Eur J Appl Physiol (2016) 116:445–446
DOI 10.1007/s00421-015-3287-5

REPLY

An inability to distinguish edematous swelling from true hypertrophy *still* prevents a completely accurate interpretation of the time course of muscle hypertrophy

Felipe Damas[1] · Stuart M. Phillips[2] · Manoel E. Lixandrão[1] · Felipe C. Vechin[1] · Cleiton A. Libardi[3] · Hamilton Roschel[1] · Valmor Tricoli[1] · Carlos Ugrinowitsch[1]

Received: 19 October 2015 / Accepted: 20 October 2015 / Published online: 29 October 2015

Dear Editor,

DeFreitas et al. state that "The findings of Damas et al. have not influenced the previously proposed time course of skeletal muscle hypertrophy" with regard to our recent publication (Damas et al. 2015). We appreciate the article from DeFreitas et al. (2011), which depicts a theoretical time course of muscle hypertrophy throughout a resistance training (RT) program. In our view, we did not misinterpret the findings of Defreitas et al., but instead we highlighted the differences between our study protocol and theirs. As can be read in our manuscript, both studies indicated significant increases in muscle cross-sectional area (CSA) around the third week of RT. However, our participants performed only four previous RT bouts before the CSA assessment (RT was performed twice a week), while DeFreitas et al. (2011) used a three times per week RT; therefore their participants performed around 9–12 RT bouts during 3–4 weeks before measurements. These differences in the experimental design are important and described in the "Discussion" section of our article (Damas et al. 2015).

The explanation the authors provide in the letter is already acknowledged in our manuscript: "Additionally, DeFreitas et al. (2011) speculated that the significant increase in muscle CSA that they found in the first week of RT in untrained individuals was *possibly* [italics added for emphasis] due to edema and could be falsely attributed to hypertrophy; thus, they considered that the increased CSA was indicative of hypertrophy only at week 3–4 (when it was different from week 1)". Since DeFreitas et al. did not provide any measurement of edema it is not possible to estimate the degree of edema that was present at the third week of RT, and that was the main reason that we *suggested* they might have overestimated the degree of increase in muscle CSA. Importantly, the authors report an increase in muscle CSA of 5.95 % at week 3, leading the reader to believe that this was the actual magnitude of muscle hypertrophy. In their letter, on the other hand, they report (perhaps more appropriately and realistically, in our opinion) an increase in muscle CSA of around 2.41 % (under the assumption that an unchanged amount of edema of 3.45 % was present at this time), which was not clearly stated in their manuscript. In addition, the authors include in their original manuscript the minimal detectable statistical difference approach stating "…if an individual has a pre- to post-training increase in CSA that is less than 3.37 % [and estimate with an incredible degree of precision], then the change was not real. The change in that scenario could be attributed to the measurement error of the instrument. However, an increase in CSA greater than 3.37 % (in total change) should be attributed to the intervention, which is typically resistance training". It seems then that a large assumption has been made by DeFreitas et al. that edema is a constant fraction of the CSA measurement and their

Communicated by Klaas R. Westerterp/Håkan Westerblad.

This reply refers to the letter available at doi:10.1007/s00421-015-3286-6.

✉ Felipe Damas
felipedamas@usp.br

[1] School of Physical Education and Sport, University of São Paulo, Av. Prof. Mello de Morais, 65, São Paulo, SP 05508-030, Brazil

[2] Department of Kinesiology, McMaster University, 1280 Main Street West, Hamilton, ON L8S 4K1, Canada

[3] Laboratory of Neuromuscular Adaptations to Resistance Training, Federal University of São Carlos, Rod. Washington Luiz, km 235, SP310, São Carlos, SP 13565-905, Brazil

measurement error and they arrive, simply by subtraction, at a 'real' hypertrophy of 2.41 % increase in muscle CSA indicated by them in the letter to the Editor. We propose that there may be, as we acknowledged in our paper, some hypertrophy but due to an unknown contribution of edema and the error of measurement even a 5.95 % increase in muscle CSA is not interpretable as hypertrophy without direct measurement.

We would like to reiterate that our findings do not invalidate their time-course study; instead we *suggest* their hypertrophy values might be overestimated. We highlight that four bouts of RT (or even 9–12 bouts we contend), performed during 2 weeks (or 3–4 weeks), are not enough stimuli or time to promote whole muscle hypertrophy to the degree estimated and reported by ourselves or by DeFreitas et al. Rather, our data including measurement of edema, muscle damage markers and functional parameters indicate the increase in muscle CSA at this early time point is largely attributed to edema-induced muscle swelling (Damas et al. 2015). We propose that without empirical data or measurement of edema-induced muscle swelling there can be no definite conclusion on the *magnitude* of 'real' hypertrophy. When measured directly increases in muscle fibre cross-sectional area are significant from pre-training only at 7 weeks and not at 4 weeks (Green et al. 1999). Finally, we agree with the authors that the theme is not closed, and a combination of both studies, analysing the time course of muscle hypertrophy coupled with a measure of edema would be indeed of upmost importance to gain full understanding on resistance training-induced hypertrophy time course.

References

Damas F, Phillips SM, Lixandrao ME, Vechin FC, Libardi CA, Roschel H, Tricoli V, Ugrinowitsch C (2015) Early resistance training-induced increases in muscle cross-sectional area are concomitant with edema-induced muscle swelling. Eur J Appl Physiol. doi:10.1007/s00421-015-3243-4

DeFreitas JM, Beck TW, Stock MS, Dillon MA, Kasishke PR 2nd (2011) An examination of the time course of training-induced skeletal muscle hypertrophy. Eur J Appl Physiol 111(11):2785–2790. doi:10.1007/s00421-011-1905-4

Green H, Goreham C, Ouyang J, Ball-Burnett M, Ranney D (1999) Regulation of fiber size, oxidative potential, and capillarization in human muscle by resistance exercise. Am J Physiol 276(2 Pt 2):R591–R596