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Ayala, Francisco ORCID logoORCID: https://orcid.org/0000-0003-2210-7389, López-Valenciano, Alejandro, Jose, Antonio, De Ste Croix, Mark B ORCID logoORCID: https://orcid.org/0000-0001-9911-4355, Vera-García, Francisco, García-Vaquero, Maria, Ruiz-Pérez, Iñaki and Myer, Gregory (2019) A preventive model for hamstring injuries in professional soccer: Learning algorithms. International Journal of Sports Medicine, 40 (5). pp. 344-353. doi:10.1055/a-0826-1955

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SDC 7: Description of the Isokinetic hamstring and quadriceps strength testing manoeuvre and measures obtained from it (names and labels).

Isokinetic hamstring and quadriceps strength assessment

A Biodex System-4 isokinetic dynamometer (Biodex Corp., Shirley, NY, USA) and its respective manufacture software were used to determine isokinetic concentric and eccentric torques during knee extension and flexion actions in both limbs following the methodology described by Ayala et al. [1,2].

The dynamometer was calibrated according to the manufacturer's instructions before the start of each test session. In each testing session only the dominant leg, determined through interview and defined as the leg preferred when kicking a ball, was tested.

Participants were secured in a supine position on the dynamometer with the hip passively flexed at 10-20º and the body head was maintained at 0º of flexion. The axis of rotation of the dynamometer lever arm was aligned with the lateral epicondyle of the knee. The force pad was placed approximately 3 cm superior to the medial malleolus with the foot in a relaxed position. Adjustable strapping across the pelvic, posterior thigh proximal to the knee and foot localised the action of the musculature involved. The range of movement was set from 0° (0º was determined as maximal voluntary knee extension for each participant) to 90° knee flexion. During the isokinetic testing procedure, the cushion setting on the control panel for the ends of the range of motion was set to its lowest (hardest) setting in order to reduce the effect of limb deceleration on the reciprocal motion.

The isokinetic examination was separated into two parts. The first part of the examination was the assessment of the hamstrings and quadriceps muscles during concentric/concentric (CON/CON) cycles with quadriceps undertaken first. After a 5 min rest period the eccentric/eccentric (ECC/ECC) testing cycle was performed. In both testing methods, two cycles of knee flexions and extensions were performed at four pre-set constant angular velocities in the following order: 60, 180, 240 and 300º/s (slow to fast). The passive eccentric mode was chosen so that the full range of movement would be completed for every action, which is important for the calculation of H/Q ratios using joint angle-specific torque values. Furthermore, this study employed continuous CON/CON and ECC/ECC cycles because they may have made the movement easier to understand and perform compared to CON/ECC cycles. The two testing parts (CON/CON and ECC/ECC) were separated by a 5 min rest interval and a rest of 30s was allowed between action cycles.

For both CON/CON and ECC/ECC cycles, participants were encouraged to push/resist as hard and as fast as possible and to complete the full range of motion. Participants were told to abort the test if they felt any discomfort or pain. During the test, all participants were given visual feedback from the system monitor. They were also verbally encouraged by the investigator to give their maximal effort, and the instructions were standardized by using key words such as "resist" and "hard and fast as possible".

Four different torque values (peak torque [PT] and three joint angle-specific torque values (15º, 30º and 45º) and the joint angle of peak torque (APT) were extracted for each movement (flexion and extension), muscle action (concentric, eccentric) and velocity (60, 180, 240 and 300º/s for concentric actions and 30, 60 and 180º/s for eccentric actions). In each of the three trials at each velocity, the PT and APT were reported as the single highest torque output and corresponding joint angle. For each isokinetic variable, the average of the 3 sets at each velocity was used for subsequent statistical analysis. When a variation >5% was found in the PT, angle-specific toque and APT values between the three trials, the mean of the two most closely related torque values were used for the subsequent statistical analyses.

Reciprocal (conventional and functional) hamstrings to quadriceps ratios as well as bilateral hamstrings and quadriceps ratios were also calculated using peak torque and joint angle-specific torque values extracted for each velocity.

Thus, the conventional hamstrings to quadriceps ratios were calculated as the ratio between the torque values produced concentrically by hamstrings and quadriceps muscles during the isokinetic tests. Functional hamstrings to quadriceps ratios were calculated as the ratio between the toque values produced eccentrically by hamstrings muscles and concentrically by the quadriceps muscles. Bilateral hamstrings and cuadriceps ratios were calculated dividing the PT value of the dominant limb by the PT value of the non-dominant leg.

