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ORIGINAL RESEARCH

Analysis of static postural balance and of intensity of musculoskeletal pains after the use of proprioceptive insoles by ostensive service militaries

Análise do equilíbrio postural estático e da intensidade das dores musculoesqueléticas após o uso de palmilhas proprioceptivas por militares do serviço ostensivo

Análisis del equilibrio postural estático y de la intensidad de los dolores musculoesqueléticas después del uso de plantillas propioceptivas por militares del servicio ostensivo

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ABSTRACT | To maintain the balance, the body uses visual, vestibular and proprioceptive systems, which send information to the central nervous system about the body's conditions in order to stabilize it. This study evaluated the effect of proprioceptive insoles on static postural balance and musculoskeletal pains after two months of use, through a longitudinal analytical study with 15 healthy male soldiers with a mean age of 34±7.5 years. They were subjected to balance evaluation through the Medicapteurs® platform and by CNT protocol. There was no statistical difference for the deviations of the body and speed of the center of pressure. Plantar pressure had a statistically significant change for the left and the right feet, corresponding to p=0.0001 and p=0.0007, respectively. There was a reduction in the mean values of the pains in the knees, feet and heels and a significant decrease in lumbar spine pain, with p=0.0180. The static balance was not significantly altered with the use of proprioceptive insoles by the militaries; however, these insoles provided a better redistribution of plantar pressures and seem to attenuate the musculoskeletal pains of the lower extremities. Therefore, insoles can be considered as a prevention therapy against injuries for this group related to their work activity.

Keywords | Musculoskeletal Pain; Postural Balance; Orthosis; Pressure.

RESUMO | Para a manutenção do equilíbrio, o organismo utiliza os sistemas visuais, vestibulares e proprioceptivos, que enviam informações para o sistema nervoso central acerca das condições do corpo com o objetivo de estabilizá-lo. Este estudo avaliou o efeito das palmilhas proprioceptivas sobre o equilíbrio postural estático e as dores musculoesqueléticas após dois meses de uso, por meio de uma pesquisa analítica longitudinal com 15 militares saudáveis do sexo masculino com média de idade de 34±7.5 anos. Eles foram submetidos à avaliação do equilíbrio por meio da plataforma Medicapteurs® e pelo protocolo CNT. Não houve diferença estatística para os desvios do corpo e velocidade do centro de pressão. A pressão plantar teve mudança estatisticamente significante para o pé esquerdo e o pé direito correspondendo a p=0.0001 e p=0.0007, respectivamente. Houve redução das médias de dores nos joelhos, pés e calcanhares e diminuição significativa da dor lombar, com p=0.0180. O equilíbrio estático não foi alterado significativamente com o uso das palmilhas proprioceptivas pelos militares, contudo

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elas proporcionaram melhor redistribuição das pressões plantares e parecem atenuar as dores musculoesqueléticas das extremidades inferiores. Por isso as palmilhas podem ser consideradas para esse grupo uma terapêutica de prevenção contra lesões relacionadas à sua atividade laboral.
Descritores | Dor Musculoesquelética; Equilíbrio Postural; Órtese; Pressão.

RESUMEN | Para mantener el equilibrio el cuerpo utiliza los sistemas visuales, vestibulares y propioceptivos, que envían información al sistema nervioso central sobre las condiciones del cuerpo para estabilizarlo. Este estudio evaluó el efecto de las plantillas propioceptivas sobre el equilibrio postural estático y los dolores musculoesqueléticas después de dos meses de uso, a través de una investigación analítica longitudinal con 15 soldados sanos con una edad media de 34±7.5 años. Ellos fueron sometidos a evaluación de equilibrio a través de la plataforma Medicapteurs® y por el protocolo CNT. No hubo diferencia estadística para las desviaciones del cuerpo y para la velocidad del centro de presión. La presión plantar tuvo un cambio estadísticamente significativo para el pie izquierdo y el pie derecho correspondiente a p=0.0001 y p=0.0007, respectivamente. Hubo una reducción en las promedio de los dolores en las rodillas, pies y talones y una disminución significativa en el dolor lumbar, con p=0.0180. El equilibrio estático no se modificó significativamente con el uso de plantillas propioceptivas por los militares, sin embargo, proporcionaron una mejor redistribución de las presiones plantares y parecen ablandar los dolores musculoesqueléticas en las extremidades inferiores. Por lo tanto, las plantillas pueden considerarse para ese grupo como una terapia de prevención contra lesiones relacionadas con su actividad laboral.
Palabras clave | Dolor Musculoesquelético; Balance Postural; Ortesis; Presión.

