# Effects of radial shockwave therapy on the limb function of dogs with hip osteoarthritis

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**The objective of this study was to evaluate the effects of extracorporeal radial shock wave therapy on the hindlimb function of dogs suffering from hip osteoarthritis. Twenty-four client-owned dogs with hip osteoarthritis were investigated; 18 of them received radial shockwave therapy and six were left untreated as controls. Force plate analysis on a treadmill was used to assess the dogs' hindlimb function before treatment and four weeks after the last treatment, and the treated dogs were re-evaluated three and six months after the treatment. The parameters chosen for evaluation were peak vertical force and vertical impulse, and the calculated symmetry indices. In the treated dogs, differences between the ground reaction forces exerted by the right and left hindlegs disappeared four weeks after the treatment, whereas in the control dogs only the peak vertical force distribution changed significantly. The significant improvement in the treated dogs was confirmed by changes in the symmetry indices. Significant improvements in vertical impulse and peak vertical force were observed three months after the treatment.**

EXTRACORPOREAL radial shockwave therapy is a common treatment in human medicine for various orthopaedic disorders, such as epicondylitis lateralis humeri, tendinosis calcarea or fasciitis plantaris (Heller and Niethard 1998). Recently, several studies have been performed to evaluate the effectiveness of the treatment, but the results have ranged from beneficial (Theodore and others 2004) to negligible (Chung and Wiley 2004).

Two different types of shockwaves can be used for the treatment of orthopaedic disorders – focused and radial shockwaves. Focused shockwaves reach their highest energy density in the depths of the tissue whereas radial shockwaves decrease in energy in proportion to the square of the distance from the surface (McClure and Merrit 2003).

In horses, shockwaves are mostly used for the treatment of tendon problems; horses suffering from proximal suspensory desmitis or osteoarthritis of the tarsometatarsal and distal intertarsal joints benefit from extracorporeal shockwave therapy (McCaroll and McClure 2000, Crowe and others 2004). Shockwave therapy has been used in dogs for some years but few studies have recorded the outcome of the treatment. Adamson and Taylor (2003) reported its effect in various orthopaedic conditions in 10 dogs, and Danova and Muir (2003) described the treatment of supraspinatus calcifying tendinopathy in two dogs. The results of these studies were evaluated by clinical examination and questions to the owners. The second study also used force plate analyses with peak vertical force as an evaluation parameter. Other studies suggesting that shockwave therapy had positive effects on the clinical signs of osteoarthritis in dogs have been described by Francis and others (2004) and Dahlberg and others (2005).

In this study 18 dogs with hip osteoarthritis were treated with a radial shockwave system.

It was hypothesised that there would be positive effects of the radial shockwave therapy on the ground reaction forces within a month of the last treatment, in comparison with the results in six untreated control dogs. Significant differences between the results for the two hindlegs were expected before the treatment began, and a redistribution of force between the hindlegs was expected during the evaluation period.

## MATERIALS AND METHODS

Twenty-four client-owned dogs of different breeds with a history and clinical signs of hip osteoarthritis, diagnosed on the basis of orthopaedic and radiographic examinations, were used; 18 of them were treated and six were left untreated as controls. The treated group ranged in age from two to 12 years (mean [sd] 6·8 [3·0] years) and weighed from 18·2 to 57 kg (mean 34·2 [10·0] kg); nine of them were male and nine female. The untreated group ranged in age from three to nine years (mean 5·3 [2·4] years) and weighed from 32·6 to 47·9 kg (mean 38·4 [5·3] kg); four of them were female and two male.

The treated dogs were treated with a Swiss DolorClast Vet (Electro Medical Systems). Before the treatment the hair in the lateral region of the hip joint was clipped, and contact gel was applied; 2000 shots with a pressure of 2 bars and a frequency of 15 Hz were applied three times with a week between the treatments. Both hips were treated, except in the dogs that had unilateral clinical signs. The control dogs were not treated in any way for seven days before the start of the study or during the evaluation period.

Four biomechanical force sensors (Type 9011 A; Kistler Instruments) mounted into a treadmill specifically developed for use in small animals were used for data collection. The rectangular platforms were 25 cm × 50 cm and contained the four piezoelectric sensors for the measurement of vertical ground reaction forces (GRF), one on each corner.

