



Ten seconds of passive stretching reduces the maximum strength

Dez segundos de flexionamento passivo reduz a força máxima

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ABSTRACT

Background: The flexibility and strength are the physical connected capabilities of the individual autonomy. When these are in adequate levels a considerable improvement in the quality of life of children, young, adults and older people has been noted. Nevertheless, for the development of these capabilities to be significant there must be an intervention of strength training (ST) and flexibility. However, according to recent evidence, there may be a possible interference between these two capabilities when performed in the same session, and the magnitude of this interference can be closely related to the duration and intensity of stretching. **Objective:** To assess whether the series of high intensity stretching (Flexing or stretching to its maximum amplitude) lasting ten seconds could negatively influence the strength generation. **Method/Design:** Were evaluated nine healthy volunteers practitioners of ST. Maximum strength was tested with and without a single stretching series, before the 1RM test (test re-test). Data were presented as mean \pm standard deviation and the significance level was 0.05. **Results:** The results shows that the use of flexibility maneuver (FM) lasting 10 seconds in levels 8-10 visual analogue pain scale (classified as severe) was enough to depress at 3.15% ($p = 0.021$ 95% CI = 0.42 to 4.01) maximum strength of subjects when compared to the method without MF. **Conclusions:** These data suggests that stretching may negatively interfere with the generation of maximum strength even in little time, leaving questionable practice for events that precede strength generation.

Keywords: Flexibility; Maximum strength; Bench press.

RESUMO

Introdução: A flexibilidade e a força são capacidades físicas intimamente ligadas à autonomia do indivíduo. Quando essas se encontram em níveis adequados é observada uma melhora considerável na qualidade de vida em crianças, jovens, adultos e idosos. No entanto, para que a evolução dessas capacidades sejam significantes é preciso que haja a intervenção do treinamento de força (TF) e flexibilidade. Contudo, segundo evidências recentes, pode haver uma possível interferência entre essas duas capacidades quando realizadas em uma mesma sessão, e a magnitude dessa interferência pode estar intimamente relacionada à duração e intensidade do alongamento.

Objetivo: Avaliar se a execução de uma série de alongamento de alta intensidade (Flexionamento ou alongamento até sua amplitude máxima) com duração de dez segundos poderia influenciar negativamente a geração de força. **Método:** Foram avaliados nove voluntários saudáveis praticantes de TF. A força máxima foi avaliada com e sem a utilização de uma série de alongamento anteriormente ao teste de 1 RM (teste e reteste). Os dados foram apresentados em média \pm desvio padrão e o nível de significância foi de 0,05. **Resultados:** Os resultados mostram que a utilização da manobra de flexionamento (MDF) com duração de 10 segundos nos níveis de 8 a 10 da escala visual analógica de dor (classificado como intenso) foi suficiente para deprimir em 3,15% ($p=0,021$; IC95%=0,42-4,01) a força máxima dos sujeitos quando comparado ao método sem MDF. **Conclusão:** Estes dados sugerem que o alongamento pode interferir negativamente na geração da força máxima até mesmo com pouco tempo de execução, deixando questionável sua prática em eventos que antecedem a geração de força.

Palavras-chave: Flexibilidade; Força máxima; Supino.

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INTRODUCTION

The flexibility and strength are essential capabilities that can directly influence the quality of life of children, youth, adults and elderly when at appropriate levels,^(1,2,3,4,5) strategies such as strength training (ST) and flexibility are commonly used in order to keep or enhances them.^(6,7,4,5)

For decades the stretch with the strength training practice has also been disseminated as preventive method of injury,^(8,9,10) and even as a performance enhancer, due to possible changes in muscle structure.^(11,12) However, both methods should be well structured and regulated, watching their intensity, frequency, time and above all, when and how they should be applied, as recently flexibility maneuver (FM) prior to ST brought controversies about its relation to injury prevention, muscle pain late-onset and especially with performance of strength training.^(10,13,14,15)

Prati and Machado⁽¹⁶⁾ analyzed forty-seven studies seeking to examine the influence of stretching on force generation. The authors concluded that the application of FM (static, passive, ballistic or proprioceptive neuromuscular facilitation - PNF) before the ST can somehow result in a negative response force. However one should take some care because the intensity, duration, protocol, muscle group and population can directly interfere with the results.

