HYDROMAT ACTION ON BONE HEALING OF DOGS SUBMITTED TO MODIFIED TIBIAL TUBEROSITY ADVANCEMENT TECHNIQUE

AÇÃO DA HIDROESTEIRA NA CICATRIZAÇÃO ÓSSEA DE CÃES SUBMETIDOS À TÉCNICA DE AVANÇO DA TUBEROSIDADE TIBIAL MODIFICADA

C. C. ZANI[1], R. M. MEDEIROS[2], J. G. PADILHA FILHO[3], M. R. F. MACHADO[4], P. C. MORAES[5], M. A. R. FELICIANO[6]

SUMMARY

The aim of this study was to evaluate the hydromat action on bone healing of dogs undergoing modified TTA (TTAm) by means of radiographic evaluation. We used 10 dogs of medium and large sizes (Canis familiaris, Linnaeus, 1758), male and female, diagnosed with Cranial Cruciate Ligament Rupture (CCLR). After the diagnosis, the animals underwent TTAm. The dogs were divided into two experimental groups with five animals in each: Group C (control), animals not treated with physiotherapy (hydrotherapy) and Group T (treated), animals treated with physiotherapy (hydrotherapy). Bone healing was evaluated radiographically in the immediate postoperative period, at 30, 60 and 90 days; by checking the positioning of implant, presence of periosteal reaction, images suggestive of rejection, infection, bone density (BD) and mineralization rate (MR). A radiographic pattern of bone healing could be visualized in both groups. Mineralization rate (MR) was not significantly different for dogs treated or not with physiotherapy (P>0.05). Dogs treated with physiotherapy (hydrotherapy) for 15 days compared with untreated animals had earlier functional use of the limb and greater range of motion. However, it was concluded that the use of hydrotherapy as an auxiliary method in the treatment of dogs undergoing modified TTA does not promote significant difference in bone healing compared to dogs that were not treated with physiotherapy.

KEY-WORDS: Dog. Hydromat. Cranial cruciate ligament. Tuberosity advancement cranial. Bone healing.

RESUMO

O objetivo desse estudo foi avaliar os efeitos da hidroterapia na cicatrização óssea de cães submetidos à técnica de Avanço da Tuberosidade Tibial modificada (TTAm), por meio de avaliações radiográficas. Foram utilizados 10 cães de porte médio ou grande (*Canis familiaris- Linnaeus, 1758*), machos ou fêmeas, com diagnóstico de Ruptura de Ligamento Cruzado Cranial (RLCCr). Após o diagnóstico, os animais foram submetidos ao TTAm. Os cães foram separados em dois grupos experimentais contendo cinco animais em cada grupo: **Grupo C (controle):** animais não tratados com fisioterapia (hidroesteira); **Grupo T (tratado):** animais tratados com fisioterapia (hidroesteira). Para a avaliação da cicatrização óssea foi realizada a análise radiográfica no pós-operatório imediato, com 30, 60 e 90 dias pós-operatório verificando posicionamento de implante, presença de reação periosteal, imagens sugestivas de rejeição, infecção, densidade óssea (DO) e índice de mineralização (IM). Pôde-se visibilizar o padrão radiográfico de cicatrização óssea em ambos os grupos. Ao avaliar o IM não foi verificada diferença significativa entre animais tratados ou não com fisioterapia (P>0,05). Os cães tratados com fisioterapia (hidroterapia) por 15 dias, comparados com animais não tratados, tiveram uso funcional do membro precocemente e a amplitude de movimento maior. Concluiu-se que a utilização da hidroterapia como método auxiliar no tratamento dos cães submetidos à TTA modificada não promove diferença significativa na cicatrização óssea em comparação aos cães que não foram tratados com fisioterapia.

PALAVRAS-CHAVE: Cão. Hidroesteira. Ligamento cruzado cranial. Avanço da tuberosidade cranial. Cicatrização. Óssea.

[1] Médica Veterinária Residente, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.
[2] Doutoranda em Cirurgia Veterinária, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.
[3] Professor Doutor do Departamento de Clínica e Cirurgia Veterinária, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.
[4] Professora Doutora do Departamento de Morfologia e Fisiologia Animal, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.
[5] Doutora em Cirurgia Veterinária, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.
[6] Pós-doutorando do Departamento de Reprodução Animal, Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal. Endereço: via de acesso Prof. Paulo Donato Castellane s/n, 14884-900, Jaboticabal, SP. email: marcusfeliciano@yahoo.com.br

Submitted: 25/04/2011 Accepted: 20/09/2011

INTRODUCTION

Cranial cruciate ligament rupture (CCLR) is the main cause of lameness in dogs (LINS, 2009). According to most studies, the technique of Tibial Tuberosity Advancement (TTA) is considered the best method for surgical correction of CCLR. The modified TTA (TTAm) consists of replacing the titanium cage spacer by another made of castor bean (*Ricinus communis*) polymer and fixing it with two stainless steel screws in the craniocaudal direction, eliminating the use of plate and "fork" (MEDEIROS, 2011).

