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HIP JOINT DENERVATION IN DOGS WITH DEGENERATIVE JOINT DISEASE SECONDARY TO DYSPLASIA

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ABSTRACT

The hip denervation technique has been performed in dysplastic dogs, demonstrating to be efficient in the relief of pain. The objective of this work was to evaluate pain relief, improvement of joint function, muscular rehabilitation and instability progression in 10 dysplastic dogs submitted to the hip joint denervation technique. The grading of the clinical presentation was performed according to specific evaluation of walking, biped station, rotation with external abduction, subluxation and iliopsoas. The muscular rehabilitation was evaluated through the circumference of the thigh and physical examination. The instability was evaluated through the values of distraction index (DI). In the claudication graduation and the biped station test, we verified that there was a significant reduction one month after surgery. In the abduction with external rotation test, there was a reduction in pain after the seventh day; in the iliopsoas test there was a significant reduction in pain in all the post-surgery times. There was a significant increase in thigh circumference after the seventh day. We observed that 90% of the articulations had a reduction in their DI, reflecting an improvement of their stability. The technique is efficient in the relief of pain, muscular rehabilitation after the improvement of the ability to exercise, and in reduction of instability, being the cause of owner satisfaction.

KEYWORDS: denervation; dysplasia; muscular rehabilitation; pain.

DENERVAÇÃO ARTICULAR COXOFEMORAL EM CÃES COM DOENÇA ARTICULAR DEGENERATIVA SECUNDÁRIA À DISPLASIA

RESUMO

A técnica de denervação coxofemoral é realizada em cães displásicos, com o intuito de aliviar a dor. O objetivo deste trabalho foi avaliar alívio da dor, melhora da função articular, reabilitação muscular e progressão da instabilidade em 10 cães displásicos submetidos à técnica de denervação da articulação coxofemoral. A graduação da apresentação clínica foi realizada através de avaliações específicas da andadura, testes de estação bípede, de rotação com abdução externa e de iliopsoas. A reabilitação muscular foi avaliada através da circunferência da coxa e exame físico. A avaliação da instabilidade foi feita através de técnica radiográfica para índice de distração. Na graduação da claudicação e teste de estação bípede foi verificado que houve redução significante a partir de um mês pós-cirúrgico. Já nos testes de abdução com rotação externa, houve redução da dor a partir do sétimo dia pós-cirúrgico; no teste de iliopsoas houve redução significante da dor, em todos os tempos do pós-cirúrgico. Houve

aumento significante da circunferência da coxa a partir do sétimo dia. Foi observado que 90% tiveram redução do índice de distração, refletindo melhora da estabilidade. A técnica é eficaz no alívio da dor, na reabilitação muscular após a melhora na capacidade de exercitar-se e na redução da instabilidade, sendo motivo de satisfação para os proprietários.

PALAVRAS-CHAVE: denervação; displasia; dor; reabilitação muscular.

INTRODUCTION

Hip dysplasia is characterized by abnormal growth or development of the hip joint, usually bilateral (93%), which may progress to degenerative joint disease (DJD). It is a common condition in dogs, prevalent in large breeds (THOMAS et al., 1992; RISER, 1993; ARAUJO et al., 1997; MARTINEZ, 1997; TORRES et al., 1999).

Owners of dysplastic animals report a history of chronic and progressive lameness. Most animals present waddling, rigid and short gait, and are reluctant to exercise. The signs may worsen acutely after increase in physical activity (HAAN & BEALE, 1999; PIERMATTEI & FLO, 1999). When the animal lives a long time with pain and DJD is present, the muscles of the pelvic region and thigh, mainly the gluteus and quadriceps muscles, usually atrophy (THOMAS, 1992; RISER, 1993; SOMMER & FRATOCCHI, 1998; PIERMATTEI & FLO 1999; NOGUEIRA & TUDURY, 2002).

There are several specific tests to assess function and pain in the hip joint, including lameness assessment, bipedal station, abduction and external rotation and iliopsoas tests (MARTINEZ, 1997; SOMMER & FRATOCCHI, 1998; PIERMATTEI & FLO, 1999; NOGUEIRA & TUDURY, 2002). Dysplastic dogs can present pain, showing discomfort through muscle tension, sharp bending of the limb or even vocalization and aggression (THOMAS et al. 1992; WENDELBURG, 1998).

Once diagnosed, dysplasia pathological changes are usually irreversible. No treatment is effective in restoring a dysplastic joint to normal (BIASI et al., 2000; COOK, 2003).

The clinical benefits of treatment when the disease is already advanced are usually temporary, and surgical techniques that promote pain relief, such as hip joint denervation, are necessary (KÜPPER & KINZEL, 1994; KÜPPER & KINZEL, 1997; KINZEL et al. 2002a, b; BRAUN et al. 2003).

KÜPPER & KINZEL (1994), in Germany, studied the arthroplasty of the acetabular rim technique, and verified that dogs submitted to this technique had a surprising pain relief within the first five to ten days after surgery. The authors concluded that this relief is caused by the elimination of the branches that innervate the capsule in the region. Thus, they developed a capsular denervation technique for pain relief of dysplastic dogs.

The pain sensory modality is associated, among other factors, to the nerve endings that occur in the fibrous coverings of bones as the periosteum and fibrous joint capsule (GARDNER, 1950). The pain that dysplastic animals feel apparently has multiple sources, including: stretch and inflammation of the joint capsule, contracture of the adductor muscles of the hip joint, which causes neuroirritative processes in their insertion, and stretching and sensitizing of the periosteum due to osteophytes formation (HAMLET et al., 1972; ARNOCZKY & MARSHALL, 1981; BANKS, 1992; GASSE et al., 1996; MORGAN, 1997; PIERMATTEI & FLO, 1999; ALVAREZ, 2001; KINZEL et al., 2002b).

The canine hip joint capsule receives greater tension on the cranial-lateral region, thus it is the region with the highest number of pain receptors. The sensory innervation of the caudal-lateral and ventral region, therefore, contributes minimally to the pain in cases of hip dysplasia (KINZEL et al., 1998; KINZEL et al., 2002a, b).

