Effect of the time of cold & heat contrast compression therapy on biomechanical changes in forearm muscles in MMA fighters:

a prospective, interventional, single-blinded, clinical pilot study

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Objective:

This study aimed to evaluate the effects of Game Ready (GR) therapy time on muscle tone, muscle stiffness and elasticity, pressure pain threshold, tissue perfusion, and muscle force.

Study Design:

Prospective, interventional, single-blinded design.

Participants: Group of 20 MMA adult fighters with mean age of 26.5 ± 4.5 years and training experience of 10.3 ± 5.0 years.

Main outcome measures: Muscle tone (T), stiffness (S), elasticity (E), pressure pain threshold (PPT), microvascular response described in non-reference units (PU) and maximum isometric force (Fmax) assessed before GR (Rest) and after GR stimulation (Post).

Agreement: The National Council of Physiotherapists (No. 9/22 of 6 April 2022) and registered in the clinical trials register under number ISRCTN90040217

Figure 2 *Equipment for myotometric measurements*

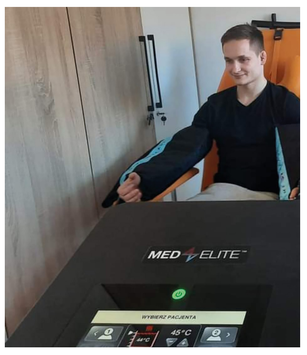

Figure 2 *Game ready contrast therapy equipment*

Characteristics of the measured parameters for individual groups

Percentage differences of the analyzed indicators immediately after GR therapy (1-5 min) for the groups: eGR10, eGR20, cGR.

Table 1. Characteristics of the measured parameters for individual groups

Variable	Group	Rest		Post		Δ (Post − Rest)		Effect size	Measures effect	ANOVA (Group × Measures)	
		mean ± sd	±95% CI	mean ± sd	±95% CI	mean ± sd	±95% CI	Cohen's *d* [descr.]	*p*-value	$F_{(2,117)}$	*p*-value
PU	eGR-10	7,33 ± 1,94	6,7; 7,95	9,98 ± 1,26	9,58; 10,38	2,66 ± 1,48	1,97; 3,35	1,62 [Large]	<0,001		
	eGR-20	7,43 ± 1,46	6,97; 7,90	11,21 ± 1,07	10,87; 11,55	3,78 ± 1,83	3,08; 4,47	2,96 [Very large]	<0,001	54,49	<0,001
	cGR	7,53 ± 1,64	7,00; 8,06	7,96 ± 1,38	7,52; 8,40	0,43 ± 0,9	−0,26; 1,12	0,29 [Small]	n.s.		
T	eGR-10	16,30 ± 1,12	15,94; 16,66	14,59 ± 1,25	14,19; 14,98	−1,72 ± 1,14	−2,14; −1,29	1,45 [Large]	<0,001		
	eGR-20	17,33 ± 1,59	16,82; 17,84	15,93 ± 1,28	15,52; 16,33	−1,41 ± 0,98	−1,83; −0,98	0,97 [Moderate]	<0,001	30,51	<0,001
	cGR	16,68 ± 1,10	16,32; 17,03	16,46 ± 1,00	16,14; 16,78	−0,22 ± 0,46	−0,65; 0,21	0,21 [Small]	n.s.		
S	eGR-10	269,1 ± 29,5	259,6; 278,5	238,2 ± 28,4	229,2; 247,3	−30,85 ± 28,46	−39,25; −22,45	1,07 [Moderate]	<0,001		
	eGR-20	286,7 ± 41,0	273,6; 299,8	270,7 ± 39,7	258,0; 283,4	−16,00 ± 8,10	−24,4; −7,6	0,4 [Small]	<0,001	25,28	<0,001
	cGR	266,8 ± 20,9	260,2; 273,5	264,2 ± 20,2	257,7; 270,6	−2,68 ± 8,20	−11,08; 5,73	0,13 [Trivial]	n.s.		
E	eGR-10	0,93 ± 0,05	0,91; 0,94	0,88 ± 0,07	0,86; 0,90	−0,05 ± 0,08	−0,08; −0,01	0,7 [Moderate]	0,001		
	eGR-20	0,96 ± 0,09	0,93; 0,99	0,91 ± 0,1	0,87; 0,94	−0,05 ± 0,07	−0,08; − 0,02	0,55 [Small]	<0,001	5,09	0,008
	cGR	0,92 ± 0,06	0,9; 0,94	0,91 ± 0,06	0,89; 0,93	−0,01 ± 0,06	−0,04; 0,03	0,1 [Trivial]	n.s.		
PPT	eGR-10	95,2 ± 11,8	91,5; 99,0	103,2 ± 15,8	97,7; 108,1	7,79 ± 13,57	3,65; 11,92	0,56 [Small]	<0,001		
	eGR-20	99,4 ± 12,70	95,3; 103,5	107,7 ± 12,2	103,8; 111,6	8,28 ± 6,21	4,15; 12,42	0,66 [Moderate]	<0,001	10,57	<0,001
	cGR	93,4 ± 8,2	90,8; 96,1	93,7 ± 8,5	91,0; 96,4	0,27 ± 2,46	−3,86; 4,41	0,03 [Trivial]	n.s.		

