2.3.2

RESTORING PLAYERS' SPECIFIC FITNESS AND PERFORMANCE CAPACITY IN RELATION TO MATCH PHYSICAL AND TECHNICAL DEMANDS

Restoring the players' specific fitness and performance capacity before joining the team for collective training sessions and competitions is essential

— With Martin Buchheit and Nicolas Mayer

In the lead up to returning to unrestricted football training and play, the players generally train individually with a physical/rehabilitation coach who ensures that the player's locomotor (i.e. running/movement) and technical loads are progressively built in relation to match demands (figure 1), while respecting indices of load tolerance, well-being (i.e. how the player is coping with those loads) and psychological readiness. Importantly, since these individual RTP sessions should prepare the players to train/play with the team within a few days, it is of utmost importance for the ball to be integrated as much as possible, and that specific movement coordination and muscle actions, decision-making, mental fatigue and overall self-confidence are considered continuously.

To illustrate our approach, we provide example of sequential RTP load progressions, i.e., designed for two common muscle injuries (hamstrings and rectus femoris) for two different playing positions in the field (wide defender, WD full back - FB and central midfielder (playing as a '6'), CM) (figure 2). The re-conditioning of both muscle groups requires the targeting of different locomotor patterns (with reference to the selective activation of those muscles in relation to specific running phases[1]); playing positions are also associated with distinct locomotor and technical demands (figure 1), which all need to be taken into account when designing the RTP program. While we acknowledge that there exist large differences in locomotor and technical demands within the same positions due to variations in players' physical profiles, style of play and match context, we have chosen to use the average demands of those 2 playing positions as a starting point to illustrate our methodology. In real-life scenarios, we recommend the systematic use of each player's unique locomotor and technical profile based on historical club data (i.e. from match analysis data) and personal observations (style of play and technical demands).

MATCH DEMANDS

The physical activity performed during matches should be considered as target for the conditioning programming. Assuming that the building up of minutes of play during matches may be progressive as well following an injury (i.e., playing 25-35 min as a sub for the first match post injury), the demands of 1 full half (45 min) to 60 minutes could be considered as the initial pre-competition target. To assess those specific physical demands, we recommend assessing the injured player's locomotor load with respect two distinct types of demands; high-speed running (HSR, which essentially put constrains on the hamstring muscles) and high-intensity actions (HIA) which encompasses all acceleration, deceleration and changes of direction activities and put major constrains on the quadriceps, adductors and the gluts) (figure 1). In the example given, we use mechanical work (MW) as the metric to measure HIA. It is important to note that this metric currently has preliminary validity and reliability only and needs to be tested further in scientific investigations.

However, we use this to illustrate the importance of the distinction between HSR and HIA in relation to individualising the RTP program according to the muscle injury location and player demands.