Finally, the functional knee flexion to knee extension ratio proposed by Croisier et al. [3] was also calculated as the ratio between the torques (peak and angle-specific values) values produced eccentrically by the hamstrings at 30º/s and concentrically by the quadriceps muscles at 240º/s.

Description of the measures obtained from the isokinetic hamstring and quadriceps strength assessment.

Measure	**Labels**	
	Dominant Leg	**Non-Dominant Leg**
	Concentric Muscle Actions	
PT-Q_{60}	<172.6, 172.6-198.25 or >198.25	<161.1, 161.1-188.65 or >188.65
PT-H_{60}	<78.5, 78.5-98.2 or >98.2	<72.9, 72.9-89.1 or >89.1
PT-Q_{180}	<115.75, 115.75-136.9 or >136.9	<115.7, 115.7-136.3 or >136.3
PT-H_{180}	<62.8, 62.8-79 or >79	<62.75, 62.75-76.25 or >76.25
PT-Q_{240}	<102.8, 102.8-125.85 or >125.85	<100.4, 100.4-121.45 or >121.45
PT-H_{240}	<60.2, 60.2-74.8 or >74.8	<59.2, 59.2-71.85 or >71.85
PT-Q_{300}	<96.35, 96.35-113.2 or >113.2	<89.8, 89.8-109.85 or >109.85
PT-H_{300}	<57.05, 57.05-71.35 or >71.35	<52.85, 52.85-63.65 or >63.65

APT-Q	<45, 45-60 or >60	
APT-H	<25, 25-35 or >35	
	Eccentric Muscle Actions	
PT-H$_{30}$	<77, 77-101.25 or >101.25	<72.15, 72.15-86.9 or >86.9
PT-Q$_{30}$	<171.95, 171.95-221.6 or >221.6	<160, 160-207.75 or >207.75
15-T-H$_{30}$	<59.75, 59.75-89.4 or >89.4	<55.05, 55.05-77.15 or >77.15
15-T-Q$_{30}$	<28.15, 28.15-48 or >48	<28.7, 28.7-46.15 or >46.15
30-T-H$_{30}$	<65.8, 65.8-82.8 or >82.8	<59.9, 59.9-76.2 or >76.2
30-T-Q$_{30}$	<82.35, 82.35-110.15 or >110.15	<73.8, 73.8-100.15 or >100.15
45-T-H$_{30}$	<61.35, 61.35-80 or >80	<56.2, 56.2-69.85 or >69.85
45-T-Q$_{30}$	<127.3, 127.3-159.5 or >159.5	<114.05, 114.05-149.05 or >149.05
PT-H$_{60}$	<78.65, 78.65-101.9 or >101.9	<69.3, 69.3-88.7 or >88.7
PT-Q$_{60}$	<180.45, 180.45-230.35 or >230.35	<164.4, 164.4-211.45 or >211.45
15-T-H$_{60}$	<66.85, 66.85-85.5 or >85.5	<56.3, 56.3-79.65 or >79.65
15-T-Q$_{60}$	<32.9, 32.9-44.4 or >44.4	<28.95, 28.95-44.5 or >44.5
30-T-H$_{60}$	<67.95, 67.95-87.75 or >87.75	<60.25, 60.25-78.15 or >78.15
30-T-Q$_{60}$	<76.8, 76.8-100 or >100	<74.2, 74.2-102.48 or >102.48
45-T-H$_{60}$	<63.95, 63.95-80.25 or >80.25	<59.45, 59.45-74.05 or >74.05
45-T-Q$_{60}$	<120.65, 120.65-159.05 or >159.05	<119.65, 119.65-148.8 or >148.8
PT-H$_{180}$	<76.25, 76.25-98.7 or >98.7	<71.6, 71.6-90 or >90
PT-Q$_{180}$	<163.3, 163.3-201.35 or >201.35	<163.15, 163.15-194.3 or >194.3
15-T-H$_{180}$	<47.35, 47.35-72.9 or >72.9	<51.75, 51.75-75.9 or >75.9
15-T-Q$_{180}$	<41.5, 41.5-53.2 or >53.2	<38.65, 38.65-53.95 or >53.95
30-T-H$_{180}$	<68.15, 68.15-85.35 or >85.35	<60.05, 60.05-83.45 or >83.45

