COMPARISON OF METHODS FOR ASSESSMENT OF EXERCISE – INDUCED MECHANICAL HYPOALGESIA

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INTRODUCTION

Changes in pain perception during exercise are subject of growing research interest, which is due to accumulation of experimental data on the role of the endogenous cannabinoid (Raichlen et al, 2011), and opioid systems (Koltyn, 2002; Pencheva et al., 2004), and relationship of this changes with endurance and other physical capacity parameters in trained and untrained.

Mechanical stimulation of the skeletal muscle tissue is an appropriate method to evaluate pain sensitivity in normal tissue, or sensitized/insensitive muscles at rest or after different types of loading.

The methodological peculiarities for assessment of exercise-induced hypoalgesia are poorly investigated. The aim of the study was to **compare and assess advantages/disadvantages of the following approaches for experimental pain assessment, applied before and after exercise: - tourniquet algometry; - hand-held algometry; and - computer-controlled cuff pressure algometry.**

METHODS

Subjects. In three different experimental sessions took part untrained, healthy men and thirteen dancers, students at SWU "Neofit Rilski", with similar anthropometric data **(Table 1).** All participants had a training session a day before the real test. They signed a statement of informed consent.

Exercise. The subjects performed submaximal test with cycle bike, at a pedaling rate of 60 revolutions/min and initial resistance of 30 W. The resistance was increased each 1.5 minutes with 30 W. The test was interrupted when subjects reached the submaximal values of heart rate (165-175 beats/ min).

Experimental protocol. Pain parameters were assessed before and after aerobic exercise. *The value of **pressure pain threshold (PPT)** was defined as the time of transition from a strong sense of compression to the feeling of pain, while **pain tolerance threshold (PTT)** – as the status when 'pain intensity is strong enough to make one feels like interrupting or stopping it'*

Experimental pain assessment techniques:

1. Tourniquet algometry (TA): Blood pressure apparatus was used. The cuff was wrapped around the right arm (at the level of m. biceps brachii). The pressure increasing continuously with constant speed. The subjects assessed verbally the pain parameters.

2. Hand – held algometry (HHA) –PTT were determinated with algometer Somedic, equipped with a probe of 1 cm^2, and increasing rate of 50 kPa/s to the back side of the right lower leg (Fig.3). The pain parameters were assessed verbally.

3. Computer-controlled cuff pressure algometry (CA) (Stoilov et al., 2009)**.** The experimental setup consists of: pneumatic tourniquet (12 cm in width), microcontroller, electro-pneumatic regulator, air compressor and 100 mm electronic visual analogue scale (VAS). Thus, the subject pain rating correlates with the values of the applied pressure (Fig.6). The cuff was wrapped around the middle of the right lower leg. The stimulation end-point was defined as the `pain intensity, strong enough to make one feels like interrupting or stopping it' at which the subjects were instructed to press the stop button. Maximum pressure limit of the device is 300 kPa. Value of pain parameters at rest were assessed with different compression rates:0.25; 0.50 and 1.00 kPa/s.

Statistics. The values are presented as mean ± SEM. Statistical differences between means were estimated by Wilcoxon paired rank sum test, Friedman ANOVA and Dunn's multiple comparison test ($p < 0.05$). GraphPad Prism and Origin were used for statistical analysis and data graphical presentation.

RESULTS & DISCUSSION

Table 1 shows the homogeneity in anthropometric variables of the tested groups.

Table 1. Anthropometric data of the subjects, participated in different experimental sessions.

Parameters	Groups: Group 1 (10 subjects)	Group 2 (11 subjects)	Group 3 (12 subjects)	Group 4 (13 dancers)
Age (years)	19.1±1.2	22.3±1.1	23.7± 0.4	21.1±1.5
Height (m)	1.75 ± 0.06	1.81 ± 0.08	1.83 ± 0.03	1.78 ± 0.09
Weight (kg)	75.40 ± 12.60	76.06 ± 7.44	81.09 ± 3.6	78.40 ± 9.60
Body mass index BMI ($kg.m^{-2}$)	24.56 ± 4.17	23.14 ± 0.94	24.11 ± 0.58	23.86 ± 5.21

