26 - EFFECTS OF HIGH-VOLTAGE CURRENT ON EDEMA, IN RATS PAW PRODUCED BY NERVE COMPRESSION

CASSIANE MERIGO NASCIMENTO
DANIELA MARTINS CUNHA
GLADSON RICARDO FLOR BERTOLINI
Laboratório de Estudo das Lesões e Recursos Fisioterapêuticos da Universidade Estadual do Oeste do Paraná
campus Cascavel – PR – Brasil
gladsonricardo@gmail.com

INTRODUCTION

In athletes, the pain to weight bearing is a common clinical presentation and may be due to various causes, such as chronic compartment syndrome, tendinitis, carpal tunnel syndrome, shin splints, stress fractures, fascial injuries, disruption of the miotendineous junction, compression syndrome of the popliteal artery, venous thrombosis induced by physical exertion and nerve compression. The typical presentation of nerve compression pain is initiated by the activity, which is exacerbated with sustained exercise, and paresthesia (EDWARDS, WRIGHT, HARTMAN, 2005; TOULIOPOLOUS; HERSHMAN, 1999)

The sciatic nerve can be compressed into any level of the abdomen to the knee. Gluteal region, local trauma, fractures and dislocations, or space-occupying lesions may compress the nerve. The piriformis syndrome has been described as a form of nerve compression causing pain along the hamstrings and buttocks. In sports medicine, where chronic hamstring pain is a common problem, this syndrome is a possible cause to explain these symptoms. The pain is exacerbated by flexion at the hip external rotation combined with active or passive internal rotation, and spasm is usually palpable in the obturator internus and / or piriformis (McCRORY; BELL, 1999).

The piriformis muscle is a lateral rotator of the hip when it is less than 90° of flexion. It is innervated by S1-S2, is medially attached to the inner surface of the sacrum and laterally to the greater trochanter, along with other lateral rotators. About 6% of sciatic pain observed are probably caused by piriformis syndrome. The severe spasm or hypertrophy of the muscle can result in compression of the sciatic nerve, causing swelling, inflammation and pain in the nerve pathway. Among its complications can mention the formation of lower limb edema, which can result in venous engorgement of the lower limb, besides being a possible cause of deep venous thrombosis and should thus be treated and prevented (BUSTAMANTE, HOULTON, 2001).

Conservative treatment based on physical therapy, nonsteroidal anti-inflammatory and / or steroids are widely used for treatment (EDWARDS, WRIGHT, HARTMAN, 2005; TOULIOPOLOUS; HERSHMAN, 1999). However, drug treatment has significant side effects; physical modalities for this have been advancing and interest (FERREIRA et al., 2005). Among the resources available, to reduce edema in the therapy field, has highlighted the use of polarized currents, such as Bernard´ Diadynamics (REINERT et al., 2005) and high voltage pulsed current (DOLAN; MYCHASKIW; MENDEL, 2003; DOLAN et al., 2003; DOLAN et al., 2005). However, there is a gap in the literature regarding the use of high-voltage current, to reduce edema, coming from nerve compression. Thus, the aim of the present study was to evaluate the effects of cathodic and anodic currents of high voltage on the paw edema, of rats, produced by an experimental model of sciatica.

MATERIALS AND METHODS

Experimental Groups

Were used 24 Wistar rats (Rattus norvegicus), weighing 377.10 ± 21.39 g and 14 ± 2 weeks old. The animals were housed in polypropylene cages, subjected to light / dark cycle of 12 hours, receiving water and food ad libitum throughout the experimental period.

The animals were randomly divided into 3 groups:

- GS (n = 8) – submitted to sciatica in the right pelvic limb and the placebo treatment (sham);
- GP + (n = 8) – submitted to sciatica in the right pelvic limb and treated with anodic current at the site of surgery;
- GP- (n = 8) – submitted to sciatica in the right pelvic limb and treated with cathode current at the site of surgery.

The project was conducted according to international standards of ethics in animal experiments (ANDERSEN et al., 2004). As approved by the Animal Ethics and Practical Sessions of Unioeste under protocol number 0209.

