Mastergradsoppgave

Active recovery and technique performance in soccer

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Prolog

This master thesis has been prepared by Physical Education Section at the University College in North Trøndelag, faculty of Levanger. It has been a long road before the project finally was completed. Big thanks to Kenneth Karlsen, who I have worked with through the testing process. Gratitude to a number of students at Sandnessjøen Secondary School Education, who participated in the project. Directed also to thank the school management at the University College in North Trønderlag, faculty of Levanger. Finally, I thank my supervisor Rolf P. Ingvaldsen for his help throughout the process.

Contents

Abstract

The present study confirms the general impression of previous studies, that active recovery has an effect on soccer players' restitution [1; 3; 25; 8; 19]. A study by Karlsen [21] suggested that technique training in a fatigue state also will give a beneficial effect for soccer players during a match [21]. These effects seem to be even more pronounced, when it comes to restitution after a period of high intensity work. The present study there were found that soccer players can, with the influence of active recovery, maintain or improve the level of technical skills.

The conclusion of the present study was that active recovery can reduced the impairment in performance. Therefore it might be suggested that technique training with lactate will have a positive effect on the skill level of soccer players not only during the high intensity effort (Karlsen, 2008) [21], but also in the following period with active recovery. This means that it might be advantageous for the soccer players on the skill level, to jog instead of standing still after the high intensity exercise periods during a match. If the present study results are confirmed, this might have implication for several sports where one have periods with high intensity exercise with complex technique.

Introduction

Bangsbo, Johansen & Saltin point to the importance of active recovery, saying that the effect of severe exercise [8], restore itself more rapidly by active rest than passive restitution. They are in line with this claim that it is an advantage for players to walk or jog instead to stand still after a period of high intensity in a soccer game. This is confirmed by Hermansen and Stenvold [19], pointing out that it is know that low-intensive activity expedite lactate reduction in blood. However, the influence of active recovery has on the technique performance in soccer is not well established. This is the background for this intervention study with a pre-and post -design, construed to test if a period (five weeks) of training with high lactate values in blood has an effect on soccer players' technical skills during a active recovery period i.e. after a high intensity periode produsing high level of lactate. The idea is that training with lactat will have a positive effect on the skill level of players not only during the high intensity effort (Karlsen, 2008) [21], but also in following periode with active recovery.

Active recovery refers to engaging in low-intensity exercise after workouts. There are two forms of active recovery. One is during the cool-down phase immediately after a hard effort or workout. The second form of active recovery includes the days following a competition or other intense workout. Research is growing on the benefits of both types of active recovery. However, the focus of this study is exclusively on the cool-down phase immediately after a hard workout.

A soccer player’s capacity to perform repetitive high intensity exercise during a match might be crucial for the final outcome. During such exercise anaerobic energy is provided from the splitting of endogenous energy- rich phosphagens (i.e. intramuscular stores of

adenosine triphoshate (ATP) and creatine phosphate (CP)) and from glycolysis which leads to lactate production even during exercise of short duration [11].

Bangsbo [3] found that active recovery immediately after the event encourages recovery and reduces muscle lactate levels faster than complete rest. After hard intervals, one group rested completely while a second group exercised at 30 percent intensity between intervals. The active group reduced blood lactate levels faster and could achieve a higher power output throughout the workout. Another study by Suzuki et al. [40] found that adding low intensity exercise to the rest period after competition did not decrease an athlete's physical recovery and actually had positive effects on psychological recovery by improving relaxation. A study by Micklewright [25] found active recovery encouraged lactic acid removal and helped speed recovery. The general theory is that low-intensity activity assists blood circulation which, in turn, helps remove lactic acid from the muscle. Low-intensity active recovery appears to significantly reduce accumulated blood lactate and speed muscle recovery. Bangsbo et al. [7] suggest that a lowered blood lactate level during active recovery is due to an elevated muscle lactate metabolism and is not caused by a transient higher release of lactate from the exercising muscles coupled with greater uptake in other tissues.

Saltin and Strange [36] claim that in soccer matches, restitution depends on the players' maximal oxygen uptake. As the soccer players cover only 10 km in 90 minutes, the oxygen uptake is often not a limiting factor for this, but is important because it will allow the players to engage in more high intensity work, i.e. to reduce the low intensity periods. The mean $VO_{2\,max}$ ofelite adult soccer players are normally reported to be between56–69 $ml \cdot kg^{-1}\ min^{-1}$ [32; 5; 13; 26; 35; 41; 43] with some individual values higher than 70 $ml \cdot kg^{-1}\ min^{-1}$. Based on results obtained from Danish elite players; fullbacks and midfield players appear to have the highest values of VO_{2max} , and goalkeepers and central defenders the lowest. Similar findings were obtained by Reilly [30], but not by Raven et al. [29]. To obtain relevant values, emphasis is placed on testing in sport-specific activities [45].

Bangsbo et al. [8] found that active recovery reduced the impairment in performance during intense exercise periods. Muscles reach normality faster when low intensity exercise is performed compared to passive recovery (standing still and walking), and that it might be

advantageous for the soccer players to walk or jog instead of standing still after the high intensity exercise periods during match. This a topic with increasing relevance for soccer as the demands for the players to move around without the ball, is constantly increasing. Therefore, especially when the team must make an effort beyond a normal day's effort, the control of fatigue and lactic acid as a problem for exposing technical skills, become increasingly relevant. It is within this endurance context, numerous explosive bursts of activities are required, including jumping, kicking, tackling, turning, sprinting pressure [39]. A soccer player is able to maintain repetitive bouts at a high intensity level for 3–8 minutes. As this intensity far exceeds LT, increased lactate levels are observed, which have to be reduced between each work period. This is the rationale behind introducing breaks of approximately 3 minutes between the exercise bouts at an intensity level of 60–70% of HR_{max} and active periods on sub maximal intensity, has been shown to reduce blood lactate at the highest rate [1;19].

Bangsbo et al. [5] quantifies the different intensity levels of soccer players during a soccer game of 90 minutes. In general the players are engaged in a total of 7 minutes (8 %) of high intensity work during a match. In addition, the players generally stood still or walked for 57 % of the time and were running at low intensity 35% of the time. There were also showed that players run a longer distance during the first half compared to the second half of the game. There were concluded that during a 90-minute game, elite-level players run about 10 km at an average intensity close to the anaerobic threshold (80–90 % of maximal heart rate) [5]. Based on Bangsbo studies [6], it was estimated that about 90 % of a soccer-game is covered by aerobic metabolism, while the remaining 10 % is covered by anaerobic metabolism. Bangsbo's description of the physical activity and energy demands in a soccer match is to a large extent supported by a series of studies. Some studies, however, find less high intensity work during a soccer match. Basset F. A. et al. [9] for example, estimate that

approximately 98 % of the total energy is derived from aerobic metabolisme, the remaining 2 % is generated from anaerobic processes. Nevertheless anaerobic power has an essential part in the most intense maximal short-term period in a soccer match. There are found that the mean distance covered by seven university players during a university-match was 10,225 km (SD= 0,580 km). Out of this, 42,9 % was described as being at a low intensity level, 42,6% was at medium intensity, and 7,5 % was at high intensity [42]. Drust et al., [14] estimate that about 50 % of a soccer game is walking, 15 % static, 30 % jogging, 4 % cruising and 1 % sprinting. In the First Division in England, soccer-players covers 8-12 km during a soccer match of minimum 90 minutes, out of which sprinting accounts for 11 % of the total activity [33]. Even though the observations of soccer players might indicate that they spend most of the time in a low intensity activity, heart rate measures indicate that they make a good effort. Results show that soccer players have heart rate values over 85 % of maximum during the most faces of a match [15]. Most estimates are that exercise intensity during soccer is about 75-80 % of $VO_{2\ max}$ [31]. Mean value for heart rate (HR) (beats·min^{-1}) during soccer is 167 [6] and 161 [16] in competitive games (90 min). An average of Danish First and Second Division players, in nearly ¼ part of a soccer game, have a pulse higher than 88 % of the maximum heart frequency. The relative high frequencies in game situations indicate that soccer puts high demands on the heart and lung transport system [3]. The maximal heart rate during a soccer match were 200 beats·min^{-1} [44; 28; 38]. According to Bachev et al., [2], the maximal heart rate was 197 beats·min^{-1}.

Nowacki et al. [27], who measured blood lactate concentration during a soccer match, reported a mean value of 5.5 mmol/L and a maximum of 7.5 mmol/L. Gerisch et al. [17] registered mean values of 6.0 mmol/L and a maximum 12.4 mmol/L blood lactate concentration. Smith et al., [38] recorded a mean blood lactate concentration of 5.23 mmol/L and a maximum of 11.63 mmol/L during a soccer match. Most studies show values between

4-6 mmol/L [37; 34; 17; 4; 16]. Bangsbo et al. [4] found that some players at a point of time in a match had a value of lactate at10 mmol/L. The average aerobic energy yield during a national level (Allsvenskan) game is around 80% of the individual maximum. Blood lactate concentration during a game averages 7 to 8 mmol/L, there players could have a value of lactate between 4 and 14 mmol/L [15]. This anaerobic character of the game may have unhappy consequences like bad coordination and an increased risk of injuries [15].With a high energy yield most players have empty muscle glycogen stores at the end of the game, and can be hypo hydrated and also have an increased body temperature [15].

Within the sports community, it is taken as a fact that lactate accumulation is the cause of the perceived fatigue during high intensity exercise. For soccer players the time needed to recover from high intensive exercise should be as short as possible. It is well known that low (active recovery) intensity exercise accelerates lactate disappearance from the blood [19; 22; 15; 3].

The question asked

In a study by Karlsen [21] showed, using the same subjects of as in this theses, that soccer players benefited from training technique with a high level of lactic acid in order to prepare for the post-test. The soccer players improved their scores when they had to perform skills at a level of lactic acid often observed during matches. Therefore the study by Karlsen, suggested that technique training in a fatigue state also will give a beneficial effect for soccer players during a match [21]. However, what influence of active recovery has on the technique performance in soccer is not well established. If it is so that the technical skill is weakened, under high-intensive activity, we can ask if practice to withstand high lactate concentrations with also will be reflected during a active recovery period?

