

Resistance exercise in water for Wistar rats submitted to tendinous trauma: nociception and edema assessment*

Exercício resistido em meio aquático para ratos Wistar submetidos a trauma em tendão: avaliação da nocicepção e edema

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SUMMARY

BACKGROUND AND OBJECTIVES: Models of physical exercise for animals are useful tools to analyze organic functions difficult to be observed in humans, such as the evolution of pain after tendinous trauma. This study aimed at comparing the effects of resistance physical exercise on pain and edema in calcaneal tendons of rats submitted to trauma.

METHOD: We used 18 Wistar rats divided in 3 groups: Control Group (CG, n = 6) – animals submitted to right calcaneal tendon trauma and untreated; Group 2 Jump (G2, n = 6) – animals submitted to trauma and treated with jumps in water, 2 series of 5 jumps; Group 3 Jump (G3, n = 6) – animals submitted to trauma and treated with jumps in water, 4 series of 5 jumps. To induce tendinous trauma, animals were anesthetized and received trauma with approximately 0.40 J in the lateral face of the calcaneal tendon. Jumps were performed daily with 24-hour intervals between applications. Digital Von Frey filament was used to assess pain and edema was assessed by tendon diameter variation with a caliper rule.

RESULTS: Results have shown a slight advantage for G2, which has performed less repetitions of the exercise; for edema, however, there has been slight advantage for G3.

CONCLUSION: Physical exercise has been slightly beneficial to decrease edema and pain.

Keywords: Calcaneal tendon, Exercise, Pain measurement.

RESUMO

JUSTIFICATIVA E OBJETIVOS: Modelos de exercício físico para animais são ferramentas úteis para análise de funções orgânicas difíceis de serem observadas em seres humanos, como na evolução do quadro algico de dor após trauma tendíneo. O objetivo deste estudo foi comparar os efeitos do exercício físico resistido, sobre a dor e edema em tendões calcâneos de ratos submetidos a trauma.

MÉTODO: Foram utilizados 18 ratos Wistar, divididos em 3 grupos: Grupo Controle (GC, n = 6) – animais submetidos à trauma no tendão calcâneo direito, e não tratados; Grupo 2 Salto (G2, n = 6) – animais submetidos ao trauma e tratados com saltos em meio aquático, 2 séries de 5 saltos; Grupo 3 Salto (G3, n = 6) – animais submetidos ao trauma e tratados com saltos em meio aquático, 4 séries de 5 saltos. Para a lesão traumática no tendão, os animais foram anestesiados e receberam trauma com cerca de 0,40 J na face lateral do tendão calcâneo. Os saltos ocorreram diariamente, com intervalo de 24 horas entre as aplicações. Para avaliação da dor foi utilizado o filamento de Von Frey digital, e o edema foi avaliado por variação do diâmetro dos tendões com paquímetro.

RESULTADOS: Os resultados dentro dos grupos apresentaram ligeira vantagem para o G2 que realizou menor número de repetições no exercício, já para o edema, houve ligeira vantagem para o G3.

CONCLUSÃO: O exercício físico foi ligeiramente benéfico na redução do edema e da dor.

Descritores: Exercício, Medição da dor, Tendão do calcâneo.

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INTRODUCTION

Acute calcaneal tendon ruptures are relatively common and 81% to 89% of them happen during sports activities¹. When tendons are injured, the body starts a healing process which may be divided into phases which are overlapped: inflammation, proliferation and remodeling^{2,3}.

Tendons, like muscles and ligaments, respond to exercise and immobilization. Physical activity is a condition where there is increased demand of several organic systems, activating mobilization mechanisms of energetic substrates and helping their redistribution aiming at maintaining muscular work⁴. Physical exercise is used to produce analgesia via endogenous opioids release, which is important in acute inflammatory conditions, even with peripheral leucocytes release^{5,6}.

Physical exercise models for laboratory animals are useful tools for scientific investigation because they help the analysis of organic components or functions, which are difficult to be observed in humans due to ethical and health aspects. So, aiming at evaluating the use of resistance exercise on nociception, there is the possibility of using jumps in water⁷. So, this study aimed at comparing the effects of resistance physical exercise, jump, on calcaneal tendon pain and edema in rats submitted to trauma.