EXPERIMENTAL PROTOCOL INJURY

The animals were anesthetized with xylazine (12 mg/kg) and ketamine (95 mg/kg) intraperitoneally, and then trichotomy was performed at the surgery site. There was an incision parallel to the right thigh biceps femoris fibers of the animal, exposing the sciatic nerve. Following the model described by Bennett and Xie (1988), we performed the compression of the nerve in four distinct regions along the same, with a distance of approximately 1 mm from each other, being used chrome wire catgut 4.0, reproducing the symptoms of a sciatica, then the suture was carried out by planes.

EDEMA EVALUATION

The edema evaluation was performed by volumetry, ie, displacement of water in a flask. Was held marking with permanent marker, the right talocrural joint interlining of all animals. The paw was inserted into a cylinder, which had marked the initial water level. With the aid of a graduated syringe (maximum capacity of 10 mL), water was removed from the cylinder until the water level returned to the initial state. The evaluations were performed before surgery, at 3 days postoperatively (PO) before and after simulation or realization of the 1st day of treatment, after 5 and 10 days of treatment.

TREATMENT PROTOCOL

In the 3rd PO, began the treatment that occurred on a daily basis, for 10 days followed, by 20 minutes each treatment, using high-voltage equipment Neurodyn High Volt, IBRAMED®, which had calibration certificate valid for the study period.

For the application of high voltage current, specifically on the surgical incision, the animals were anesthetized and positioned in the left lateral position. The electrodes used were rubber-silicone, and positioned on the incision region and the in the animals lumbar region. The active electrode (the site of surgery) was 1 cm2 and the passive electrode (lower back) was 4 cm2 areas. The current intensity used was increased to observe muscle contraction, and then reduced in 10% of this value, thus producing stimulation only at sensitive. The frequency used was 50 Hz, with phase duration of 50 μs.

RESULTS ANALYSIS

The normality of the results was analyzed by the Kolmogorov-Smirnov test, were expressed by descriptive statistics (mean and standard deviation) and analyzed by statistical inference, when using analysis of variance with repeated measures with post hoc of Tukey, in both tests the level of significance was α = 0.05.

RESULTS

The results were analyzed by comparing pre-injury times, with the later, and also compared the values post-injury with the following. For GS significantly increased compared with the time pre-injury, pre-simulation and after the simulation, but there was no difference after 5 and 10 days of simulation (Fig. 1).

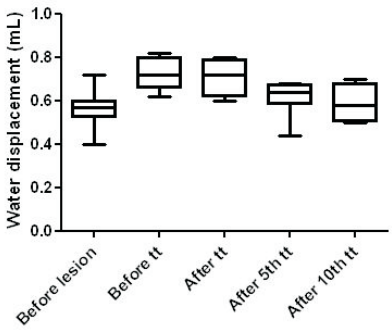

Figure 1 – water displacement in mL for the sham group. * Statistically significant difference when comparing with the time pre-injury. *statistically significant difference when comparing with the time pre-treatment.

For the group of anodic current, a significant increase in pre and post-treatment, when compared to the time pre-injury, but no difference when comparing the pre-treatment with the following (Fig. 2).

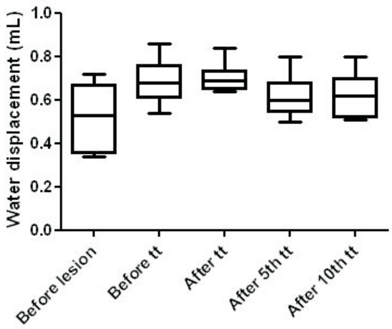

Figure 2 – water displacement in mL for the group of anodic current. * Statistically significant difference when comparing with the time pre-injury.

For the group of cathode current, similar to that of anodic current, a significant increase in the moments before and after initial treatment, but at no time difference was significant (Fig. 3).