The hip joint capsule in dogs is enervated in the cranial-lateral portion by branches of the gluteal nerve, in the caudal-lateral portion by branches of the sciatic nerve, in the cranial-medial portion by branches of the femoral nerve, and in the caudal-medial portion by branches of the obturator nerve (GASSE et al. 1996; KINZEL et al. 1998; KINZEL et al. 2002a, b). All these branches initially traverse the periosteum of the ilium body before reaching the joint capsule (GASSE et al. 1996; KINZEL et al. 1998; KINZEL et al. 2002b). The craniolateral denervation technique of the hip joint in dysplastic dogs with DJD makes the animals feel more comfortable because of the pain relief and the return of joint and limbs function, abolishing the need for pain medications. These results favor the physical conditioning of the muscles of the hip and

thigh, strengthening the incongruous dysplastic joint; however, the joint lesions caused by dysplasia and its evolution remain unchanged (KÜPPER & KINZEL, 1994; GASSE et al. 1996; KÜPPER & KINZEL, 1997; KINZEL et al. 2002a, b; BRAUN et al. 2003).

The degree of muscle atrophy in the pre-operatory period is an indicator for postoperative success: the greater the muscle atrophy of the affected limb, the longer the time to improvement (BRAUN et al. 2003). There are reports in literature of different techniques of joint capsule denervation, differing mainly in their surgical approach, which can be open or closed. Success in relieving pain is reported for all techniques, ranging from 90.6% to 96% (KÜPPER & KINZEL, 1997; KINZEL et al. 2002a, b; BRAUN et al. 2,003; FERRIGNO et al. 2007a; SELMI et al., 2009; MINTO et al., 2012; ANDERSON, 2011; SILVA et al., 2012).

Pain relief was observed in the first postoperative week (FERRIGNO et al., 2007a). Some patients were evaluated for 10 years after surgery and remained pain-free during the whole period (KINZEL et al. 2002b). However, BRAUN et al. (2003) reported recurrence of pain in 32.6% of cases, in a 3.5-year period of evaluation, but even in these cases, owners considered the results as satisfactory. Younger animals under one year of age showed better results than those at higher ages, between 7 and 8 years.

This study aimed to evaluate pain relief, joint function improvement, muscle rehabilitation and instability progression in dysplastic dogs with DJD, submitted to the hip joint denervation technique.

MATERIAL AND METHODS

For this study, we used 10 dogs diagnosed with DJD secondary to hip dysplasia (four Rottweilers and six German Shepherds, seven dogs aged from six months to one year and four months of age, and three dogs aged between five and nine years of age). The weight ranged from 18 to 37 kg.

After the clinical evaluation, we carried out a general orthopedic examination to detect painful changes in all joints and meticulous examination on the hip joints. We created scales (Chart 1) specifically for this study to evaluate the function and joint pain by the bipedal station, gait, abduction with external rotation and iliopsoas tests.

Chart 1: Scores of specific tests used to evaluate the function and joint pain of dogs undergoing denervation technique. Recife-PE, 2005

Scores	Tests			
	Bipedal station	Gait	Abduction with external rotation	Iliopsoas
0	No alteration	No alteration	No complaints	
1	Remains in position with slight hip and back flexion	Mild lameness with only short steps	Discreet head movement and limb flexion	
2	Hip and back flexion trying to get down	Moderate lameness with short steps, occasional lack of support of the limb, and head up	Raises the head and / or cry; limb flexion, but there is no difficulty at immobilizing dog on the table	
3	Unable to start positioning	Severe lameness with head down and lack of ability to take many steps	Tries getting up and cries or shows aggression; limb flexion, muscle tension with limited immobilization of the dog on the table	

We considered the volume of muscle mass, by measuring the circumference of the thigh, with the aid of a tape measure, at the midpoint between the greater trochanter and the proximal border of the patella, to assess thigh muscle before surgery, 48 hours, seven days, one, two, four and six months after surgery.

The radiographic confirmation of hip dysplasia and verification of DJD and degree of instability was made with the animal under anesthesia and using the PennHip® technique of positioning, determining the values of the distraction index (DI) and NorDis (ADAMS et al. 1998).

On the day of surgery, the animals were taken to the surgical preparation room where we

applied prophylactic antibiotic cephalothin[1] (25mg/kg/IV), flunixin meglumine[2] (1mg/kg/SC) and shaved the area to be operated. Then we applied pre-anesthesia with diazepam[3] (0.5 mg/kg/IV) and acepromazine [4] (0.05 mg/kg/IM). We administered the anesthesia induction medication in the operating room and it depended on the patient's clinical condition (thiopental sodium[5] – 12.5 mg/kg/IV, ketamine[6] – 12.5 mg/kg/IM or propofol[7] – 4 mg/kg/IV). For epidural anesthesia, we injected bupivacaine[8] (1mg/kg) in the L_7-S_1 vertebral space. Anesthesia was maintained with halothane[9] or isoflurane[10] depending on the organic and cardiovascular status of each dog.

The surgical approach to the hip joint, as described by KINZEL et al. (2002b), comprehended a 3-5 cm long incision, starting at the cranial region of the greater trochanter and progressing toward the iliac crest. At this area, we addressed the biceps femoris, gluteus medius and tensor fascia lata muscles, which were divulsed through the triangle among them. We inserted a Hohmann retractor ventrally to the gluteus medius and deep muscles, leaning on the dorsal margin of the ilium, cranial to the iliac spine, rising and dorsally moving these muscles away with a lever movement. Thus we exposed and made visible the area to be denervated in the body of the ilium bone, craniolaterally to the hip joint capsule (Figure 1a).

We performed the denervation by eliminating the periosteal from cortical surface of the ilium bone, debriding and scraping with a periosteum elevator, an area shaped like a half-moon in between the cranial-dorsal margin of the articular capsule to the ventral margin of ilium, also extending the maneuver around the areas of the iliac muscle insertions of the rectus femoris and gluteus deep muscles (Figure 1b).

After washing the tissue with saline solution, we performed an occlusion of the wound in three levels: muscle fascia, subcutaneous tissue and skin, using for such needled nylon suture, and the respective suture patterns: scalloped continuous, simple continuous and isolated simple.

We prescribed, after the animals' recovery from anesthesia, dressing on the surgical wound with chlorhexidine gluconate (once a day), covered with sterile gauze and micropore tape, cephalexin antibiotic (25 mg / kg / TID - completing 24 hours) and flunixin meglumine anti-inflammatory (1.0 mg / kg / SID - for 2 days).