METHOD

After the Animal Experiment Ethics Committee approval and Practice Sessions in the State University of Western Paraná (UNIOESTE), under n. 3910/2010, this study was carried out according to international standards for animal experiment ethics. The study involved 18 Wistar rats, which remained in polypropylene cages with free access to water and food, with controlled light/dark cycles of 12 hours at controlled room temperature ($24 \pm 1^\circ \text{C}$).

Animals were randomly distributed in three groups: Control Group (CG, $n = 6$) – animals submitted to right calcaneal tendon trauma and untreated; Group 2 Jump (G2, $n = 6$) – animals submitted to trauma and treated with jumps in water, 2 series of 5 jumps; and Group 3 Jump (G3, $n = 6$) – animals submitted to trauma and treated with jumps in water, 4 series of 5 jumps.

To injure the calcaneal tendon, animals were previously anesthetized with peritoneal ketamine (95 mg/kg) and xylazine (12 mg/kg). They were placed in the left lateral position and an equipment weighing 575 g, with 8 cm

height and approximate energy of 0.4 J was used to injure the right calcaneal tendon⁸.

A digital Von Frey pressure algometer of the brand Insight[®] was used to evaluate nociception⁹. Test was performed with the animal manually restrained and filament was applied to medial calcaneal tendon. Filament's polypropylene tip was applied perpendicular to the area with gradual pressure increase and as soon as the animal removed the paw, the test was interrupted to record removal threshold.

Evaluations were performed before the injury (EV1), one hour after (EV2), at the end of the first treatment session (EV3), 24 hours after the injury (EV4) and finally at the fifth (EV5) and sixth (EV6) day after the injury.

Edema was evaluated by right calcaneal tendon diameter with a caliper rule positioned medially and laterally⁸, in the same moments of nociception evaluation.

Exercises for injured tendons started soon after the post-injury evaluation moment with an exercise protocol consisting of jumps in water.

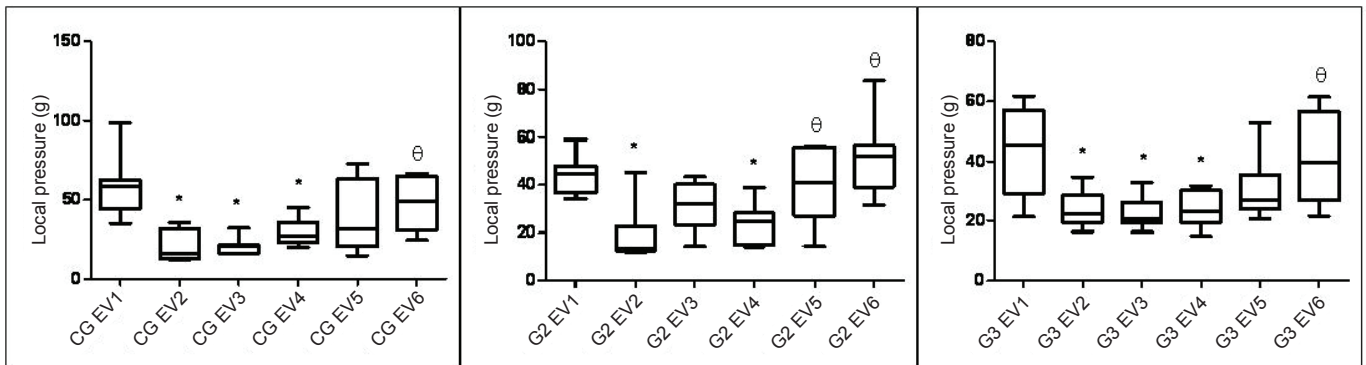
Groups G2 and G3 were treated with 2 series of 5 jumps, or 4 series of 5 jumps, respectively. CG animals were not treated, however they experienced the water sensation for less than one minute.

Results were analyzed by the ANOVA test for repeated measures to compare within groups, and by unidirectional ANOVA to compare among groups. In both cases, Tukey's test was used as post-test with significance level of $\alpha = 0,05$.

