RANGE OF MOTION, TRACTION-FORCE AND MUSCLE-ACTIVITY AT SELF- AND EXTERNAL-REGULATED STRETCHING

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Introduction:
In Literature, only active and passive stretching-methods are described. More recent investigations under laboratory conditions either consider only passive execution forms or do not indicate accurately, which methodology was applied (3). Under sport-practical criteria a more intensive effect (2) and a larger range of motion (4) is attributed to the passive form. However, until now, there has been no clearly defined guidance concerning active and passive stretching. The following application of self-, and external-stretching concepts (Fig. 1), allows definition of self-, and external-regulated parts during stretching-exercises, and clearly differentiates (5) between the varying conditions. The following study, based on this new terminology, tests and identifies differences between direct and indirect self-stretching and further compares these results against indirect external-stretching data.

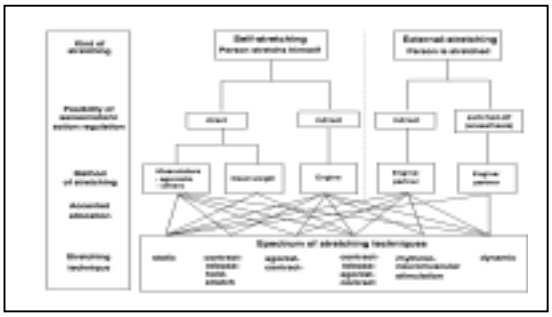

Fig. 1: Variety of the different forms of stretching

Material and Methods:
27 sport students [(m=16, w=11); 25±2 years; 68±10 kg; 176±8 cm] were divided into three groups at random and completed to checkup the hamstring muscles three standardized test forms in each case. Test 1: Direct self-stretching (DS) by independent stretching through a rope, Test 2: Indirect self-stretching (IS) whereby an engine was controlled by the test person and Test 3: Indirect external-stretching (IE) as the test leader operated the enging. The parameters utmost range of motion (ROM_{max}) with a three-dimensional movement-analysis-system, traction-force (TF) at constant angle of the first ROM_{max} in each case, most tolerated traction-force (TF_{max}) with a force receiver in both cases and muscle-activity (MA) of the M. biceps femoris with EMG were measured. With each course, the test leg was brought into maximum stretch 15 times and then relaxed immediately. To relativize the muscle-activity (%MA), a maximum voluntary contraction was executed at each test form 5% below the average ROM_{max}.

	Direct self-stretching		Indirect self-stretching		Indirect external-stretching	
	Rep. 1	Rep. 15	Rep. 1	Rep. 15	Rep. 1	Rep. 15
ROM_{max}[°]	104±11	113±12	100±12	108±12	99±13	108±13
TF_{max} [N]	165±49	185±47	169±41	191±60	171±51	193±59
TF [N]	170±56	133±40	172±48	137±49	185±60	144±57
MA [mV]	169±104	150±86	230±243	266±386	228±263	197±172
%MA [%]	10±7	10±6	14±13	15±15	12±10	11±8

Tab. 1: Measured parameters in dependence of each stretching-method of repetition (Rep.) 1 and 15 (MW±SD)

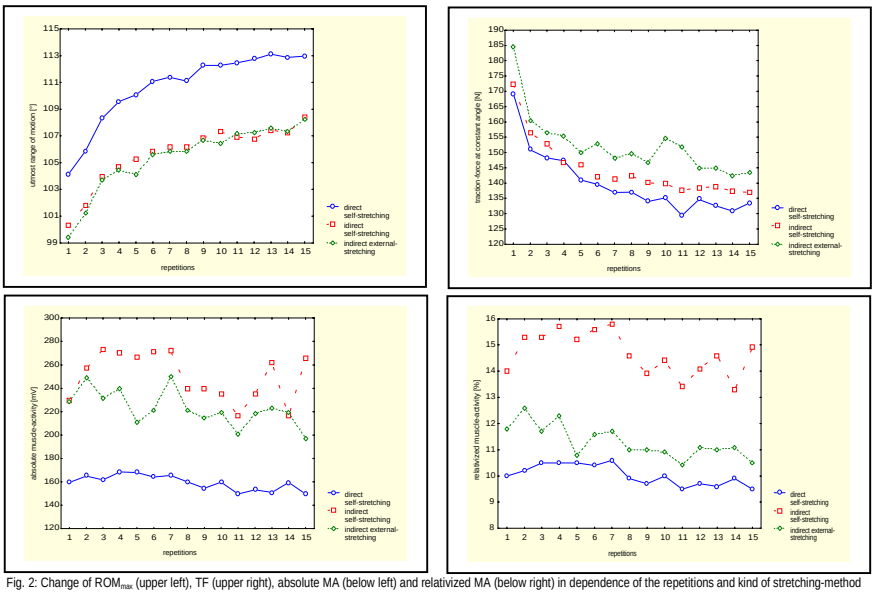

Fig. 2: Change of ROM_{max} (upper left), TF (upper right), absolute MA (below left) and relativized MA (below right) in dependence of the repetitions and kind of stretching-method

Results:
In the case of the three methods, high-significant changes emerged after 15 maximum stretches ($p \leq 0{,}001$). ROM_{max} increased itself with DS as well as with IE about 9% and with IS about 8%. TF decreased with DS about 21%, with IS about 20% and with IE about 22%. TF_{max} rose with DS about 12% and with IS as well as with IE about 13%. MA was reduced with DS by 6% and with IF by 14% and climbed with IS about 16%. %MA decreased with DS about 5% and with IE about 11% and increased with IS about 6% (Tab. 1). Concerning the effectiveness, no differences existed between the three stretching-types. In the average, with DS ROM_{max} was 5% higher than with IS and IE ($p \leq 0{,}001$). In the mean, TF was with DS 4% lower than with IS and 13% deeper than with IE. The average values for TF_{max} were with DS 1% lower than with IE and manifested equally strong like with IS. MA was in the average with DS 57% more inferior than with IS ($p \leq 0{,}01$) and 40% lower than with IE ($p \leq 0{,}01$). In the middle, %MA lay with DS opposite IS 47% deeper and opposite IE 13% deeper. Between the two indirect procedures, on the average no significant differences could be proved for the tested parameters. With DS significantly higher ROM_{max} with simultaneous clearly removing TF and smallest MA than with the indirect procedures were measured (Fig. 2).

Discussion:
The three methods were conducted with the parameters ROM_{max}, TF and TF_{max} to identify changes during the process of 15 repeated maximum stretches (compare 1). The direct self-stretching, as the most simply feasible and the most frequently used method in practice, shows equally good effects as the indirect methods with constantly larger ROM_{max} by clearly diminishing TF and lowest absolute and relativized MA.

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