The GRFs of the dogs in both groups were measured before the treatments began (T0) and four weeks after the last treatment; 16 of the treated dogs were re-evaluated three months after the last treatment and 13 were re-evaluated after six months.

The dogs were not trained on the treadmill before the measurements, during which they were allowed to walk at a comfortable speed. The velocity of the treadmill ranged from 1·06 to 1·22 m/second (mean 1·19 [0·05] m/second). The GRF was measured at 300 Hz and analysed by using software (SIMI Motion Version 6.5; SIMI Reality Motion Systems). For the evaluation, five valid steps of the hindlimbs were chosen; a step was 'valid', when the four force plates had been hit by their corresponding limbs.

The parameters of the GRFs chosen were peak vertical force (PFz) and vertical impulse (IFz) of the hindlimbs. All the measurements were normalised with respect to the dog's bodyweight and expressed as a percentage of bodyweight as described by Roush and McLaughlin (1994) and McLaughlin and Roush (1995). The values of PFz and IFz were averaged over five valid steps of each trial.

At the outset of the study the values of PFz and IFz were categorised according to the affected body side (better or worse), and the measurements were labelled accordingly: PFzB and IFzB for the more weight-bearing limb and PFzW

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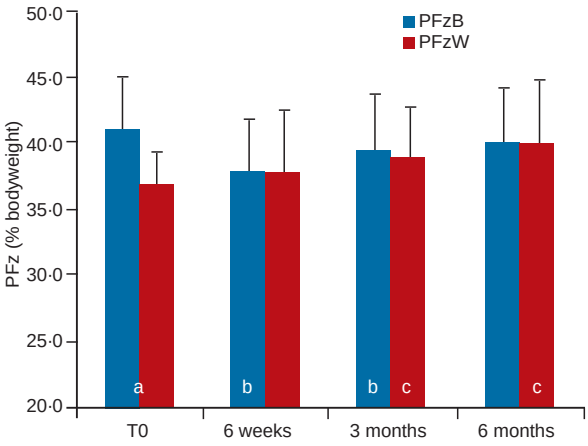


**FIG 1: Mean (sd) peak vertical force measurements (PFz) before (T0) and at intervals after the start of the treatment of 16 dogs with hip osteoarthritis with radial shockwave therapy. PFzB The more weight-bearing limb, PFzW The lamer limb, a Significant difference between the two hindlimbs, b Significant decrease in comparison with pretreatment value, c Significant increase in comparison with pretreatment value**

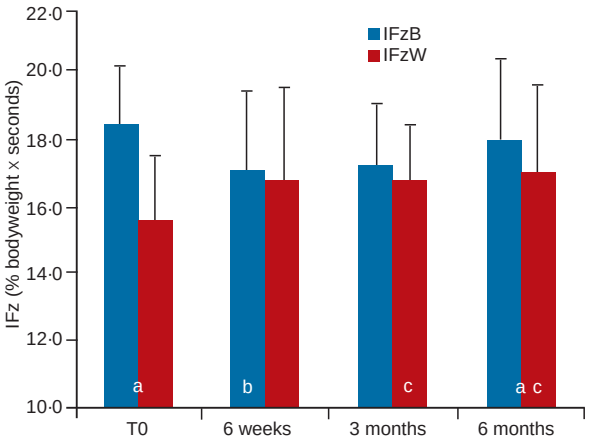


**FIG 2: Mean (sd) vertical impulse measurements (IFz) before (T0) and at intervals after the start of the treatment of 16 dogs with hip osteoarthritis with radial shockwave therapy. IFzB The more weight-bearing limb, IFzW The lamer limb, a Significant difference between the two hindlimbs, b Significant decrease in comparison with pretreatment value, c Significant increase in comparison with pretreatment value**

and IFzW for the lamer limb. On the basis of these categories symmetry indices (SI) were then calculated for the PFz and IFz, in accordance with Budsberg and others (1993):

$$\text{SIPFz} = \frac{\text{PFzB}}{\text{PFzW}} \text{ and SIIFz} = \frac{\text{IFzB}}{\text{IFzW}}$$

giving the ratios of the measurements in the more weight-bearing limb over the lamer limb.