Material and methods

Subjects

22 male and female volunteer subjects participated in the experiment. They all came from a group of soccer players. The players were playing in the Norwegian third, fourth Division, second Division women and regional junior/youth league. None of the subjects withdrew from the study, but eight participants had to drop out of the study because of illness and/or injuries, leaving us with 14 players who completed the experiment. Eight subjects were in the training group. The other six players were in the control group. The results were collected and treated confidential, to ensure that no individual could be identified from the electronically stored data.

The ethical committee at Norwegian University of Science and Technology, School of Medicine, approved the study. Protocols were in accordance with the Declaration of Helsinki recommendation guiding physicians in biomedical research involving human subjects. Subjects were informed about the test protocols, but not about the aim of the study.

Design and procedure

The study was conducted with a pre-post-design. The subjects were split into two groups; an intervention group and a control group, matched on skill and gender. To begin with all of the subjects were tested in a pre-test (Figure 1). The intervention group engaged in a soccer specific training program of five weeks with active recovery (Appendix H). During the five weeks between the pre- and post-tests, the intervention group and control group trained together eight times on the soccer-field test track (Appendix C). The control group trained similarly to the intervention group but their training was integrated in the “normal” training routines, and all of their training was conducted without active recovery and without the

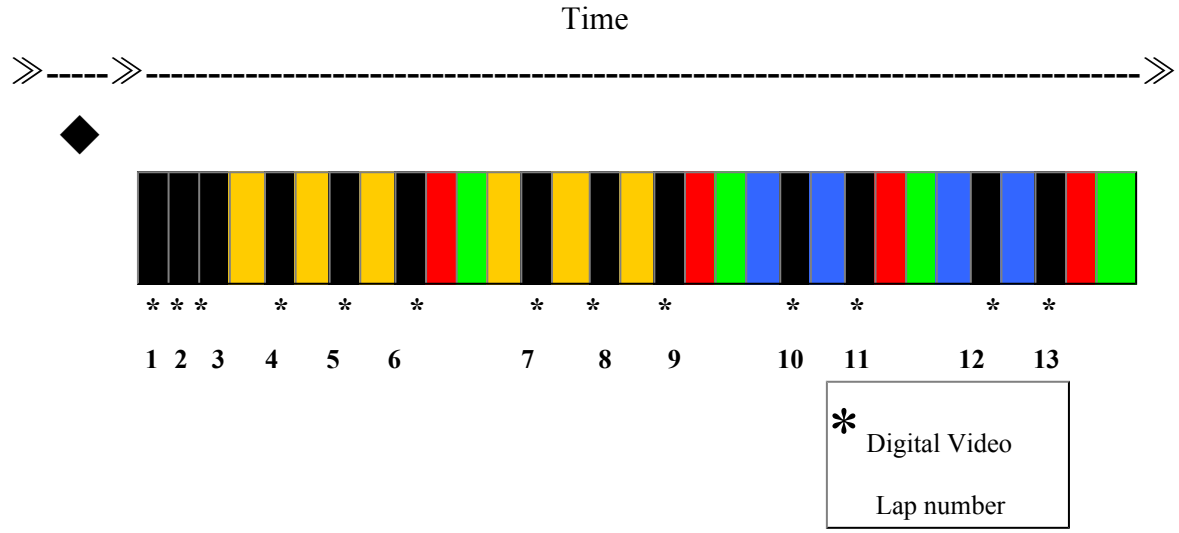
soccer players being exposed to high levels of lactate (Appendix H, without fatiguing protocol and active recovery). To control their training, a coach/teacher observed the intervention group every session and was instructed to tell them to do the cool-down phase immediately after training with high lactate acid. The total training hours were the same for both groups. After the intervention period of five weeks, both groups were tested in a post-test. The pre- and the post-tests were identical.

The two groups trained differently during the five weeks intervention period:

Intervention group: required to practice active recovery in addisjon to practice soccer skills with a high lactate level. (Appendix H).

Control group: participated without active recovery and high lactate levels but with the same soccer skills in a normal soccer training setting.

Pre-Test procedure for training and nutritional regime was present for the subjects two days before testing session (Appendix E). The subjects were informed about the purpose of the experiment before the collection of data. During the pre- and post –tests, and during the training sessions the subjects were motivated to do their very best. Furthermore, before the tests started, they were reminded that they could leave the experiment at any time. The subjects had to go trough a Laboratory test ($VO_{2\ max}$), Soccer- field test with scores, Lactate-test, Fatguing protocol, Active recovery and meausering of The Borg Scale and Heart Rate. The experimental procedure sequence is presented in Figure 1.



*The scores for lap **one to three** is without additional lactic acid (normal), lap **four to nine** are with additional lactic acid, and from lap **ten to thirteen** are the active recovery period . The Borg Scale and Lactate- test were measured after lap six, nine, eleven and thirteen. The fatiguing session were in between each track run from lap four to lap nine.*

***Figure 1** : Illustration of the experiment procedure*

The Laboratory test (VO_{2max} –test)

The subjects were tested in $VO_{2\ max}$ no more than 2 days before the soccer -field test (pre-test procedure Appendix E). The Borg scale (15- Grade scale) was measured at the end of the VO_{2max}- test on every subject (Appendix G). The football players were tested in a laboratory with room temperature of 21-22 ºCand relative humidity of 50%. A Metamax II (Cortex Biophysic GmbH, Leipzig, Germany) portable metabolic analyzers that weigh 1,3 kg, including batteries, was used for estimating $VO_{2\ max}$. The instrument was calibrated against ambient air and a commercial gas of known concentrations of O_2 (16 %) and CO_2 (4 %) each morning and lunchtime before the start of each group of subjects. The concentration of O_2 and CO_2 in the room air was read and the flow transducer was calibrated using a 3-L high-precision calibration syringe (Calibration syringe D, SensorMedics, Yorba Linda, CA) before testing a new subject. Body length and body weight were measured. During experiments in the laboratory, the data collected was immediately transferred to and stored on a PC. The subjects were given 20 minutes warm up at approximately 50- 60 % of $VO_{2\ max}$, running. $VO_{2\ max}$ was determined during 5.0% inclination (Marathon Laufband, Heinz Kittler GmbH, Germany), as described by [18]. Shortly, running speed was increased by 1km*hour $^{-1}$ every minute to a level that brought the subjects to $VO_{2\ max}$ after about 6 minutes. The highest heart rate, measured by short- range radio telemetry (Polar Sporttester, Polar Electro Oy., Finland), during the last minute of running was defined as maximal heart rate.

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The Soccer field- test

During the pre- and post-tests the subjects had to go through the Soccer field - test thirteen times, from lap one to thirteen. The Soccer field- testing was performed on a high quality soccer field consisting of artificial curled nylon grass filled with sand and rubber (figure in Appendix C). The Soccer field- test was carried out no more than two days after the laboratory test (Appendix E). Precision and rhythm/relaxation where measured in every part of the Soccer field- test. The subjects were instructed to perform all –out with an official soccer- ball. The dependent variable in this research, were defined from the followed criteria in figure 2, and each of the criteria was scored after a scale from 1 to 9, there 1 is the lowest and 9 is the highest (Appendix D). The variables precision (A) and rhythm (B) were measured separately in numner one, two and three for the skill -elements of the Soccer-field test. The performances of the subjects were measured during each of the test runs, from lap one to thirteen.

1. A: Receiving the ball precision, passed from a distance of ten metres. B: Receiving the ball rhythm.
2. A: Dribbling precision dribbled nine cones with 1.5 metres between them. B: Dribbling rhythm.
3. A: Passing precision, pass the ball through a 1.5 metre goal located 13 meters away. B: Passing rhythm.
4. Time from the first to the last touch of the ball.

Figure 2*; The Soccer- field test contained these four test skill elements. The variables A precision and B rhythm were measured.*

Heart rate monitor

The subjects were asked to wear a polar heart rate monitor, type Polar Sport tester (Polar Electro Oy, Kempele, Finland). The heart rate was recorded every 5.sekund, and the measurements were transferred to PC with Polar Advantage Interface (Polar). The measurements were analysed by the Training Advisor (PC-program, Polar). The purpose of the polar heart monitor was to record an accurate heart rate during the Laboratory test ($VO_{2\ max}$ -test) and during the Soccer- field test. The maximum heart rate was measured to be 6 beats per min (bpm) higher than the highest heart rate found during the $VO_{2\ max}$ -test [20].

Fatiguing protocol

During the pre- and post-tests the subjects had to go through the Soccer field - test thirteen times. From lap four to nine the subjects had to go through the Fatiguing protocol six times to increase their lactate levels. The subjects were instructed to perform all out in 60 seconds run with no ball in a track with acceleration, change of speed and turning after 3 meters, also called “doggis (see Appendix C). The criteria for accepting the subjects´ effort was that they, after the fatigue task, scored a minimum of 18 on the Borg scale (*The 15- Grad scale*), and reached a minimum level lactate acid of 4 mmol/L. The intensity of this exercise was also confirmed by heart rate measurement done with a Polar Accurex Plus (PE 300; Polar Electro, OY Kempele, Finland).

Lactate- test

Lactate samples were taken from the finger tip four times on every subject during experiment. Two of them were taken during fatigue period (lap six and nine), and the last two were taken during active recovery period (lap eleven and thirteen) (See figure 1). The subjects were tested on an ergometer bike to maintain activity, the workload was low. The

blood lactate concentration was measured by the LT-1710 Lactate ProTM analyzer (Arkray Factory Inc., KDK Corporation, Shiga, Japan). The instrument provides reliable blood lactate concentrations [24; 23]. An electrode strip was inserted into the strip inlet of the meter, and the meter switched on automatically. When the other end of the strip touched a drop of whole blood, about 5 microL was aspirated and measurement started. The lactate concentration was displayed after 60 seconds; the meter turned off when the strip was removed. The used strip was discarded (procedure Appendix F). Lactate Pro was calibrated with instructions from the producer.

The Borg Scale, The 15- Grad scale

Pre- test procedure info is given to all the subjects before the test starts (Appendix G). The subjects were asked to rate how hard they perceived the exercise RPE_{peak} , based on this scale from 6 to 20, at the end of the Laboratory test ($VO_{2\ max}$ -test) and in lap six, nine, eleven and thirteen (See figure: 1). Borg scale was shown to the subjects when it remained 15 seconds to measure lactate. Borg scale was visible in 10 seconds for the subject before it was taken away, and within those seconds the subject has form an opinion (Appendix G). The Borg Scale is a method of rating perceived exertion (RPE) and used by many coaches and physiologists to assess an athlete's level of intensity during training or testing sessions. It can estimate the perceived exertion, breathlessness and fatigue during exercise. The 15-point scale is illustrated in the Appendix E: point 6 would be the equivalent of sitting down doing nothing, 9 would be walking gently, 13 a steady exercising pace and 19/20 the hardest exercise you have ever done. This scale is used in many studies and is rated to be reliable and valid [10].

