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Variation of intraocular pressure in resistance exercise performed in two different positions

Variação da pressão intraocular no exercício resistido realizado em duas diferentes posições

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ABSTRACT

Objective: To verify the variation in IOP in the resistance exercise performed in the sitting and supine. **Methods:** A 14 volunteers of the Center for Physical Activities of the Sorocaba Eye Bank (BOS Fit). Exclusion criteria were adopted: I) media opacity; II) change in volume of the eyeball or no eyeball; III) IOP greater than 21mmHg; IV) age 20 and over 40; V) time practice of resistance training less than 30 days. Initially the test was performed to predict the leg press exercise to determine the percentage charge for the exercise thereof during the experiment. The volunteers underwent two interventions separated by an interval of 72 hours, both with the same volume and intensity in the leg press exercise, 3 sets of 15 repetitions with 60% 1RM, interval time between sets 60 seconds and moderate speed, according to the following positions: P1) leg press performed in the sitting position and P2) leg press in supine position. IOP was obtained using the Perkins tonometer in three moments: M1) immediately before exercise; M2) immediately after the third series; M3) three minutes after completion of third grade. Each sequence was obtained by measuring the position of their exercise performance. **Results:** We found that in both positions there was a significant drop in IOP after exercise (M2), remained significantly reduced after three minutes of recovery (M3). However, there was no difference in IOP second position (P1 and P2), regardless of time of measurement (M1, M2 and M3). **Conclusion:** There was a decrease in IOP due to resistance exercise and was not observes differential response of IOP of IOP according to the position of the exercise.

Keywords: Intraocular pressure/physiology; Exercise; Resistance training; Posture

RESUMO

***Objetivo**: Verificar a variação da PIO no exercício resistido na posição sentada e em decúbito dorsal.* ***Métodos**: Foram avaliados 14 voluntários do Centro de Atividades Físicas do Banco de Olhos de Sorocaba (BOS Fit). Os critérios de exclusão adotados foram: I) opacidade de meios; II) alteração de volume do bulbo ocular ou ausência de bulbo ocular; III) PIO maior do que 21mmHg; IV) idade inferior 20 e superior a 40 anos; V) tempo de prática de treinamento resistido inferior a 30 dias. Inicialmente foi realizado o teste de predição no exercício leg press para determinar o percentual de carga para o respectivo exercício durante o experimento. Os voluntários foram submetidos a duas intervenções separadas em um intervalo de 72 horas, ambas com o mesmo volume e intensidade no exercício leg press, ou seja, 3 séries de 15 repetições com 60% 1RM, tempo de intervalo entre as séries de 60 segundos e velocidade moderada, de acordo com as seguintes posições: P1) leg-press executado na posição sentada e P2) leg press na posição em decúbito dorsal. A PIO foi obtida utilizando o tonômetro de Perkins em três momentos: M1) imediatamente antes do exercício; M2) imediatamente após a terceira série; M3) três minutos após a finalização da terceira série.* ***Resultados**: Em ambas as posições houve queda significativa da PIO após o exercício (M2), permanecendo significativamente reduzida após três minutos de recuperação (M3). Contudo, não houve diferença da PIO segundo a posição (P1 e P2), independentemente do momento de aferição (M1, M2 e M3).* ***Conclusão**: Houve queda da PIO decorrente ao exercício resistido e não foi verificada resposta diferencial da PIO de acordo com a posição do exercício.*

***Descritores:** Pressão intraocular/fisiologia; Exercício; Treinamento de resistência; Postura*

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Introduction

The intraocular pressure (IOP) is determined by the production, circulation and drainage of aqueous humor through trabecular and uveoscleral outflow, and also by the episcleral venous pressure(1). The vitreous volume, choroidal blood volume, scleral rigidity, orbicular muscle tension of the eye and the external pressure may also affect the IOP(2). Besides that, the IOP can be varied due to several factors such as circadian rhythm(3), body position(4), physical exercise(5), among others.

In relation to the circadian rhythm there is an IOP peak in the early morning hours and the value becomes lower in the late afternoon, with floating of 4 to 6 mmHg. Said variation is related to the activity of the autonomic nervous system, humoral control and change muscle tone(3,4,6,7). However, it was found that regardless the body position there is a significant increase in the IOP at night that is kept until the early morning hours, but the daily curve of IOP shows differences according to age(8).

As for the body position, the IOP lying down is higher than sitting, and possibly the hydrostatic changes such as the elevated episcleral venous pressure which occur from one position to another may explain said differences(9). Regarding physical exercises, both aerobic and anaerobic activities - including weightlifting (resistance training) - show a reduction in the IOP due to the reduction of plasma osmolality, hyperventilation, increased nitric oxide synthesis, reduction in plasma pH, among other mechanisms(10,11).