INTRODUCTION

Proprioception influences postural modulation[1]. Maintaining balance occurs by stimuli that keep the center of gravity at the support base[2], and the foot, with its mechanoreceptors, has properties for this control[3].

This function is evaluated by posturography, which checks the displacement of the pressure center (PC)[4]. Posturology uses this assessment to detect erect posture disorders, whose recommended treatment is the use of insoles[5]—orthotics manufactured with moldable material used inside shoes. Its principle of use is the prevention and therapy of standing posture, distributing the peak pressure and stimulating the feet sensory receptors[6].

In the work environment, insoles can be used to decrease symptoms related to activities that adopt the same position[7]. Militarism is included in this context. In this work activity, there are a set of health-damaging factors, and the military's complaints of pain are relevant[8]. Moreover, the design of military footwear and the attenuation of ground reaction forces do not seem to be effective[9].

Thus, this study analyzed the effect of the use of proprioceptive insoles on static balance and intensity of musculoskeletal pain in ostentatious service militaries, addressing overloads and possible repercussions on balance adjustments.

METHODOLOGY

This is an analytical, quantitative and longitudinal study with militaries from a battalion. The inclusion criteria were: being a military of ostensive patrolling, male, between 20 and 50 years old, who use boot or combat boot and feel musculoskeletal pain after prolonged orthostatic posture. Exclusion criteria: presence of neurological and cardiorespiratory sequelae; musculoskeletal lesions less than six months prior to the study; coordination, balance and ambulation changes; flat feet degrees II and III; cavus feet degrees II and III; valgus or varus knees; temporomandibular dysfunctions; visual changes; and structural scoliosis.

In balance assessment, the S-PLATE Medicapteurs® platform was used, measuring 610×580mm, with an active surface of 400×400mm of 1,600 resistive sensors, maximum pressure capacity of 100N, obtaining 100 images per second and frequency of 100Hz, in mode of postural acquisition. This procedure was performed pre-insole, immediate post-insole and late post-insole.

The participant positioned himself standing on the platform, in bipodalic support, barefoot, wearing light clothes, with heels apart forming an angle of 30°, arms in the extension of the body, stopped and with eye fixation at a point ahead for 30 seconds. For immediate evaluation, the same position was adopted with the addition of foot devices in the plantar region.

After two months, the late reassessment was performed, following the same protocol and with the placement of the insole on the top of the platform, so that the participant stepped on it.

The parameters verified were: the mean range of PC displacement in the anteroposterior and latero-lateral in millimeters (mm), the mean velocity of PC in millimeters per second (mm/s) and mean plantar pressure in grams per square centimeter (g/cm^2). In addition to examination on the platform, the CNT protocol was used[10] for the prescription of the insole, in which the length of the upper limbs and the level of the iliac crests were observed, and then the test of the ascending thumbs is performed. The visual analog scale (VAS) was used to measure pain before and after two months of the insole use.

The insole used was the Comfort Standard model of the Podaly®, of thermoplastic resin TCSLIN with thermoglued EVAPOD cover. The insoles were composed of 3 mm, 6 mm and 9 mm wedges, retrocapital and infracapital bar, small and large hemidomes, intrametatarsal joint and medial longitudinal elevation selected according to each participant's assessment.

The significance level was set at $p<0.05$. In the analyses of deviations, mean PC speed and mean plantar pressure of the feet, the Friedman's test was used. For the evaluation of lumbar spine pain, the Wilcoxon signed-rank test was used, through bioest.5.0® software.

RESULTS

Table 1 shows the characterization of the sample group, composed of 15 militaries, predominantly young adults.

Table 1. Characterization of the sample profile

n=15	Age (years)	Weight (Kg)	Height (cm)
Mean	34.6	77.3	170.2
Standard deviation	7.5	9.4	4

Participants were instructed to use insoles at work for two months. At the end of this period the mean time of use was 28±10 days.

Regarding balance, deviations showed no statistically significant difference. However, a decrease in the mean values was observed, except in the latero-lateral deviation, when comparing the moments of pre-insole, immediate insole and late insole, as shown in Table 2.

On the other hand, the values of the mean plantar pressure of the left foot and the right foot had an evident reduction, with statistical significance, as shown in Table 3.

