76 mEq/L respectively for 3.51±0.57 mEq/L, 3.66±0.55, P＜0.05); and there was no difference among the indexes of group HES, IES, SB and W.

3) There was no significant difference among the concentrations of sodium and chloride and blood osmotic pressures of four different experiment treatments at the same time point (P＞0.05).

Table 2 Concentration Changes of Blood Glucose, Sodium, Potassium and Chloride at Various Time Points before Dehydration and after Rehydration by Supplementing Different Liquids

Variables	HES(a)	IES(b)	SB(c)	W(d)	Multi-comparison
		Glucose (mmlo/L)			
Pre-dehydration	4.38±1.29	4.45±1.57	4.27±0.89	4.44±0.88	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-0	4.97±0.71	4.89±0.68	5.06±0.79	4.96±0.87	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-60	5.98±1.89	6.69±1.63	7.57±2.32	4.58±0.87	P_{ad}^*; P_{bd}^*; P_{cd}^* P_{ab}^*; P_{ac}^* P_{bc}
RE-120	4.92±0.91	5.03±1.27	5.11±1.68	4.59±0.58	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Na+(mEq/L)					
Pre-dehydration	130.81±6.54	128.77±4.78	130.70±5.32	132.29±3.45	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-0	131.34±5.32	132.59±7.21	132.23±5.45	129.89±6.34	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-60	130.35±8.46	127.34±7.56	131.40±6.12	129.89±9.32	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-120	124.57±10.12	125.85±10.80	127.19±8.56	125.53±7.87	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
K+(mEq/L)					
Pre-dehydration	3.68±0.57	3.89±0.51	3.83±0.56	3.75±0.55	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-0	3.71±0.66	3.79±0.49	3.85±0.67	3.76±0.78	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-60	3.95±0.87	4.06±0.78	3.88±0.51	3.97±0.69	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-120	4.32±0.57	4.16±0.76	3.51±0.57	3.66±0.55	P_{ad}^*; P_{bd}^*; P_{cd}; P_{ab}; P_{ac}^* P_{bc}^*
CI-(mEq/L)					
Pre-dehydration	98.77±11.19	96.32±8.78	97.44±9.56	96.87±7.98	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-0	102.43±9.78	99.87±6.89	101.55±7.65	99.61±9.14	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-60	97.65±11.56	98.75±6.76	97.89±9.01	96.54±7.63	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
RE-120	94.56±10.07	93.78±8.76	95.67±9.06	94.55±5.27	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}

3.3 Anaerobic Power

Table 3 shows: the anaerobic power performances of participants before dehydration and after rehydration (RE-120) by supplementing four solutions of HES, IES, SB and W. The results shows that there were no significant difference among the anaerobic power indexes of four experiment treatments at two time points (P＞0.05).

Table 3 Wingate Anaerobic Power Performances before Dehydration and after Rehydration by Supplementing Different Liquids

Variables	HES(a)	IES(b)	SB(c)	W(d)	Multi-comparison
Maximum anaerobic power(W/kg)					
Pre-dehydration	137.23±15.56	135.43±22.12	139.54±17.21	137.38±18.66	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Post-rehydration	138.27±41.81	138.59±20.32	135.57±19.32	137.66±20.43	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Minimum anaerobic power(W/kg)					
Pre-dehydration	71.56±7.51	72.32±8.54	74.32±10.45	69.98±8.94	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Post-rehydration	72.45±6.65	71.32±11.65	73.56±10.67	70.77±8.12	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Average anaerobic power (W/kg)					
Pre-dehydration	104.58±7.56	101.11±8.43	103.77±7.87	101.69±8.05	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Post-rehydration	102.76±14.14	101.65±14.43	102.77±6.877	101.43±8.87	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Fatigue index %					
Pre-dehydration	0.47±0.93	0.46±0.41	0.48±0.29	0.49±0.15	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}
Post-rehydration	0.46±0.19	0.48±0.32	0.45±0.31	0.50±0.34	P_{ad}; P_{bd}; P_{cd} P_{ab}; P_{ac} P_{bc}

4. Conclusion

Good nutritional status can improve the results and health level of college students' sports activities. Excessive or inadequate nutrition intake can have negative influence on college students' sports activities.This article is intended for providing college students with some information about diet, hoping it is helpful for college students' sports activities and health maintenance.