30-T-Q_{180}	<97.1, 97.1-117.8 or >117.8	<82.4, 82.4-114.4 or >114.4
45-T-H_{180}	<74.05, 74.05-89.1 or >89.1	<66.85, 66.85-81.3 or >81.3
45-T-Q_{180}	<144.3, 144.3-168 or >168	<131.5, 131.5-167.35 or >167.35
APT-H	<25, 25-35 or >35	
APT-Q	<50, 50-65 or >65	
	Unilateral Conventional Ratios	
H/Q_{CONV60}	<0.47, 0.47-0.60 or >0.60	
H/$Q_{CONV180}$	≤0.60 or >0.60	
H/$Q_{CONV240}$	≤0.60 or >0.60	
H/$Q_{CONV300}$	<0.6, 0.6-0.8 or >0.8	
	Angle-Specific Unilateral Conventional Ratios	
15-H/Q_{CONV60}	<0.93, 0.93-1.165 or >1.165	<0.915, 0.915-1.17 or >1.17
15-H/$Q_{CONV180}$	<1.06, 1.06-1.425 or >1.425	<1.075, 1.075-1.505 or >1.505
15-H/$Q_{CONV240}$	<0.8, 0.8-1.175 or >1.175	<0.75, 0.75-1.065 or >1.065
15-H/$Q_{CONV300}$	<0.54, 0.54-0.885 or >0.885	<0.565, 0.565-0.885 or >0.885
30-H/Q_{CONV60}	<0.645, 0.645-0.76 or >0.76	<0.625, 0.625-0.735 or >0.735
30-H/$Q_{CONV180}$	<0.695, 0.695-0.835 or >0.835	<0.66, 0.66-0.82 or >0.82
30-H/$Q_{CONV240}$	<0.665, 0.665-0.785 or >0.785	<0.645, 0.645-0.755 or >0.755
30-H/$Q_{CONV300}$	<0.835, 0.835-1.085 or >1.085	<0.87, 0.87-1.075 or >1.075
45-H/Q_{CONV60}	<0.435, 0.435-0.515 or >0.515	<0.425, 0.425-0.515 or >0.515
45-H/$Q_{CONV180}$	<0.505, 0.505-0.595 or >0.595	<0.495, 0.495-0.585 or >0.585
45-H/$Q_{CONV240}$	<0.535, 0.535-0.62 or >0.62	<0.515, 0.515-0.615 or >0.615
45-H/$Q_{CONV300}$	<0.545, 0.545-0.645 or >0.645	<0.515, 0.515-0.61 or >0.61
	Unilateral Functional Ratios	

H/Q_{FUNC60}	<0.6, 0.6-0.7 or >0.7	
$H/Q_{FUNC180}$	≤0.80 or >0.80	
H_{30}/Q_{240}	<0.8, 0.8-1.0 or >1.0	
	Angle-Specific Unilateral Functional Ratios	
$15\text{-}H/Q_{FUNC60}$	<0.915, 0.915-1.175 or >1.175	<0.875, 0.875-1.12 or >1.12
$15\text{-}H/Q_{FUNC180}$	<0.8, 0.8-1.315 or >1.315	<0.985, 0.985-1.32 or >1.32
$15\text{-}H_{30}/Q_{240}$	<1.42, 1.42-1.785 or >1.785	<1.18, 1.18-1.63 or >1.63
$30\text{-}H/Q_{FUNC60}$	<0.605, 0.605-0.735 or >0.735	<0.545, 0.545-0.695 or >0.695
$30\text{-}H/Q_{FUNC180}$	<0.755, 0.755-0.945 or >0.945	<0.715, 0.715-0.865 or >0.865
$30\text{-}H_{30}/Q_{240}$	<0.875, 0.875-1.05 or >1.05	<0.765, 0.765-0.965 or >0.965
$45\text{-}H/Q_{FUNC60}$	<0.435 ,0.435-0.525 or >0.525	<0.415, 0.415-0.5 or >0.5
$45\text{-}H/Q_{FUNC180}$	<0.665, 0.665-0.76 or >0.76	<0.575, 0.575-0.715 or >0.715
$45\text{-}H_{30}/Q_{240}$	<0.635, 0.635-0.775 or >0.775	<0.585, 0.585-0.71 or >0.71
	Bilateral Ratios	
H/H_{CON60}	No Asymmetry or Asymmetry	
H/H_{CON180}	No Asymmetry or Asymmetry	
H/H_{CON240}	No Asymmetry or Asymmetry	
Q/Q_{CON60}	No Asymmetry or Asymmetry	
Q/Q_{CON180}	No Asymmetry or Asymmetry	
Q/Q_{CON240}	No Asymmetry or Asymmetry	
H/H_{ECC60}	No Asymmetry or Asymmetry	
H/H_{ECC180}	No Asymmetry or Asymmetry	

PT: peak torque; H: hamstring; Q: quadriceps; CON: concentric; ECC: eccentric; APT: angle of peak torque.

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