To check the effectiveness of the technique in relieving pain, returning to function and muscle rehabilitation, we performed the same preoperative evaluations 48 hours, seven days, one, two, four, and six months after the surgery.

We evaluated DJD progression and joint laxity at two moments, prior to surgery and six months after surgery, and we compared radiographic images obtained by the PennHip® technique (distraction index) including NorDis.

We used the nonparametric Wilcoxon test for differences between ordered pairs to compare the results of the preoperative and postoperative moments of evaluation. We calculated the improvement amplitude of the scores by subtracting the preoperative score by that established after surgery (REIS, 2003).

[1] Sodium Cephalothin 1 g, Instituto BioChimico Ltda, Rio de Janeiro-RJ.
[2] Banamine 10 mg. Schering-Plough Veterinária – Indústria Química Farmacêutica Schering-Plough Inc. São Paulo-SP
[3] Diazepam 5mg/1ml. Sigma Farma. Nature's Plus Farm. Ltd. Hortolândia-SP
[4] Acepran 0.2% and 1% – Univet S.A. Indústria Veterinária. São Paulo-SP.
[5] Thiopentax 1g, Cristalia – Produtos Químicos Farmacêuticos Ltd. Itapira-SP.
[6] Dopalen 10%. Laboratórios Calier do Brasil Ltd. Osasco-SP
[7] Diprivan 1%. AstraZeneca do Brasil Ltd. Cotia Moinho Velho-SP.
[8] Marcaína 05%. AstraZeneca do Brasil Ltd. Cotia Moinho Velho-SP.
[9] Halothane. Cristalia – Produtos Químicos Farmacêuticos Ltd. Itapira-SP
[10] Forane. Abbott Laboratórios do Brasil Ltd. São Paulo-SP

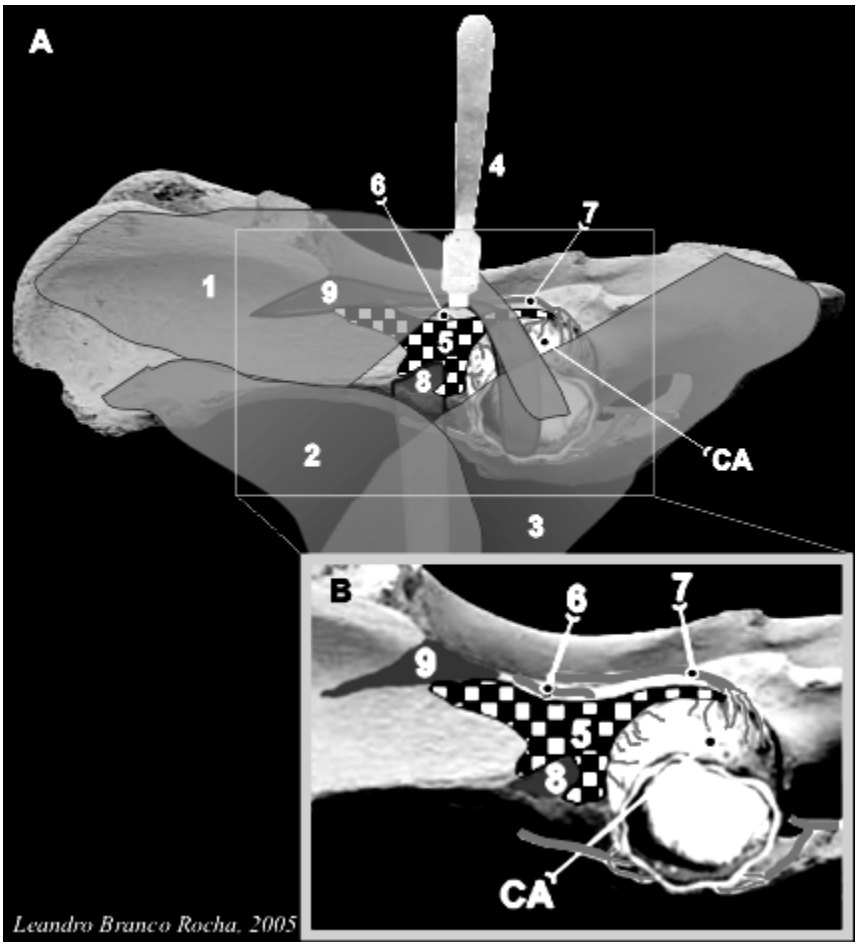

Figure 1: A - Surgical approach to hip joint denervation in dogs, A - performed through the triangle among the gluteus medius (1), tensor fascia lata (2) and biceps femoris (3). Hohmann retractor (4) raising dorsally the gluteus medium (1) and deep muscles (9). B - Scraping area of the periosteum (5 - plaid) removing the gluteus cranial nerve branches (6) and some sciatic nerve branches (7), forming a half-moon to the cranial-dorsal joint capsule (CA). Denervation extending around the insertions of the rectus femoris (8) and deep gluteus muscle (9). Recife-PE, 2005.

RESULTS AND DISCUSSION

All dogs showed signs of pain to varying degrees in the preoperative period, affecting joint function.

At the bipedal station test, we found that, within 48 hours after surgery, only one dog (10%) showed reduction of pain, eight (80%) remained stable and one (10%) worsened; within seven days, six dogs (60%) presented reduction of pain and four (40%) remained stable; within one month, seven dogs (70%) reduced the pain and three (30%) remained stable; within two months, eight dogs (80%) showed reduction of pain and two (20%) remained stable; within four and six months, seven dogs (70%) presented reduction of pain and three (30%) returned to the preoperative state, identifying that 70% of the animals that were positive for this test before surgery became negative from two months after surgery on.

In the gait assessment, we found that, within 48 hours, only one dog (10%) improved, eight (80%) remained stable and one (10%) worsened; within seven days after surgery, five dogs (50%) improved, four (40%) remained stable and one (10%) worsened; within one month, six dogs (60%) improved and four (40%) remained stable; within two months, seven dogs (70%) improved and three (30%) remained stable; within four months, seven dogs (70%) improved and three (30%) returned to preoperative state; within six months, eight dogs (80%) improved and two (20%) remained stable.