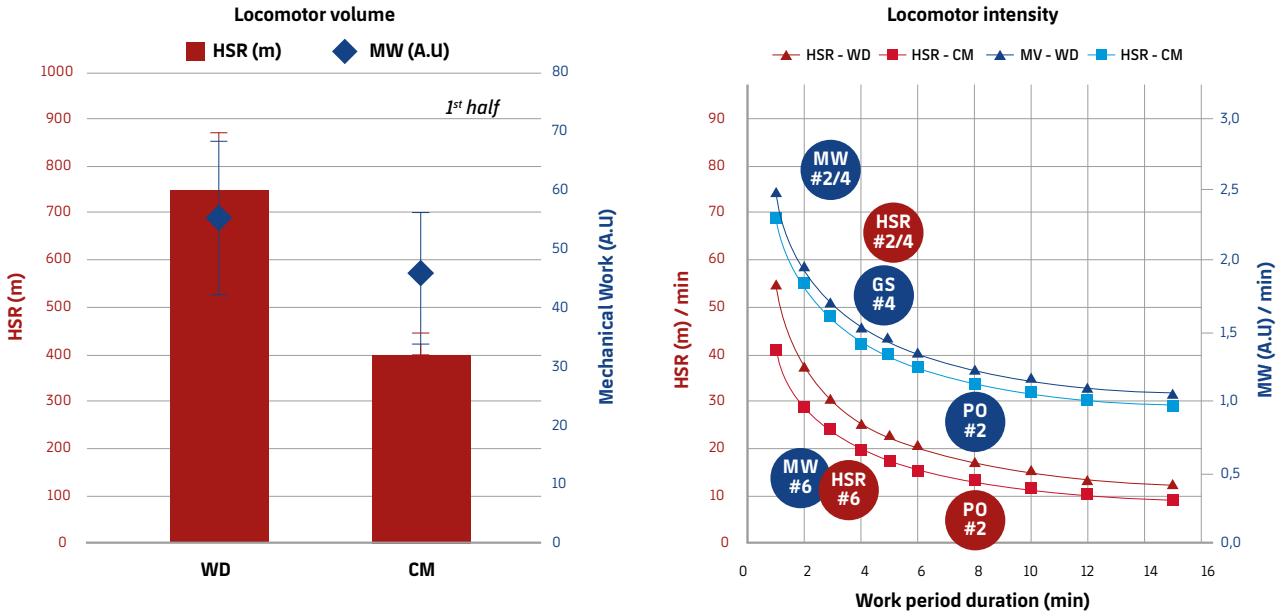

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Figure 1
Summary of the worst case-scenarios for locomotor volume demands (± standard deviation, SD) during League 1 and Champions League matches (1st half) for a wide defender (WD) and a midfielder (playing as a '6', CM), in terms of volume (left panel) and intensity (right panel) of high-speed running (HSR) and HIA expressed as mechanical work (MW). Volume refers to the greatest running distances covered during halves (± SD). Intensity is expressed, over exercise periods from 1 to 15 min, as 1) peak distance ran > 19.8 km/h per min, which is used as a proxy of HSR intensity and 2) peak MW per min (adapted from[2]). For example, over block periods of 4 min, CM can cover a maximum of 20 m of HSR / min. Similarly, WD can cover up to 55 m of HSR over 1 min-periods. For figure clarity, SD (~25%) are not provided for peak intensities. Adapted from Lacome et al.[3] The blue and red circles refer to the different specific training drills within S4 sessions, as indicated in Table 1 (HSR) and 2 (WM) with orange and blue backgrounds, respectively. #2/4 refers to the types of high-intensity training sequences with both a high neuromuscular strain and a metabolic component (mainly oxidative energy, Types #2; oxidative and anaerobic energy contribution, Type #4). #6 refers to Type #6 drills involving a high neuromuscular strain (but a low metabolic component), referring to quality high-speed and mechanical work training (long rests in between reps). The HSR and mechanical work intensity of 4v4 game simulations (with goal keeper, GS) and 6v6, 8v8 and 10v10 possession games (PO, without goal keeper) in which player participate at the end of the RTP process (S5, Table 1 and 2) is also shown. HSR intensity is not mentioned for such GSs, since the size of the pitch prevents player to reach such high speeds.

MUSCLE INJURED, LOAD PROGRESSION AND INTEGRATION OF POSITION-BASED PHYSICAL AND TECHNICAL MATCH DEMANDS

It is essential to build the cognitive and technical aspects alongside the locomotor demands. The sessions detailed in Figure 2 and table 1 are designed to target, alongside the integration of player- and position-specific technical tasks i) neuromuscular components in an isolated manner ("quality" sessions, such as Type #6 [4], see Table 1 legend) as well as ii) metabolic conditioning that often also integrates important neuromuscular demands (such as Types #2 or #4[4] see table 1 legend). Neuromuscular training refers to acceleration, deceleration, change of direction (i.e. measured MW as a proxy of HIA), speed and strength training which primarily relies on the performance of the neuromuscular system. Metabolic conditioning refers to the contribution and development of the aerobic and/or anaerobic energy systems.[4] It is important to consider that the progressions in load should be subtle to avoid excessive spikes.[5] We believe that the progressions should also be aimed at building up locomotor loads with alternations in session main objectives (cf tactical periodization