Physical rehabilitation (physiotherapy) is required for animals that had cranial cruciate ligament rupture, even after stabilization. The benefits of physical therapy are promoting proper healing, reestablishing limb functions quickly and preventing complications caused by inactivity, such as muscle atrophy and joint contracture (CLARK & McLAUGHLIN, 2001; MARSOLAIS et al., 2002). There are many situations where hydrotherapy can be effective, such as rehabilitation of postoperative fractures, stabilization of cranial cruciate ligament, neurological conditions, tendonitis, fitness and disorders in which the dog is reluctant to support the member or there is lack of movement, strength and proprioceptive ability (LEVINE et al., 2004).

The objective of this study is to evaluate the effects of hydrotherapy on bone healing of dogs undergoing TTAm through radiographic evaluations, checking placement of implant, presence of periosteal reaction, images suggestive of rejection, infection, bone density (BD) and mineralization rate (MR).

MATERIAL AND METHODS

Dogs and Experimental Groups

We used 10 dogs of medium and large sizes (*Canis familiaris- Linnaeus, 1758*), male and female diagnosed with CCLR. The dogs selected for this study had clinical signs of lameness without weight bearing, pain and muscle atrophy of the affected limb. The diagnosis was based on anamnesis, physical examination and x-rays.

Drawer and tibial compression tests were performed during physical examination and a positive result suggested the presence of CCLR. The x-ray was carried out with the dog in the lateral decubitus position. The extent of the tibial tuberosity advancement (TTA) necessary to reposition the patellar tendon perpendicular to the tibial plateau was determined by measurements on a mediolateral x-ray of the joint positioned at 135°, as recommended by Damur et al. (2005) and x-ray evaluation was performed as described by Hoffmann (2006). The x-rays also helped to determine the size of both the spacer for the TTAm and the screws needed to fix it to the body and to the crest of the tibia.

After the CCLR diagnosis, the dogs underwent a TTAm surgical procedure. Postoperatively, the dogs were separated into two experimental groups with five animals each:

- Group C (control): the dogs did not undergo physiotherapy (hydromat).

- Group T (treated): the dogs underwent physiotherapy (hydromat).

The dogs of Group T underwent physical rehabilitation 10 days after the TTAm, which consisted of using the hydromat during 10 minutes, for 15 days, daily. The patients remained hospitalized in the immediate postoperative period and during hydrotherapy for daily monitoring of the operated limb.

Evaluation of Bone Healing

Bone healing evaluation of the dogs from different experimental groups that underwent TTA, consisted of mediolateral and craniocaudal x-rays at different postoperative times, immediately after, 30, 60 and 90 days. The parameters evaluated were as follows: positioning of implant, presence of periosteal reaction, images that suggest rejection, infection and any relevant changes during postoperative period.

The x-rays were performed using the radiographic equipment Tridoros 812E – Siemens[7] and chassis with 40 x 30 cm Kodak MXG/Plus[8] radiographic films. After exposure, the X-ray films were developed by the automatic Kodak X-OMAT 2000 Processor.

For the evaluation of bone healing by studying the radiopacity of the tissue involved, in an objective and constant, we used the measurement of optical density (OD) of bone growth in the castor bean polymer implant in both groups evaluated in the moment immediate postoperative period times, immediately after, 30, 60 and 90 days. From the OD, we obtained a comparison value, called mineralization rate (MR) inversely proportional to the optical density, areas of high and low exposure of each assessed x-ray and the extreme positive and negative radiopacity. This mineralization rate allowed the assignment of a numerical value to determine the relative radiopacity of the implant in each dog, and thus to compare treatments at different times.