The pain scores triggered by the abduction test with external rotation, compared between the preoperative and postoperative moments, allowed to confirm that, after 48 hours, only three dogs (30%) showed reduction of pain and seven (70%) remained

stable; within seven days, six dogs (60%) showed reduction of pain and four (40%) remained stable; within one month, eight dogs (80%) presented reduction of pain, one (10%) remained stable and one (10%) returned to the initial state; within two months, seven dogs (70%) showed reduction of pain, two (20%) returned to the initial state and one (10%) remained stable; within four months, six dogs (60%) presented reduction of pain and four (40%) returned to the initial state; and within six months, eight dogs (80%) presented reduction of pain, one (10%) remained stable and one (10%) returned to the initial state.

The pain scores triggered by iliopsoas test, compared between preoperative and postoperative moments, allowed confirm that, after 48 hours, three dogs (30%) showed reduction of pain and seven (70%) remained stable; seven days after surgery, seven dogs (70%) showed reduction of pain, two (20%) remained stable and one (10%) returned to the initial state; within one, two, four and six months, ten dogs (100%) showed reduction of pain. There were no cases of worsening of the pain in this test.

The application of the Wilcoxon test showed that there was no statistically significant reduction in the degree of pain at the bipedal station test and gait assessment, within 48 hours and seven days, but there was a statistically significant reduction from one month on. In abduction test with external rotation, we found that there was a statistically significant reduction of pain from the seventh postoperative day on. At the iliopsoas test, there was statistically significant decline in pain at all evaluation moments after surgery (P <.01).

Along the return visits, with the exception of the fourth month, the average degree of pain decreased gradually (Figure 2) and the amplitudes of pain relief rose (Figure 3). However, there was interference in these results for the reasons stated below.

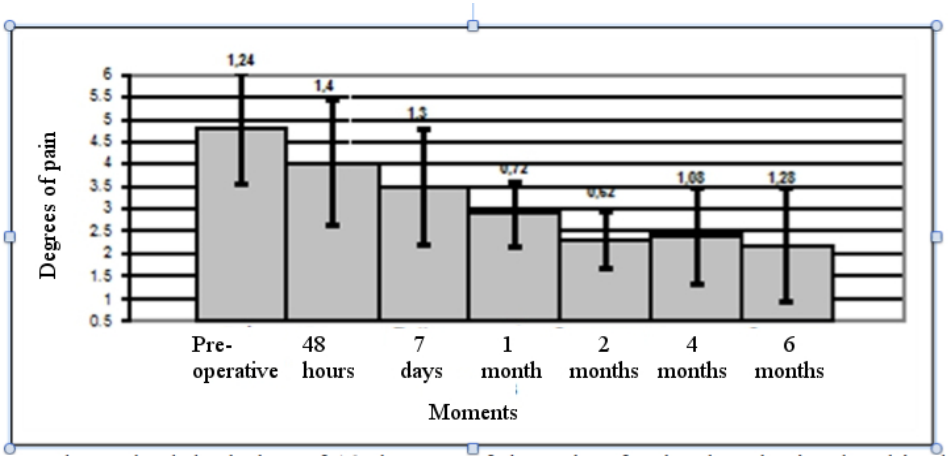

Figure 2: Mean and standard deviation of 10 degrees of the pain of animals submitted to hip denervation, in pre-and postoperative moments. Recife-PE, 2005.

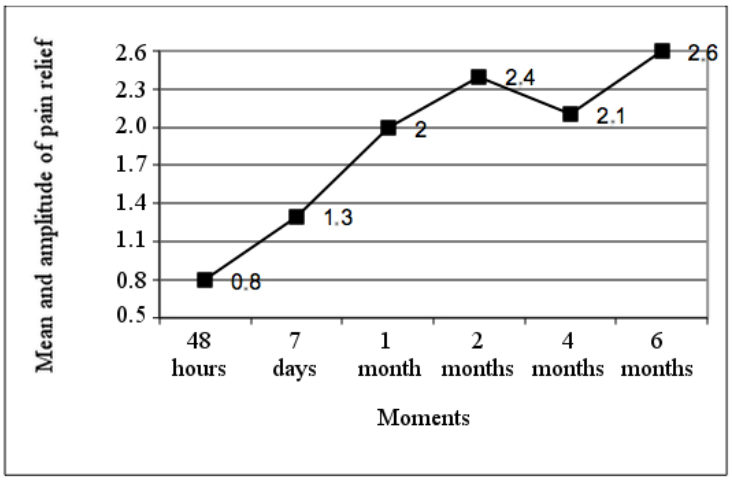

Figure 3: Mean and amplitude of pain relief (degree difference compared to the preoperative evaluation) in the postoperative evaluation moments. Recife-PE, 2005.

The limited reduction of pain at the bipedal station test and of lameness at gait assessing during the periods 48 hours and seven days was consistent with the results reviewed in the literature (KINZEL et al. 2002a). It is known that the reactivity to mechanical stimuli is increased at the surgical site, as well as in the surrounding tissues, due to the action of inflammatory mediators (PASCOE, 1998), and this sensitization worsens with the mechanical action of the unstable femoral head.

The animal 1, at the 48-hour return, showed severe pain in the left pelvic limb, and was diagnosed with postsurgical cranial-dorsal hip dislocation. This occurred because after surgery there was a pain relief in the joint capsule, leading the animal to support this member more firmly, developing more physical activities, including running, which, along with pre-existing muscular atrophy, contributed to the dislocation. Surprisingly, from the seven-day return, the animal showed progressive reduction of pain, with a minimal degree of pain for two months. Because of that, the dogs submitted to surgery subsequently underwent resting in kennels for seven days and gradual return to activities, which helped to prevent the occurrence of dislocation in the other dogs.

The worsening of the clinical signs of dogs 7 and 10 at the bipedal station test was due to the concomitant presence of pain in the lumbosacral spine, diagnosed at the preoperative period, which may have been exacerbated by the increased postoperative movement generated by the hip denervation. Disorders affecting the lumbosacral spine are part of the differential diagnosis of hip dysplasia, so dysplastic animals should be subjected to a detailed neurological and orthopedic examination (LECOUTEUR & CHILD, 1997). Even presenting a secondary condition, these animals benefited from the surgery, showing improved gait, reflected in the satisfaction of the owners.