paradigm, allowing the physiological quality targeted a given day to recover the following day[6]). This should avoid creating excessive muscle soreness / residual fatigue from one day to the other, and helps players to train every day, which in turn may accelerate their full return to train/competition. Figure 2 illustrates how the locomotor contents of the sessions, in terms of HSR and MW may be modulated in response to 1) the muscle injured and 2) the position-specific locomotor demands. Table 1 and 2 provide the details of the sessions both in terms of locomotor load and technical orientations. For example, after a typical introductory session (S1) the focus/building up of HSR vs. MW differs in relation to muscle injury [with a greater emphasis on progressively building HSR after hamstring (HS) injury (S2HS) vs. building MW after a quadriceps injury (S2Q)]. After some progressions in terms of HSR and MW, the locomotor targets are further adapted based on the player's playing position. Following those final individual sessions (S1-S4), when it comes to transitioning with the team, we request players to participate in some (but not all) team training sequences, and to perform some extra/ individualized conditioning work. When taking part to in some of the game situations, we have them playing as jokers (or floaters, being systematically with the team in possession of the ball) for a few days, which has been shown to decrease their locomotor demands by 30% compared with the other players.[2] This offers a relatively safe (less contacts, no defensive role and no shots) and progressive loading for RTP players, while allowing them to be exposed to the most specific types of locomotor (especially decelerations and turns), technical and cognitive demands. This last phase of the RTP process is crucial since it allows players to regain their confidence and in turn, their full match-performance capacity. Finally, before their participation with the team as jokers/floaters, RTP players need sometimes to be exposed to specific warm-up sequences. They should also perform some individual conditioning work post session (in relation to the injury and individual game demands) (table 1 and 2).