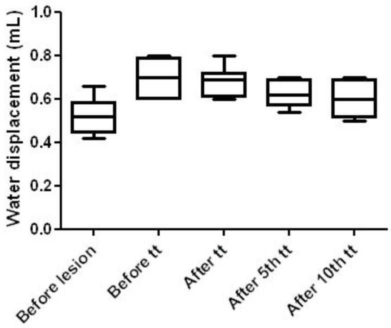

Figure 3 – water displacement of in mL for the group of cathode current. * Statistically significant difference when comparing with the time pre-injury.

DISCUSSION

The sciatic nerve is the largest of the human body, being subject to injuries such as crushing, transection, stretch and freezing. Experimental models of sciatic nerve compression in rats have been used because of its similarity to the sciatic nerve in humans (PACHIONI et al., 2006). In this study, we used a model of sciatic compression in rats, which mimics the symptoms of sciatica, to evaluate the effect of high voltage current, using the positive (anodic current) and negative (cathode current) on the evolution of the edema of the affected limb.

The assessment showed that edema was present at the 3rd postoperative day, observed for the placebo group and similarly to the treated groups, showed a significant increase of values at the time prior to the start of treatment, and the difference persisted until the 3rd day of treatment simulation. Comparisons of pre-treatment times with the following submitted to the sham group, significant decrease in 5 and 10 days of simulation.

We inferred that the swelling may be due to nerve compression, since the second Dorrel (2005), and Bustamante and Houlton (2001), both disc herniation, producing nerve root compression, and the piriformis syndrome can cause swelling to over the affected lower limb. Moreover, according to Bustamante and Houlton (2001) the piriformis syndrome can contribute to compression of nerves and vessels, causing not only engorgement of the nerve sheath, but also venous stasis and possible mechanical obstruction of the flow of the lower limb in general. The sciatica pain produces disuse atrophy that create greater immobility and increased venous stasis. Endothelial damage could be explained by external compression, directing the chronic inflammation and edema. Thus, endothelial damage associated with venous stasis and immobility of the limb, facilitating platelet aggregation and thrombus formation and could provide the patient a deep venous thrombosis.

However, the edema could also be explained by the fact that to accomplish the sciatic nerve compression, we conducted an open surgical experiment, producing injury, and the sciatic nerve, also in skin, subcutaneous tissue, fascia and muscle tissue, which in itself creates an important inflammatory process, resulting exudate. Regardless of the cause of the edema, it is not diminished with the use of current cathode or anode.

Differently to that seen here, Cook et al. (1994), using anodal high-voltage current, observed a edema reduction induced by albumin labeled with Evans blue, and reported that the effect was possibly due to increase in absorption of protein by the lymph flow. Concurrently, Dolan, Mychaskiw and Mendel (2003), Dolan et al. (2003) and Dolan et al. (2005) observed positive effects in reducing traumatic edema in rat paws, using cathodal high-voltage current. However, it is noted that the studies cited, unlike the present study, the minimum duration of treatment was 1 hour and occurred in the distal limb.

Reinert et al. (2005) using another form of the polarizing current (Bernard´ Diadynamics), observed that the anodic current, with less intensity than the motor level, observed a reduction in the formation of traumatic edema in rat paws. In a contrary, the present study, both the stimulation anode and the cathode, not only did not produce a decrease in swelling, but also when comparing with the control group, no significant reduction of 5 and 10 days compared to the before treatment for groups electrostimulated. That is, electrical stimulation produced worse effects than when it was just a sham treatment.

It read, however, as limitations the not stimulation (active) in the distal limb, being performed only in the proximal right pelvic limb. Nor were evaluated other inflammatory characteristics or lymph flow, which can also be the focus of investigation in future studies.

CONCLUSION

Based on these results, we concluded that with the methodology used, no beneficial effects of edema reduction, with the high voltage current.

ACKNOWLEDGMENTS

To National Counsel of Technological and Scientific Development (CNPq), for supporting this work (480748/2008).

REFERENCES

ANDERSEN, M. L.; D'ALMEIDA, V.; KO, G. M.; KAWAKAMI, R.; MARTINS, P. J.; MAGALHÃES, L. E.; TUFIK, D. **Princípios éticos e práticos do uso de animais de experimentação**. São Paulo: UNIFESP, 2004.