Dysplastic dogs with advanced age and severe fibrosis in the joint capsule normally presented positive result at the bipedal station test (NOGUEIRA & TUDURY, 2002). Of the dogs in this situation (three dogs), only number 3 showed no improvement at this test.

In the fourth month, the return of claudication of dog 4 was due to the pseudocyesis state, which causes symptoms such as weakness, lethargy and abnormal behavior (ETTINGER & BARRETT, 1997). The owner reported that when the animal came out from under the bed, it presented lameness, which ceased when this behavior was interrupted, leading us to believe that the positioning under the piece of furniture somehow promoted a mechanical overload in one of the other sources of pain of dysplasia (GARDNER, 1950; HAMLET et al. 1972; ARNOCZKY & MARSHALL, 1981; and MORGAN, 1997).

Despite the increasing tendency, the low average of improvement amplitude of lameness at gait assessment (Figure 4) happened because this evaluation was also affected by the postoperative dislocation of the animal 1, lumbosacral pain pre-existing in the animals 7 and 10, and the absence of lameness of the animal 8 at all times.

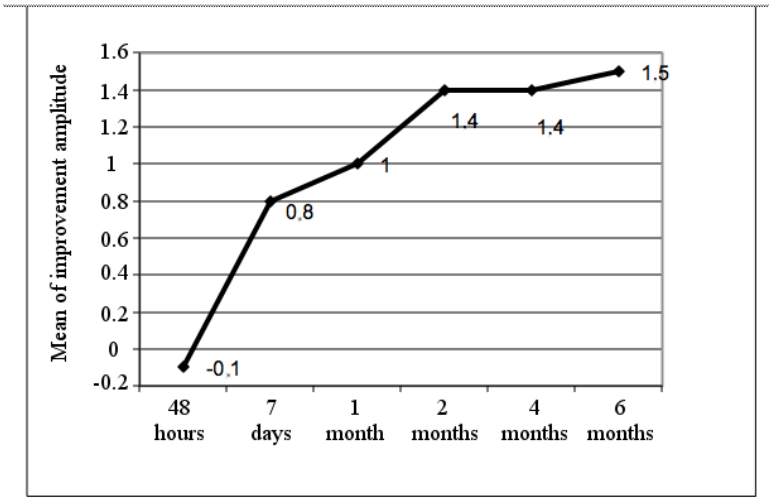

Figure 4: Means of improvement amplitude of claudication (difference of degree compared to the preoperative evaluation) in the postoperative evaluation moments. Recife-PE, 2005.

BRAUN et al. (2003) observed the absence of pain during rotation, flexion and extension of the joint in 61.5% of 26 dogs for an average evaluation period of three years and four months; however, in this study, we verified, within six months, the absence of pain in the abduction test with external rotation only in one dog (10%).

Compared to other tests, the mean scores of the abduction test with external rotation were higher (Figure 5), despite showing a tendency to grow and the mean improvement amplitudes of the scores were low (Figure 6), probably because this test causes distention of other areas of the joint capsule (dorsal-caudal region) (NOGUEIRA & TUDURY, 2002), which cannot be submitted to denervation by the approach used in this study (GASSE et al., 1996).

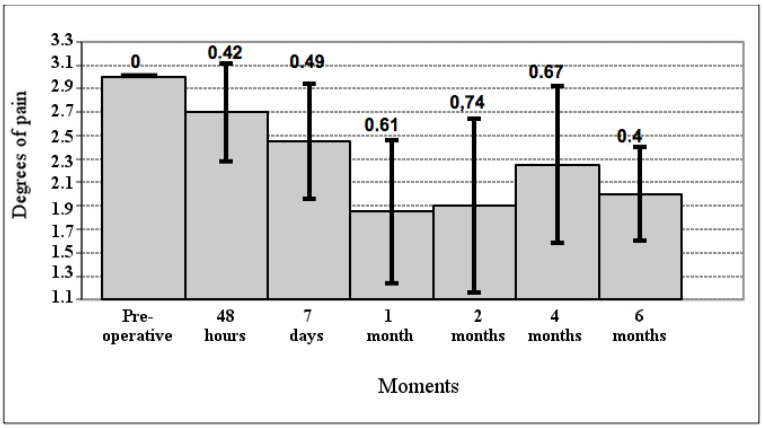

Figure 5: Mean and standard deviation of the pain scores at the abduction test with external rotation of 10 animals submitted to hip denervation, in pre-and postsurgery evaluations. Recife-PE, 2005.

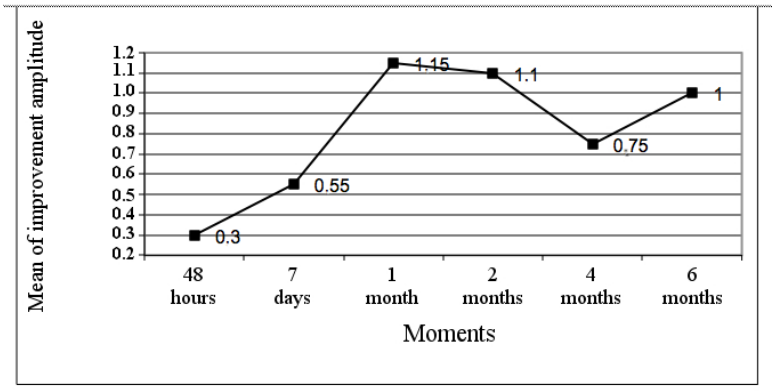

Figure 6: Means of improvement amplitude of pain in the abduction test with external rotation (difference of degree in relation to the preoperative evaluation) in the postoperative evaluation. Recife-PE, 2005.

The means of pain in the iliopsoas test also tended to decrease during the postoperative return visits of the animals (Figure 7). Compared to the results of the other tests, this one showed higher mean amplitude of pain relief in the postoperative evaluations (Figure 8). It is known that the contraction of the periarticular hip adductor muscles causes neuroirritative processes at the muscle insertions, and hence pain (HAMLET et al., 1972; ARNOCZKY & MARSHALL, 1981; BANKS, 1992; GASSE et al., 1996; MORGAN, 1997; PIERMATTEI & FLO, 1999; ALVAREZ, 2001; KINZEL et al., 2002b). Therefore, pain relief in the joint capsule released adductor muscles tension, relieving the neuroirritative process in their insertion.