PU - perfusion unit (non-reference units); Fmax- maximum isometric force (kgf); T- muscle tone (Na Hz); S- stiffness (N/m); E- elasticity (NaN); PPT- pressure pain threshold (N/cm).

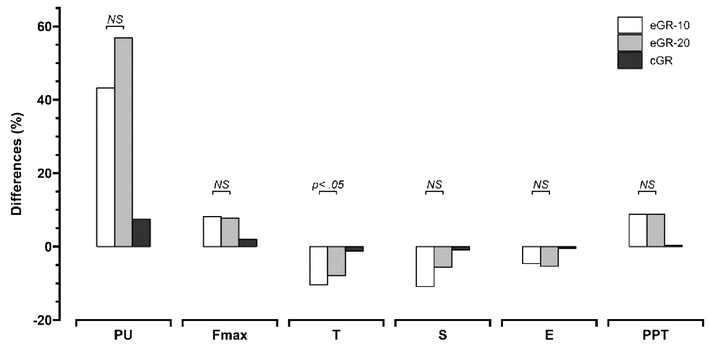

Figure 4. *Percentage differences of the analyzed indicators immediately after GR therapy (1-5 min) for the groups: eGRI0, eGR20, cGR. PU – perfusion unit; Fmax- maximum forearm muscle force; T- muscle tone; S – stiffness; E – elasticity; PPT - pressure pain threshold. Significant difference between groups (p < .05); NS - no statistical significance*

Results:

Both after eGR-10 and eGR-20, the differences compared to the measurements in PU made at rest were statistically significantly (p<0.001) higher (greater effect was obtained after eGR-20). Statistically significant differences (p<0.001) were observed in Fmax between the values recorded at rest and after eGR-10 and eGR-20 (dCohen effect sizes were larger in the eGR-20). A statistically significant (p<0.001) decrease in the value of the T parameter was observed, both in the eGR-10 and eGR-20 (greater decreases were observed in the eGR-10). A similar tendency was observed in the S parameter, for which both in the eGR-10 and eGR-20, a statistically significant (p<0.001) decrease after the therapy was observed. Both in the eGR-10 and eGR-20, a statistically significant (p=0.001 and p<0.001, respectively) decrease in the E value was observed. In terms of PPT, statistically significant differences (p<0.001) were observed between the values recorded at rest and after eGR-10 and eGR-20 (Cohen effect sizes were larger in the eGR-20).

Conclusions:

This study provides evidence that GR is a stimulus that can influence muscle biomechanical changes, pain threshold, muscle strength, and tissue perfusion. The results suggest that 10 minutes is sufficient to achieve beneficial changes, which influence the optimization of regeneration in sports

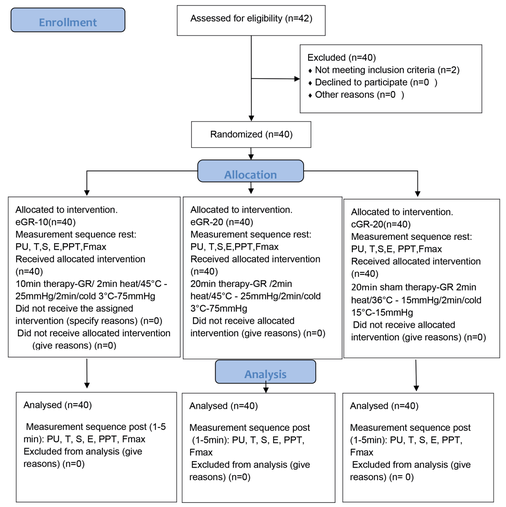

Figure 1. *CONSORT flow chart of study participants.*