Active recovery

Active recovery with the cool-down phase was done after lap nine to thirteen immediately after the Soccer field –test. The subjects were instructed to perform active recovery on low intensity exercise in 60 seconds at 50- 60% of their maximal heart rate. Maximal heart rate was set after Laboratory test ($VO_{2\ max}$ -test). During active recovery period; lactate samples, measuring of *The Borg Scale* and *The Soccer field-test* were taken in lap ten and thirteen (figure 1).

Video

The subjects' outcome in the Soccer-field test was recorded by a Sony DCR – TRV33E, 25 Hz, digital video camera. The camera was stationed vertical in the right corner of the football -specific track, and placed at left side corner of the subject, at a distance of 15 m (Appendix C). The subject's position, related to camera, was in the centre of the active field. This position remained the same in all conditions and across groups. Based on recordings, frequency of each movement type with ball position could be established. The performance was analyst by specific criteria (Appendix D).

Statistics

The data was analyzed using SPSS.

Results

To present the overall effect of the active recovery for intervention group and control group, across trials (lap number), the results are plotted for each variable. The plots show each variable with separate plots for the intevention group and control group, and display the average pre-test and post-test results. The analysis shows on the over all mean values from pre-test to post- test on lap one to three, period without additional lactic acid (normal period), in *The soccer field-test* and lap ten to thirteen (active recovery period). The results of lap one to three, are taken from the study of Karlsen; 2008 [21] to reveal the results under conditions without lactat. In the The analysis focuses on the results for lap ten to thirteen, the period of active recovery.

Physiological measurements

The height and weight were measured of the 14 subjects who participate in all the tests. The mean body length for the intervention group were 176,8 cm (n= 8, SD= 9,54). For the control group the mean body length were 176,2 cm (n= 6, SD= 8,66). Mean body weight for the intervention group were 70,7 kg (n= 8, SD= 5,22) pre-test and 71,2 kg (n= 6, SD= 6,91) post-test. For the control group the results were 68,2 kg (n= 6, SD= 5,91) pre-test and 67,9 kg (n= 6, SD= 5,88) post-test.

The mean $VO_{2\ max}$ in the pre- and post-tests *(*Laboratory test) for the intervention group were 57,1 (n= 8, SD= 11,1) in the pre-test, and 59,0 (n= 7, SD= 10,7) in the post-test. A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,118, z= -1,185). For the control group the results were 54,1 (n= 6, SD= 9,8) in pre-test, and 54,4 (n= 6, SD= 9,1) in post-test. The same analysis showed no significant difference (p= 0,118, z= -1,185).

Normal period

The normal period are mean results from lap one to three, taken from the study of Karlsen; 2008 [21], to reveal the results under conditions without lactat.

The Borg-scale

The Borg-scale was registered on a scale from 6 to 20, where 6 are very low score and 20 are very high score.

The lactate test

The lactate tests were registered on a Lactate ProTM analyzer. 1 is as a very low score and over 4 is a high score (all of he participants had to reach a minimum level of 4 mmol/l).

Heart rate monitor (HR)

The heart rate (HR) test was registered on the heart rate monitor Polar Accurex Plus (PE 300; Polar Electro, OY Kempele, Finland). For lap one to three the heart rate for the intervention group and the control group showed no significant difference [21].

The soccer field -test

The soccer field -test consisted of three test skill elements. The results were plotted for each variable. The plots showed each variable with separate plots for the two groups and displayed the average pre- and post results for the groups. The analysis focuses on the scores for lap one to three (normal period). The results was registered on a scale from 1 to 9; 1 is the worst score and 9 is the best score (Appendix D and figure 2).

1 A: Receiving the ball precision, passed from a distance of 10 meters.

The mean score for laps one to three, i.e. the period where the players were not exposed to additional lactate acid was as follows. The mean score for the intervention group in the pre-test was 6,56 (SD= 0,89), and the score in the post-test was 6,61 (SD= 0,78). A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,426, z= -0,187). For the control group the same analysis showed no significant difference between the pre-test 6,00 (SD= 1,36) and the post-test 6,28 (SD= 1,36) scores (p= 0,486, z= -0,036) [21].

1B: Receiving the ball rhythm

The mean scores for laps one to three, i.e. the period where the players were not exposed to additional lactate acid were as follows. The mean score for the intervention group in the pre-test was 6,69 (SD= 0,48), and the score in the post-test was 6,52 (SD= 0,73). A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,264, z= -0,632). For the control group the same analysis showed no significant difference between the pre-test 5,50 (SD= 1,29) and the post-test 5,83 (SD= 0,92) scores (p= -0,540, z= -0,540) [21].

2A: Dribbling precision

The mean score for laps one to three, i.e. the period where the players were not exposed to additional lactate acid, were as follows. The mean score for the intervention group in the pre-test was 6,25 (SD= 1,00), and the score in the post-test was 6,09 (SD= 0,90). A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,286, z= -0,566). For the control group the same analysis showed no significant difference between the pre-test 5,64 (SD= 1,22) and the post-test 5,83 (SD= 1,54) scores (p= 0,294, z= -0,543) [21].

2B: Dribbling rhythm

The mean scores for laps one to three, i.e. the period where the players were not exposed to additional lactate acid were as follows. The results are presented in figure 6a (intervention group) and 6b (control group). The mean score for the intervention group in the pre-test was 6,44 (SD= 0,81), and the score in the post-test was 6,39 (SD= 0,94). A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,500, z= 0,000). For the control group the same analysis showed no significant difference between the pre-test 5,57 (SD= 1,09) and the post-test 5,57 (SD= 1,41) scores (p= 0,376, z= -0,318) [21].

3A: Passing precision

The mean scores for laps one to three, i.e. the period where the players were not exposed to additional lactate acid were as follows. The mean score for the intervention group in the pre-test was 6,38 (SD= 1,59), and the score in the post-test was 5,87 (SD= 1,52). A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,52, z= -1,628). For the control group the same analysis showed no significant difference between the pre-test 6,21(SD= 1,72) and the post-test 6,89 (SD= 1,71) scores (p= 0,127, z= -1,14) [21].

3B: Passing rhythm

The mean scores for laps one to three, i.e. the period where the players were not exposed to additional lactate acid were as follows. The mean score for the intervention group in the pre-test was 6,38 (SD= 0,81), and the score in the post-test was 6,22 (SD= 0,85). A one-tailed Wilcoxon test for 2-related samples showed no significant difference (p= 0,170, z= -0,954). For the control group the same analysis also showed no significant difference between the pre-test (mean= 5,86, SD= 1,03) and the post-test (mean= 5,89, SD= 1,13) scores (p= 0,298, z= -0,530) [21].

4: Time used from the first to the last touch of the ball

Time used from the first to the last touch of the ball was registered with the help of a digital video camera. The mean score for laps one to three, i.e. the period where the players were not exposed to additional lactate acid were as follows. The mean score for the intervention group in the pre-test was 8,78 (SD= 1,32), and the score in the post-test was 8,45 (SD= 1,10). A one-tailed Wilcoxon test for 2-related samples showed significant difference (p= 0,014, z= -2,199). For the control group the same analysis also showed significant difference between the pre-test 9,11(SD= 1,24) and the post-test 8,52(SD= 1,25) scores (p= 0,004, z= -2,670).

The mean score for each individual was calculated for lap four to nine, i.e. the period where the players were exposed to additional lactate acid. The mean score for the intervention group in the pre-test was 9,24 (SD= 1,41) and the score in the post-test was 8,79 (SD= 0,84) [21].

Fatiguing period

The fatuguing period is taken from the study of Karlsen, 2008 [21] to reveal the results under conditions with lactat.The study found that analysis of lap four to nine (with lactic acid) the fatiguing period were valid conform to what is measured in soccer matches.

Active recovery period

Mean results from lap 10-13 (figure 1).

The Borg- scale

The mean score for the intervention group and the control group (pre-post) are presented in the figure 3a and 3b. The mean score for each individual was calculated for lap ten to thirteen, i.e. the active recovery period, cool- down phase. The mean score for the intervention group in the pre-test was 12,25 (SD= 1,44) and the score in the post-test was 12,06 (SD= 1,98). The mean difference between the pre- test and post- test was 0,187 (SD= 2,07). A dependant t-test shows that t(15)= 0,362 (p= 0,723). The mean score for the control group the pre-test was 13,08 (SD= 1,78), and the in the post-test 13,75 (SD= 1,48). The mean difference between the pre- test and post- test was -0,667 (SD= 2,23). A dependant t-test shows that t(11)= - 1,036 (p= 0,322).