On the other hand, it is known that there is an IOP variation due to the change in body position, patients in supine position have higher blood pressure values in relation to the measurements obtained in the sitting position, and the increased episcleral venous pressure(12) may be considered as an important factor for IOP fluctuation resulting from the change in posture. In fact, studies have demonstrated the hypotensive effect of resistance training in IOP. However, it is not defined in the literature if exercises performed in different positions also have different effects on IOP.

In this sense the objective of the present study was to verify the IOP variation in the resistance training in the sitting position and in the supine position.

Methods

Sample

This experimental study was conducted in healthy patients submitted to two resistance training sessions. By convenience the sample consisted of 20 patients (10 male and 10 female). The exclusion criteria adopted were: i) media opacity; ii) volume change of ocular bulb or absence of ocular bulb iii) age below 20 or over 40 years old, and iv) time practicing resistance training below 30 days. The inclusion criteria considered was a medical certificate corresponding to clinical and laboratory assessment and electrocardiogram. The experimental procedures were carried out on the premises of the Physical Activities Center of the Eye Bank if Sorocaba (BOS Fit).

The protocol was conducted following the ethical principles established in the Declaration of *Helsinki* proposed by the World Medical Association. The project was sent to approved by the Research Ethics Committee of the Ophthalmology Hospital of Sorocaba (opinion No.101.533). All participants were informed about the research and their respective degree of involvement, and then asked to sign the Informed Consent, consisting of explanation about the following aspects: i) justification, objectives and procedures used; ii) discomfort, possible risks and expected benefits; iii) form of follow-up and assistance and their guardians; iv) information on the possibility of inclusion in the control group; v) freedom to refuse to participate or withdraw their consent at any stage of the research, without penalty or loss and vi) guarantee of confidentiality in relation to the data collected.

Instruments and procedures

To determine the training loads, the prediction test(13) initially performed was the *leg-press* exercise, which aims to estimate the maximum load for resistance training by means of the application of submaximal loads to exhaustion. According to the relevant protocol, a random load is applied, and the volunteers as asked to exercise to fatigue. The repetitions are recorded and related to a specific table to check the estimated load to be used in the experiment, here 60% of one maximum repetition (1MR).

The volunteers underwent two interventions separated by an interval of 72 hours, both with the same volume and intensity in the *leg-press* exercise, i.e., 3 sets of 15 repetitions with 60% 1MR, a time interval between series of 60 seconds and moderate speed, according to the following positions: P1) *leg-press* performed in a sitting position and P2) *leg-press* in the supine position. The IOP was obtained using the Perkins tonometer, always by the same ophthalmologist with experience in this technique, in three moments: M1) immediately before the exercise, M2) immediately after the third set and M3) three minutes after the completion of the third set. Each measurement sequence was obtained in the respective performance position of the exercise, watching a distant object with the contralateral eye, after instillation of a droplet of proparacaine eyedrops and a droplet of fluorescein eyedrops. Although the Goldman applanation tonometer is considered the gold standard for the measurement of IOP, other tonometers shoe good mesurement correlation(14,15). In this study, the use of the Perkins tonometer is justified by the practicality of employment in field situations of physical exercise, allowing it to be taken anywhere and that the measure is made with minimal displacement of the patient assessed, as well as allowing the measurement in the supine position(16).

Statistical analysis

The mean and the standard deviation were descriptively calculated, and the data were presented in the tabular form and in box diagram (Box-plot). We used ANOVA with repeated measures and Bonferroni post-test, adopting a significance level of 5% to compare to the measures for the variables studied. The software used was GraphPadPrism®.

Results

Table 1 shows the IOP response in both positions at three different moments, and demonstrates the significance in reducing the IOP after the beginning of the exercise.

Table 1

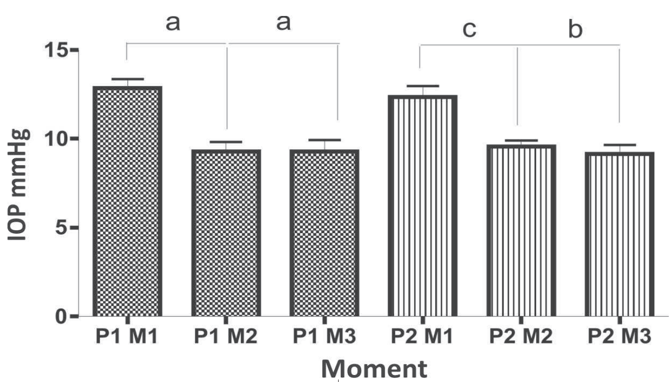
IOP response according to the position of the exercise and according to the assessment moment