In addition to the methods mentioned above (static, passive, ballistic or PNF), there is the bending, this can considerably increase the level of flexibility of practitioners, characterized by muscle extension to its maximum capacity, which leads to a high sense pain during execution.⁽¹⁾ The relationship with the ST has been little studied,^(17,18) but because it is a high-intensity protocol, possibly would not need a very long time of the maneuver to be led to negative results in muscle strength.

In this way, and knowing that the influence of a time less than 30 seconds flexing at full strength has not yet been evaluated, this study aimed to evaluate the short passive static bending (1 set of 10 seconds) would cause a deficit strength in the test one repetition maximum (1RM) in the bench press exercise.

METHODS

Subjects

Nine male volunteers were randomly recruited from three gyms of Americana-SP. In agreement, all subjects participated in the study by signing the free and informed consent. The procedures performed followed in accordance with the Declaration of Helsinki and the second according to the resolution 196/96 of the Conselho Nacional de Saúde do Ministerio da Saúde (CNS/MS).

For the recruitment of individuals were determined some exclusion criteria:

- To have less than 12 months of experience with ST
- Blood pressure (BP) over than 139 mmhg in basal levels;
- Heart rate (HR) greater than 89 beats per minute (BPM) in the state of rest;
- Any injury records in the last six months, muscle pain constant or any type of orthopedic surgery.

Sample characterization

All data were obtained in a specific room, and the volunteers showed up to collect on predetermined day and time.

The analysis procedures were: a) individuals were at rest for 15 minutes in the supine position; b) was measured BP by auscultation using aneroid sphygmomanometer (Premiun[®]) and stethoscope rapport (Premiun[®]); c) HR measured by a heart rate monitor (Polar[®]) and d) to calculate the body mass index (BMI) was measured weight and height by a mechanical scale with stadiometer (Filizola[®]). The characteristics of the subjects are presented in the table 1.

Familiarisation stage

Após 24 horas da coleta os sujeitos foram submetidos à familiarização no teste de 1RM no exercício de supino horizontal de barra livre em banco específico. O local determinado foi o mesmo onde os sujeitos treinavam regularmente.

The procedures familiarization consisted of 1) verification of BP and HR in the basal state,⁽⁵⁾ 2) Estimated load calculation for the test by Brzycki Protocol validated by Nascimento,⁽¹⁹⁾ 3) five minutes of heating dynamic, 4) specific heating composed of eight repetitions with 50% of the estimated load, 5) four minutes apart, 6) Three repetitions with 70% of the estimated load, 7) four minutes interval and 8) finally the 1RM test. The time interval between trials was proposed suggested by the predominance of interest via the phosphagenic and recovery.⁽²⁰⁾ If the charge were not validated on the first try is increased from 4 to 6 kg in total and is performed more two attempts always interval between three to five minutes.

Control stage

The control protocol was made after forty-eight hours of familiarization stage; the order and time interval of the tests were identical to reliably preceding step and in the same locations. The last load obtained in the test was the first to be tested. The individual was stimulated and encouraged verbally to make a second repetition; Where two repetitions were performed, was increased from 4 to 6 kg of the total load. After four minutes apart a new series was held, with a maximum of three attempts. Thus the load was recorded as true.

**Table 1.** Volunteers' characteristics.

Subjects	Weight (kg)	Height (cm)	BMI (kg/m ²)	Age	Experience/ST (Months)
Subject 1	75	175	24.5	21	36
Subject 2	73.2	179	22.8	22	38
Subject 3	72.1	174	23.8	22	31
Subject 4	77.4	176	25	23	24
Subject 5	74.5	175	24.3	21	40
Subject 6	71.8	174	23.7	20	42
Subject 7	75.4	171	25.8	23	28
Subject 8	78.1	177	24.9	24	34
Subject 9	75.7	171	25.9	32	50
MEANS	74.8	174.7	24.5	23.1	35.9
STANDARD D.	2	2.4	0.9	1.2	7.4

Subtitle: kilograms (kg); centimeters (cm); kilograms/meters² (kg/m²); Total experience in Strength Training (EXPERIENCE/ST) and standard deviation (SD).