The research discussed the weightlifters supplemented four kinds of solutions of low osmotic pressure electrolyte solution, isometric pressure electrolyte solution, sports beverage or water after they dehydrated by 2% of their weight acutely to discuss the impacts of the solutions on liquid retention rate, conformity of gastrointestinal tract, blood glucose, blood electrolyte, osmotic pressure and anaerobic power performance. The result showed that after they dehydrated by 2% of their weight, water or other liquids equaling to 1.5 times of dehydrating amounts were supplemented for 4 times within 90 minutes would not influence the anaerobic powers of the players, while liquids containing carbohydrate and electrolyte would maintain blood glucose with high conformity of gastrointestinal tract.

The result of the research showed that there was no difference among the liquid retention rates of four experiment treatments, but at the time of 90min of the rehydration, supplementing HES, IES, SB would result in better conformity of gastrointestinal tract than W; this might be related to the results of former researches indicating that increasing the sweet taste would result on better taste [Freedman et al.,2010]. Supplementing solution containing carbohydrate would slow down liquids entering into blood and maintain relatively high osmotic pressure and reduce urine volume[Osterberg et al.,2010], in addition, sodium and chloride ions belong to the main positive ions and negative ions of extracellular fluid respectively, therefore, whether there is carbohydrate or electrolyte in the liquid is still a key factor influencing the rehydration effect. However, research of Rowlands[Rowlands et al.,2011] indicated that supplementing low osmotic pressure carbohydrate electrolyte solution had better effect of supplementing isometric pressure solution; research of Kim[Kim et al., 2013] also indicated that there was no difference among the impacts to conformity of gastrointestinal tract by supplementing three solutions of HES, IES and SB with different osmotic pressures, which was not consistent with the result of former research. The reason might be that the supplementing time of the research was the recovery phase in static rest phase after the participants dehydrated by 2% of their weight acutely, which was not the same as the conditions of the players of researches performed by other scholars. On the other hand, there was no significant difference of the blood osmotic pressure values and rest values of participants after four experiment treatments, this result was not consistent with the result of the research performed by Park[Park et al., 2012], the reason might be that the four experiment treatments to participants of the research were conducted in the method of static oven inducting dehydration with the average dehydration time of 247.6 minutes; while the former researches were conducted in the method of dynamic sport inducting dehydration with the average dehydration time of 120 minutes, therefore, the result of the research might be due to the long dehydration time and different modes resulting in adaptation effect of human body.

There was no significant difference between the maximum anaerobic power, the minimum anaerobic power, the average anaerobic power and fatigue indexes after the four experiment treatment and those before the experiment treatment. For the experiment was the imitation of the rehydration during the acute dehydration of players before the competition to the competition period, the Wingate anaerobic tests were only performed before the experiment and at the time of RE-120, and the variation condition of the anaerobic powers of the participants after dehydration were not measured, the result of the research could only indicate that supplementing liquids equaling to 1.5 times of dehydrating amounts after players dehydrated by 2% of their weight may avoid the decrease of anaerobic powers, the direct impacts of supplementing different liquids to the anaerobic power were still unclear. Measuring sport performance immediately after each supplementation of rehydration solutions may be designed for future researches to further understand the impacts of four supplementation liquid to the anaerobic power. The participants of the research were all females with certain amount of muscles for the program of weightlifting, and the research adopted the passive dehydration method of thermal environment not easy to result in muscle fatigue, so the result of the research might be different from results of former researches. In addition, although the blood glucoses supplementing IES and SB at RE-60 are significantly higher than that supplementing HES and W, the difference of blood glucose did not remain at RE-120, which resulted in no difference of anaerobic power performances of the four experiment treatments after rehydration. Further researches are required to find the reasons resulted in the variations of blood glucose.

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