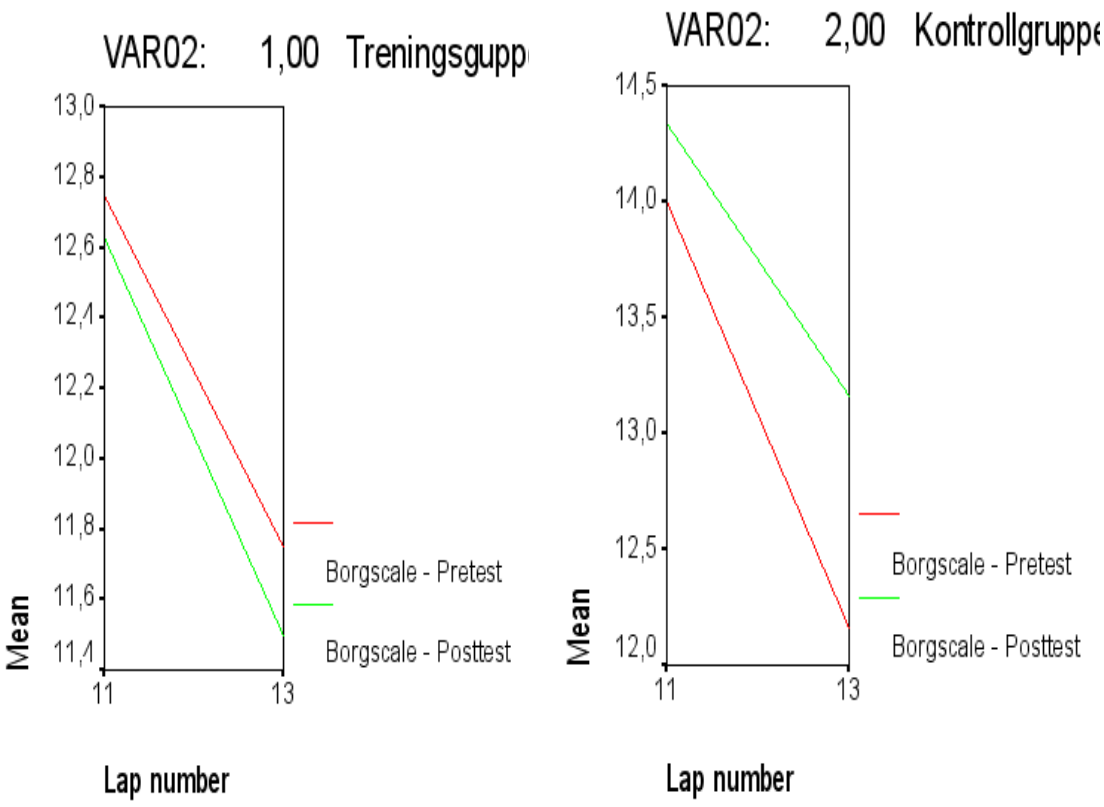

Figure 3a and 3b.*Mean score for the Borg –scale, the intervention group (3a) and for the control group (3b).*

The Lactate- test

The mean score for the intervention group and for the control group (pre-post) are presented in figure 4a and 4b. The mean score for each individual was calculated for lap ten to thirteen, i.e. the period with active recovery. The mean score for the intervention group in the pre-test (figure 4a) was 5,56 (SD= 2,52) and mean score post was 3,90 (SD= 1,65). The mean difference between the pre- test and post- test was 1,656 (SD= 1,81). A dependant t-test shows that t(15)= 3,650 (p=0,002).

The mean score for the control group (figure 4b) in the pre-test was 3,54 (SD= 2,22), and mean score post-test was 3,20 (SD= 1,28). The mean difference between the pre- test and post- test was 0,336 (SD= 1,67). A dependant t-test shows that t(10)= 0,668 (p= 0,519).

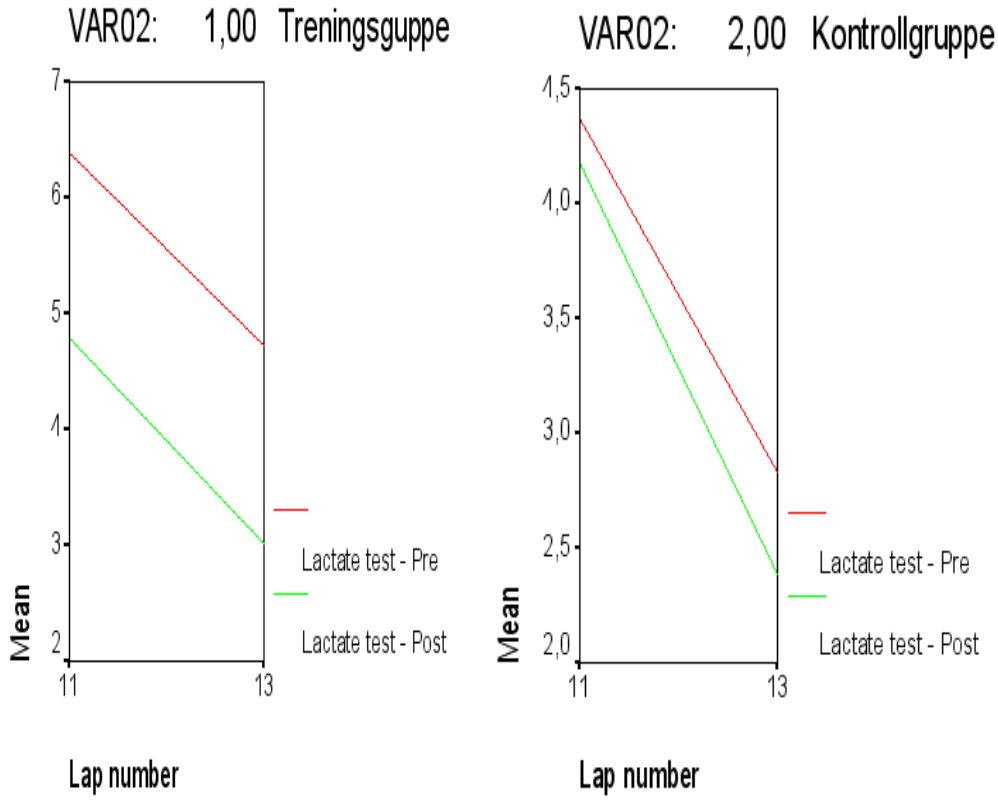

Figure 4a and 4b*.Mean score for the Lactate-test, the intervention group (4a) and for the control group (4b).*

Heart rate monitor (HR)

The mean score for each soccer player were calculated for lap ten to thirteen, i.e. the active recovery period. The mean score for the intervention group in the pre-test was 164, 59 (SD= 11, 01), and mean score post-test was 161,94 (SD= 12,54). The mean difference between the pre- test and post- test was 2,656 (SD= 8,08). A dependant t-test shows that t(31)= 1,859 (p= 0,073). For the control group the pre-test was 170,30 (SD= 15,17) and mean score post-test was 168,69 (SD=14,95). The mean difference between the pre- test and post- test was 1,608 (SD= 4,55). A dependant t-test shows that t(22)= 1,696 (p=0,104).

The soccer field -test

The soccer field -test consisted of three test skill elements. To present the overall effect of active recovery for both groups across trials (lap number), the results were plotted for each variable. The plots showed each variable with separate plots for the two groups and displayed the average pre- and post results for the groups. The analysis focuses on the scores for lap ten to thirteen (active recovery period). The results was registered on a scale from 1 to 9; 1 is the worst score and 9 is the best score (Appendix D and figure 2).

1 A: Receiving the ball precision, passed from a distance of 10 meters.

The mean score for each individual was calculated for lap ten to thirteen, i.e. the period of active recovery. The results are presented in figure 5a and 5b. The mean score for the intervention group in the pre-test (figure 5a) was 5, 93 (SD= 1,84) and mean score post was 6,80 (SD= 1,37). The mean difference between the pre- test and post- test was -0,867 (SD= 2,19). A dependant t-test shows that t(29)= -2,165 (p=0,039).

The mean score for the control group (figure 5b) in the pre-test was 6, 08 (SD= 1,44), and mean score post was 6,79 (SD= 0,78). The mean difference between pre- test and post- test was -0,708 (SD = 1, 49). A dependant t-test shows that t(23)= -2,331 (p = 0,029).

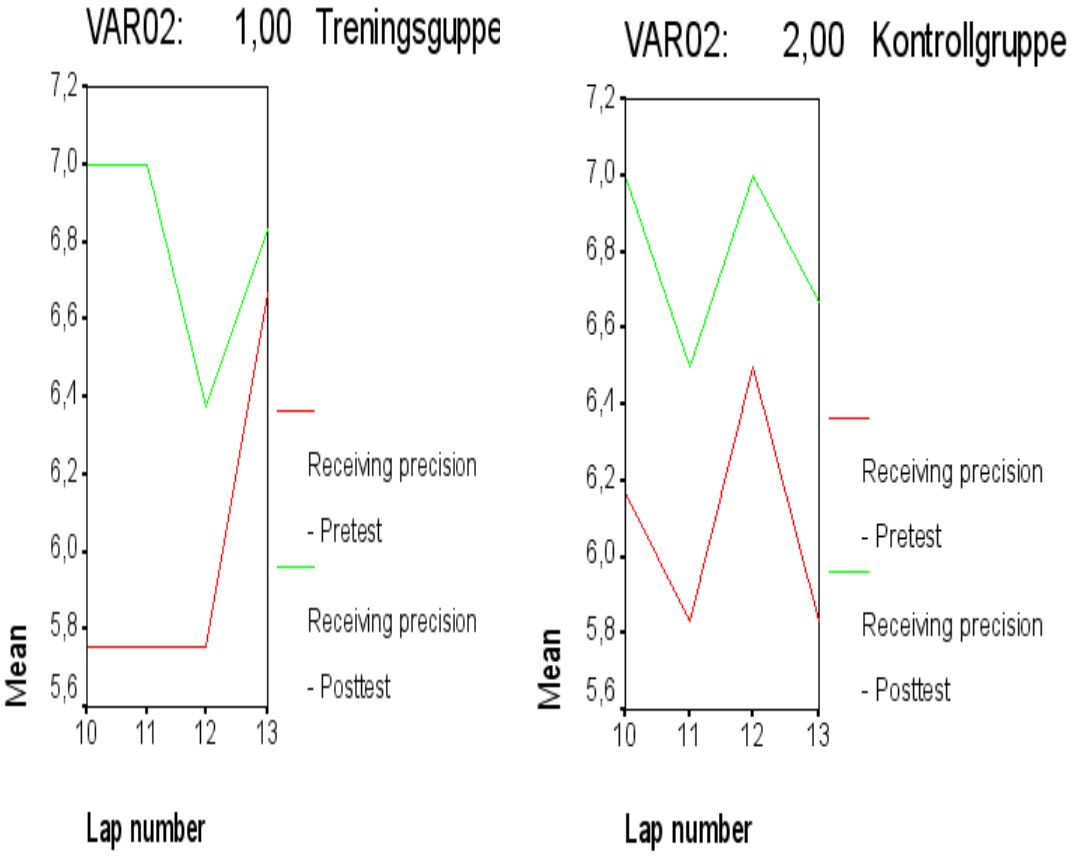

Figure 5a and 5b*.Mean score for 1A, the intervention group (5a) and for the control group (5b).*

1B: Receiving the ball rhythm

The mean score for the intervention group and for the control group (pre-post) are presented in figure 6a and 6b. The mean score for the intervention group in the pre-test (figure 6a) was 6, 07 (SD= 0,74) and mean score post-test was 6,47 (SD= 0,68). The mean difference between the pre- test and post- test was -0,400 (SD = 1, 32). A dependant t-test shows that t(29)= -1,934 (p= 0,063). The mean score for the control group (figure 6b) in the pre-test was 5,75 (SD= 0,99), and mean score post-test was 5,79 (SD= 0,93). The mean difference between the pre- test and post- test was -0,042 (SD= 0, 95). A dependant t-test shows that t (23) = -0,214 (p= 0,833).