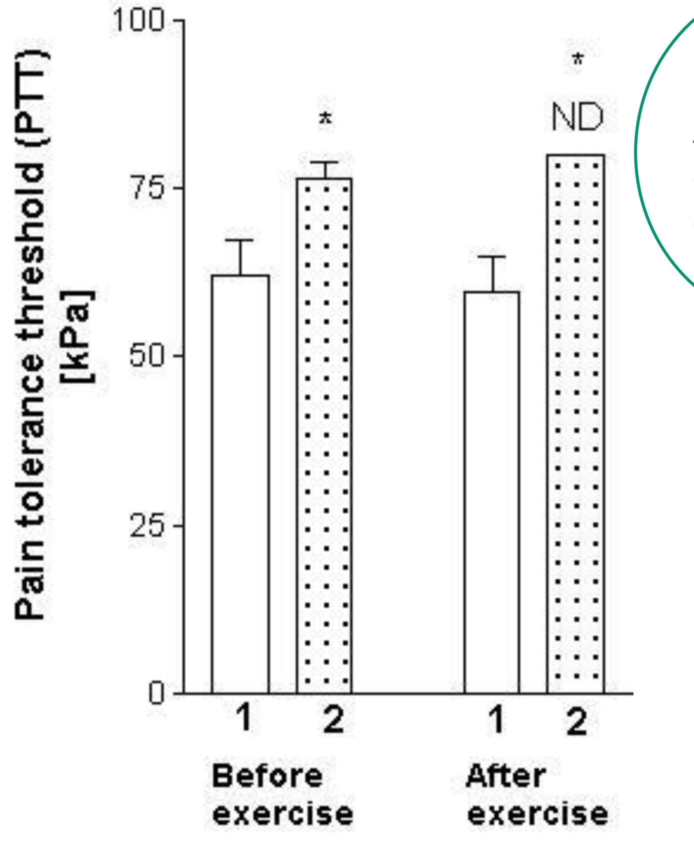


Figure 1. Pain tolerance thresholds (mean ± SEM) before and after aerobic exercise in and untraied (1) and dancers (2), assessed by **tourniquet algometry**; ND – not determinated; **Statistically significant differences between untrained and dancers (p<0.05);*

Data in Figure 1 show:

*1) Hypoalgesia after exercise was detected (Koltyn, 2002); 2) Dancers had more pronounced hypoalgesia after exercise; 3) PTT values were higher in dancers before exercise; 4) **TA** does not allows determination of PTT values, especially in trained after aerobic exercise.*

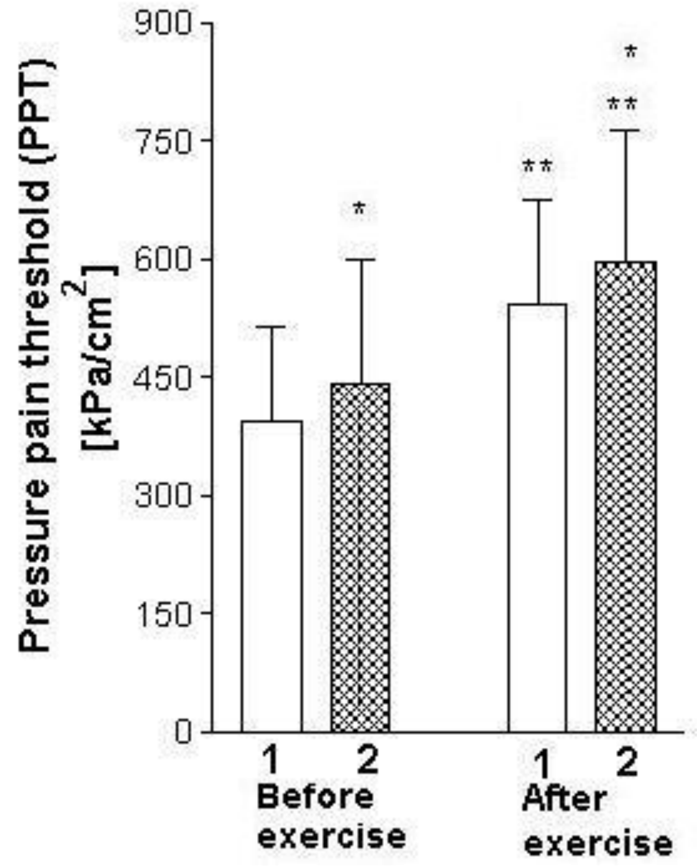


Figure 2. Pressure pain thresholds (mean ± SEM) before and after aerobic exercise, in medial (1) and lateral (2) head of m. gastrocnemius and m. soleus head of right lower leg, assessed by **hand-held algometry**. **Statistically significant difference between lateral and medial head (p<0.05); **Statistically significant difference between PPT values before and after exercise (p<0.05);*

