The Handball-specific-complex-test, a tool for performance diagnostics and his benefits

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Science basisandbackground

Athletics and performance diagnostics has no evidence in team handball sport yet. One of the main reason is the difficulty to parametrizise and quantify the athletic´s performance during competition (performance efficacy). A golden standard in performance efficacy is missing and therefore, no tests for analysis can be created or validated. Motorscapacitieslike endurance, sprintingand agility can not be identified due to these lacks, although these abilities are needed to be improved specifically in athletic training.

Surprisingly in science literature for team handball we found three times more publications dealing with training programs instead of handball performance diagnostics (handball and training: 370 vs. handball and tests: 123).

This issue is not realized properly by the responsible actors like coaches, athletic trainers or sport managers. Performance diagnostics and athletic training are mainly based on experience or habits as well on uncritical transmission of non sports-specific tests like field-test, jump-test, sprint-test and shuttle-run protocols.

This unsatisfactory situation leads us in the year of 2008, to work with performance diagnostics in team handball sport more intensively. After 8 years of studies,we created a handball-specific complex test (HBCT) and proofed it for reliability (Koke 2015; Schwesig et al. 2016a). A first edition of the HBCT was published in 2010 (Schwesig et al. 2010), followed by longitudinal application (Schwesig et al. 2012). Due to further modifications and validation the current edition is available since July 2015 and published in 2016 (Schwesig et al. 2016b; Hermassi et al. 2017)

The goal for establishment was the inclusion of sport-specific actions like dribbling, throw or feint as well the respect of workload and demand in team handball. The athlete´s performance is meant as a sum and not as a synthesis of single actions. Therefore, the complex test was designed to demonstrate the intermittent character of the sport and relied on it, instead of assessing these activities separately

Description of HBCT

The HBCT (Figure 1) consists of four activity series (AS; Table 1): agility parcours, defensive action, sprint (10 m, 20 m) and throw on goal parcours. The four AS are to be completed twice and containing five active pauses (four times for 15 s, once 30 s between the two rounds), which reflects the intermittent load character during the match. The 10 minutes follow-up is based on the duration of the half-time (15 min) and is used to measure the ability of recovery of in the athlete duringthis period.

Beforecompleting the HBCT, the handball player performa warm-up (20 minutes) and the “throw on goal”-parcours (part 4 of the activity series) to compare throwing velocity and accuracy with and without pre-load.