Table 4 shows musculoskeletal pain before and after late insole. It is observed that the most cited areas are the feet and lumbar spine. There is also a decrease in the average pain values in all anatomic regions.

Pain in the lumbar spine was analyzed by the Wilcoxon signed-rank test, with a statistically significant difference of $p=0.0180$, since it was the most reported pain.

Table 2. Mean±standard deviation for the latero-lateral and anteroposterior dislocations in millimeters and mean speed of oscillations in millimeters per second in static posture between study moments

	Pre-insole	Immediate insole	Late insole	p – value*
latero-lateral deviation	0.96±0.33	0.76±0.23	1.01±0.69	0.0730
Anteroposterior deviation	1.23±0.60	1.12±0.57	1.13±0.47	0.6271
Average speed	1.43±0.43	1.30±0.42	1.34±0.43	0.4419

*Statistical test: Friedman's test, p<0.05.

Table 3. Mean±standard deviation of mean plantar pressure in grams per square centimeter in the right foot and left foot in static posture between study moments

	Pre-insole	Immediate insole	Late insole	P – value*
Left foot	240.73±32.73	228.40±24.60	215.13±29.49	0.0001*
Right foot	244.07±31.68	221.47±22.13	217.13±21.82	0.0007*

*Statistical test: Friedman's test, p<0.05.

Table 4. Absolute, mean and standard deviation of intensity of pre-insole and post-insole musculoskeletal pain, according to the anatomical region.

Anatomical region	n	Pre-insole pain		After late insole pain	
		Mean	SD	Mean	SD
Lumbar spine	10	4.7	1.7	2.5	1.27
Right knee	2	6	1.41	1.5	2.12
Left knee	2	7	0	3.5	4.95

(continues)

Table 4. Continuation.

Anatomical region	n	Pre-insole pain		After late insole pain	
		Mean	SD	Mean	SD
Right foot	4	5.5	3	1.75	0.96
Left foot	5	5.6	2.6	1.8	0.84
Right heel	2	4.5	0.71	3	0

DISCUSSION

The effects of the prescription and the types of plantar arches[11] must be evaluated to recommend an insole. It is known that the militaries are liable to injury. Moreover, the military shoe and insoles do not consider the types of feet[12].

A decrease in the means is observed when comparing the values of oscillations and mean velocity, except for late latero-lateral deviation, without, however, statistically significant difference. These results show that in healthy adults imbalances are discrete[13]. On the other hand, the increase in late latero-lateral deviation may be related to the adaptive process generated by manipulation in plantar support.

Studies show that plant reliefs generate changes in body stabilization[14], which legitimizes the decrease in oscillations and the speed of the pressure center seen in the analyses of this study. Similar to Mantovani et al.[15], in which the values of the mean anteroposterior oscillation before, during and after the use of insoles showed a reduction in the initial values, even without significant difference.

Ahmadi et al.[16] also did not report significant difference in balance after insertion of lateral wedges in 18 patients with medial osteoarthritis in the knees. In Hemmati et al.[17], orthotics did not present negative effects on foot balance and therefore are not a threat to the balance. Studies in which there are balance dysfunctions are needed[18]. Evidence shows significant reduction in body balance in children with cerebral palsy after insole use[19].

These orthotics are a precautionary means in people with normal balance oscillations. There are studies suggesting that they can reduce stress injuries in the femoral and tibial region in militaries[20].

In this study, plantar pressure showed statistical difference, similar to studies that agree that insoles reduce pressures[21,22]. These data disagree with Almeida et al.[23], in which there was no significant difference.

It is difficult to confront the data[23] due to the different materials of insoles in both aforementioned studies. Despite these divergences, it can be inferred that, in general, custom insoles have a better mechanism of attenuation of loads, since they consider individual characteristics of the feet. This breakdown of plant loads is useful, reducing the risk of lesions in lower extremities[24].

Regarding musculoskeletal pain, there is a decrease in means and significant reduction for lumbar pain. The military shoe can cause injuries due to its shape and material, which do not respect the individual characteristics[25].

Ferreira et al.[22] reported significant reduction in painful sensation in the lumbar spine, legs, feet and left knee after two months of orthosis use. In Almeida et al.[23], a decrease in levels of pain was observed in the feet and lumbar spine. However, Chuter et al.[26] have not shown sufficient evidence that insoles can impact on lumbar spine pain. Cambron et al.[27] observed a significant reduction after six weeks of use. These results indicate that the treatment of back pain by means of insole requires further studies[28].

