Cardiac Adaptation of Hungarian Motocross Athletes

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Abstract
The aim of this study is to examine the Hungarian A- level motocross
athletes' physiological condition during a standardized treadmill stress
test. Furthermore, we would like to prove with comparisons to other study
results that motocross is a physiologically demanding sport apart from the
mental-concentrative and psycho-emotional stress factors. **Methods:** 6
Hungarian A-level motocross (MX) athletes (age 20.5 s=3,4) took part in
our 8 stage treadmill stress test. Before the test we measured EDD, ESD,
IVS, PW with an echo and calculated the LVMass(g) = $0,8[1,04[(IVS + PW + EDD)^3 - EDD^3] - 13,6] + 0,6$ and LVMass/ BSA (g/m^2). During the
test we did EKG. **Results(n=6):** mean EDD= 53mm (s=2,5); mean ESD=
33mm (s=1,7); mean IVS= 11,8mm (s=1,2); mean PW= 11mm (s=0,6). MX
atletes' mean LVmass is 233,5g (s= 41,2) and the mean LVmass/ BSA is
123,6 g/m^2 (s=16,1), while rowers' LVmass/ BSA= 121,7 g/m^2, t(5)= 0,299,
p=0,777; and swimmers' LVMass/ BSA= 125,1 g/m^2, t(5)= -0,218, p=0,836
(Vencunas et al.). Resting mean HR was 50,2 min^{-1} (s=6,7). At the final
stage they reached 91% (s=2,2) of their HRmax. HR recovery after 1 min
was 78,5% (s=3,8) and after 2 min was 66% of the mean HRmax (r=0,973,
p=0,01). **Conclusion:** The EKG data refers to a well-trained athlete. A-level
MX athletes have the same cardiac adaptation to training as a professional
or Olympic athlete of the highly dynamic sports.

Key words: motorsports, cardiovascular endurance

Introduction

Earlier researches and publications of the exercise intensity and cardiovascular load in motocross (MX) racing have revealed that the A- level athletes are able to perform the whole motos – which are about 30 minutes – in the maximal heart rate zone. Thus the mean heart rate is 95% of the maximum. (Augustin, 2011; Konttinen et al., 2007; Nagy, 2011)

This performance is done on a motorbike of 100 kg, 30- 40 bhp, dressed in complete protective gear while jumping huge obstacles fighting against 39 other athletes for one goal to cross the finish line first and win the race. The possibility of a crash and injury is a constant factor of a race as well as the alternation of the conditions like speed, the opponents' position, the surface and quality of the racetrack. All these components make the athlete taking decisions continuously in every moment of the competition.

Motorsports and motor car racing cause high mental-concentrative and psycho-emotional stress (Schwaberger, 1987.). During racing hardly possible setting apart physiological and psychological stress as none of the above- mentioned researches report this. Thus the pure physiological strain of motocross and the athletes' long-term cardiopulmonary adaptation is still unknown.

According to the classification of sports those whose maximal oxygen consumption – which is the dynamic aspect of the 2 dimensional classification – during competition reach higher than 70% are classified to "high" at the dynamic component. This category contains e.g. boxing, canoeing, kayaking, cycling and triathlon (Mitchell, et al., 2005.). On the basis of Konttinen et al. motocross should be classified as a highly dynamic sport as the athletes reach 71% of their maximal oxygen consumption during a race.

The cardiovascular and pulmonary system as the human body adapt to regular sport activity. A kind of regulative adaptation is responsible for the athletic bradycardia, which could be detected as lower resting heart rate. There are, furthermore, structural adaptations of the athlete's heart, which are cardiomegaly and cardiac

hypetrophy. These mainly depend on personal genomics, the type, intensity and amount of training. The greatest cardiac hypertrophy occurs at endurance sports where the regular intensity is high enough, features aerobic strain and the session are in-between 10-90 minutes (Dickhut, 2005).