Position	Moment					
	M1		M2		M3	
	RE	LE	RE	LE	RE	LE
Sitting (P1)	12.85 ± 1.91	12.21 ± 1.80	[a]9.28 ± 1.97	[b]9.35 ± 2.02	[a]9.28 ± 2.36	[b]9.00 ± 2.48
Supine (P2)	12.35 ± 2.30	11.78 ± 1.42	[c]9.57 ± 1.22	[b]8.78 ± 1.18	[b]9.14 ± 1.91	[a]8.35 ± 1.78

a=p<0.001; **b**=p<0.01; **c** =p<0.05

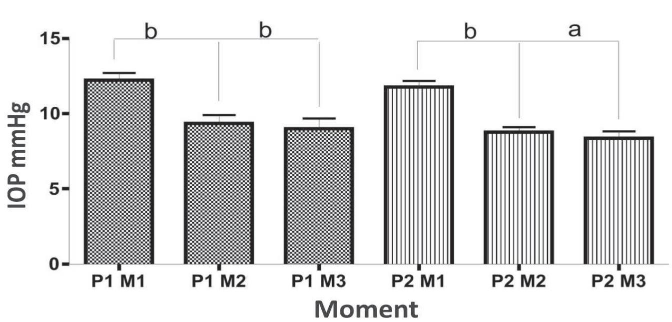
It was observed that in both positions there was a significant decrease in IOP after the exercise (M2), remaining significantly reduced after three minutes of recovery (M3). However, there was no difference in IOP according to the position (P1 and P2), regardless of the moment of measurement (M1, M2 and M3).

Figures 1 and 2 show the variation of IOP in the right eye (RE) and left eye (LE) according to the position in the moments pre-exercise (M1), post-exercise (M2) and three minutes after exercise (M3).



a= p<0.001; **b**= p<0.01; **c** = p<0.05

Figure 1. Changes in the IOP in the RE according to the position, second moment.



a= p<0.001; **b**= p<0.01; **c** = p<0.05

Figure 2. Change in the IOP in the LE according to the position, second moment

Discussion

In a study of boxing athletes who underwent resistance training sessions, values significantly lower in the IOP were found after performing the exercises, regardless the body position of the volunteers[17].

However, a survey was conducted with 82 patients not subject to physical exercise which presented the following conditions: primary open angle glaucoma (POAG), normal pressure glaucoma (NPG) and individuals with normal eyes (NE). It was observed that the IOP was higher in the supine position than in the sitting position[18], regardless of the condition. The mean difference in IOP between the supine and the sitting positions in the POAG was 3.41mmHg. However, the NPG group was 2.77mmHg, and finally in volunteers with NE the difference found was 2.45mmHg. The authors consider that the respective difference may be associated with increased episcleral venous pressure.

It is also pointed out that the exercises performed with the legs positioned above the head can result in elevation of IOP[19]. On the other hand, this increase may be due to increased choroidal vasculature and episcleral venous pressure, in which the flow of ocular tissues becomes committed, and the choroid is a very vascularised tissue which can cause dynamic changes in the aqueous humor liquid, causing increased IOP[20].

Another study[21] which also found that the variation in the aqueous humor drainage according to the body position found that the average IOP in 21 volunteers in the sitting and supine positions was significantly different, i.e., respectively, 17.8+1.7mmHg and 19.9+1.6mmHg. On the other hand, there was no significant difference in the aqueous humor drainage according to the body position, with observed values of 0.30+0.31 (seatting) and 0.28+0.09l/min/mmHg (supine)

Regarding the volume and intensity of training[17,22] it is observed that the resistance training causes a decreased IOP regardless of the load used during the exercise session, with a greater change in the method which calls for the development of muscle strength. In fact, in these conditions the total volume of training and the time in which the muscles remain under tension are higher than in other methods of resistance training. However, the supine exercise performed with maximum load for four repetitions in voluntary apnea caused a mean increased IOP of 4.3±4.2mmHg in young healthy volunteers[23].

Hypothetically, exercises performed in the supine position would naturally increase the IOP levels. However, the hypotensive effects of resistance training[7,11,17,24] seems to interfere in this process, antagonizing the potential increase in IOP by mechanisms that promote the reduction of the formation and/or increased aqueous humor outflow.

Conclusion

There was a drop in the IOP due to resistance training, and the differential response of IOP according to the position of the exercise was not verified. In practical terms, these results can contribute to the selection of resistance training for people with risk factors for ocular hypertension or glaucoma, since it was found that exercises in both the sitting and the supine position promote the reduction of the IOP.