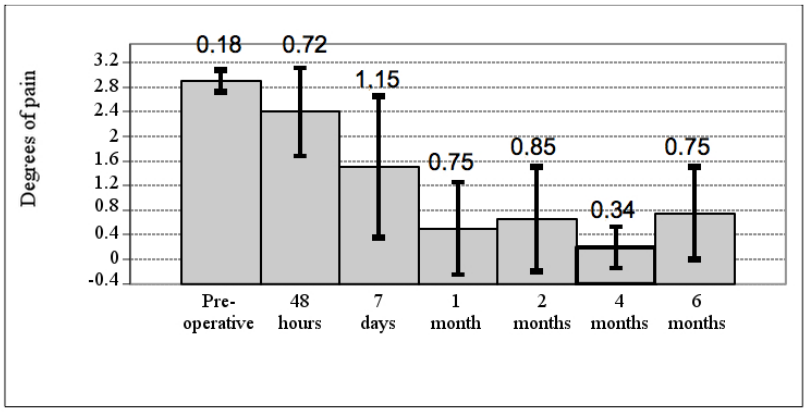

Figure 7: Mean and standard deviation of degrees of pain at the iliopsoas test of 10 animals submitted to hip denervation, in pre-and postoperative evaluations. Recife-PE, 2005.

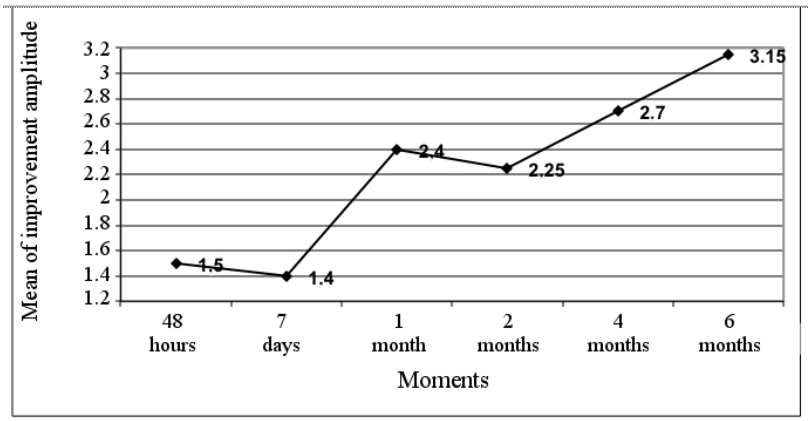

Figure 8: Means of improvement amplitude of pain at the iliopsoas test (difference of degree in relation to the preoperative evaluation) in the postoperative evaluation. Recife-PE, 2005.

Recurrence of pain may occur after denervation (BRAUN et al., 2003). The results presented here show the importance of determining the exact origin of the recurrent pain because other sources interfered in the intensity of pain relief trends.

At the six-month evaluation, there was greater negativity of pain signs at the gait assessment (80%) and bipedal station test (70%) than in the more specific abduction test with external rotation (10%) and iliopsoas test (50%). In short, the functional assessment (gait and bipedal station) was more consistent with the clinical improvement and satisfaction of the owners than the evaluation in recumbency along with specific orthopedic tests.

At the visual preoperative assessment of thigh and pelvis muscle, nine dogs (90%) presented muscle atrophy, except the animal 8. When the dysplastic animal lives long with the pain, the muscles of the pelvic region and thigh are usually atrophic, especially the gluteus and quadriceps (THOMAS, 1992; RISER, 1993; SOMMER & FRATOCCHI, 1998; PIERMATTEI & FLO, 1999; NOGUEIRA & TUDURY, 2002).

The Wilcoxon test showed that there was a statistically significant increase in thigh circumference (muscle mass) ($P > 0.05$) from the seventh postoperative day on, when six dogs (60%) had already presented increase in muscle mass with an average growth in thigh circumference of 35.8 cm to 37.3 cm. At six months, seven dogs (70%) showed circumference improvement at an average of 37 cm (preoperative) to 40 cm.

The animal 1, even suffering from hip dislocation on the left pelvic limb, showed gradual improvement of muscle atrophy, although slower

than the right limb, so that, at six months, both limbs presented the same muscle mass with normal appearance.

The literature emphasizes the importance of introducing gradually and progressively an exercise program, respecting the limitations of the animals with osteoarthritis (MILLIS & LEVINE, 1997; COOK, 2003). An initial and partial restriction of exercise should be strictly recommended to dysplastic dogs undergoing denervation to prevent dislocation. Probably, the degree of the muscular atrophy and of distension of the support structures causes frailty, which can lead to dislocation.

Animals 2, 5, 6 and 10, displayed increased thigh circumference, which might have been influenced by the fact that they were at the growing phase; actually, in the owner's opinion and at the visual clinical examination by a veterinarian, animals 2, 5 and 6 showed reduced muscular atrophy. Figure 9 shows the stable increase of circumference means of thighs in animals between six months to one year and four months of age. Animals over five years of age did not present a tendency to increase these values over time. This confirms that the best muscle rehabilitation results occur in younger animals (BRAUN et al., 2003).

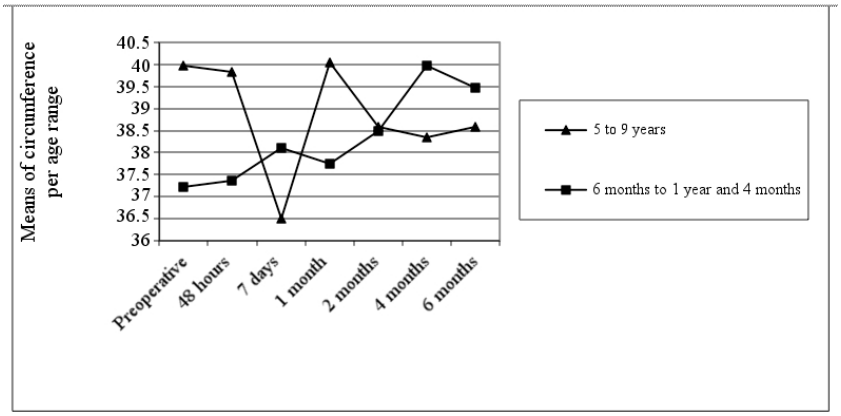

Figure 9: Means of thigh circumference by age. Recife-PE, 2005.