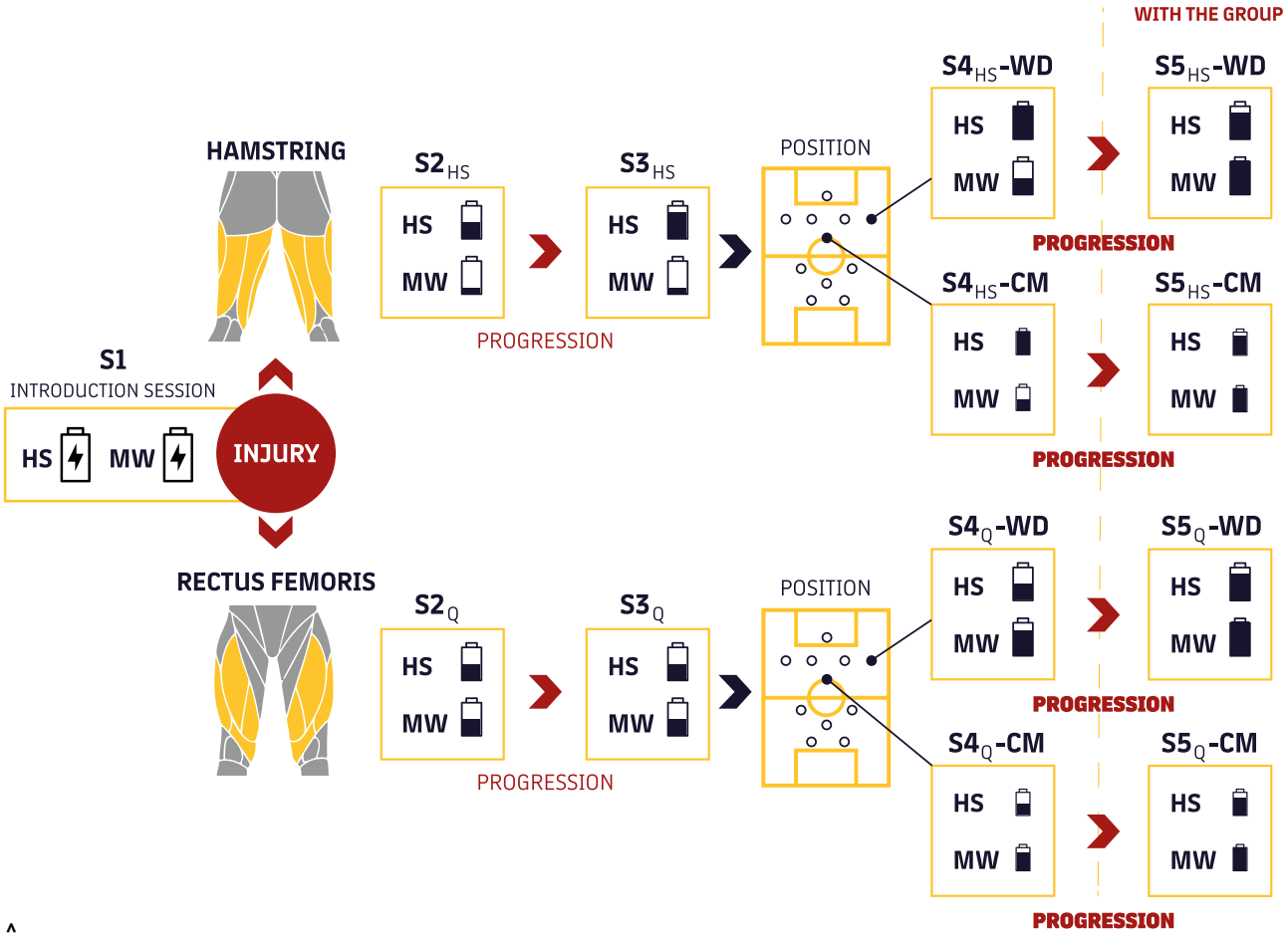

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Figure 2
Example of four sequential RTP load progressions in terms of the volume of locomotor demands, i.e., high-speed running (HSR) and mechanical work (MW). The sessions are designed for two very common muscle injuries (i.e., hamstrings, see details in Table 1 and rectus femoris, see details in Table 2) for two different playing positions in the field (wide defender, WD and central midfielder, MD). The size of the battery represents the actual/absolute volume of match demands (one half), while the coloured part within each battery represents the relative portion of one-half demands that is completed during the given session. Note that the total number of sessions required within each phase is obviously injury and context-dependent.

S1: Introduction session

- Low-intensity running related to sensations (6-8')
- Hip mobility + Running drills
- Agility closed-drills
- Functional work (without the ball)
- Type #1: 2x 4-min set: 6x 20s (slalom run 45° 80m) /20s (jog) (TD > 14.4 km/h ≈ 1000m, MaxV < 16 km/h).
- Cool down (3-5')

$S2_{HS}$:

- Monitoring (1): 4-min run at 12 km/h
- HIP mobility + Running drills
- Agility **closed**-skills (quality)
- Functional work with the ball (preparation)
- Technical Work with a Metabolic component
- Type #1: 1 x 3-min set: 15s (slalom run 65m) /15s (jog) (> 19.8 km/h ≈ 250m, MaxV < 22 km/h)
- Cool down (3-5')

$S3_{HS}$:

- Hip mobility + Running drills
- Agility **closed** to **open**-skills + Technical work
- Monitoring (2): 4 straight-line high-speed runs(box-to-box), 70m in 13s, 30-s passive recovery (> 19.8 km/h ≈ 200m)
- Technical Work Metabolic component + Neuromuscular constraints
- Type #2: 1 x 6min 40s set: 10s (50 m) /20s (passive) + 5s (28 m) /15s (passive) (> 19.8 km/h ≈ 250m, MaxV < 24 km/h)
- Cool down (3-5')

$S4_{HS}$-WD:

- Mobility + Technical work (short pass/volley)
- Running drills + Technical work (control/pass)
- Agility (<10m) + decision (quality)
- Type #6: Speed progression: 1x 10m, 1x 15m, 1x 20m (MaxV > 25km/h, rest between reps: 45s)
- Technical work: being orientated (3/4), dribbling and crossing
- I. Type #2: 1 x 4-min set: 10s (slalom 55 m) /20s (passive) (>19.8km/h ≈ 400m) *
- II. Type #2: Specific WD: 1 x 4-min set: 10s (technical demand: dribbling, passing, crossing) / 20s (passive) (>19.8km/h ≈ 300m)