BENNETT, G. J.; XIE, Y. K. A. A pheripheral mononeuropathy in rat that procedures disorders of pain sensation like those seen in man. **Pain**, v. 33, p. 87-107, 1988.

BUSTAMANTE, S.; HOULTON, P. G. Swelling of the leg, deep venous thombosis and the piriormis syndrome. **Pain Research Management,** v. 6, n. 4, p. 200-2003, 2001.

COOK, H. A.; MORALES, M.; LA ROSA, E. M.; DEAN, J.; DONNELLY, M. K.; MCHUGH, P.; OTRADOVEC, A.; WRLGHT, K. S.; KULA, T.; TEPPER, S. H. Effects of electrical stimulation on lymphatic flow and limb volume in the rat. **Physical Therapy,** v. 74, p. 1040-1046, 1994.

DOLAN, M. G.; GRAVES, P.; NAKAZAWA, C.; DELANO, T.; HUTSON, A.; MENDEL, F. C. Effects of ibuprofen and high-voltage electric stimulation on acute edema formation after blunt trauma to limbs of rats. **Journal of Athletic Training,** v. 40, n. 2, p. 111-115, 2005.

DOLAN, M. G.; MYCHASKIW, A. M.; MATTACOLA, C. G.; MENDEL, F. C. Effects of cool-water immersion and high-voltage electric stimulation for 3 continuous hours on acute edema in rats. **Journal of Athletic Training,** v. 38, n. 4, p. 325-329, 2003.

DOLAN, M. G.; MYCHASKIW, A. M.; MENDEL, F. C. Cool-water immersion and high-voltage electric stimulation curb edema formation in rats. **Journal of Athletic Training**, v. 38, n. 3, p. 225-230, 2003.

DORRELL, W. Another swollen calf. **The Lancet,** v. 366, p. 27, 2005.

EDWARDS, P. H.; WRIGHT, M. L.; HARTMAN, J. F. A practical approach for the differential diagnosis of chronic leg pain in the athlete. **American Journal of Sports Medicine,** v. 33, n. 8, p. 1241-1249, 2005

FERREIRA, D. M.; ZÂNGARO, R. A.; VILLAVERDE, A. B.; CURY, Y.; FRIGO, L.; PICOLO, G.; LONGO, I.; BARBOSA, D. G. Analgesic effect of He-Ne (632.8 nm) low-level laser therapy on acute inflammatory pain. **Photomedicine and Laser Surgery**, v. 23, n. 2, p. 177-181, 2005.

McCRORY, P.; BELL, S. Nerve entrapment syndromes as a cause of pain in the hip, groin and buttock. Sports Medicine, v. 27, n. 4, p. 261-274, 1999.

PACHIONI, C. A. S.; MAZZER, N.; BARBIERI, C. H.; FAZAN, V. P. S.; PADOVANI, C. R.; MORO, C. A.; SILVA, C. A. A. Lesão por esmagamento do nervo isquiático de ratos: estudo da vascularização. **Acta Ortopédica Brasileira**, v. 14, n. 4, p. 203-207, 2006.

REINERT, T. C.; GONZALES, T. C.; SIQUEIRA, F. C. H. N.; LOTH, E. A.; BERTOLINI, G. R. F. Uso de correntes diadinâmicas de Bernard em edema agudo traumático de ratas. **Reabilitar,** v. 7, n. 26, p. 24-28, 2005.

TOULIOPOLOUS, S.; HERSHMAN, E. B. Lower leg pain diagnosis and treatment of compartment syndromes and other pain syndromes of the leg. **Sports Medicine**, v. 27, n. 3, p. 193-204, 1999.