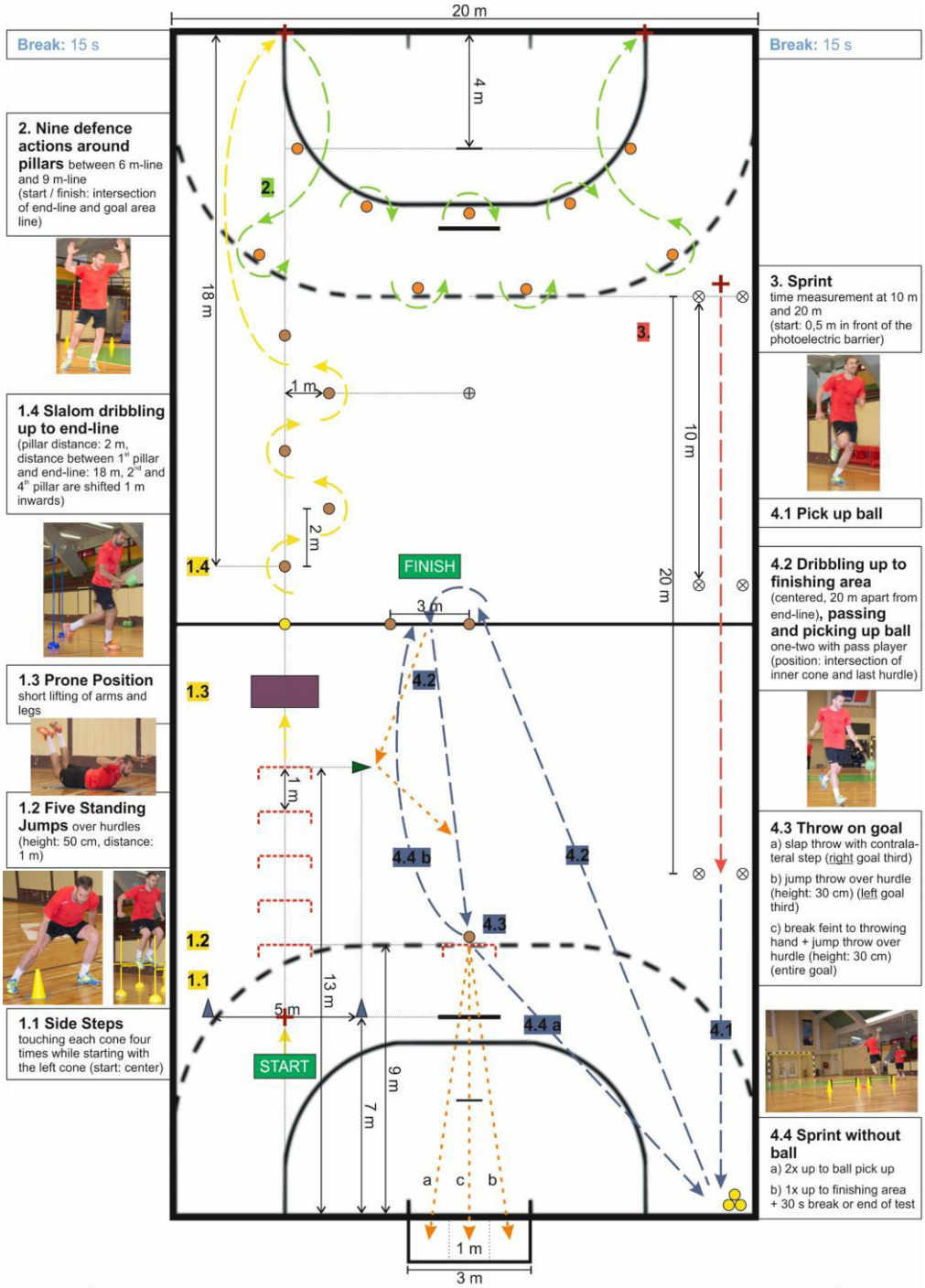
Break: 15 s
2. Nine defence actions around pillars between 6 m-line and 9 m-line (start / finish: intersection of end-line and goal area line)
1.4 Slalom dribbling up to end-line (pillar distance: 2 m, distance between 1st pillar and end-line: 18 m, 2nd and 4th pillar are shifted 1 m inwards)
1.3 Prone Position short lifting of arms and legs
1.2 Five Standing Jumps over hurdles (height: 50 cm, distance: 1 m)
1.1 Side Steps touching each cone four times while starting with the left cone (start: center)
20 m
4 m
18 m
1 m
2 m
10 m
20 m
3 m
5 m
13 m
9 m
7 m
1 m
3 m
FINISH
START
1.4
1.3
1.2
1.1
2.
3.
4.1
4.2
4.3
4.4 a
4.4 b
a
c
b
Break: 15 s
3. Sprint time measurement at 10 m and 20 m (start: 0,5 m in front of the photoelectric barrier)
4.1 Pick up ball
4.2 Dribbling up to finishing area (centered, 20 m apart from end-line), passing and picking up ball one-two with pass player (position: intersection of inner cone and last hurdle)
4.3 Throw on goal
a) slap throw with contralateral step (right goal third)
b) jump throw over hurdle (height: 30 cm) (left goal third)
c) break feint to throwing hand + jump throw over hurdle (height: 30 cm) (entire goal)
4.4 Sprint without ball
a) 2x up to ball pick up
b) 1x up to finishing area + 30 s break or end of test
Ball path
Ball
Hurdle
Cone
Path
Photoelectric barrier
Marking tape
Mat
Radar
Pillar
Pass player

Table 1: Detailed description of the HBCT

Number and name of activity series		Description	Pictures
Measurement of heart rate and lactate before, during (only heart rate) and after test (10 minutes) Blood lactate concentration measurements were performed sampling players' ear lobe blood before the test and 2, 6 and 10 minutes after the end of HBCT.			
Individual warm up of every athlete (20 minutes)			
1 Agility parcours	a) Side steps	Side steps between two cones (distance: 5 m). Touching each cone four times while starting with the left cone (start: center)	
	b) Standing jumps	Five standing jumps over hurdles (height: 50 cm, distance: 1 m)	
	c) Prone position	prone position sort lifting of arm and legs	
	d) Slalom dribbling	Slalom dribbling up to end-line (pillar distance: 2 m; pillar distance between 1st pillar and end-line: 18 m; 2nd and 4thpilaar are shifted 1 m inwards)	
2 Defensive action		Nine defense actions around pillars between 6 m-line and 9 m-line; 90° angle in the elbow and shoulder joint during the action(start/finish: intersection of endline and goal area line)	
3 Sprint		Sprint without ball handling; time measurement at 10 and 20 m (start: 0,5 m in front of the starting line)	
4 Throw on goal parcours	a) Pick up ball	The athlete picks up a ball at the corner of the side line and goal line (three times).	
	b) Dribbling	Dribbling up to finishing area (centered, 20 m apart from end-	

		line), passing and picking up ball with pass player (position: intersection of inner cone and last hurdle)	
	c) Throw on goal	Throw 1: slap throw with contralateral step (target: right goal third) Throw 2: jump throw over hurdle (height: 30 cm; target: left goal third) Throw 3: break feint to throwing hand + jump throw over hurdle (height: 30 cm; target: entire goal)	
	d) Sprint without ball	1. two times up to ball pick up 2. one up to finishing area + 30 s break between two rounds or end of the test	