$S4_{HS}$-CM:

- Mobility + Technical work (short pass/volley)
- Running drills + Technical work (control/pass)
- Agility (<10m) + decision (quality)
- Type #6: Speed progression: 1x 10m, 1x 15m, 1x 20m (MaxV > 25km/h, rest between reps: 45s)
- Technical work: taking information, controlling and COD with the ball, passing (5 to 20m)
- I. Type #2: 1x 4-min set: 10s (COD = 2x 25m)/ 20s (passive) + 5s (constraints)/25s (passive) (>19.8km/h ≈ 200m)
- II. Type #2: Specific CM: 1x 4-min set: 10s (with technical demand: turning, dribbling, passing) / 20s (passive) (>19.8km/h ≈ 150m)

S5hs-WD and S5hs-CM: in addition to taking part into possession games (without goal keeper) and game situations (with goal keepers) with the team as jokers/floaters initially, we recommend players to do some extra Type #6 high-speed runs aiming at reaching close-to-max velocities (with the volume adjusted with respect to distance of the following match). S4HS-WD drills with an orange background refer to the drills shown in Figure 1, right panel.

< Table 1
Example of session details of the hamstring injury sequential RTP load progressions.

Distance to run are provided for a player with an average locomotor profile (i.e., maximal aerobic speed 17.5 km/h, velocity reached at the end of the 30-15 Intermittent Fitness test (VIFT[7]) of 20 km/h and maximal spring speed of 32 km/h[8]). Note that the physiological objectives of each locomotor sequence (in terms of metabolism involved and neuromuscular load) is shown while using one of the 6 high-intensity training Types as suggested by Buchheit & Laursen.[4] Type #1, aerobic metabolic, with large demands placed on the oxygen (02) transport and utilization systems (cardiopulmonary system and oxidative muscle fibers); Type #2, metabolic as type #1 but with a greater degree of neuromuscular strain; Type #3, metabolic as type #1 with a large anaerobic glycolytic energy contribution but limited neuromuscular strain; Type #4, metabolic as type #3 but a high neuromuscular strain; Type #5, a session with limited aerobic response but with a large anaerobic glycolytic energy contribution and high neuromuscular strain; and Type #6 (not considered as HIIT) involving a high neuromuscular strain only, referring typically to quality high-speed and mechanical work training (long rests in between reps). Extended from figure 1 in Buchheit & Laursen.[4] Red font: emphasis on HSR running. Blue font: emphasis on MW. Green font: monitoring drills (see below). Text highlighted in orange refers to the HSR drills shown in figure 1 (right panel); Text highlighted in blue refers to the MW drills shown in figure 1 (right panel). Note: Slalom runs with 45° angles are often used (e.g., S1, S2HS) to decrease the actual neuromuscular load: turning at 45° requires to decrease running speed (less HSR) and doesn't requires to apply strong lateral forces (less MW), which in overall make the neuromuscular demands of these runs very low.[1]

See Table 1 for legends. Note: for the S2Q session, 10s/10s is preferred to other HIIT formats for the fact that it requires a greater number of accelerations than with longer intervals, which may help building up this capacity in a controlled and safe manner.

S1: Introduction session

- Low-intensity running related to sensations (6-8')
- Hip mobility + Running drills
- Agility closed-drills
- Functional work (without the ball)
- Type #1: 2x 4-min set: 6x 20s (slalom run 45° 80m) /20s (jog) (TD > 14.4 km/h ≈ 1000m, MaxV < 16 km/h).
- Cool down (3-5')

$S2_Q$:

- Monitoring (1): 4-min run at 12 km/h
- Hip mobility + Running drills
- Agility **closed**-drills (quality)
- Type #6: Mechanical work (45-90°): 6x 5+5m 45° CODx1 / 6x 5+5m 90° CODx1 (r: 45s between reps)
- Functional work with the ball (sensations)
- Type #1: 1 x 4-min set: 10s (slalom 45m) /10s (passive) (> 19.8 km/h ≈ 250m, MaxV < 22 km/h)
- Cool down (3-5')