The data were analysed by using SPSS, version 11.5. After testing for normal distribution by the Kolmogorov-Smirnov test, the changes over time and the differences between body sides within the groups were compared by using a paired *t* test. A P value less than 0·05 was considered statistically significant.

## RESULTS

All the dogs tolerated the treatment well and they did not need to be sedated. Before the treatments began there were significant differences between the left and right hindlimb in both PFz (Fig 1; P<0·01) and IFz (Fig 2; P=0·01). Six weeks after the first treatment there was no longer a significant difference, because the higher values of the more weight-bearing limb had decreased and the lower values of the lamer limb had increased. In the case of IFz, IFzB had decreased significantly (P=0·04) and IFzW had increased (P=0·06); in the case of PFz, only PFzB had changed significantly (P=0·002). This change became clearer in terms of the symmetry indices (Table 1), which showed significant changes towards unity in both SIPFz (P=0·01) and SIIFz (P=0·01).

There were also significant differences initially between the hindlegs of the untreated dogs, in PFz (Fig 3; P=0·001) and IFz (Fig 4; P<0·01). The difference in IFz was maintained after six weeks, but the difference in PFz was no longer significant, although the difference was larger than in the treated dogs. These findings were confirmed by the corresponding symmetry indices (Table 1), which showed no significant changes. The evaluations of the treated dogs after three and six months showed that after three months PFzB had increased slightly but was still significantly lower than before the treatment (P=0·04), but after six months the difference was no longer significant. After three and six months PFzW had significantly increased (P=0·04). This redistribution of PFz was confirmed by the symmetry indices, which showed a significant improvement after both three and six months (P=0·01). In contrast, although IFz still showed an improvement after three months, with no significant differences between the left and right hindlimbs, after six months the differences became significant again (P=0·01); however, these differences between the legs remained smaller than at the beginning of the study, as was confirmed by the value of SIIFz, which had improved significantly after three and six months (P=0·01).

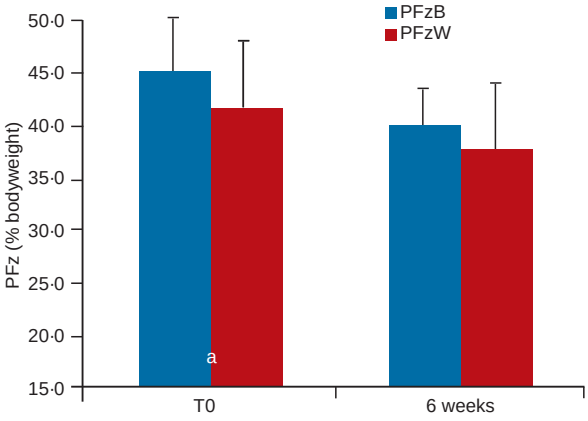


**FIG 3: Mean (sd) peak vertical force measurements (PFz) made six weeks apart in six dogs with hip osteoarthritis that were not treated. PFzB The more weight-bearing limb, PFzW The lamer limb, a Significant difference between the two hindlimbs**

## DISCUSSION

The lack of representative studies in the field of shockwave therapy in dogs complicates the comparison of the results of this study with those reported in the literature. Although Francis and others (2004) and Dahlberg and others (2005)

**TABLE 1: Mean (sd) symmetry indices of the peak vertical force (PFz) and vertical impulse (IFz) before treatment began (T0) and at intervals during the treatment of 18 dogs with hip osteoarthritis with radial shockwave therapy (group 1) and six dogs with hip osteoarthritis that were left untreated (group 2)**

| | Group 1 | | Group 2 | |
|---|---|---|---|---|
| Time | PFz | IFz | PFz | IFz |
| T0 | 1·11 (0·018) | 1·20 (0·16) | 1·08 (0·07) | 1·16 (0·12) |
| 6 weeks | 1·04 (0·03)* | 1·07 (0·05)* | 1·06 (0·04) | 1·16 (0·08) |
| 3 months | 1·05 (0·04)* | 1·06 (0·08)* | | |
| 6 months | 1·04 (0·05)* | 1·08 (0·07)* | | |