Experimental stage

In the same places with the same evaluators, after forty-eight hours of the control step, the subjects underwent the test with stretching, as proposed by Simon.⁽¹⁷⁾ After the dynamic warm the group was subjected to stretching. Stretching was carried out by a single evaluator for all volunteers. Subjects were placed on two supports and held a side elevation of the abductees shoulders with the supine hand and thumbs directed upwards. The evaluator held both hands voluntary abducting the glenohumeral joint to the maximum pain threshold identified by the individual.

The intensity was measured by adapting the visual analogue scale, where scores of 8, 9 and 10 were accepted as intense and bearable by the subject (Sociedade Brasileira para o Estudo da Dor/SBED). Thus, when it reached the maximum supportable point, the position was maintained for ten seconds, and after one minute interval, was performed with 1 RM load obtained by the above analysis. Soon after it was verified whether or not there was loss of strength if the whole movement by the volunteer was not carried the load was reduced 4-6 kg; finally was given a four-minute interval for the retry.

Data analysis

Data were analyzed using the SPSS version 17.0 (SPSS INC., CHICAGO, IL, USA), with 5% significance level. After descriptive analysis, the data were expressed as mean \pm standard deviation and the Shapiro-Wilk normality test was performed. For parametric statistics was used Student's t test.

RESULTS

Figure 1 shows the absolute values of maximum strength in force groups without stretching (STRENGTH) and group strength with stretching (STRENGTH.S.). When comparing two groups, volunteers who had previously been stretching (STRENGTH.S.) showed a reduction of 3.15% ($p = 0.021$) in the

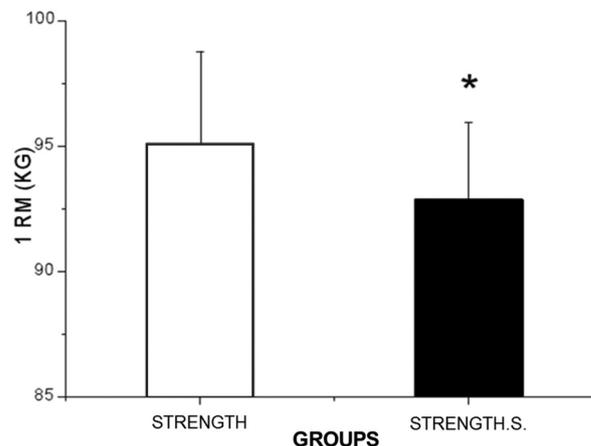


Figure 1. Strength Comparison with and without stretching. Legend: Absolute values of maximum strength (1RM) in kilograms (kg) compared with the group without stretching and stretching prior to the 1 RM test. Where, STRENGTH = 1RM test without stretching, STRENGTH.S. = 1RM with previous stretching test. * Indicates statistically significant difference from the STRENGTH group ($p = 0.021$, 95% CI 0.42 to 4.01).

power exercise bench press. With respect to absolute values, the STRENGTH group showed mean values of 95.1 kg, 92.9 kg against the STRENGTH.S. group, and this difference ($p = 0.0021$; CI 95%: 0.42 to 4,01).

DISCUSSION

The results of this study suggested that a short stretch of time (ten seconds) performed in the pain threshold, can reduce the maximum force in 1RM.

Corroborating our results Gomes (21) found reduced strength in the 1RM test with the PNF technique. The authors stated that six seconds stable PNF and maintenance thirty seconds, hampered performance of maximum strength as well as static stretching protocol (three series of thirty-second).



However, Simão⁽¹⁷⁾ applied the PNF protocol with three series of six seconds and six seconds interval and observed no reduction of load even raised using a high intensity of discomfort (pain). Possibly the method used, the time and the maneuver did not allow changes in muscle compliance and consequently changes in the strength, in addition, we should consider that in this study the sample groups had a high standard deviation as much weight (62 to 89 kg) and old (17-30 years), varying the length of experience with ST, are important variables for best results.