Figure 6a and 6b*.Mean score for 1B, the intervention group (6a) and for the control group (6b).*

2A: Dribbling precision

The mean score for the intervention group and for the control group (pre-post) are presented in the figure 7a and 7b. The mean score for each individual was calculated for lap ten to thirteen, i.e. the period of active recovery. The mean score for the intervention group in the pre-test (figure 7 a) was 6,00 (SD= 1,17) and mean score post-test was 6,57 (SD= 1,01). The mean difference between the pre- test and post- test was -0,567 (SD= 1,36). A dependant t-test shows that t(29)=-2,288 (p=0,030).

The mean score for the control group (figure 7b) in the pre-test was 5,62 (SD= 1,28), and mean score post-test was 5,87 (SD= 1,54). The mean difference between the pre- test and post- test was -0,250 (SD= 1,54). A dependant t-test shows that t(23)= -0,796 (p= 0,43).

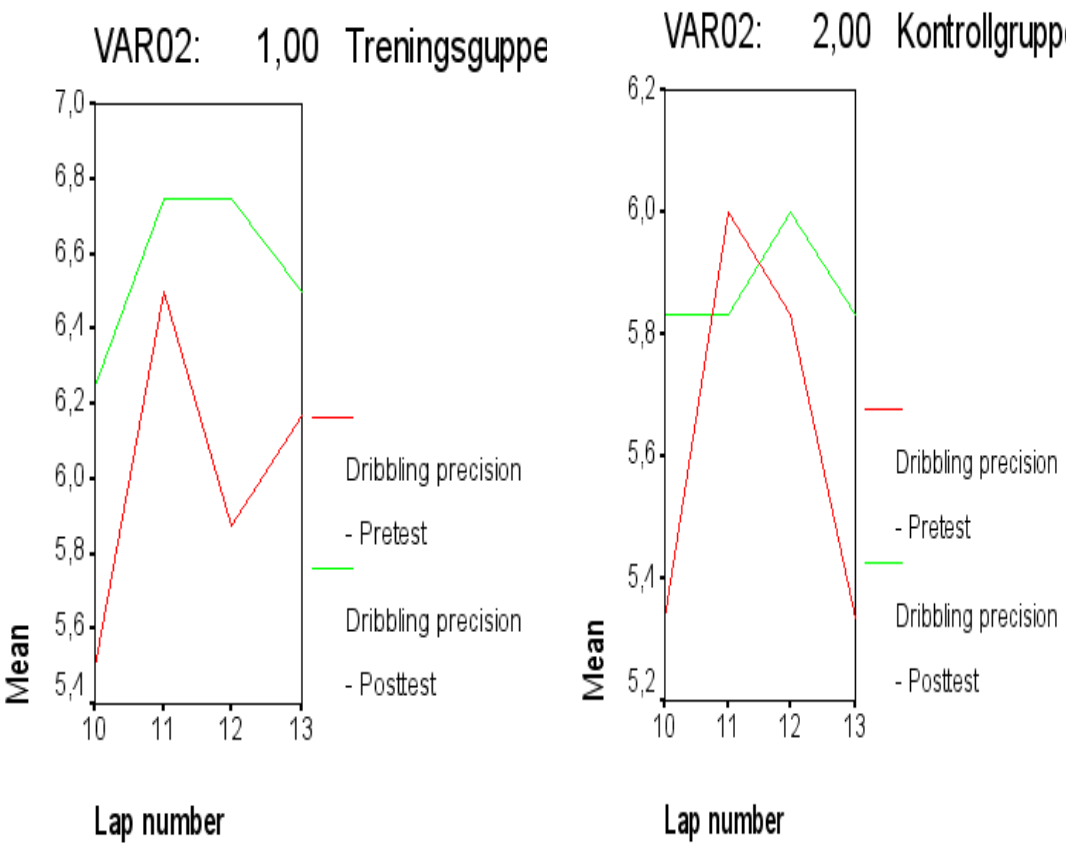

Figure 7a and 7b*.Mean score for 2A, the intervention group (7a) and for the control group (7b).*

2B: Dribbling rhythm

The results are presented in figure 8a (intervention group) and figure 8b (control group). The mean scores for each individual were calculated for laps ten to thirteen, i.e. the period of active recovery. The mean score for the intervention group in the pre-test (figure 8a) was 6,13 (SD= 1,28) and mean score post was 6,97 (SD= 0,72). The mean difference between the pre-test and post- test was 0,833 (SD= 1,31). A dependant t-test shows that t(29)= -3,470 (p=0,002).

The mean score for the control group (figure) in the pre-test was 5,79 (SD= 1,22), and mean score post-test was 5,62 (SD= 1,21). The mean difference between the pre- test and post- test was 0,167 (SD= 1,31). A dependant t-test shows that t(23)= 0,624 (p= 0,539).

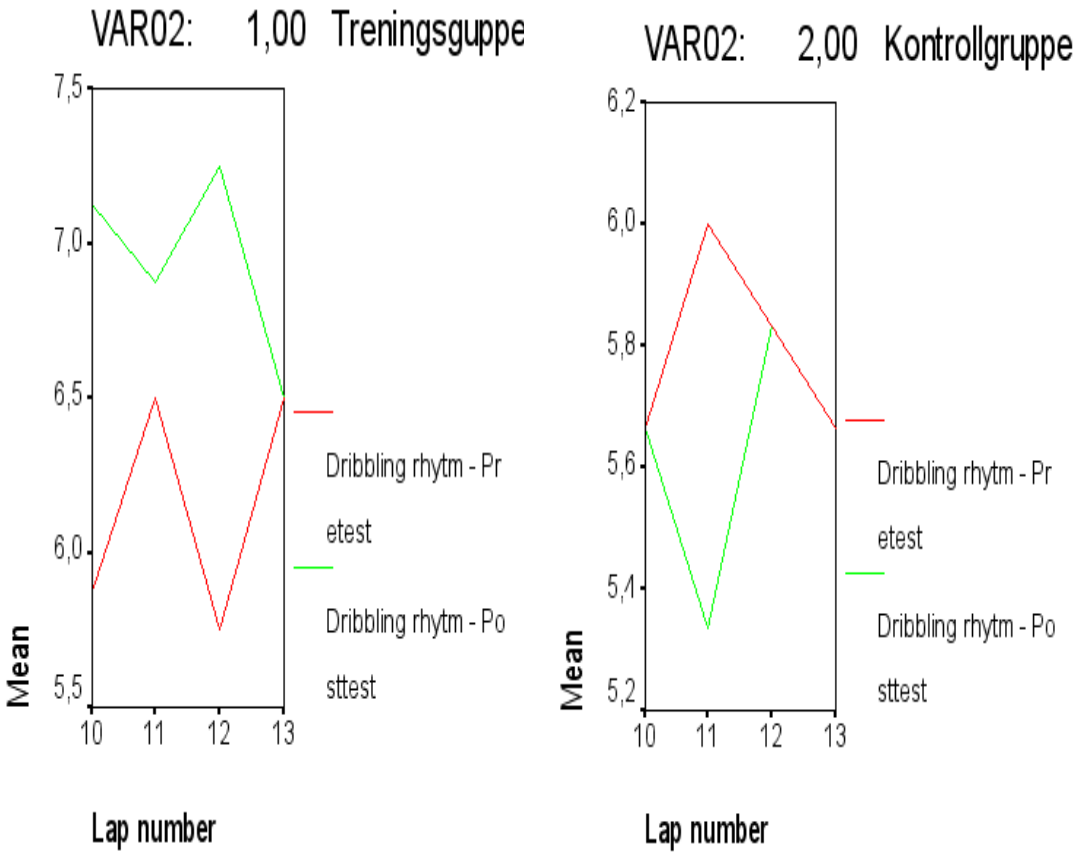

Figure 8a and 8b*.Mean score for 2B, the intervention group (8a) and for the control group (8b).*

3A: Passing precision

The mean score results are presented in figure 9a (intervention group) and figure 9b (control group). The mean score for each individual was calculated for lap ten to thirteen, i.e. the period of active recovery.The mean score for the intervention group in the pre-test (figure 8a) was 6,00 (SD= 1,95) and mean score post-test was 6,63 (SD= 1,63). The mean difference between the pre- test and post- test was -0,633 (SD= 2,36). A dependant t-test shows that t(29)= -1,472 (p= 0,152).

The mean score for the control group (figure) in the pre-test was 6,22 (SD= 1,65), and mean score post-test was 5,69 (SD= 1,69). The mean difference between the pre- test and post- test was 0,522 (SD= 2,27). A dependant t-test shows that t(22)= 1,100 (p=0,283).

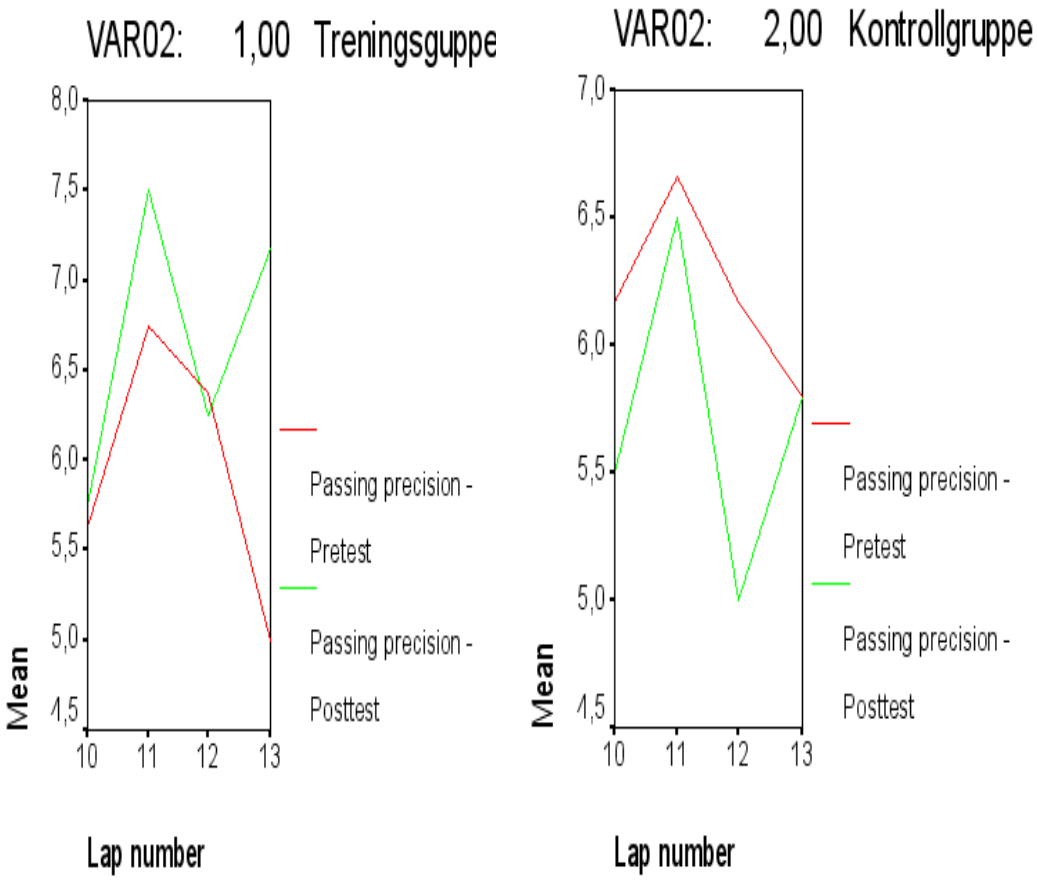

Figure 9a and 9b.*Mean score for 3A, the intervention group (9a) and for the control group (9b).*