* Significant improvement compared with T0

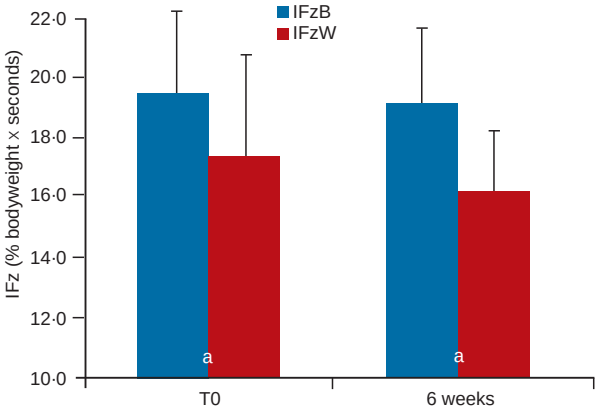


**FIG 4: Mean (sd) vertical impulse measurements (IFz) made six weeks apart in six dogs with hip osteoarthritis that were not treated. IFzB The more weight-bearing limb, IFzW The lamer limb, a Significant difference between the two hindlimbs**

described positive effects for this kind of treatment in orthopaedic disorders, they used peak vertical force, PFz, for the evaluation and did not measure vertical impulse. However, this parameter, IFz, provides essential information on the limb loading over the whole stance phase, whereas PFz only provides information on the early stance phase (DeCamp 1997). This is in accordance with Budsberg and others (1996, 1999) who emphasised the importance of measuring the vertical impulse when assessing the function of the joints.

In the treated dogs, there was a reduction in the difference between the GRFs of the left and right hindlimb four weeks after the last treatment. The limbs with higher values had developed lower values, whereas the initially more affected limbs had developed higher values. In a study by Budsberg and others (1999) with the purpose of evaluating the efficacy of etodolac in improving hindlimb function in dogs with osteoarthritis of the hips, the authors observed significantly improved GRF values compared with baseline values in the most severely affected limb after the treatment. In the present study the IFz of the initially lamer limb also showed an improvement after the radial shockwave therapy. However, PFz of the lamer limb did not increase, but the significant difference between the hindlimbs disappeared six weeks after the first treatment. There were similar changes in PFz in the untreated dogs, but there was no improvement in IFz after six weeks. These results indicate that evaluating only PFz can lead to misinterpretations. During the subsequent evaluations of the treated dogs, PFzW and IFzW improved significantly compared to pretreatment, but after six months the difference between the IFz values of the left and right limbs became significant again, although the difference was smaller than before the treatment.

To the authors' knowledge, there has been no study of the long-term effects of radial shockwave therapy in dogs. In human beings a long-term analgesic effect of the therapy for plantar fasciitis has been described by Heller and Niethard (1998). Because of the lack of a control group for the assessments of the treated dogs after three and six months it is difficult to interpret these results. However, they indicate that the therapy has a potential long-term benefit, because a significant effect was observed for at least three months. The treated dogs showed a distinct response to the shockwave treatment, followed by an improved balancing of the load between the two hindlimbs. This finding may indicate that the dogs experienced a decrease in pain with a decrease in the degree of lameness.

Before the treatment began IFz had higher symmetry indices than PFz, possibly because IFz contains information about the stance phase as a whole. Hottinger and others (1996) have shown that in the stance phase the hip joint of dysplastic dogs was characterised by more extension, whereas the femorotibial and tarsal joints were more flexed than in normal dogs. Furthermore, the coxofemoral extension and femorotibial flexion are more rapid at the end of the stance phase, whereas tarsal extension occurs more slowly. These kinematic changes may be a response to painful stimuli from the arthritic joint, resulting in a decreased IFz. The slight asymmetry of PFz could indicate that the touchdown of the leg on the ground may be slightly less painful than the lift-off.

In bilaterally affected dogs it can be difficult to evaluate symmetry indices because a change of lateralisation of the lameness cannot be assessed, but the results of this study demonstrate the usefulness of calculating these indices; the findings corresponded well with the GRF results. Calculating the symmetry indices eliminates the variation in GRFs due to different measurement velocities or different types of dog, giving the method an important advantage. As reported by Budsberg and others (1993), even clinically sound dogs do not have perfect gait symmetry. In this study it was shown that the symmetry indices deviated from perfect symmetry by 4 per cent for PFz and 6 per cent for IFz. Although the treated dogs showed significant improvements in both symmetry indices, they did not reach the values characteristic of healthy dogs for IFz. This was expected, because shockwave therapy cannot cure the underlying problem.

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## Notes