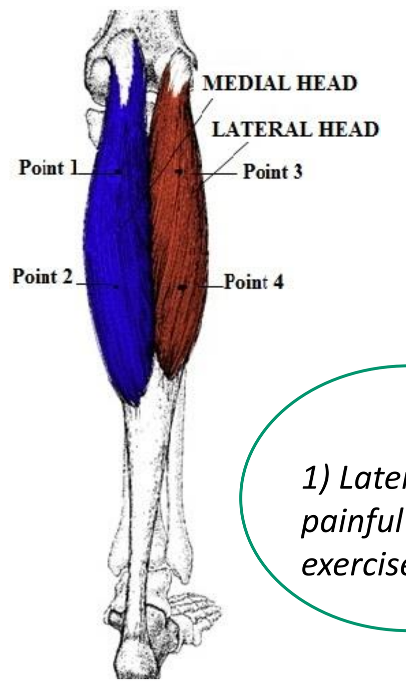


Figure 3. Tested points over right lower leg with **hand-held algometry.**

Data in Figure 2 show:

1) Lateral head of m. gastrocnemius is less sensitive to pressure painful stimulus than medial head; 2) PPT values are high after exercise in both lateral and medial head of m. gastracnemius.

*- **HHA** allows evaluation of PPT in different points of the muscle tested, using different compression rates and probe size (Nie et al., 2009) **but** is not suitable for PTT determination and has high variability (Giburm et al., 2011).*

RESULTS & DISCUSSION

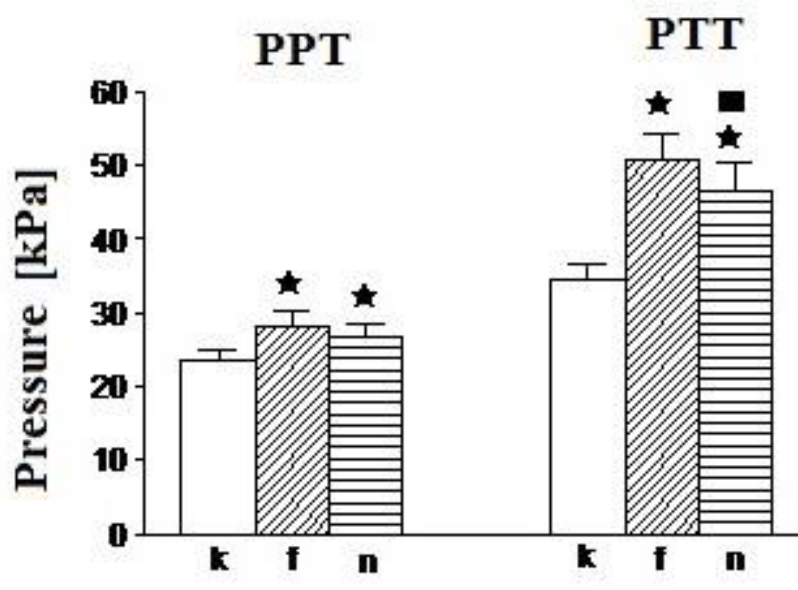


Figure 4. PPT and PTT values (mean ± SEM) before (k) and after exercise (f - feedback; n – non feedback), assessed by **computer-controlled cuff algometry**; ▪Statistically significant differences compared to the values assessed with feedback; * Statistically significant differences compared with the values before exercise (p<0.05).

Data in Figure 4 show:

1) Increase in PPT and PTT values after exercise compared with the values before; 2) Changes in PTT values are more pronounced than this in PPT, after exercise.