$S3_Q$:

- Hip mobility + Running drills
- Agility **closed** to **open**-skills + Technical work
- Type #6: Mechanical work (45-90°): 2x 5+5+5m 45° CODx1 / 2x5+5+5m 90° CODx2 (r: 45s between repetitions)
- Technical work with Metabolic component
- Type #6: Mechanical work (130-180°): 4x5+5m 130° CODx1 / 4x5+5m 180° CODx1 (r: 45s between reps)
- Technical work with Metabolic component
- Cool down (3-5')

$S4_Q$-WD:

- Mobility + Technical work (short pass/volley)
- Running drills + Technical work (control/pass)
- Agility (<10m) + decision (quality)
- Monitoring (2): 4 straight-line high-speed runs(box-to-box), 70m in 13s, 30-s passive recovery (> 19.8 km/h ≈ 200m)
- Technical work: spreading, being orientated, controlling + passing backwards, inside, forwards
- I. Type #6, Mechanical work: 5+10m CODx1 + Finishing on small-goal, 2x 45°, 90°, 130°, 180° (r: 45s between reps)
- II. Type #2/4: Specific WD Mechanical work: 2x 3min 30s-set: 6 x ≈10s (specific) /≈25s (walk)

$S4_Q$-CM:

- Mobility + Technical work (short pass/volley)
- Running drills + Technical work (control/pass)
- Agility (<10m) + decision (quality)
- Monitoring (2): 4 straight-line high-speed runs(box-to-box), 70m in 13s, 30-s passive recovery (> 19.8 km/h ≈ 200m)
- Technical work: COD with the ball, being orientated, repeating short passes, playing between 2 lines and behind the defensive line
- I. Type #6, Mechanical work: 5+5+5m CODx2 + Finishing on small-goal, 2x 45°, 90°, 130°, 180° (r: 45s between reps)
- II. Type #2/4: Specific CM Mechanical work: 2x 2min 55s set: 5 x ≈10s (specific) /≈25s (walk)

S5Q-WD and S5Q-CM: in addition to taking part into possession games (without goal keeper) and game situations (with goal keepers) with the team as jokers/floaters initially, we recommend players to perform some additional acceleration/speed work with specific movement patterns of high quality (Type #6) including some kicking exercises (long balls and shoots). S4Q-WD drills with a blue background refer to the drills shown in Figure 1, right panel.

< Table 2
Example of session details of the quadriceps injury sequential RTP load progressions.

Figure 3
Schematic illustration of each of the Type #2 sequence described in Table 1 for session S4HS-WD, S4HS-CM, S4Q-WD and S4Q-CM.
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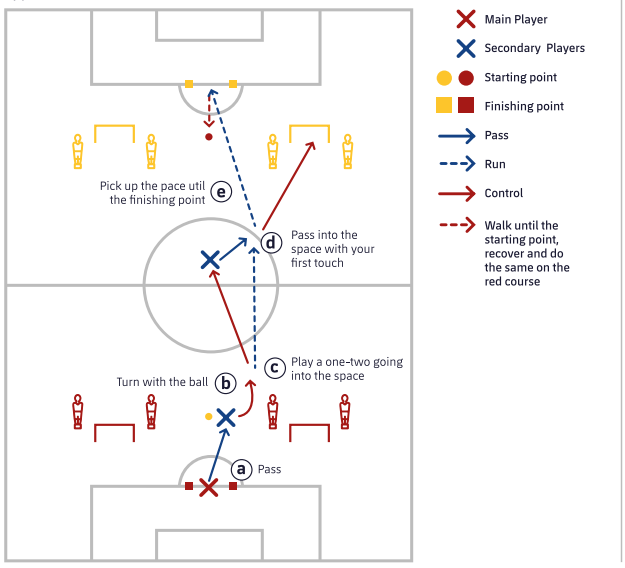
S4 HS - CM