Of the animals with lumbosacral pain, number 10 showed surprising improvement in the mean muscle mass, from 36 cm preoperatively to 40 cm at six months; on the other hand, dog 7 presented periods of temporary improvement at four months, returning to atrophy at six months.

It is known that some animals endure enough pain while others respond disproportionately to a minimum stimulus (AIGÉ & CRUZ, 2001). We verified that in animal 8, which, even with positivity at abduction test with external rotation at iliopsoas test, showed negativity at the gait assessment and bipedal station tests, matching the owner reports that even preoperatively the animal showed no major difficulties in performing its activities, favoring normal muscle mass.

As the owners verified the improvement in the activities performance, they, on their own, encouraged their animals to exercise, favoring muscle rehabilitation. However, animal 3 did not receive this stimulus, and the sedentary lifestyle worsened muscle atrophy.

Although the results were affected by the factors mentioned, there was a trend to increase muscle mass after the pain relief at the joint capsule due to the denervation effects (Figure 10).

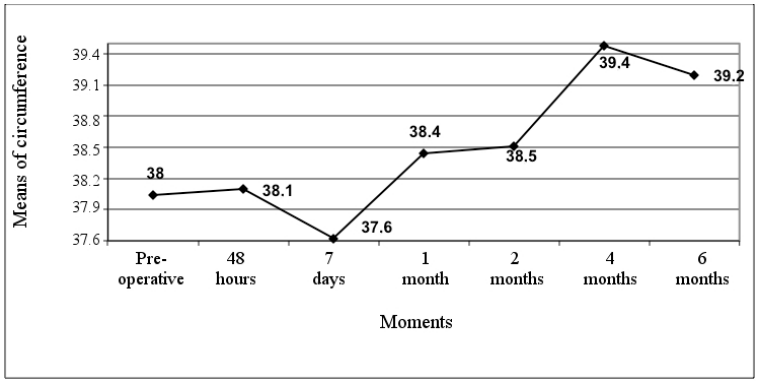

Figure 10: Mean values of thigh circumferences of the animals in the preoperative and postoperative evaluations. Recife-PE, 2005.

It is known that controlled and low impact physical exercise helps to maintain proper muscle mass and to lose weight, reducing the burden of stress on the joint; increase the angle of joint movement (HAAN & BEALE 1999; DASSLER, 2003) and decrease inflammation with consequently pain relief (MILLIS & LEVINE, 1997; HARDIE 2003). However, we did not prescribe specific exercises to the animals in this study, maintaining the usual activities imposed by the owner in the preoperative management. The animals that profited from hip denervation demonstrated besides the immediate improvement, a gradual improvement, probably due to the increase in physical activity with its consequent long-term benefits.

Although we discussed the results of muscle rehabilitation, these results should be confirmed in future studies, since most of the dogs were young and muscle mass gain may be due to the growth of each animal.

To maintain joint stability, proper muscle volume is necessary (RISER & SHIRER, 1967), among other factors. The lower the DI and the greater the NorDis, the closer the acetabulum is to the head of the femur, providing greater joint stability (ADAMS et al., 1998). The dysplastic dogs submitted to hip denervation benefited (as evidenced by the Wilcoxon test) with significantly decrease in the DI and increase in the NorDis ($P < 0.01$), in which, of 20 denervated joints, 18 (90%) showed reduced DI and 16 (80%) increased NorDis. Figures 11 and 12 show the trends of decrease and increase of the DI and NorDis means, respectively.

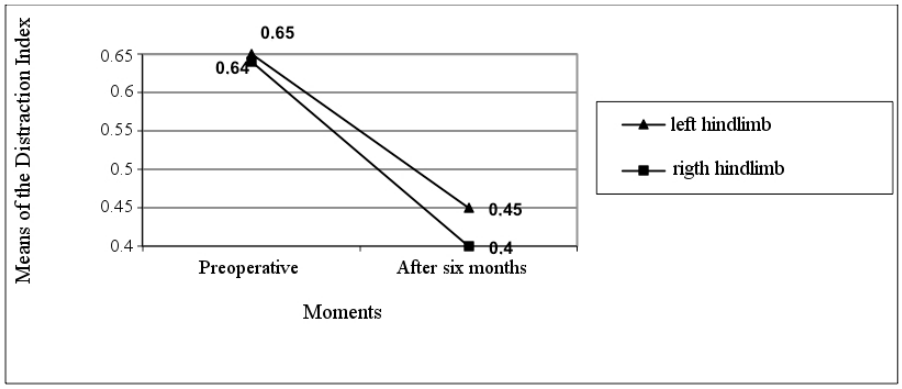

Figure 11: Mean of DI before surgery and after six months. Recife-PE, 2005.

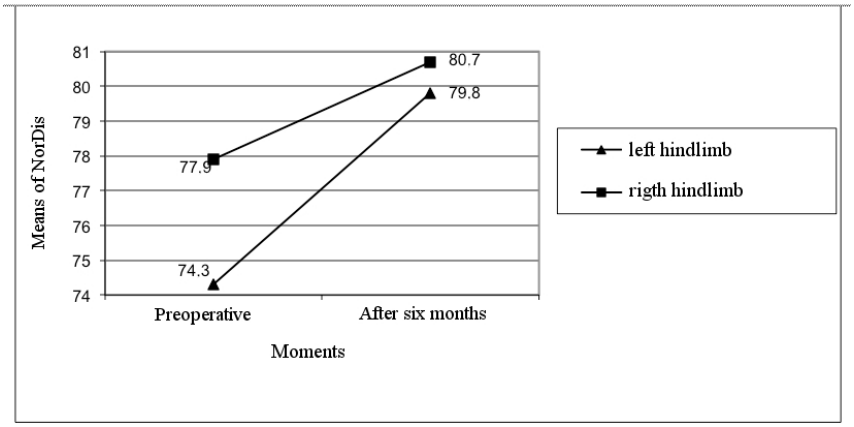

Figure 12: Mean of NorDis before surgery and after six months. Recife-PE, 2005.

The muscle rehabilitation with consequent improvement in joint stability, provided by hip denervation, had already been postulated in the literature (KÜPPER & KINZEL, 1994; KINZEL & KÜPPER, 1997; KINZEL et al., 2002a, b; BRAUN et al., 2003; FERRIGNO et al., 2007a), and the radiographic findings of this work confirm this statement.