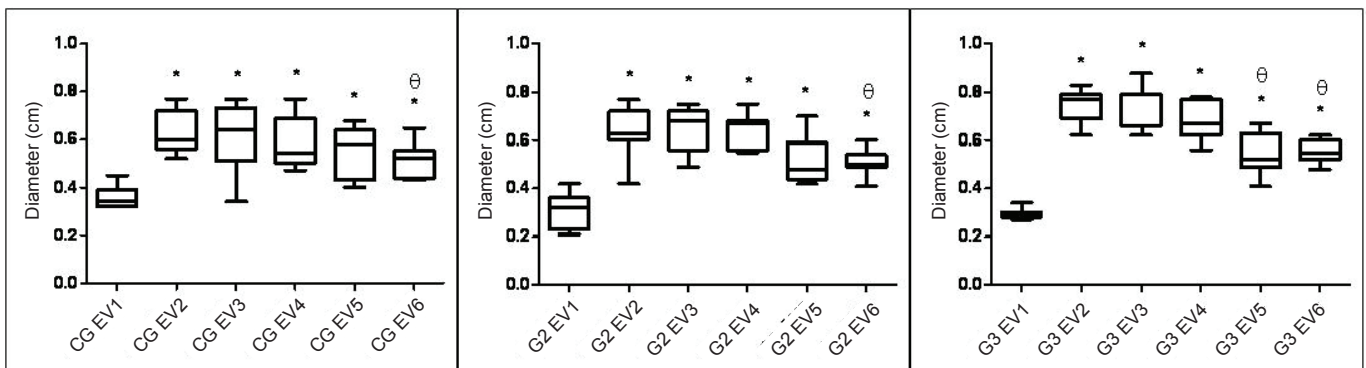
RESULTS

In nociception evaluation for CG there has been significant decrease when EV1 was compared to EV2, EV3 and EV4, with return to baseline values as from EV5. In comparing EV2 with the next moments there has been difference only with EV6. Similar results were obtained for G3. For G2 there has been significant difference when comparing EV1 to EV2 and EV4. There has been no significant difference in the comparison among groups in all evaluated moments ($p > 0.05$).

With regard to edema evaluation results, there has been difference when comparing EV1 to all other moments, for the three groups. For CG and G2, there has been no difference in EV2 as compared to next moments, except for EV6 ($p < 0.05$). For G3 there has been difference in EV2 with regard to EV5 and EV6 ($p < 0.05$) (Graphy 2). There have been no significant differences when comparing among groups in all evaluated moments ($p > 0.05$).



Graph 1 – Values observed in the evaluation with digital Von Frey filament on calcaneal tendon of CG, G2 and G3 groups.
* Significant difference as compared to EV1. θ Significant difference as compared to EV2.



Graph 2 – Values obtained with caliper rule edema evaluation for CG, G2 and G3 groups.
* Significant difference as compared to EV1. θ Significant difference as compared to EV2.

DISCUSSION

The treatment of calcaneal tendon injuries is still the center of attention and controversies about the same problem: restoring normal function, strength and mobility^{10,11}.

Physical exercises are being increasingly stressed for acting both in preventing and treating injuries, as well as for providing better quality of life¹². In addition, resistance exercises increase β -endorphin and enkephalin levels¹³ and promote opioid-mediated analgesia¹⁴.

The behavior observed in this study for groups performing the physical exercise jump was slightly superior as compared to CG, however when comparing among groups, this better result was not confirmed. Edema and pain are among cardinal inflammation signs and physical exercises may accelerate repair by interfering with several inflammatory process stages, promoting chemotaxis and increased phagocytosis capacity. This way, the injury is more rapidly recovered by means of anti-inflammatory agents, more rapidly decreasing edema and pain¹².

More or less physical activity may also change tendon biomechanical properties and composition⁷, that is why physical activity is also indicated for tendon injuries rehabilitation. However, the application of load on tendons and ligaments has little or no short-term effect on their structural characteristics, so it is believed that the protocol used did not produce such adaptive changes at least during the first days of injury. Some limitations of the study are the non-observation of the involved analgesic mechanism, as well as lack of histological and / or biochemical analysis of the inflammatory process, which are suggestions for future studies.

CONCLUSION

Results allow inferring that resistance physical exercise was slightly efficient to decrease edema and nociception.

ACKNOWLEDGMENTS

To Araucária Foundation through PIBIC scholarship and affirmative actions.

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Submitted in December 13, 2011.

Accepted for publication in February 18, 2012.