

New aspects of exercise testing on dynamometer

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Introduction:

- isokinetic tests are a common method to quantify strength capacity
- in high speed movements, substantial limitations (validity) are still present
Baltzopoulos 1989; Chow 1997; Yen 2005
- effect of gravity and the moment of inertia are influencing factors

Purpose: to investigate the effect of compensating the moment of inertia (I_{comp}) on the realized speed in single and multijoint movements at different speeds compared to no compensation of the moment of inertia (I_{no_comp}).

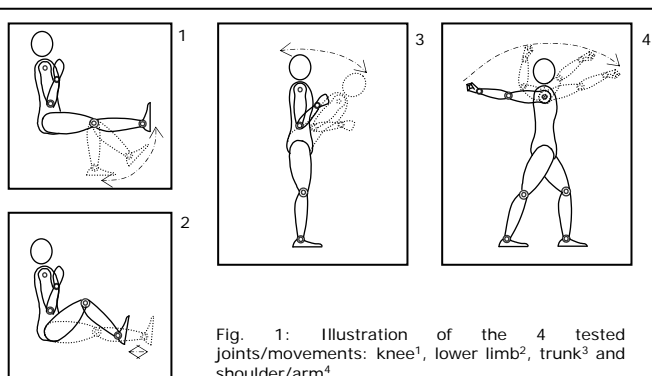


Fig. 1: Illustration of the 4 tested joints/movements: knee¹, lower limb², trunk³ and shoulder/arm⁴

Methods:

Subjects

- N=25 healthy subjects (age: 27 ± 4.4 years; N=11/14 ♀/♂)
- activity level ranged between no exercise up to daily exercise

Material

- rotational and linear dynamometers (Con-trex® MJ/LP/TP/WS CMV AG)

Protocol

- 10 min. warm-up run on a treadmill
- strength test with maximum effort
- 5 repetitions each test; 60 seconds break between tests
- measurement type: isokinetic concentric
- Modi: I_{comp} vs. I_{no_comp} in randomized order
- test progression randomized
- movements (Fig. 1):
 1. single joint knee extension and flexion (K) (60, 180 and 360°/s)
 2. lower limb extension and flexion (L) (0.3, 0.6 and 0.9 m/s)
 3. trunk extension and flexion (T) (60 and 120°/s)
 4. complex shoulder/arm extension (S) (60, 180 and 360°/s) (Fig. 1)

Outcome measure: realized maximum velocity

Statistics: descriptive (mean and 95% confidence interval)

Results:

- effect of I_{comp} mode (compensation of inertia) depends on the movement and on the measurement speed
- knee (Tab. 1):
 - no differences between modi
- lower limb (Tab. 1):
 - no differences in extension
 - higher velocities reached in flexion (I_{comp} mode)
- trunk (Fig. 2):
 - all subjects preset speed at 120°/s with I_{comp} mode but not with I_{no_comp} mode
- shoulder/arm (Tab. 1):
 - higher velocities in extension (diff. up to 170°/s) (I_{comp} mode)
- preset speed not reached by all subjects in all movements due to ROM (range of motion) (independent of modi)

Discussion:

- validity of isokinetic tests with high velocities is enhanced (I_{comp} mode)
Chow 1997; Mayer 2001
- limits, due to the ROM, are still present

Conclusion:

- I_{comp} measurement mode is highly relevant for high speed tests with large body segments involved
- patients with lower strength levels will probably benefit already at low test speeds and tests with small inertia (e.g. knee).

References:

- Baltzopoulos V, Brodie DA: Isokinetic dynamometry. Applications and limitations. Sports Med. 1989; 8: S101-S116.
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TP trunk flexion concentric isokinetic I_{comp} vs. I_{no_comp}

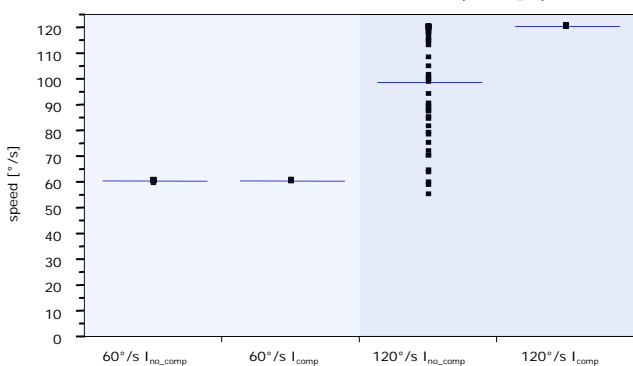


Fig. 2: Realized maximum speed: trunk flexion at preset 60 and 120°/s in I_{no_comp} and I_{comp} measurement mode (comparison: no compensation - with compensation of the moment of inertia) [°/s]

joint/movement	preset speed	Extension		Flexion	
		$V_{max} I_{no_comp}$	$V_{max} I_{comp}$	$V_{max} I_{no_comp}$	$V_{max} I_{comp}$
knee	60 [°/s]	60.9	60.9	60.8	60.8
knee	180 [°/s]	181.1	181.0	181.3	181.3
knee	360 [°/s]	349.9	350.0	347.1	349.4
lower limb	0.3 [m/s]	0.305	0.301	0.300	0.303
lower limb	0.6 [m/s]	0.592	0.593	0.421	0.593
lower limb	0.9 [m/s]	0.670	0.678	0.420	0.680
trunk	60 [°/s]	60.5	60.6	60.5	60.5
trunk	120 [°/s]	116.6	120.5	98.5	120.6
shoulder/arm	60 [°/s]	61.5	61.4		
shoulder/arm	180 [°/s]	136.1	182.5		
shoulder/arm	360 [°/s]	142.5	305.5		

Tab. 1: Realized maximum speed in knee, lower limb, trunk and shoulder/arm extension/flexion at preset speed [°/s ; m/s]