3B: Passing rhythm

The results are presented in figure 10a (intervention group) and figure 10b (control group). The mean score for each individual was calculated for lap ten to thirteen, i.e. the period of active recovery. The mean score for the intervention group in the pre-test (figure 10a) was 5,73 (SD= 1,01) and mean score post-test was 6,50 (SD= 0,68). The mean difference between the pre- test and post- test was -0,800 (SD= 1,16). A dependant t-test shows that t(29)= -3,788 (p= 0,001).

The mean score for the control group (figure) in the pre-test was 5,74 (SD= 1,05), and mean score post-test was 5,35 (SD= 1,11). The mean difference between the pre- test and post- test was 0,391 (SD= 1,34). A dependant t-test shows that t(22)= 1,401 (SD= 0,175).

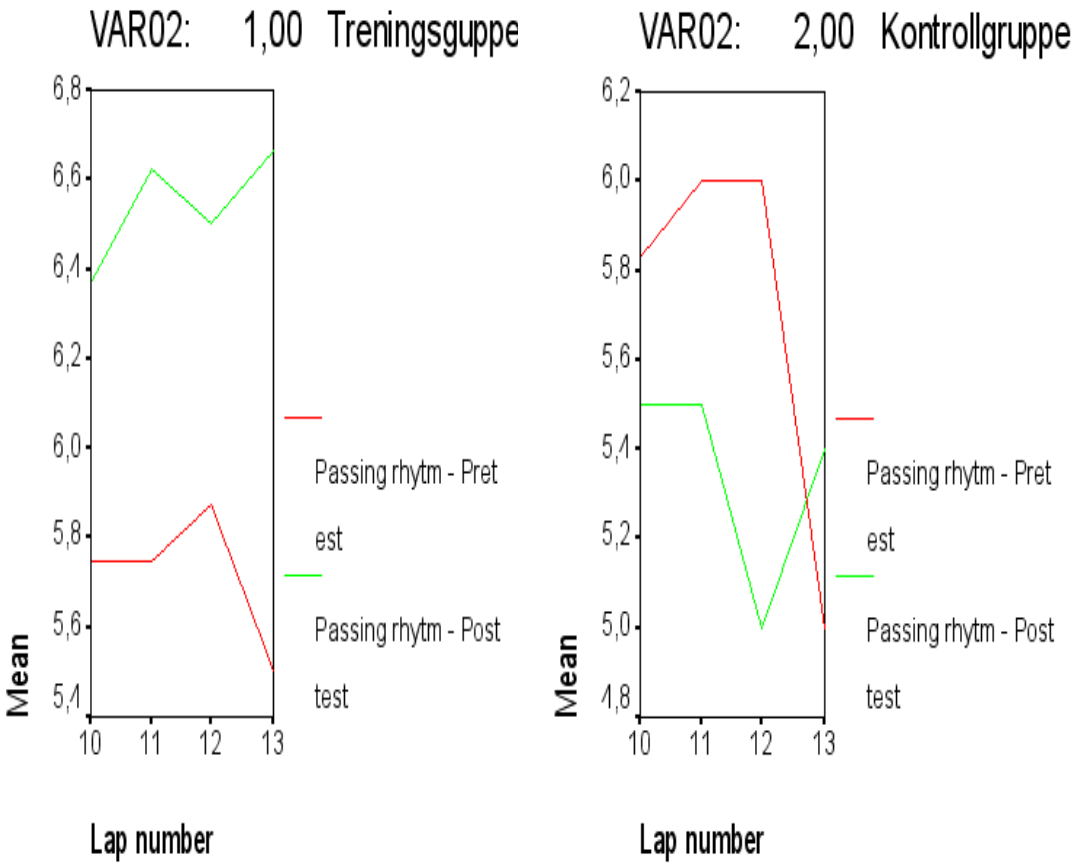

Figure 10a and 10b*.Mean score for 3B, the intervention group (10a) and for the control group (10b).*

4: Time used from the first to the last touch of the ball

The results are presented in figure 11a (intervention group) and figure 11b (control group). The mean score for each individual was calculated for lap ten to thirteen, i.e. the period of active recovery. The mean score for the intervention group in the pre-test (figure 11a) was 9,22 (SD= 1,82) and mean score post-test was 8,12 (SD= 0,84). The mean difference between the pre- test and post- test was 1,100 (SD= 1,89). A dependant t-test shows that t(29)= 3,188 (p= 0,003)

The mean score for the control group (figure 11b) in the pre-test was 8,91 (SD= 1,16), and mean score post-test was 9,14 (SD= 1,37). The mean difference between the pre- test and post- test was -0,226 (SD= 1,20). A dependant t-test shows that t(22)= -0,902 (p=0,377)

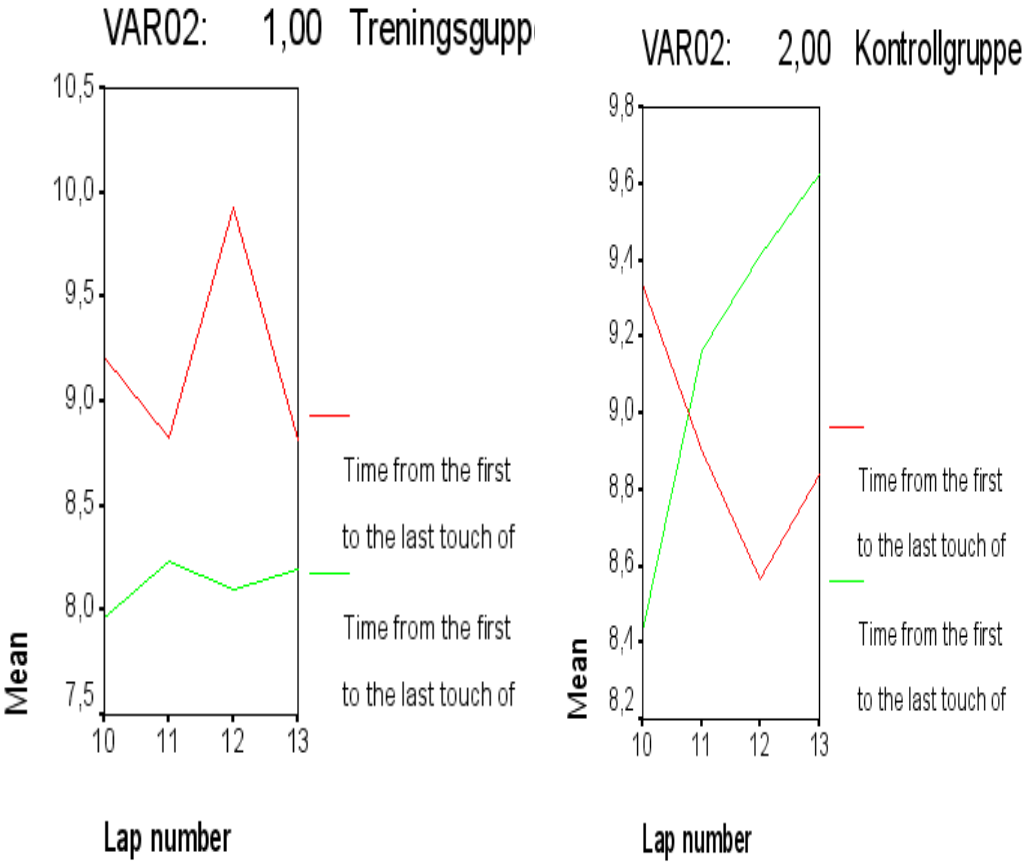

***Figure 11a and 11b**.Mean score for 4, the intervention group (11a) and for the control group (11b).*

Discussion

The experiment was carried out as planned, even though eight of the subjects dropped out of the study because of disease and / or damage, 14 subjects completed the experiment. There was no problem to motivate the subjects to do their best in tests and training sessions. The mean physiological measurements were similar to previously reported measurements for soccer players [32; 5; 13; 26; 35; 41; 43].

For the variable $VO_{2\ max}$ there were no significant differences from the pre- to post-test for neither group. Therefore, this variable does not seem to pose any threat as a confounding variable when it comes to changes from the pre- to the post-test. Even though the intervention group showed a higher average score on the $VO_{2\ max}$, the differences were not significant. The intervention group did consequently not show a higher cardiovascular fitness [29], as indicated by the $VO_{2\ max}$ values pre/post compared to the control group. The mean $VO_{2\ max}$ of elite adult soccer players are normally reported to be between 56–69 $ml \cdot kg^{-1}\ min^{-1}$ [32; 5; 13; 26; 35; 41; 43], this means that the subjects in this study were at the same fitness level. This makes the study relevant for the majority of players around the world. On the other hand, one has to be aware of the fact that the range of $VO_{2\ max}$ measurements are large, and individual differences are probably larger in lower divisions than in elite teams.

By analyzing the Borg-scale, self- rating results, one can assume that the participants have perceived the soccer field- test as somewhat difficult. This also indicates to other studies by Borg [10], that it was perceived as a test. The present study supports the use of RPE scores as a means of assessing exercise effort, with the proviso that certain situations or subjects may lessen their validity.