As limitations of this study we can cite the small sample and the differences in the frequency of insole use by the participants. Moreover, all militaries were allocated in a single group, although the different types of feet were considered in the analysis. This is a limitation because the degree of contact of the foot with the insole may vary depending on the type of arch, leading to different levels of stimulation, adaptation periods and correction of asymmetries. Furthermore, the study population was healthy, so the results were discrete. The implications of the insole could be more evident in groups of militaries with balance deficits.

CONCLUSION

Static balance has not been significantly altered by the use of proprioceptive insoles by healthy militaries. However, they provided attenuation and better distribution of plantar pressures and seem to influence musculoskeletal pain in the lower extremities. Therefore, a disease prevention therapy related to their work activity is recommended for this group.

REFERENCES

1. Foisy A, Kapoula Z. How plantar exteroceptive efficiency modulates postural and oculomotor control: inter-individual variability. Front Hum Neurosci. 2016;10:228. doi: 10.3389/fnhum.2016.00228
2. Duarte M, Freitas SMSF. Revisão sobre posturografia baseada em plataforma de força para avaliação do equilíbrio. Rev Bras Fisioter. 2010;14(3):183-92. doi: 10.1590/S1413-35552010000300003
3. Kleiner AFR, Schlittler DXC, Sánchez-Arias MR. O papel dos sistemas visual, vestibular, somatosensorial e auditivo para o controle postural. Rev Neurocienc [Internet]. 2011;19(2):349-57. Available from: http://www.revistaneurociencias.com.br/edicoes/2011/RN1902/revisao%2019%2002/496%20revisao.pdf
4. Sabchuk RAC, Bento PCB, Rodacki ALF. Comparação entre testes de equilíbrio de campo e plataforma de força. Rev Bras Med Esporte. 2012;18(6):404-8. Available from: http://www.scielo.br/pdf/rbme/v18n6/12.pdf
5. Janin M. Correlation between clinical and kinetic testing in sport podiatry. Ter Man. 2012;10(47):7-11.
6. Ferreira DMA, Barela AMF, Barela JA. Influência de calços na orientação postural de indivíduos com escoliose idiopática. Fisioter Mov. 2013;26(2):337-48. doi: 10.1590/S0103-51502013000200011
7. Almeida JS, Vanderlei FM, Pastre EC, Martins RADM, Padovani CR, Filho GC. Comparison of two types of insoles on Musculoskeletal symptoms and plantar pressure distribution in a work environment: a randomized clinical trial. Clin Med Res. 2016;14(2):67-74. doi: 10.3121/cmr.2016.1301
8. Neto ATC, Faleiro TB, Moreira FD, Jambeiro JS, Schulz RS. Lombalgia na atividade policial militar: análise da prevalência, repercussões laborativas e custo indireto. Rev Baiana Saúde Pública. 2013;37(2):365-74. DOI: 10.22278/2318-2660.2013.v37.n2.a336
9. Andersen KA, Grimshaw PN, Kelso RM, Bentley DJ. Musculoskeletal lower limb injury risk in army populations. Sports Med Open. 2016;2(22):2-9. doi: 10.1186/s40798-016-0046-z
10. Przysiezny WL. Manual de reorganização neuromúsculo articular através de estímulos na região plantar. Brusque: Associação Brasileira de Pesquisa em Podoposturologia; 2017.
11. Urabe Y, Maeda N, Kato S, Shinohara H, Sasadai J. Effect of shoe insole for prevention and treatment of lower extremity injuries. J Phys Fitness Sports Med. 2014;3(4):385-98. doi: 10.7600/jpfsm.3.385
12. Hinz P, Henningsen A, Matthes G, Jäger B, Ekkernkamp A, Rosenbaum D. Analysis of pressure distribution below the metatarsals with different insoles in combat boots of the german army for prevention of march fractures. Gait Posture. 2008;27(3)535-8. doi:10.1016/j.gaitpost.2007.06.005
13. Nunes ADM, Fonseca LCS, Scheicher ME. Comparação das inclinações lateral e anteroposterior no equilíbrio estático entre jovens, adultos e idosos. Rev Bras Geriatr Gerontol. 2013;16(4):813-20. doi: 10.1590/S1809-98232013000400015