Despite being demonstrated in mathematical values (DI and NorDis), the decrease in the space between the femoral head and the acetabulum was easily observed, even without measuring these ratios, as shown in Figure 13.

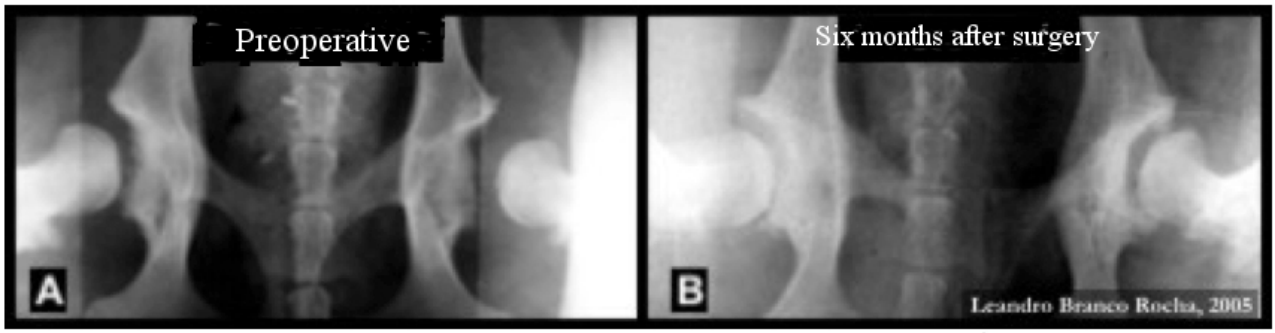

Figure 13: Radiographic examination of the hip joints of dog 7 by the PennHip ® method for determining DI and NorDis. We observed visible reduction in the space between the femoral heads and acetabulum, with greater coverage of the femoral heads by acetabulum, six months after denervation. Recife-PE, 2005.

The laxity of the hip joint is simulated during the DI and NorDis evaluation, similar to the position of the hip bone structures during weight bearing (NOGUEIRA et al., 2005). Thus, greater coverage of the femoral head by the acetabulum occurred in dogs with decreased DI and increased NorDis (SMITH et al., 1990) (Figure 13). During weight bearing and ambulation, this reflects lower capsular distension, with greater coverage of the femoral head, reducing the sensitive stimulus at the capsule areas that cannot be enervated by the approach used in this study. Probably, this phenomenon was also inter-related with the gradual improvement of pain, as muscle rehabilitation and joint stabilization occurred.

In preoperative radiographic evaluation, we observed that all the animals showed varying signs of DJD. After six months, seven of them showed no distinct radiographic changes compared to pre-surgical assessment; however, animal 7 (Figure 13) had an increase of osteophytes on acetabular edges, animal 4 had an osteophytes fracture at the cranial acetabular rim of the right pelvic limb, and the animal 10 presented a greater remodeling of the femoral head of the left pelvic limb, with no differences in functional improvement compared to the contralateral limb, in which there was no worsening of radiographic degenerative disease, but we must emphasize that the severity of radiographic findings is usually not proportional to the clinical

findings (RISER, 1993; MARTINEZ, 1997). Joint damages caused by dysplasia and its evolution remain unchanged (KINZEL & KÜPPER, 1997; KINZEL et al., 2002b). We confirmed that once we did not observe improvement in radiographic presentation in any of the 10 cases, which was already expected, since it is known that no treatment is effective in restoring a dysplastic joint with DJD to normality (BIASI et al., 2000; COOK, 2003).

The laxity assessment of adult animals with severe DJD is generally not reliable, because the thickening of the joint capsule, periarticular fibrosis and osteophyte make the femoral head firmer in the acetabulum (CHALMAN & BUTLER, 1985; PIERMATTEI & FLO, 1999), but this does not affect the results, because the radiographic instability was compared among the animals in a small time interval (six months). Furthermore, worsening of degenerative changes was observed only in three animals.

FERRIGNO et al. (2007b) and SELMI et al. (2009) evaluated dogs submitted to denervation and verified no difference in pain scores assigned by veterinarians and owners. Thus, the evaluation of the owner is important to assess pain, because they are more familiar with the daily behavior of their pets than the vet.

In the return visit after a month, the owners reported that soon after the seventh postoperative day, the animals showed a significant improvement, agreeing thus with the results obtained by KINZEL et al. (2002a) and FERRIGNO et al. (2007a).

All owners reported that, after denervation, their dogs began to show attitudes that they could not before the surgery, such as: staying longer in the bipedal and quadrupedal standing positions and in standing position, scratching the body with the hindlimbs, sitting and lying down with unusual positioning of the limbs and greater disposition for their activities, as observed by KÜPPER & KINZEL (1994); KINZEL & KÜPPER (1997); KINZEL et al. (2002a, b); BRAUN et al. (2003); FERRIGNO et al. (2007a), and these improvements reflect in a better quality of life for dogs (HAAN & BEALE, 1999; MINTO et al., 2012). Through anamnesis, we also proved that younger dogs (six months to one year and four months) showed faster improvement than older animals (five to nine years), corresponding to the assessment of muscle mass per age range shown in Figure 9 (BRAUN et al. 2003).

When dysplasia is already in advanced stage, the benefits of nonsurgical treatments are usually temporary (KÜPPER & KINZEL, 1994; KINZEL & KÜPPER, 1997; KINZEL et al., 2002a, b; BRAUN et al., 2003; FERRIGNO et al., 2007a). The owners of the dogs 3, 4, 8, and 9 reported that before denervation the animals had already undergone various medical treatments, with recurrence of pain within a period of six months. After denervation, these same owners as well as the owners of other dogs reported satisfaction with the results during the evaluation period. Any of the animals needed medication during the evaluation period.

The simplicity of the technique, considering the short duration of surgery (average 45 minutes) and convalescence were also cause for satisfaction to the owners (MINTO et al., 2012).

CONCLUSION

The technique of hip joint denervation in dysplastic dogs with degenerative joint disease is effective in relieving pain, hence providing an improvement of joint function. The muscle rehabilitation after the improvement in exercise capacity decreases the DI and increases NorDis, in other words, reduces instability. The improvement of the quality of life of patients is cause for satisfaction of the owners.

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