Normal period

The mean score for laps one to three (normal) for the soccer-field test had no difference between pre- and post-scores were found for neither the intervention group, nor for the control group. However, both groups used less time when they were not exposed to lactic acid.

Fatiguing period

The mean heart rate was approximately equal to previously reported results during match [15; 31; 6; 16], and lactate acid values were in the same range as previous studies of soccer matches [27; 17; 38]; one can assume that the intensity during the test were like a soccer match.

Active recovery period

Based on the findings in the active recovery period the present study showed that active recovery has an influence on the technique performance in soccer.

The difference in receiving the ball when passed from a distance of ten meters (1A) is clearly significant ($p< 0.05$) when the pre- test and post- test are compared for the intervention group. This indicates that the subjects in the intervention group have had an effect of training with active recovery, on receiving skills.

The Dependant t-test showed no significant difference in receiving the ball rhythm (1B) and dribbling precision (2A).

The difference in dribbling rhythm (2B) is clearly significant ($p<0.05$) when the pre- test and post- test are compared for the intervention group. This indicates that the subjects in the intervention group have had an effect of training with active recovery, on dribble rhythm. This appear to indicate that soccer players benefit from training with active recovery. Further

surported by the results from the control group, where the same analysis showed no significant change in their behavior from the pre- to the post-test. Furthermore, the results for both variables in laps one to three, i.e. the period where the players were not exposed to additional lactate acid were almost identical in the pre-and post-tests. This is attesting to the validity of the data, as the effect of active recovery training seems to be specific.

The Dependant t-test showed no significant difference in passing precision (3A).

The difference in passing rhythm (3B) is clearly significant ($p<0.05$) when the pre- test and post- test are compared for the intervention group. This indicates that the subjects in the intervention group have had an effect of training with active recovery, on passing rhythm. Attesting to the structure of the training is the observations that for the mean score for laps 1-3 for the test skill element 3B, no difference between pre- and post-scores were found for neither the intervention group, nor for the control group.

The difference in time from the first to the last touch of the ball (4) is clearly significant ($p<0.05$) when the pre- test and post- test are compared for the intervention group. This indicates that the subjects in the intervention group have had an effect of training with active recovery, on time from the first to the last touch of the ball. The results from the pre- to the post-tests were improved.

General

The present study confirms the general impression of previous studies, that active recovery has an effect on soccer players' restitution [1; 3; 25; 8; 19]. A study by Karlsen [21] suggested that technique training in a fatigue state also will give a beneficial effect for soccer players during a match [21]. These effects seem to be even more pronounced, when it comes to restitution after a period of high intensity work. In the present study there were found that soccer players not just only benefit in lactate reduction but also, with the influence of active recovery, can maintain or improve the technical skills in soccer through training. Based on

the findings in the studie the effect of elevated lactate concentration appears not to be dramatic. Lactate concentration at different laps varied markedly between subjects, and the technique score tended to be higher in pre- test. The present studie showed that active recovery can reduced the impairment in performance, this means that it might be advantageous for the soccer players on the skill level, to jog instead of standing still after the high intensity exercise periods during a match.

In the present studie there were few participants, the training took place in a relative short period of time (5 weeks), and the participants were beneath the highest level of soccer. There was also limited control over the training sessions that the players in both groups undertook throughout the intervention period of the study outside the specific training administered as part of the experiment. Furthermore, it would of course have been an advantage to do this study with more precise measures of both movements and performances.

In future studies one should therefore verify the present findings using a movement analytic system. But despite the possibility of these possible confounding variables and limitations, the results were according to expectations; the influence of active recovery, can maintain or improve the technical skills in soccer through practice. One should of course be careful not to generalize these results findings to all kind of sports. But at least this study should encourage further studies along theses lines. If the present study results are confirmed, this might have implication for several sports where one have periods with high intensity exercise with complex technique.

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Appendix

Appendix A - Information to the subjects

Til elever og/eller foreldre/foresatt

I anledning vår masteravhandling om ”teknikktrening ved utmattelse og restitusjon” som gjennomføres gjennom Høgskolen i Nord-Trøndelag, skal vi teste både VO2max og gjennomføre laktat (melkesyre) målinger. Dvs. enkle blodmålinger. Prosjektet gjøres i samarbeid mellom undertegnede og Sandnessjøen V.G.S idrettsfag. Søknader for godkjenning for publisering er sendt ut til Personvernombudet for forskning, Biobank, og Regional Etisk Komité for medisinsk forskning. Før materialet kan inn til vitenskapelige tidsskrifter, som gjør forskningsresultatene tilgjengelige for alle. Det er viktig at flest mulig stiller seg positive til å stille opp for å sikre seg at alle testene blir presise.

I den anledning spør vi om dere kan være med på disse testene. Dere under 18 år trenger underskrift hjemmefra. Lever å fort som mulig. Deltakelse er frivillig og det er mulig å trekke seg underveis uten å måtte begrunne dette. VO_{2max} målingene som gjennomføres på tredemølle, vil foregå på treningsrommet på skolen, mens den fotballtekniske og restitusjonsmålingene vil foregå i Helgelandshallen.

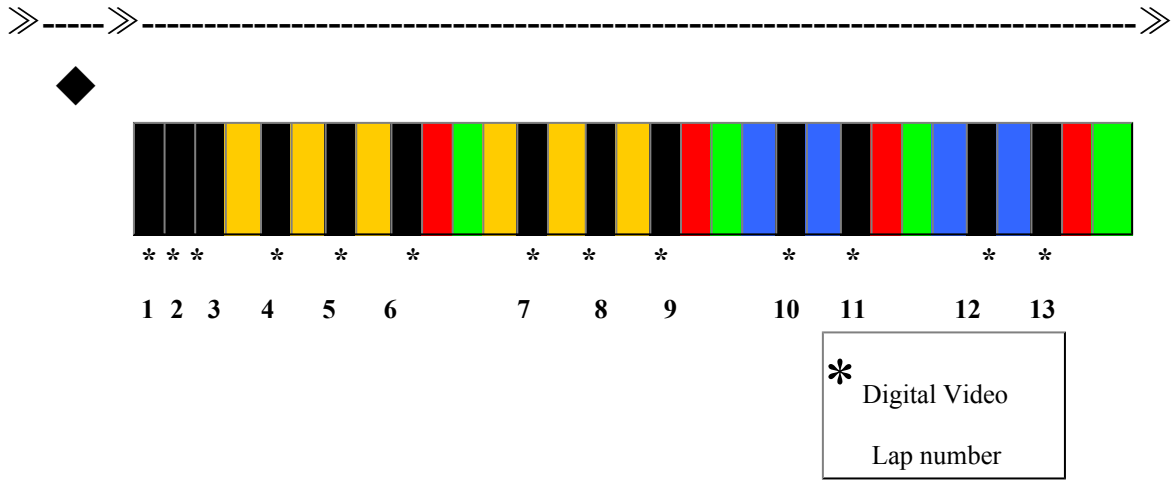
Dette skjer i skoletida, men det vil også bli tatt i bruk tid litt utover ettermiddagene. Erfaringer med fysiologisk testing er at det er givende og gir noe tilbake til utøverne som dere kan bruke som motivasjon og kunnskap senere. VO_{2max} testene vil bli tatt først, slik at vi har viktige data til teknikk og restitusjonstestene. Etter første test blir enkelte elever tatt ut til å trene spesifikt på testen, mens en annen gruppe elever trener på testen, men i uthvilt tilstand.

Ca. 4-6 uker senere vil det bli tatt nye tester for å se om det er forskjell. De samme testene vil bli gjort om igjen. Resultatene deres er underlagt taushetsplikt og behandles konfidensielt. Navnet deres eller skolens navn brukes ikke i noe skriftlig arbeid. Resultatene vil bli ført inn på data uten navn. Navn, med tilhørende kode, oppbevares på en separat liste, som ikke blir lagret elektronisk. Denne listen vil kun være tilgjengelig for undertegnede. Hvis dere ønsker det, vil dere i etterkant trekke dere fra undersøkelsen og be om at deres data blir slettet. Skolen vil få tilgang til resultatene. Det vil være en ekstra ressurs for skolen når de planlegger videre aktiviteter.
Mvh For mer informasjon kan vi kontaktes på tlf.
Kenneth Karlsen (95 04 27 53) Kurt G. Almendingen (91 82 69 39)

Fyll ut svarslippen nedenfor og lever den til idrettsfag sitt personale:

…… kan delta i fysiologiske tester som gjelder VO2max og laktat målinger.
(Elevens el foreldre/foresattes navn)

