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Original research

Does a run/walk strategy decrease cardiac stress during a marathon in non-elite runners?

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ABSTRACT

Objectives: Although alternating run/walk-periods are often recommended to novice runners, it is unclear, if this particular pacing strategy reduces the cardiovascular stress during prolonged exercise. Therefore, the aim of the study was to compare the effects of two different running strategies on selected cardiac biomarkers as well as marathon performance.
Design: Randomized experimental trial in a repeated measure design.
Methods: Male ($n = 22$) and female subjects ($n = 20$) completed a marathon either with a run/walk strategy or running only. Immediately after crossing the finishing line cardiac biomarkers were assessed in blood taken from the cubital vein. Before (−7 days) and after the marathon (+4 days) subjects also completed an incremental treadmill test.
Results: Despite different pacing strategies, run/walk strategy and running only finished the marathon with similar times (04:14:25 ± 00:19:51 vs 04:07:40 ± 00:27:15 [hh:mm:ss]; $p = 0.377$). In both groups, prolonged exercise led to increased B-type natriuretic peptide, creatine kinase MB isoenzyme and myoglobin levels ($p < 0.001$), which returned to baseline 4 days after the marathon. Elevated cTnI concentrations were observable in only two subjects. B-type natriuretic peptide ($r = -0.363$; $p = 0.041$) and myoglobin levels ($r = -0.456$; $p = 0.009$) were inversely correlated with the velocity at the individual anaerobic threshold. Run/walk strategy compared to running only reported less muscle pain and fatigue ($p = 0.006$) after the running event.
Conclusions: In conclusion, the increase in cardiac biomarkers is a reversible, physiological response to strenuous exercise, indicating temporary stress on the myocyte and skeletal muscle. Although a combined run/walk strategy does not reduce the load on the cardiovascular system, it allows non-elite runners to achieve similar finish times with less (muscle) discomfort.

1. Introduction

Benefits of regular running on cardiorespiratory fitness are known to reduce all-cause and cardiovascular mortality.[1] In contrast, sudden death in marathon runners with no prior documentation of heart disease shows that prolonged endurance exercise can have the opposite effect in exceptional cases.[2] Especially in recreational endurance runners with less training the risk for cardiac dysfunction and injury is increased after completing a marathon.[3–5] In this respect, the steadily growing number of participants in running events[6] emphasizes the need to assess biochemical markers that allow the prediction of the cardiovascular risk during prolonged exercise at submaximal intensity.

Previous studies have shown that prolonged running evokes abnormal elevations in creatine kinase MB isoenzyme (CK-MB), cardiac troponin (cTnI), and B-type natriuretic peptide (BNP).[5] In clinical settings, increased serum levels of these cardiac markers are strong prognostic indicators of cardiac events.[3,7] However, there is still an ongoing debate whether elevations in CK-MB, TNP and BNP after strenuous exercise reflect irreversible cardiac damage or just a reversible cardiac fatigue.[8–10] In this respect,

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Fortescue et al.[11] argue that high BNP and TNP concentrations after a marathon, particularly in non-elite runners, might be due to an incomplete myocardial adaptation to training in which vulnerable myocytes are selectively eliminated. Furthermore, increases in cardiac markers correlate with post-race diastolic dysfunction, increased pulmonary pressures and right ventricular dysfunction after 2000 m rowing.[3]

Compared to running, walking is associated with lower energy expenditure and less physiological stress.[12] Therefore, fitness experts still recommend walking breaks to make novice runners complete a marathon successfully and safely.[13] Referring to the stress on the cardiovascular system, this recommendation is hardly based on evidence, as the effect of intermittent running on selected cardiac markers has not been investigated yet. However, a previous study has shown that regular walking breaks do not reduce fatigue and muscular stress during a 24 km run,[14] whereas hormonal (e.g. testosterone and cortisol) responses seem to differ from continuous running.[15] Furthermore, a high variability of pacing impairs marathon performance,[16] possibly due to a higher energy demand, which is associated with an uneconomical running strategy.

The aim of the study was to compare the effects of a run/walk strategy (RWS) vs running only (RUN) on selected markers of cardiovascular injury and stress (CK-MB, BNP, cTnI & myoglobin) as well as marathon performance. Additionally, it was examined whether or not the pacing strategy during a marathon influences the restoration of maximal aerobic performance. Higher serum concentrations of CK-MB, BNP and myoglobin, which are associated with an increased cardiovascular risk, were expected after the run/walk protocol (RWS).