According to Oliveira⁽²²⁾ the lower the stretching length of time, the lower its negative influence on the generation of muscle strength. This relationship-time influence, seems to be a factor almost decisive for further reductions in maximum strength. In our study we found a decrease in strength of 3.15%, a value smaller compared to the study Costa,⁽¹³⁾ wherein the authors have utilized three sets of twenty seconds and stretching observed 8.75% decrease, but the operation used by these authors was not bending. Since we found almost half of the reduction reported by Costa,⁽¹³⁾ with a time of performing six times lower, possibly it highlights the importance of the intensity of the stretch in the reduction of maximum strength.

Corroborating this point, Endlichet (23) found a reduction of 4% to 8 minutes of the maneuver, which is a very similar result with ours, yet with a very less time. Thus showing that not only the time, but the intensity seems to be a determining factor in this reduction.

One possible mechanism is to be noted that the possibility of stretching maneuver has the capacity to alter the elastic properties of the muscle unit, reducing the drive voltage.^(24,25) Accordingly, a more pliable material would undergo a rapid period decrease in length until the elastic components were adjusted for other power transfer.⁽²⁶⁾

Prati⁽¹⁸⁾ observed that the application of the preceding stretching to a maximum repetition test to 90% of 1RM, because reducing the number of movements performed. The youngsters and the stretching maneuver resemble the present study, but its protocol was made up of three ten-second series, suggesting that the application time was sufficient to decrease the amount of maximum repetitions 5RM to 3,1RM.

Souza and Penoni⁽²⁷⁾ have not reported the same. With the use of three different protocols (static stretching, dynamic and static plus dynamic) preceding the strength test at 90% of 1RM in the bench press, suggested that these maneuvers were not able to cause deficits in muscle strength. They also stressed that the execution time and the intensity could be related to not decrease the shear force.

Thus, the current findings in the literature and in this study leave no doubt as to the use of FM as a preparatory way to ST especially when held in its maximum amplitude. There are several variables that must be observed, such as: muscle group, mode and specificity, multi movement or uni articulate,

nutritional status, predisposition on test day, training experience, intensity of FM, the intensity standardization, total time of application stretching, familiarization with the tests, type of FM and factors of gender/age.

CONCLUSION

The results of this study demonstrate that the implementation of passive static stretching using VAS as pain intensity rating factor in scores of 8, 9 and 10 was enough to cause reduced muscle strength in the 1RM test in young and trained men.

It is suggested that when the scope of ST practitioner is to improve their performance (force) the exercise bench press with bar, passive stretching with high levels of the subjective perception of pain begins to be questioned as a preparatory way not bringing benefits in the preparation of muscles to generate force.

AUTHORS CONTRIBUTION

HSDM: Question preparation, experimental design, data collection and writing of the article. RMJ: Question preparation, experimental design, data collection and writing of the article. SCD: Question preparation, experimental design and data collection. JMM: Question preparation and writing of the article. CBU: Elaboração da pergunta, experimental design and writing of the article.

COMPETING INTERESTS

The authors declare no conflicts of interest.

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REFERENCES

1. Dantas, EHM. Alongamento e Flexionamento. 5ª Ed. Rio de Janeiro: Shape, 2005.
2. Cadore EL, Pinto RS, Krueel LFM. Adaptações neuromusculares ao treinamento de força e concorrente em homens idosos. *RevBras de Cineantropom e Desenvolvimento Hum.* 2012;14(4):483-95.
3. Almeida TT, Jabur MN. Mitos e verdades sobre flexibilidade: reflexões sobre o treinamento de flexibilidade na saúde dos seres humanos. *Motricidade.* 2006;3(1):337-44.
4. Coelho LFS. O treino da flexibilidade muscular e o aumento da amplitude de movimento: uma revisão crítica da literatura. *Motricidade.* 2007;4(3):61-72.
5. American College of Sports Medicine. Position stand - Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *MedSci Sports Exerc.* 2011;3(7):1334-59.
6. Kraemer WJ, Ratamess NA. Physiology of resistance training: current issues. *Orthop. Phys. Therapy Clin. North Am.:Exerc. Tech.* 2000;467-13.
7. Michelin E, Coelho CF, Burini RC. Efeito de um mês de destreino sobre a aptidão física relacionada à saúde em programa de mudança de estilo de vida. *RevBrasMed Esporte.* 2008;14(3):192-6.
8. SafranMR, Seaber AV, Garrett WE Jr. Warm-up and muscular injury prevention: an update. *Sports Med.* 1989;8:239-49.