The mineralization rate was determined by an equation that established a relationship between OD and MR, where the mineralization rate values rank between 0 and 10. Firstly, the mean OD between the most and less radiopaque areas of the x-rays in the region of the implant were measured using a digital densitometer. Subsequently, the mean OD value of each implant was determined for the studied times and fitted into the equation below to determine the mineralization rate (MR):

MR = (OD mean – OD + rad.)×10/(OD – rad. – OD + rad.) – 10

OD mean: mean optical densitometry of the implant

OD + rad.: optical densitometry of the x- ray most radiopaque area (mean)

[7]Siemens Medical Ltda. Londres

[8] Kodak Brasileira COM e IND Ltda. São Paulo

OD – rad.: optical densitometry of the x- ray least radiopaque area (mean)

Optical densitometry was performed in every x-ray in order to evaluate possible differences between the bone densities of dogs treated or not with postoperative physiotherapy.

Statistical Analysis

The mean values of the x-rays determined MR. These values were treated as completely randomized design, in a split plot, with the treatments (treated or not with physiotherapy) as plots and postoperative times (immediately after, 30, 60 and 90 days) as sub-plots. Means were compared by Tukey test at 5% significance level.

RESULTS AND DISCUSSION

First, there were no complications during the course of the surgeries. According to Hoffmann (2006) and Lavafer (2007), the CCLR results in instability and secondary osteoarthritis, while it is also observed the presence and progression of osteoarthritis in the knee joint of dogs treated with conservative techniques or extracapsular, intracapsular and TTA, contrary to what was observed in this study using the modified TTA.

The visual examination of the postoperative x-rays showed that the castor bean polymer implant was adequately positioned and both screws traversed the two cortical bones as expected. It was also possible to visualize the standard radiographic bone healing in dogs of both groups, with increased opacity in the region of the tibial crest osteotomy, and early callus formation in the first 30 postoperative days. After 60 days, radiopacity increased in implant region and the callus showed greater intensity, between one and two thirds of the total size of the tibia crest advance. After 90 days, the x-ray examination showed healing osteotomy throughout its almost total length. No degenerative diseases were present in the knee joint and/or changes of soft tissues, at the end of 90 days, (Figure 1 and 2). The results from the x-ray examinations of dogs that underwent TTAm, at different postoperative times, corroborates the findings for bone healing or scarring reported by Henry, 2010.

The visualization of radiographic findings consistent with osteoarticular changes have been used as a clinical standard for assessing the progression of degenerative diseases. However, according to Vasseur (1992), these changes are not necessarily directly related with the functional recovery of the studied osteoarticular structure. From the optical densitometry and mineralization rate evaluations developed in this study for the different experimental groups, it was possible to determine in a straightforward way the bone healing of dogs that underwent TTAm (Figure 3).

The mineralization rate (MR) was not significantly different between dogs treated or not with physiotherapy ($P>0.05$) (Table 1). However, in Figure 3 showing the MR with relation to experimental groups and postoperative times, it can be seen that after 30 days the MR decreased for both treatments, followed by an increase until the 90th day.

Souza et al. (2006) studied the physical rehabilitation of dogs that underwent knee replacement surgery and compared it with dogs that were left untreated. The dogs treated with physiotherapy (hydrotherapy, massage, passive movement and walking) during 15 days, had early functional use of the limb and greater range of limb movement compared to dogs that were not treated. Degani (1998) also reported that the use of hydromat during the postoperative aims to restore a proper healing, quick functional recovery of the affected limb and to prevent complications caused by disuse, such as muscle atrophy and joint contracture. In this study, the dogs treated with physiotherapy during the postoperative had higher mineralization rates than the control group, that is, it was possible to observe early proper healing of the dogs that were treated with physiotherapy. Also, these dogs had reduced muscular spasms and physical discomfort, decreased muscle fatigue and increased range of motion. These findings resulted in improved fitness and early recovery from injury of treated dogs compared to control group.