EFFECTS OF HIGH-VOLTAGE CURRENT ON EDEMA, IN RATS PAW PRODUCED BY NERVE COMPRESSION

Among the complications of the sciatic nerve compression, we can mention the lower limb edema formation. As a resource, to reduce edema, has highlighted the use of high voltage pulsed current. However, there is a gap with respect to their use in reducing edema that comes from nerve compression. This work aimed to evaluate the effects of current high voltage on the paw edema of rats, produced by an experimental model of sciatica. We used 24 rats divided into 3 groups: GS – placebo

treatment; GP+ - treated with anodic current, GP- - treated with cathode current. The model consisted of nerve tie nerve compression in four distinct regions, with catgut thread. The evaluation was carried out by volumetry, with immersion of the foot in a cylinder with a syringe, the water was removed until the water level returned to initial state. The evaluations occurred before surgery to postoperative day 3, before and after the simulation or realization of the 1st treatment, after 5 and 10 days of treatment. No 3 PO, began the treatment, daily for 10 consecutive days, 20 minutes each. For the application of high voltage current on the incision, the animals were anesthetized and positioned in lateral lying. The current intensity used was 10% lower than the motor threshold. The results showed significant increase for all groups when comparing pre-and post-stimulation, with the time pre-injury, but there were no differences between pre-injury with 5 and 10 days. By comparing the time pre-stimulation with the following, only the sham was significantly decreased in 5 and 10 days. It is concluded that the methodology used, no beneficial effects of edema reduction, with the high voltage current.

KEYWORDS: Transcutaneous Electric Nerve Stimulation; Sciatica; Edema.

EFFETS DE COURANT HAUTE TENSION SUR L'OEDÈME, LES PIEDS DANS RATS REALISE PAR COMPRESSION NERVEUSE

Parmi les complications de la compression du nerf sciatique, on peut citer la formation d'œdème des membres inférieurs. En tant que ressource, afin de réduire l'œdème, a mis en évidence l'utilisation de courant pulsé de haute tension. Toutefois, il existe un écart par rapport à leur utilisation dans la réduction de l'oedème qui vient de la compression du nerf. Ce travail visait à évaluer les effets de la haute tension actuelle sur l'oedème patte de rat, produit par un modèle expérimental de la sciatique. Nous avons utilisé 24 rats répartis en 3 groupes: GS - traitement par placebo; GP + - traitées avec anodique actuelle, GP - traitées avec une cathode en cours. Le modèle comprenait nerf compression du nerf amarria dans quatre régions distinctes, avec un fil de catgut. L'évaluation a été effectuée par volumétrie, à l'immersion du pied dans un cylindre avec un cylindre de seringue, l'eau a été retirée avant que le niveau d'eau retournée à l'état initial. Les évaluations ont eu lieu avant la chirurgie pour jour après l'opération 3, avant et après la simulation ou la réalisation du traitement 1st, après 5 et 10 jours de traitement. N PO 3, a commencé le traitement, par jour pendant 10 jours consécutifs, à 20 minutes chacune. Pour l'application de courant haute tension sur l'incision, les animaux ont été anesthésiés et placés en décubitus latéral. L'intensité du courant utilisé était de 10% inférieur au seuil moteur. Les résultats ont montré augmentation significative pour tous les groupes lors de la comparaison pré-et post-stimulation, à l'époque pré-blessure, mais il n'y avait pas de différence entre la pré-blessure avec 5 et 10 jours. En comparant l'époque pré-stimulation par la suite, seuls le faux a été significativement diminué dans 5 et 10 jours. Il est conclu que la méthodologie utilisée, aucun effet bénéfique de la réduction de l'oedème, avec le courant à haute tension.

MOTS-CLÉS: Transcutaneous electrical nerve stimulation; sciatique; Edema.