9. Bixler B, Jones RL. High-school football injuries: effects of a post-halftime warm-up and stretching routine. *FamPract Res J*. 1992;12:131-9.
10. Marek SM, Cramer JT, Fincher AL, Massey LL, Dangelmaier SM, Purkayastha S, et al. Acute Effects of Static and Proprioceptive Neuromuscular Facilitation Stretching on Muscle Strength and Power Output Culbertson. *J Athl Train*. 2005;40(2):94-03.
11. ShellockFG, Prentice WE. Warming-up and stretching for improved physical performance and prevention of sports-related injuries. *Sports Med*. 1985;2:267-78.
12. Smith CA. The warm-up procedure: to stretch or not to stretch. A brief review. *J Orthop Sports PhysTher*. 1994;19:12-7.
13. Costa EC, Santos CM, Prestes J, Silva JB, Knackfuss MI. Efeito agudo do alongamento estático no desempenho de força de atletas de jiu-jítsu no supino horizontal. *Fit Perf J* 2009;8(3):212-7.
14. Kay AD, BlazeovichAJ. Effect of Acute Static Stretch on Maximal Muscle Performance: A Systematic Review. *Med Sci Sports Exerc*. 2012;44(1):154-64.
15. Nogueira CJ, Galdino LAS, Vale RGS, Dantas EHM. Efeito agudo do alongamento submáximo e do método de facilitação neuromuscular proprioceptiva sobre a força explosiva. *HU Revista*. 2009;35(1):43-8.
16. Prati JELR, Machado SEC. Efeitos agudos da flexibilidade sobre a força muscular. *Revista Brasileira de Fisiologia do Exercício*. 2006;5(1):50-5.
17. Simão R, Giacomini MB, Dornelles TS, Marramom MGF, Viveiros LE. Influencia do aquecimento específico e da flexibilidade no teste de 1RM. *Revista Brasileira de Fisiologia do Exercício*. 2003;2:134-40.
18. Prati JELR, Machado SEC, Jacob Sobrinho AH, Carvalho MCGA, Dantas EHM. Efeito agudo do flexionamento passivo sobre a força máxima: um estudo experimental. *Fit Perf J*. 2006;5:311-7.
19. Nascimento MA, Cyrino ES, Nakamura FY, Romanzini M, PiancaHJC, Queiróga MR. Validação da equação de Brzycki para a estimativa de 1-RM no exercício supino em banco horizontal. *RevBrasMed Esporte*. 2007;13(1):47-50.
20. Panveloski-Costa AC, Papoti M, Moreira RJ, Seraphim PM. Respostas lactacidêmicas de ratos ao treinamento intermitente de alta intensidade. *RevBrasMed Esporte*. 2012;18(2):122-5.
21. Gomes TM, Rubin EC, Homero Junior SN, Novaes JS, Trindade A. Efeito agudo dos alongamentos estático e FNP sobre o desempenho da força dinâmica máxima. *Revista Brasileira de Fisiologia do Exercício*. 2005;4(1):13-6.
22. Oliveira DP, Silva LC, Alonso O. Efeito do alongamento prévio no desempenho em teste de força muscular máxima. *RevBras de Ciências da Saúde*. 2008;3(17):54-8.
23. Endlich PW. Efeitos agudos do alongamento estático no desempenho da força dinâmica em homens jovens. *Rev Bras Med Esporte*. 2009;15(3):200-03.
24. Kubo K, Kanehisa H, Fukunaga T. Effects of resistance and stretching training programmes on the viscoelastic properties of human tendon structures in vivo. *J Physiol*. 2002;1:219-26.
25. Kubo K, Kanehisa H, Kawakami Y, Fukunaga T. Influence of static stretching on viscoelastic properties of human tendon structures in vivo. *J Appl Phys*. 2001;90:520-7.
26. Wilson GJ, Murphy AJ, Pryor JF. Muscle tendinous stiffness: its relationship to eccentric, isometric, and concentric performance. *J Appl Phys*. 1994;76:2714-9.
27. Souza JCF, Penoni ACO. Efeito agudo dos métodos de alongamento estático e dinâmico sobre a força dinâmica. *Conexões*. 2008;6:132-43.