14. Foisy A, Gaertner C, Matheron E, Kapoula Z. Controlling posture and vergence eye movements in quiet stance: effects of thin plantar inserts. PLOS One. 2015;10(12):e47654. doi: 10.1371/journal.pone.0143693
15. Mantovani A, Martinelli AR, Savian NU, Fregonesi CEPT, Lança AC. Palmilhas proprioceptivas para o controle postural. Colloq Vitae. 2010;2(2):34-8. doi: 10.5747/cv2010.v02.n2.v035
16. Ahmadi F, Forghany S, Nester C, Jones R. Effects of laterally wedged insoles on static balance in patients with medial compartment knee osteoarthritis. J Foot Ankle Res. 2014;7(Suppl 1):A22. doi: 10.1186/1757-1146-7-S1-A22
17. Hemmati F, Forghany S, Nester C. The effects of pronated foot posture and medial heel and forefoot wedge orthoses on static balance in older people. J Foot Ankle Res. 2014;7(Suppl 1):A17. doi: 10.1186/1757-1146-7-S1-A17
18. Marini I, Alessandri Bonetti G, Bortolotti F, Bartolucci ML, Gatto MR, Michelotti A. Effects of experimental insoles on body posture, mandibular kinematics and masticatory muscles activity. A pilot study in healthy volunteers. J Electromyogr Kinesiol. 2015;25(3):531-9. doi: 10.1016/j.jelekin.2015.02.001
19. Christovão TCL, Pasini H, Grecco LAC, Ferreira LAB, Duarte NAC, Oliveira CS. Effect of postural insoles on static and functional balance in children with cerebral palsy: a randomized controlled study. Braz J Phys Ther. 2015;19(1):44-51. doi: 10.1590/bjpt-rbf.2014.0072
20. Snyder RA, DeAngelis JP, Koester MC, Spindler KP, Dunn WR. Does shoe insole modification prevent stress fractures? A systematic review. HSS J. 2009;5(2):92-8. doi: 10.1007/s11420-009-9114-y
21. Ibrahim M, El Hilaly R, Taher M, Morsy A. A pilot study to assess the effectiveness of orthotic insoles on the reduction of plantar soft tissue strain. Clin Biomech (Bristol, Avon). 2013;28(1):68-72. doi: 10.1016/j.clinbiomech.2012.09.003
22. Ferreira EI, Ávila CAV, Mastroeni MF. Use of custom insoles for redistributing plantar pressure, decreasing musculoskeletal pain and reducing postural changes in obese adults. Fisioter Mov. 2015;28(2):213-21. doi: 10.1590/0103-5150.028.002.AO01
23. Almeida JS, Filho GC, Pastre CM, Padovani CR, Martins RADM. Comparison of plantar pressure and musculoskeletal symptoms with the use of custom and prefabricated insoles in the work environment. Rev Bras Fisioter. 2009;13(6):542-8. doi: 10.1590/S1413-35552009005000063
24. Gerych D, Tvrznik A, Prokesova E, Nemeckova Z, Jelen K. Analysis of peak pressure, maximal force, and contact area changes during walking and running with conventional and shock absorbing insoles in the combat boots of the czech army. J Mech Med Biol. 2013;13(2):1350042. doi: 10.1142/S0219519413500425
25. Schulze C, Lindner T, Schulz K, Finze S, Kundt G, Mittelmeier W, Bader R. The influence in airforce soldiers through wearing certain types of army-issue footwear on muscle activity in the lower extremities. Open Orthop J. 2011;5:302-6. doi: 10.2174/1874325001105010302
26. Chuter V, Spink M, Searle A, Ho A. The effectiveness of shoe insoles for the prevention and treatment of low back pain: a systematic review and meta-analysis of randomised controlled trials. BMC Musculoskelet Disord. 2014;15(140):1-8. doi: 10.1186/1471-2474-15-140

27. Cambron JA, Dexheimer JM, Duarte M, Freels S. Shoe orthotics for the treatment of chronic low back pain: a randomized controlled trial. Arch Phys Med Rehabil. 2017;98(9):1752-62. doi: 10.1016/j.apmr.2017.03.028

28. Sahar T, Cohen MJ, Ne'eman V, Kandel L, Odebiyi DO, Lev I, et al. Insoles for prevention and treatment of back pain. Cochrane Database Syst Rev. 2007;4:CD005275. doi: 10.1002/14651858.CD005275.pub2