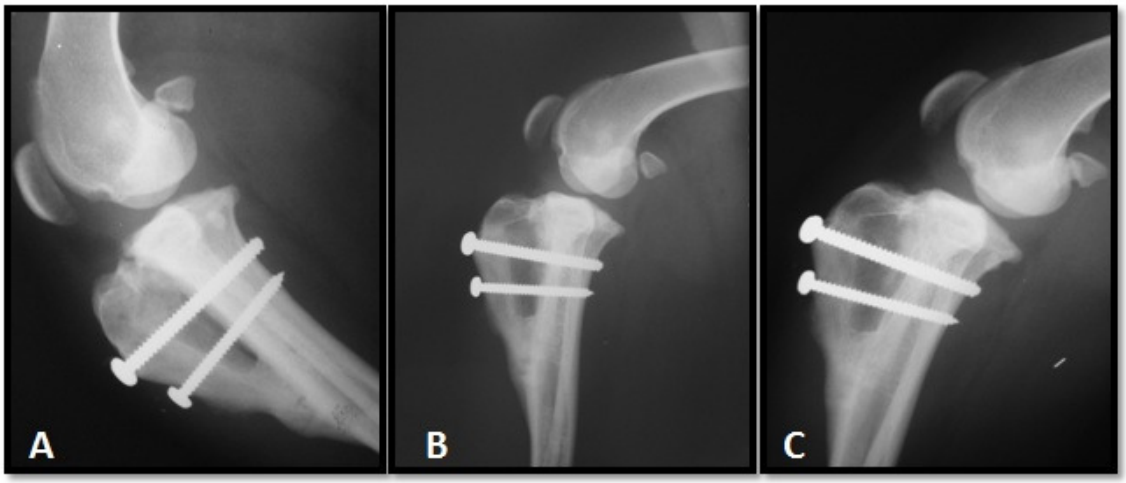

Figure 1: Mediolateral x-ray image of the knee joint of dogs after TTAm, treated with hydrotherapy. (A) 30 days; (B) 60 days and (C) 90 days postoperative.

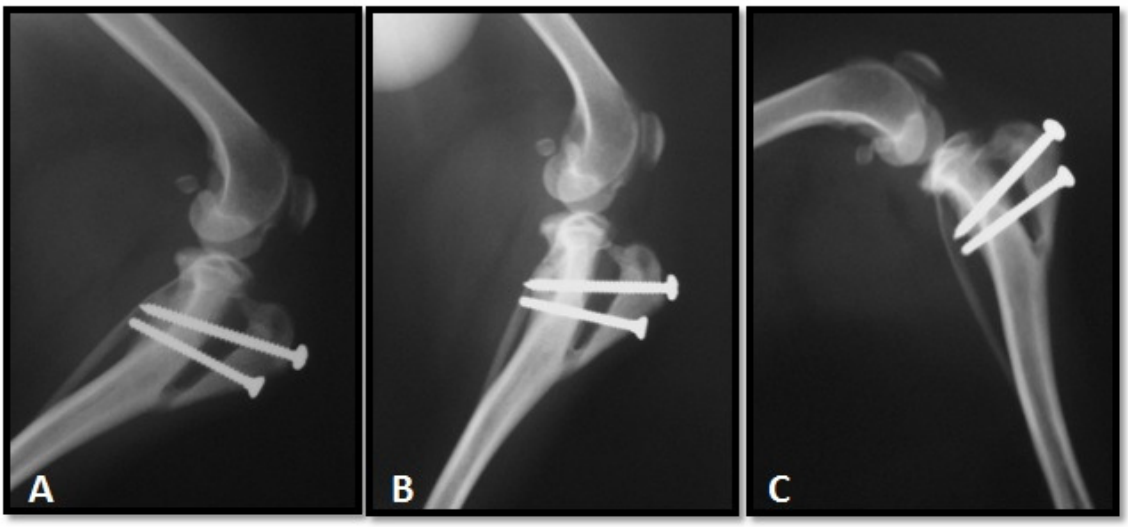

Figure 2: Mediolateral x-ray image of the knee joint of dogs after TTAm, not treated with hydrotherapy. (A) 30 days; (B) 60 days and (C) 90 days postoperative.

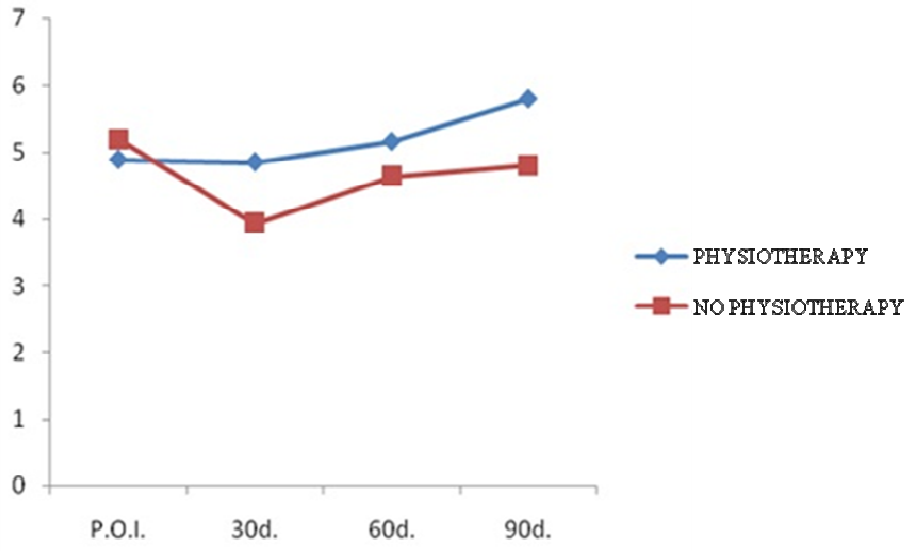

Figure 3- Mineralization rates and treatments (with and without physiotherapy) versus postoperative time, immediately after (p.o.i.), 30 days (30d.), 60 days (60d.) and 90 days (90d.)