Appendix B - The experimental procedure sequence



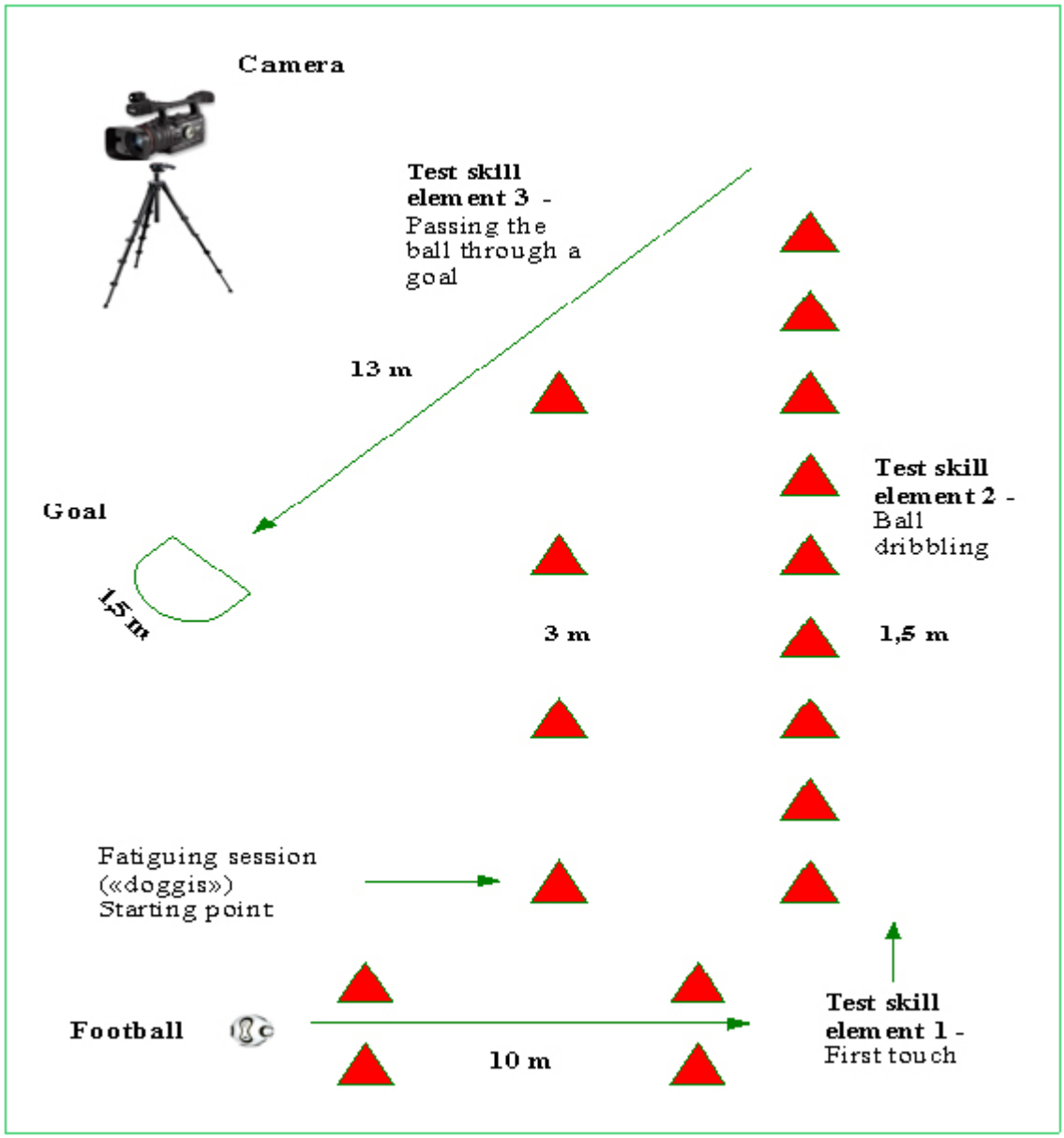
Laboratory test, VO2 maxand Borg Scale

Soccer field- test	Fatiguing protocol	Lactate test	The Borg Scale	Active recovery period

*The scores for lap **one to three** is without additional lactic acid (normal), lap **four to nine** are with additional lactic acid, and from lap **ten to thirteen** are the active recovery period. The Borg Scale and Lactate- test were measured after lap six, nine, eleven and thirteen. The fatiguing session were in between each track run from lap four to lap nine.*

***Figure 1 :** Illustration of the experiment procedure*

Appendix C - The Soccer -field test



The test track: The figure is illustrating the three skill components of the track and the position of the video camera. The test contained three test skill elements. First, the player received the ball, second, they dribbled nine cones with the ball, and third, at the end of the track, they passed the ball through a goal (Karlsen et al., 2005).

Appendix D - The Soccer - field test Score

Soccer - field test Score

The quality of first touch and passes were registered with a digital video camera. The quality was scored by the following four criteria:

1. Receiving precision (A) and rhythm (B), received the ball, passed from a distance of 13 meters
2. Dribbling precision (A) and rhythm (B), dribbled nine cones with 1.5 meters between them.
3. Passing precision (A) and rhythm (B), (at the end of the soccer- field track) passed the ball through a 1.5 meter goal located 13 meters away.
4. In addition, time used from the first to the last touch of the ball.

Each of the criteria was scored after a scale from one to nine (there one is the lowest and nine the highest) after the following elements:

Test skill element 1 – **1A**)Receiving the ball: First touch quality, precision 1 = total miss 2 = Completely out of control 3 = badly, out of area 4 = under middle 5 = middle 6 = over middle 7 = good 8 = very good 9 = ball tightly to the foot **1B) Rhythm** 1 = stiff as a log 2 = several corrections 3 = bad 4 = under middle 5 = middle 6 = over middle 7 = good 8 = very good 9 = dancing, elegant	Test skill element 2 – **2A**)Dribbling the ball between cones The dribbling quality, precision: 1 = can't finish the track 2 = several corrections 3 = bad, over 3 misses 4 = under middle, maximal 3 misses 5 = middle contribution with maximal 2 misses 6 = relatively close to the cones and maximal 1 miss, 7 = tight to the cones and no failures 8 = very tight to the cones and no failures 9 = extremely tight to the cones and no failures **2B) Rhythm** 1 = stiff as a log 2 = several corrections 3 = bad 4 = under middle 5 = middle 6 = over middle 7 = good 8 = very good 9 = dancing, elegant	Test skill element 3 – **3A**)Passing the ball The quality of the pass in relation to the target, precision: 1 = total miss 2 = goes far away 3 = long wide 4 = outside 5 = near the goal 6 = post out 7 = post in 8 = nice hit 9 = perfectly in the middle of the goal **3B) Rhythm** 1 = stiff as a log 2 = several corrections 3 = bad 4 = under middle 5 = middle 6 = over middle 7 = good 8 = very good 9 = dancing, elegant	Test skill element **4** - Time used on the soccer-field test track In addition, time used from first to last touch of the ball in the test track was registered.

Appendix E - Procedure for training and nutritional regime

Pre-Test procedure; in VO2max test, Soccer- field test and LactatePro LT-1710, Arkay KDK, Japan

The training and nutritional regimens in the two days immediately prior to the testing session can have an impact on your results. Please follow the following suggestions;

- Maintain a high carbohydrate diet

Try to emphasize such things as pasta, rice, bread, and potatoes in your meals. You should consume some type of carbohydrate drink (gatorade, power ade, exceed, etc.) immediately (within 30 minutes) following your workouts. Fat and protein will have no effect on lactate levels but may detract from the amount of carbs you can consume. Avoid all alcohol.

- Caffeine raises both lactate and heart rate levels

Do not consume caffeinated beverages in the 90 minute period before your test. If you have a morning test and need a cup of coffee make sure you are awake early enough to have it.

- Avoid higher intensity training

Strength training and categories V, IV, and III all use carbohydrates as their major fuel source. Carbohydrate depletion will result in false results. If you are training in the two days prior to testing try to do only category VI, and technical sessions. Please use some form of carbohydrate drink during these sessions and try to keep them to 90 minutes or less. Only one training session should be done the day before the test.

Appendix F - Lactate Pro Procedure

Lactate Pro Procedure

Performing a test:

1. Clean finger.
2. Prick finger.
3. Wipe away first drip of blood.
4. Insert test strip into Lactate Pro.
5. Place test strip (now in the Lactate Pro) in blood drop on finger (will fill via capillary action).
6. Machine beeps when it has enough blood.
7. The machine counts down from one minute and displays blood lactate levels in Mmol/L.
8. Throw strip in sealed box.

Lactate Pro was calibrated with instructions from the producer before every subjects.

Appendix G - The Borg Scale (The 15- Grad scale)

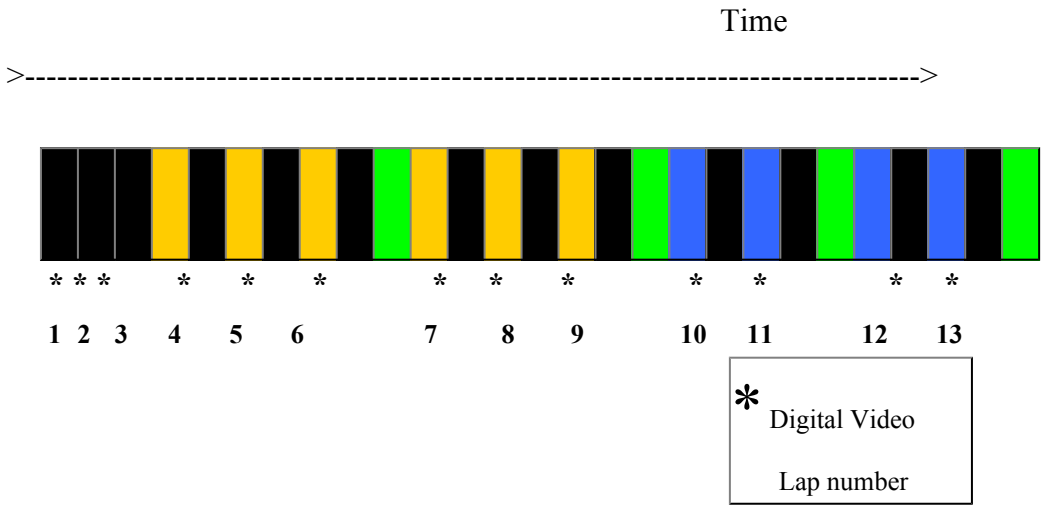
Borgs skala, en subjektiv gradering av anstrengelse.

For å kunne si noe om den subjektive opplevelse av anstrengelse ved en bestemt aktivitet er det utviklet et enkelt tallsystem, kalt Borgs skala, der tall mellom 6 og 20 skal angi ulike anstrengelsesgrader. Denne skalaen (Borg RPE = ratings of perceived exertion) er den mest brukte i forbindelse med testing og opptrening av friske personer. Skalaen er kjønns- og aldersuavhengig. Den subjektive opplevelsen av anstrengelse er imidlertid avhengig av personens fysiske form. Både muskelstyrke og aerob kapasitet reduseres med økende alder.

6	Ikke anstrengende
7	Meget, meget lett
8	
9	Meget lett
10	
11	Ganske lett
12	
13	Litt anstrengende
14	
15	Anstrengende
16	
17	Meget anstrengende
18	
19	Svært anstrengende
20	Maksimalt anstrengende

Appendix H - Active recovery period training regime

Intervention group; soccer specific training program of five weeks, eight times, procedure:



Soccer field- test	Fatiguing protocol	The Borg Scale	Active recovery period

Appendix I - Fullmaktserklæring

FULLMAKTSERKLÆRING – MASTERAVHANDLING

Tittel: Active recovery and technique performance in soccer.

Sett ett kryss:

- Jeg ønsker at min avhandling skal være allment tilgjengelig X
- Min avhandling må bare lånes ut etter samtykke i hvert enkelt tilfelle
- Min avhandling inneholder taushetsbelagte opplysninger og er derfor ikke tilgjengelig for

  andre

Dato: 2/6-09 Navn: Kurt G. Almendingen