References

1. Weinreb RN, Brandt JD, Garway-Heath D, Medeiros, FA. Intraocular pressure. WGA - Consensus series 4. Amsterdam: Kugler Publications, 2007.
2. Talieri IC, Honsho CS, Nunes N, Souza AP, Duque JC. [Behavior of intraocular pressure according to cardiorespiratory and hemodynamic effects induced by desflurane in dogs subjected to experimental hypovolemia]. Arq Bras Oftalmol. 2005;68(4): 521-6. Portuguese.
3. Jaén-Díaz JI, Cordero-García B, López-de-Castro F, De-Castro-Mesa C, Castilla-López-Madridejos F, Berciano-Martínez F. [Diurnal variability of intraocular pressure]. Arch Soc Esp Oftalmol. 2007;82(11):675-9.
4. Shuba LM, Doan AP, Maley MK, Zimmerman MB, Dinn RB, Greenlee EC, et al. Diurnal fluctuation and concordance of intraocular pressure in glaucoma suspects and normal tension glaucoma patients. J Glaucoma. 2007;16(3):307-12.
5. Dane S, Koçer I, Demirel H, Ucok K, Tan U. Effect of acute submaximal exercise on intraocular pressure in athletes and sedentary subjects. Int J Neurosci. 2006;116(10):1223-30.
6. Asejczyk-Widlicka M, Pierscionek BK. Fluctuations in intraocular pressure and the potential effect on aberrations of the eye. Br J Ophthalmol. 2007;91(8):1054-8.
7. Conte M, Scarpi MJ, Rossin RA, Beteli HR, Lopes RG, Marcos HL. [Intraocular pressure variation after submaximal strength test in resistance training]. Arq Bras Oftalmol. 2009;72(3):351-4. Portuguese.
8. Mansouri K, Weinreb RN, Liu JH. Effects of aging on 24-hour intraocular pressure measurements in sitting and supine body positions. Invest Ophthalmol Vis Sci. 2012;53(1):112-6.
9. Rodrigues LD, Silva MR, Schellini SA, Jorge EN. [Intraocular pressure peaks: comparison between the circadian curve, diurnal curve and the 6 a.m. measurement]. Arq Bras Oftalmol. 2004;67(1):127-31. Portuguese.
10. Ashkenazi I, Melamed S, Blumenthal M. The effect of continuous strenuous exercise on intraocular pressure. Invest Ophthalmol Vis Sci. 1992;33(10):2874-7.
11. Harris A, Malinovsky VE, Cantor LB, Henderson PA, Martin BJ. Isocapnia blocks exercise-induced reductions in ocular tension. Invest Ophthalmol Vis Sci. 1992;33(7):2229-32.
12. Weber AK, Price J. Pressure differential of intraocular pressure measured between supine and sitting position. Ann Ophthalmol. 1981;13(3):323-6.
13. BrzyckI M. Strength testing: predicting a one-rep max from reps-to-fatigue. J Phys Educ Recreation Dance. 1993;64(1):88-90.
14. Andrada Márquez MT, Fesser Oroz I, Antón López A. [Comparative study of two portable tonometers: Tono-Pen XL and Perkins]. Arch Soc Esp Oftalmol. 2003;78(4):189-96. Spanish.
15. dos Santos MG, Makk S, Berghold A, Eckhardt M, Haas A. Intraocular pressure difference in Goldmann applanation tonometry versus Perkins hand-held applanation tonometry in overweight patients. Ophthalmology. 1998;105(12):2260-3.
16. Favarato M, Almodin J, Almodin F, Cvintal T. [Intraocular pressure and exotalmometer evaluation before and after peribulbar anaesthesia in cataract surgery]. Rev Bras Oftalmol. 2011;70(3):68-173. Portuguese.
17. Conte M. Associação entre exercícios resistidos e pressão intraocular [tese]. São Paulo: Universidade Federal de São Paulo; 2009.
18. Meirelles SH, Mathias CR, Brandão G, Frota AC, Yamane R. [Postural influence on intraocular pressure and visual field defects in open angle glaucoma and normal tension glaucoma]. Rev Bras Oftamol. 2008;67(1):19-24. Portuguese.
19. Hilton E. Exerc-eyes: effects of exercise on ocular health [Internet]. Anstey: Sportvision, 2003 [cited 2013 Set 10]. Available from: www.sportvision.co.uk/pdf/articleexerceyes.pdfý
20. Prata TS, De Moraes CG, Kanadani FN, Ritch R, Paranhos A Jr. Posture-induced intraocular pressure changes: considerations regarding body position in glaucoma patients. Surv Ophthalmol. 2010;55(5):445-53. Review.
21. Selvadurai D, Hodge D, Sit AJ. Aqueous humor outflow facility by tonography does not change with body position. Invest Ophthalmol Vis Sci. 2010;51(3):1453-7.
22. American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc. 2009;41(3):687-708. Review.
23. Vieira GM, Oliveira HB, de Andrade DT, Bottaro M, Ritch R. Intraocular pressure variation during weight lifting. Arch Ophthalmol. 2006;124(9):1251-4.
24. Avunduk AM, Yilmaz B, Sahin N, Kapicioglu Z, Dayanir V. The comparison of intraocular pressure reductions after isometric and isokinetic exercises in normal individuals. Ophthalmologica. 1999;213(5):290-4.

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