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Effect of dynamic onset threshold on the rate of force development. A new paradigm.

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INTRODUCTION:
The determination of the force onset (FO) can affect the assessment of the rate of force development (RTD) in isometric explosive contractions [1,2]. Typically, a fixed FO either as absolute, relative or arbitrary value is used [1]. As "gold standard" stands the set of FOs manually, with low initial force value, in a non-filtered signal, with a custom-made dynamometer [1,3]. However, many laboratories are using commercial dynamometers with noisy force signal that need to be filtered [4]. Additionally, if numerous trials exist, the manual FO setting is labor intensive, time consuming [5] and could demonstrate poor reproducibility [6]. Furthermore, all fixed FOs, although objective, do not consider the contraction dynamics (velocity, acceleration), hence they do not assure identical dynamic starting condition. Therefore, this study aimed at investigating the effect of different dynamic onsets on maxRTD, time to reach maxRTD (TR) and the variability (coefficient of variation (CV)).
METHODS:
Moment-time traces from knee extension contractions were used (trials=120, n=10). Data were filtered and seven dynamic FOs (100:50:400Nm/s) were applied to calculate the RTD from onset, every 1ms, until 250ms (250 intervals). We calculated mean, standard deviation and CV. Friedmans test and Wilcoxon posthoc with a Bonferroni correction was used for TR and maxRTD. Statistical Non-Parametric Mapping (SnPM{F}) with Bonferroni post hoc correction (a=0.0024) was used for the CVs for the different FOs and intervals.
RESULTS:
Dynamic onset affected significant the maxRTD and TR (both $x^2(6)=716.7$, $p<.001$). Post hoc analysis showed significant increase in maxRTD and decrease in TR in all but for FOs 350vs400Nm/s ($p=0.59$) (maxRTD: 1633.3±22.9, 1703.4±21.9, 1760.7±21.2, 1804.7±20.9, 1843.5±21.1, 1877.7±21.3, 1905.4±21.2Nm/s and TR: 62.1±17.7, 57.7±15.7, 54.7±15.1, 52.5±14.7, 50.6±14.6, 48.9±14.4, 47.5±14.2 ms for 100:50:400Nm/s respectively). The SnPM{F} CVs comparison showed significant reduction clusters between 0-50, 120-199 and 220-250ms ($p=.01$). Post hoc comparison SnPM{F} only at 1-100ms area, showed significant lower CV clusters (~1-45ms) between FOs 100:50:400, 150:50:400, 200:300 Nm/s and non-beyond 250Nm/s.
CONCLUSION:
The CV did not show any difference after 250Nm/s indicating that any further increase of the FO will not further reduce the CV. As expected, the dynamic FO affects the maxRTD and TR. Additionally, the respective force levels (0.2±1.6, 0.2±1.7, 0.6±1.6, 1.0±1.6, 1.4±1.6, 1.7±1.6, 2.1±1.7 Nm for 100:50:400Nm/s) remained low, indicating that the method can reliably assess RTD. This study provides the first evidence of a dynamic FO that considers also the dynamic status of the contraction.
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