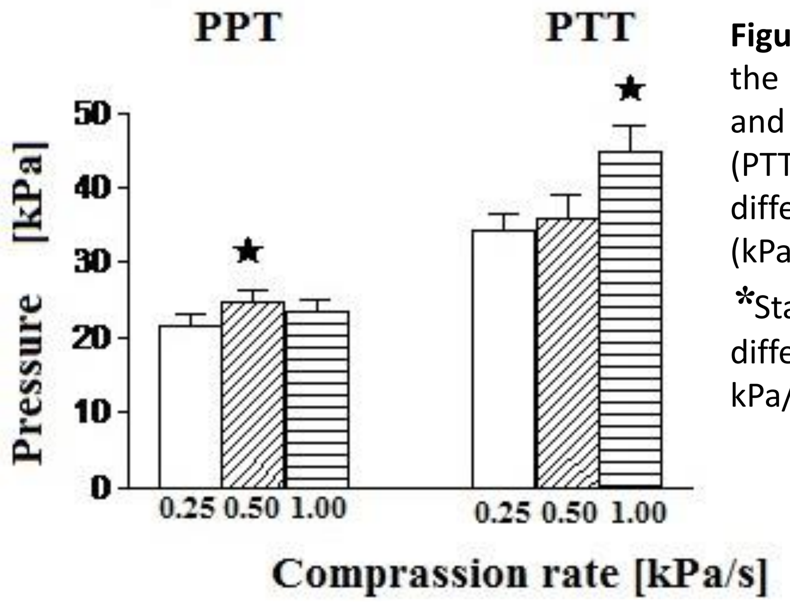
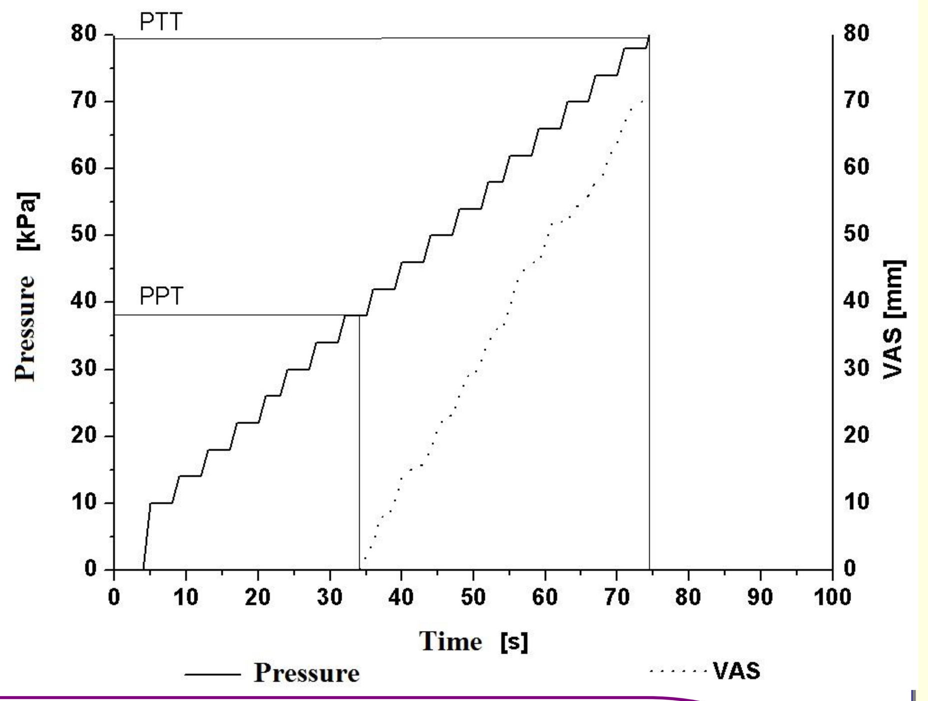


Figure 5. Values (mean ± SEM) of the pressure pain threshold (PPT) and pain tolerable threshold (PTT), assessed with three different compression rates (kPa/s): 0.25, 0.50 and 1.00 *Statistically significant differences as compared to 0.25 kPa/s ($p < 0.05$).

Figure 6. Typical curve pressure / time / VAS. After reaching the pressure pain threshold (PPT), the increase in pressure intensity correlated with pain intensity increase; PTT - pain tolerable threshold.



*- The advantages of **CA** is the precise quantitative evaluation of pressure-pain function (Fig. 6) (Jespersen et al., 2007); it allows also assessment of temporal (Fig. 5) and spatial summation of the stimulus (Jespersen et al., 2005), but is not suitable for specific location of the muscle and for field application.*

CONCLUSIONS

- **Hypoalgesia** after exercise was established with the three tested techniques;

- Although, the **TA** is an easy way to evaluate changes in pain perception; it is more suitable for determination of exercise – induced hyperalgesia;

- **HHA** allows evaluation of PPT in different points of the muscle tested, but it is not suitable for PTT and has high variability;

-The advantages of **CA**, as a novel experimental technique, allows precise quantitative evaluation of PPT and PTT values and building of stimulus-response curves;

- The combinations of experimental pain assessment methods depends on the design of the particular study.

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