EFECTOS DE LA CORRIENTE DE ALTA TENSIÓN SOBRE EL EDEMA, LOS PIES EN RATAS PRODUJERON POR COMPRESIÓN NERVIOSA

Entre las complicaciones de la compresión del nervio ciático, podemos mencionar la formación de edema de miembros inferiores. Como recurso, para reducir el edema, ha puesto de relieve la utilización de impulsos de corriente de alta tensión. Sin embargo, hay una brecha con respecto a su uso para reducir el edema que viene de la compresión del nervio. Este trabajo se propuso evaluar los efectos de la alta tensión actual en el edema de la pata de ratas, producidas por un modelo experimental de la ciática. Se utilizaron 24 ratas, divididas en 3 grupos: GS - el tratamiento con placebo; GP + - tratados con corriente anódica, GP - tratados con corriente catódica. El modelo consiste en la compresión del nervio en cuatro regiones distintas, con hilo de catgut. La evaluación fue llevada a cabo por volumetría, con la inmersión del pie en un cilindro con una jeringa, el agua se retiró hasta el nivel del agua volvió a su estado inicial. Las evaluaciones se produjeron antes de la cirugía de día postoperatorio 3, antes y después de la simulación o la realización de tratamiento de la 1 ª, después de 5 y 10 días de tratamiento. PO n º 3, comenzó el tratamiento, al día durante 10 días consecutivos, a 20 minutos cada uno. Para la aplicación de alta tensión actual en la incisión, los animales fueron anestesiados y se coloca en decúbito lateral. La intensidad de la corriente utilizada fue 10% menor que el umbral de motor. Los resultados mostraron aumento significativo para todos los grupos al comparar el pre-y post-estimulación, con el tiempo pre-lesión, pero no hubo diferencias entre el antes de la lesión con 5 y 10 días. Mediante la comparación de la época pre-estimulación con el siguiente, sólo el simulacro se redujo significativamente en 5 y 10 días. Se concluye que la metodología utilizada, no tiene efectos beneficiosos de la reducción del edema, con la tensión de alta corriente.

PALABRAS CLAVE: Estimulación Eléctrica Transcutánea del Nervio; Ciática; Edema.

EFEITOS DA CORRENTE DE ALTA VOLTAGEM SOBRE O EDEMA, EM PATAS DE RATOS, PRODUZIDO POR COMPRESSÃO NERVOSA

Dentre as complicações da compressão do nervo isquiático, pode-se citar a formação de edema de membro inferior. Como recurso, para redução de edema, tem destaque o uso de correntes pulsadas de alta voltagem. Contudo, existe uma lacuna, com respeito ao uso delas na redução de edema advindo de compressão nervosa. Dessa forma, objetivou-se avaliar os efeitos de correntes de alta voltagem sobre o edema de pata de ratos, produzido por modelo experimental de ciatalgia. Foram utilizados 24 ratos, divididos em 3 grupos: GS – tratamento placebo; GP+ – tratado com corrente anódica; GP- – tratado com corrente catódica. O modelo de compressão nervosa consistiu na amarria do nervo, em quatro regiões distintas, com fio catgut. A avaliação foi realizada pela volumetria, com imersão da pata em uma proveta graduada, com auxílio de uma seringa graduada, era retirada a água até que o nível de água retornasse à marcação inicial. As avaliações ocorreram antes da cirurgia, ao 3º PO, antes e após a simulação ou realização do 1º tratamento, após o 5º e 10º dias de tratamento. No 3º PO, iniciou-se o tratamento, diário, por 10 dias seguidos, 20 minutos cada. Para a aplicação da corrente de alta voltagem, sobre a incisão cirúrgica, os animais foram anestesiados e posicionados em decúbito lateral. A intensidade da corrente utilizada, era 10% menor do que o limiar motor. Os resultados mostraram aumento significativo, para todos os grupos ao comparar o pré e pós-estimulação, com o momento pré-lesão, mas, não houve diferenças entre pré-lesão com 5º e 10º dias. Ao comparar o momento pré-estimulação com os seguintes, apenas o simulacro apresentou diminuição significativa no 5º e 10º dias. Conclui-se que com a metodologia realizada, não houve efeitos benéficos de redução de edema, com a corrente de alta voltagem.

PALAVRAS-CHAVE: Estimulação Elétrica Nervosa Transcutânea; Ciática; Edema.

PUBLICAÇÃO NO FIEP BULLETIN ON-LINE: http://www.fiepbulletin.net/80/a2/26