Type #2 - 10s / 20s x8

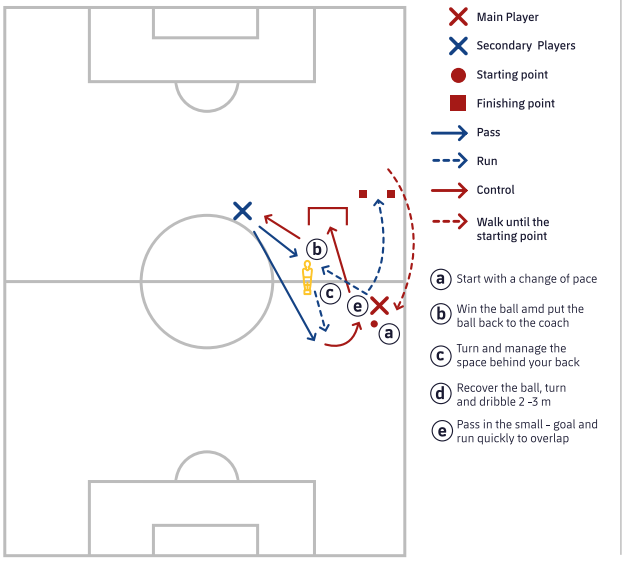


S4 HS - WD

Type #2 - 10s / 20s x8

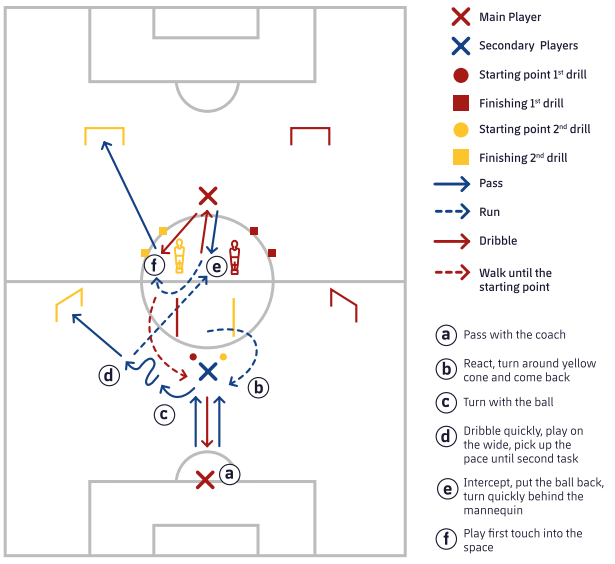
S4 Q - WD

Type #2/4 - ~ 10s / ~ 25s x6 - 2 sets



S4 Q - CM

Type #2/4 - ~ 10s / ~ 25s x5 - 2 sets



MONITORING THE RTP PROCESS IN THE FIELD

The monitoring of the responses to these types of RTP sessions is performed using both objective and subjective measurements. More specifically, toward the end of the sequence progression, as a part of one of the specific session, we conduct a standardized running test[9] (4-min run at 12 km/h where HR response is monitored in relation to historical data and used as a proxy of cardiovascular fitness, followed by 4 x 60m straight-line high-speed runs where both stride balance and running efficiency are examined via accelerometer data[10]) (See Table 1, e.g., green fonts, session S2HS and S3HS or S2Q and S4Q). Daily wellness assessment and medical screening are conducted daily to guide/adjust the loading of each session.

KEY MESSAGES IN RESTORING PLAYER'S SPECIFIC FITNESS AND PERFORMANCE CAPACITY DURING RTP

1. Consider the muscle injury type as a guide for RTP progression, e.g. Hamstring muscle requires more progressive loading of HSR, whereas Quadriceps muscle likely requires greater focus on HIA progressions and loading
2. Individualise further, the target physical loads (in terms of both volume and intensity, Figure 1 right panel) and technical demands based on the players' position on the field (using individual data if possible and knowledge of his playing style).
3. Facilitate players transition from individual to team work while adjusting the initial team sessions (individual warm-up, extra conditioning post session, and more importantly playing as joker during game-based sequences).
4. Monitor internal load to determine how the player is coping with these demanding final sessions before returning to competitions
5. Consider the players' psychological readiness to a) re-join the team and b) return to full match-play