The Hungarian Motorcycle Sport Federation (MAMS) issued 32 A- level licenses in 2014. Fifteen out of these are international licenses. According to the operative motocross regulation of MAMS 2014 a National Championship race day has to has one free practice (25 min) to get acquainted with the track. This is followed by a qualifying race (10 min +2 laps) for the start positions, and two motos (25 min +2 laps) where the athlete who gets the most points wins the raceday. The rest time among the two motos is at least 1 hour (MAMS, 2014).

We designed this present study to examine the Hungarian A-level motocross athletes' physiological condition – without any psychological stress factors – during a standardized treadmill stress test. Furthermore, we would like to prove by an echocardiogram with the athletes' cardiac adaptation that motocross is a physiologically demanding sport apart from the mental-concentrative and psycho-emotional stress factors.

Methods

Six Hungarian A- level athletes volunteered to partake, and have accepted the terms and offered their results anonymously for the study. Their age was 20,5 (s=3,4). They have been A- level athletes at least for four years, they have at least three training sessions and one race a week respectively. They all participate in either MX1 or MX2 of the Hungarian National Motocross Championship.

First of all the anamnesis was recorded, which was followed by a resting EKG and an echocardiogram. During these test we monitored the signs of any adaptation – data which is not pathologically differs from reference ranges – to physical activity. These data were: the left ventricular end-diastolic diameter (EDD), left

ventricular end-systolic diameter (ESD), the interventricular septal thickness (IVS) and posterior wall thickness (PW). We calculated the mass of the left ventrical by the convention of the American Society of Echocardiography (ASE). $LVMass(g) = 0,8[1,04[(IVS + PW + EDD)^3 - EDD^3] - 13,6] + 0,6$ (Nagy, 2001.). Eliminating the individual physiological differences we did the calculation by body surface area (BSA) as well: $LVMass/ BSA (g/m^2)$.

Insofar as the athlete had been proved to be healthy and competent he could take part in the treadmill stress test. The tests were done on a h/p/ cosmos treadmill. All the data were collected and processed by Cosmed Quark software. The test protocol contains eleven stages. The first eight has an increasing speed and angle and three deducting stages. The stages are the following respectively: stage 1: 2 min, 2,7 km/h, slope:10%; stage 2: 5 min, 4 km/h, slope:12%; stage 3: 2 min, 5,5 km/h, slope:14%; stage 4: 2 min, 6,8 km/h, slope:16%; stage 5: 2 min, 8 km/h, slope:18%; stage 6: 2 min, 8,9 km/h, slope:20%; stage 7: 2 min, 9,7 km/h, slope:22%; stage 8: 8 min., 11 km/h, slope:21%. The test stops any time when the athlete is exhausted or he reaches stage 8 and the heart rate becomes constant.

The three deducing stages are the following respectively: stage 9: 1 min., 5 km/h, slope: 10%; stage 10: 4 min., 3,5 km/h, slope: 10%; stage 11: 5 km/h, slope: 0%.

We calculated the HRmax by the basic formula HRmax=220 – age. We divided the athletes' HR of each stage-end by the HRmax to get comparable values. The LVmass was divided by BSA for the same reason as above to avoid the anthropometric difference. A Polish- American team studied Olympic and professional athletes' echocardiogram (Venckunas, et al., 2008). Their study has not calculated the % of LVmass/ BSA but all the requisite data is available so by the reason of objective comparison to the MX athletes we calculated them. Therefore it was possible to compare the adaptation to training of LV in MX to the sports in the same dynamic category. As in the introduction – we expected that MX cause the same adaptation to exercise as other sports in the same dynamic category like basketball, long-distance running, rowing, cycling, swimming.

We made statistical analyses with IBM SPSS Statistics 22. software. Beside the mean data we give standard deviation as s=x. We compared data to reference values with one sample t-test with $p<0,05$ and $p<0,01$ significance level. The relationship between different variables were examined by Pearson's correlation with $p<0,01$ significance level.