2. Methods

In response to a newspaper advertisement, recreational athletes applied for the study by submitting personal data including age, weight, profession and exercise experience. Only runners with a regular training volume of 10–20 km/week, who did not participate in marathons before, were included. Exclusion criteria were any chronic or acute cardiovascular, neuronal and orthopedic diseases that could jeopardize the performance and safety of participants during the marathon. Prior to the study they received a medical check-up including a detailed personal anamnesis, ECG at rest and during exercise, echocardiography as well as measurement of blood pressure. At baseline cardiac parameters (BNP, CK-MB, cTnI and myoglobin) were assessed in a venous blood sample. Out of 127 volunteers, 48 male and female recreational runners were randomly selected to participate in this investigation. The anthropometric data of the study participants, who completed all measurements, are shown in Table 1. They all read and signed an informed-consent approved by the ethics committee. Prior to the experimental trial participants engaged in a familiarization period including three months of aerobic training to prepare for the marathon and build up a comparable exercise performance. For the experimental trial recreational athletes were randomly assigned to two groups completing a marathon either by running only (RUN; $n = 21$) or with a run/walk strategy (RWS; $n = 21$).

In a laboratory setting, participants completed exercise testing 7 days before (baseline) and 4 days after the marathon. At rest, a blood sample was taken from the cubital vein to assess cTnI, BNP, CK-MB and myoglobin levels. The blood analysis was performed with MeterPro (Alere Triage, Australia) providing high sensitivity by using a 99th percentile cTnI with a cut off at 0.02 ng ml^{-1}. Regarding the assessment of CK-MB, myoglobin and BNP the applied assay uses a sensitivity of 1.0 ng ml^{-1}, 5.0 ng ml^{-1} and 5 pg ml^{-1}, respectively. Following the assessment of body composition with a bioimpedance device (Data Input, BIA 2000s, Germany), participants' aerobic performance was measured in an incremental running test under continuous registration of the heart rate. Therefore, they gradually increased speed from initial 7.0 km h^{-1} by 1.5 km h^{-1} after each 1200 m until exhaustion. The test was stopped when participants were unable to maintain the speed. At rest and after each increment, lactate and glucose concentration were assessed with enzymatic-amperometic method (Dr. Müller Gerätebau, SUPER GL Ambulance, Germany) in 10 μl blood taken from an earlobe. Heart rate, lactate and glucose concentration were processed with WinLactat 4.6 (Mesics GmbH, Germany) to derive individual target zones for the marathon. Additionally, the Dickhuth[17] model was applied to the lactate-velocity curve to determine the individual aerobic and anaerobic threshold. Four days after the marathon the exercise test was repeated to assess whether or not aerobic performance was recovered and cardiac markers returned to baseline levels.

All recruited recreational runners participated in the EON Mitte Kassel Marathon (May 2013 in Kassel, Germany). The course had 180.8 m difference in altitude including a maximal incline of 7% over a distance of 500 m (starting at 37 km). Using the water stations as reference, the RWS switched from running to walking every 2.5 km. Each walking period was compromised of 60 s at a self-chosen velocity in which participants felt comfortable. In contrast, the RUN completed the marathon by running only. During the event heart rate and velocity were recorded continuously with heart rate monitors with integrated GPS (RCX3 GPS, Polar Electro GmbH, Finland). Immediately after crossing the finishing line, lactate was measured in 10 μl blood taken from an earlobe and participants were asked to rate muscle pain (5-point scale: 0 = none, 4 = worst pain) and exhaustion (5-point scale: 0 = none, 4 = extreme). Additionally, a blood sample was taken from the cubital vein to assess cTnI, BNP, CK-MB and myoglobin.

The statistical analysis was performed with SPSS Statistics 19.0. In advance, the Shapiro–Wilk test was applied to check whether or not the data were normally distributed. As our variables followed a Gaussian distribution, analysis of variance was used for comparison between and within participants. To calculate possible interaction effects between groups a two-way ANOVA (factors: group, time) with repeated measures on the second factor was applied. Cardiac markers, aerobic performance, heart rate and blood lactate were selected as dependent variables. By using Student's t test for unpaired samples mean and maximal heart rates during marathon, perceptual measures (self-reported muscle pain & fatigue) and finish times were compared between RWS and RUN. Furthermore, possible relationships between cardiac markers (BNP in ng l^{-1}, CK-MB in ng ml^{-1} & myoglobin in μg l^{-1}) and performance parameters (maximal velocity in km h^{-1} & velocity at the individual anaerobic threshold) were investigated by calculating the Pearson correlation coefficient. The level of significance was set at $p \leq 0.05$.

3. Results

Due to cramps two participants in RUN were not able to continue running and cross the finishing line. The RWS and RUN completed the marathon in 04:14:25 ± 00:19:51 (hh:mm:ss) and 04:07:40 ± 00:27:15 (hh:mm:ss), respectively. The difference in marathon time was not significant between the groups ($F = 0.80$; $p = 0.377$). Furthermore, participants' mean (158 ± 7 min^{-1} vs 154 ± 6 min^{-1}; $F = 2.22$; $p = 0.146$) and maximal heart rate (174 ± 8 min^{-1} vs 173 ± 7 min^{-1}; $F = 2.22$; $p = 0.888$) did not differ significantly between RWS and RUN. The average marathon speed was correlated with velocity at the individual aerobic ($r = 0.653$; $p < 0.001$) and anaerobic threshold ($r = 0.761$; $p < 0.001$) as well as the maximal velocity during the treadmill test ($r = 0.805$;