The duration time of load is 90 seconds, including breaks (90 seconds), warm-up (20 minutes) and pre- and post-preparation (20 minutes) test time over all takes about 45 minutes for each athlete

Equipment of HBCT and measurement systems

Parameters for the HBCT like time, throwing velocity, heart rate and blood lactate concentration are determined as follows:

Time: Time is recorded using photoelectric cells (AF Sport, Wesel, Germany), placed at the start (0 m) and at 10 and 20 m afterwards.

Throwing speed: The maximum throwing speed is determined using a Speed Check Radar gun (Stalker Solo 2; Stalker, Plano, TX, USA). The reliability of the radar system was previously checked by measuring rolling balls by the radar and checking them over a given distance using photoelectriccells(Chelly SM and Denis C, 2001). The intraclass correlation coefficient (ICC) and coefficient of variation (CV) for the test was 0.92 and 3.0%, respectively.

Heart rate: Heart rate is measured using a real time monitoring system (Polar Team Pro System; Polar Electro Oy, Kempele, Finland). Mean heart rate during 10 minutes of recovery following the HBCT is measured and calculated (HBCT heart rate R0-R10).

Lactate: Blood lactate concentration was sampled from a players' ear lobe before the test and 2, 6 and 10 minutes after the end of HBCT. Lactate measurementwas performed using a lactate analyzer (Super GL easy; Dr. Müller Gerätebau GmbH, Freital, Germany).

For test assessment additional instruments and devices are needed as follows:

Table 2: Devices and materials for the conduction of HBCT

Action sequence	Materials
1. Agilityparcours	• 1 time watch • 1 handball • 2 cones • 5 hurdles • 1 floormat • 5 slalomrod • fixingtape
	• 1 time watch • 4 cones • 9 slalomrods
3. Sprint	• tape for starting line • 3 Stative • Pairs of light barriers including tripods
4. Throw on goalparcours	• 1 time watch • radar • 1 an athletefor ball serving • 3 handball • 3 slalomrods • 2 hurdles • 1 goal • 2 strapsfordividinggoal in third

* Over all two time watches are needed. A measure tape is necessary (at least 20 m long) to build up the test parcours.

Staff demand

The staff effort includes 5 persons. The test supervisor (1) carries out the determination of time and speed and provides implementation of the parcours. A staff assistant (2) at the court takes care for the correct time of recovery. In addition both are responsible to document and evaluate possible technical failures (i.e., dribbling, goal throw) of the test by participants. A serving athlete (3) is also present inthe field, andespecially for series 4 of the test. A fourth and fifth staff person provide the heart rate frequencyand blood lactate concentration, during and after the test.

Parameters and benefit of HBCT

The HBCT allows the measurement of the following parameters:

- number of technical errors,
- time (e.g., 10 m-Sprint, 20 m-Sprint, best and whole time),
- throwing velocity.

Furthermore a lot of dimensions can be evaluated:

- speed with and without ball, anaerobic capacity (handball-specific),
- speed endurance with and without ball,
- metabolic and cardiac recovery ability (handball-specific),
- handball-specific skills under pressure of time or accuracy (e.g., ball handling, throw accuracy).
- So far, in comparison to other single test of performance (threadmill step-test, jump- and sprint-diagnostics) the HBCT demonstrates a more precise image of the athlete´s performance capacity, based on sport-specific demands and loads, what is on high importance for reliability and validity. In conjunction with a threadmill performance diagnostic test and video game analysis it is possible to assess the single athlete´s capacities completely

Limitations

For test application and practicability an individual warm-up of the athlete should be replaced by a standardized program. Furthermore, a standard value of pre-load beforethe test would be of interest to minimize individual influences of the athletes before testing. One day of recovery or regenerative training on strength or endurance prior to assessment is recommended.

It is important to mention from our point of view that the HBCT in the current and new edition should be validated again regarding match efficacy. Furthermore, determination and parametrization of this

match efficacy needs to be assessed more specifically, because this is the golden standard for best reliability of a diagnostic test like the HBCT.

As a limitation we confine according to significance and validity ofthe HBCT that sports-specific factors like decisions in action, game effort, influence of opponents and psychological threat under action are not considered. These facts are not available for standardisation or numerical assessments. Therefore, these should be regarded to sufficient match observation and analysis.

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