Results

The mean heights of the sample (n=6) was 177cm (s=6,5), mean weight of 75kg (s=12,3), mean BSA was 1,91 m^2 (s=0,18). During the resting EKG the mean HR was 50,2 min^{-1} (s=6,7) which is significantly lower than non- trained males' reference values 70 min^{-1} (Gyetvai et al., 2008.) t(5)= -7,245, p=0,001 (p<0,05).

The results of the echocardiograms are the following: mean EDD= 53mm (s=2,5); mean ESD= 33mm (s=1,7); mean IVS= 11,8mm (s=1,2); mean PW= 11mm (s=0,6). The mean IVS and PW values were significantly higher than the high-end of the 10mm reference values (Lengyel and Asbót, 2012.). IVS t(5)= 3,841, p=0,012 és PW t(5)= 3,873, p=0,012; (p<0,01).

The above mentioned LV values (n=6) the MX atletes' mean LVmass is 233,5g (s= 41,2) and the mean LVmass/ BSA is 123,6 g/m^2 (s=16,1). In the comparison to Vencunas et al. study results did not show significant difference among MX athletes' LVmass/ BSA and basketball players, long-distance runners, rowers, cyclists or swimmers at the significance level of p<0,01. The closest values to MX athletes' are the rowers' LVmass/ BSA= 121,7 g/m^2, t(5)= 0,299, p=0,777; and swimmers' LVMass/ BSA= 125,1 g/m^2, t(5)= -0,218, p=0,836.

During the treadmill stress test all six athlete reached the 7th stage then two of them were not allowed to start the 8th stage because of safety reasons. The mean duration of the stress test was 18,8 minutes (s=2,42) without the three deducing stages. The stage-end HR of the HRmax values shown by table 1.

The mean HR recovery 1 minute after the last stage (7th or 8th) was dropped by 12,5% (s=4,1) so the sample's HR was 78,5% (s=3,8) of their mean HRmax. The 2-minutes recovery drop was 25% (s=3,5) which means 66% of the mean HRmax. These two recovery values examined by Pearson's correlation coefficient correlates strongly r=0,973, p=0,01. The mean HR after one's last stage (7th or 8th) was 91% (s=2,2). Thus there is a significant difference from the HRmax of a motocross race which is 95,5% (Nagy, 2011) t(5)= -5,031, p=0,004.

Discussion

According to the resting EKG results we found that MX athletes have significantly lower resting HR than non- trained males (Gyetvai at al., 2008.). This refers to a well-trained athlete.

The echocardiography proves that the sample's IVS and PW values are significantly higher (p<0,01) than the reference values of non-trained men (Lengyel and Asbót, 2012).

The mean LVmass divided by the mean BSA does not differ significantly (p<0,01) from the highly dynamic sports like basketball, long-distance running, paddling, cycling and swimming. We found that swimmers and rowers (Venckunas at al., 2008.) has the closest kind of cardiac adaption to exercise like MX athletes. The difference among the sample's and rowers' mean LVmass/ BSA is 1,97 g/m² and differs from swimmers' LVmass/ BSA -1,43 g/m². Thus with Konttinen et al. it is proven that MX belongs to the highly dynamic class in the classification of sports (Mitchell, et al., 2005.).

We paid great attention to the reached highest HR at the end of the last stage of the treadmill stress test and to the recovery HR values. The HRmax of the stress test is significantly lower (p<0,05) than the HRmax of a MX race (Nagy, 2011). This 4,5% difference could be the indicator of the mental-concentrative and psycho-emotional stress during a MX race. The verification of this theory needs bigger sample and a circumstantial psychological study.

According to the one minute and two minutes HR recovery data which correlates (p=0,01) and reduces to 66% of the HRmax implies that a MX athlete is in the lower range of the target HR zone (American Heart Association, 2013.)

In conclusion, we can say that an A-level MX athlete has the same cardiac adaptation to training as a professional or Olympic athlete of the highly dynamic sports, hence their HR recovery is outstanding.

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