Table 1 - Mean values of mineralization rates determined from the radiographic evaluation of dogs from the control group and the group that underwent TTAm.

Variables	Means	P values
Treatments (T):		
- Group T	5.1735A	0.88
- Group C	4.6400ª	
Postoperative (P.O.):		
- 0 days	5.0380A	
- 30 days	4.3900A	0.60
- 60 days	4.8980A	
- 90 days	5.3010ª	
Interaction - T x P.O	-	0.37

Means followed by the same letters do not differ (p>0.05).

CONCLUSIONS

The careful evaluation of the x-rays shows that the hydrotherapy treatment does not significantly influence the bone healing process. However, clinically, it was noted that the treated group had an improvement in the physical condition and earlier recovery when compared to the untreated group.

REFERENCES

CLARK, B.; McLAUGHLIN, R. M. Physical rehabilitation in small-animal orthopedic patients. **Veterinary Medicine**, Mississipi, p.234-246, março, 2001.

DAMUR, D.; GUERRERO, T.; MONTAVON, P. M. Advancement of the Tibial Tuberosity for the Treatment of Cranial Cruciate Stifle: Short Guide for the Operating Room. Zurique: **Clinic for Small Animal Surgery**, Vetsuisse Faculty University of Zurich, p.1-6, 2005.

DEGANI, A. M. Hidroterapia: os efeitos físicos, fisiológicos e terapêuticos da água. **Fisioterapia em Movimento** v.11, n.1, p.93-105, 1998.

HENRY, G. A. Consolidação de fraturas e complicações. In: THRALL, D.E. **Diagnóstico de Radiologia Veterinária**, 5ªed.: Ed. Elsevier, Rio de Janeiro, cap.16, p.284-305, 2010.

HOFFMANN, D. E.; MILLER, J. M.; LANZ, O. I.; MARTIN, R. A.; SHIRES, P. K. Tibial tuberosity advancement in 65 canine stifles. **Veterinary and Comparative Orthopedics and Traumatology,** Columbus, v.19, n.4, p.219 – 227, 2006.

LEVINE, D.; RITTENBERRY, L.; MILLIS, D. L. Aquatic Therapy. In: MILLIS, D. L.; LEVINE, D.; TAYLOR, R. A. **Canine rehabilitation & physical therapy.** 1ªed,: Ed. Elsevier, Missouri, cap.15, p.264-288, 2004.

LINS, B. T.; RAHAL, S. C.; LOUZADA, M. J.; DALMAS, J. C.; SELMI, A. L. Mechanical Resistance Of The Modified Stabilization Method For The Tibial Tuberosity Advancement Technique. *Ex vivo* experimental study in dogs**. Ciência Rural**, Santa Maria, v.39, n.2, p.467-472, mar-abr, 2009.

MARSOLAIS, G. S.; DVORAK, G.; CONZEMIUS, M. G. Effects of postoperative rehabilitation on limb function after cranial cruciate ligament repair in dogs. **Journal of the American Veterinary Medical Association**, v.220, n.9, p.1325-1330, 2002.

MEDEIROS, R. M. **Desenvolvimento, aplicação e avaliação de nova técnica de avanço da tuberosidade tibial com uso de espaçador de polímero de mamona fixado com parafusos para correção da ruptura do ligamento cruzado cranial em cães**. 2011. ix, 52 f. : il. Dissertação (mestrado em Cirurgia Veterinária) - Faculdade de Ciências Agrárias e Veterinárias, Universidade Estadual Paulista, Jaboticabal, 2011.

SOUZA, S. F. Reabilitação em cães submetidos a artroplastia do joelho. **Ciência Rural,** v.36, p.1456-1461 n.5, set-out, 2006.

VASSEUR P. B., BERRY C. R. Progression of stifle osteoarthrosis following reconstruction of the cranial cruciate ligament in 21 dogs**. Journal of the American Animal Hospital Association**, v.28, p.129–136, 1992.