Extracorporeal Focused Shockwave Treatment for Nonunion Fracture of the Tibia in a Dog

Kirsten Haeusler

Haeusler, K. - Zentrum für Tierphysiotherapie Team Haeusler, Stuttgart, Germany

INTRODUCTION

Non-unions that occur after bone fractures are typically treated surgically. However, this comes with the risk of infection and failure of osteosynthesis. Extracorporeal shock wave treatment (ESWT) is a non-invasive treatment that potentially stimulates bone regeneration. Hafner et al. 2016 showed that tibial non-unions in humans could be treated successfully in 88,3 % of presented cases. Therefore, this treatment was used as an effective and safe treatment for the delayed nonunion of the tibia in a small dog (10 kg/22lb).

CLINICAL FINDINGS

The patient was sent to us after being presented to the referring veterinarian with a persisting lameness of the right hind leg. The dog was rescued from a shelter in Romania and moved into the new home in February 2022. The owner reported off-loading the right hind limb while standing, skipping while walking, and intermitting three-legged trotting.

The dog showed mild discomfort when palpated on the leg when presented to the vet. No wounds or scars were present. The Patella luxation grade was a 1 out of 4, but swelling on the tibia could be palpated. An x-ray was taken, and the x-ray (Fig. 1) showed a non-union of the shaft of the tibia with the formation of secondary bone healing but at the level of the fracture site, there was still a gap where there were no signs of normal healing.

Unfortunately, the x-ray was only taken on this plane, so we lacked the second plane view.

After a second opinion from an orthopedic surgeon was requested and surgery wasn´t an option, the dog was referred to us for treatment with the focused shockwave.

We started with an initial gait analysis on the CanidGait® pressure-sensitive treadmill. This is to evaluate and document objectively how much the dog will load his injured hind leg. It helps us to understand the effect of such an injury and the compensatory movement of the other legs and the effect on the whole body.

Fig. 1: X-ray initial visit to the vet on 08.03.2022

Materials and Methods

The owners of the dog were introduced to the mechanisms behind the use of the treadmill and the use of the shockwave. The dog is a small size mixed-bred neutered male. His age was estimated to be three years. His blood report was regular, and no other signs of injury were present.

The CanidGait® pressure-sensitive treadmill (Zebris Medical) was used to evaluate the amount of off-loading of the four legs.

The dog was introduced to the treadmill and was given the time to acclimatize to it for about 3 minutes. He freely stepped onto the treadmill and was motivated to walk with the intermittent giving of treats. Once the speed was increased to a comfortable velocity for the dog, the measurement was started. Three measurements were taken at a velocity of 2,5 kph (0,69 m/s). One was on levelled ground, the second on a 10 % incline, and the last on a 5 % decline. The total time on the treadmill for these runs was 4 minutes.

After walking on the treadmill, the injured leg was palpated, and Cody showed only mild discomfort on palpation. The area was re-evaluated on the x-ray, and the gap was located. The treatment area was cleaned, and ultrasound gel was applied. A DUOLITH® SD1 »ultra« (Storz Medical) was used, and the anatomical offstand perfectly fit the bone‘s shape. Once the handpiece was positioned to the gap of the non-union, the machine was started at 6Hz and 0,01 mJ/mm^2. Then the intensity slowly increased to 0,07 mJ/mm^2 until he showed mild irritations by licking his lips and looking toward the treatment site. A total amount of 2000 impulses were applied to the bone (1,2)

After treatment, the owner was instructed to keep the dog on a short leash; walking was encouraged but playing or running with other dogs was prohibited. We also asked the owner to be aware of any swelling or off-loading in the next two days, as these are typical findings after shockwave treatment.

The shockwave treatment was repeated weekly for three consecutive weeks, with 2000 impulses and 0,15 mJ/mm^2 on the second and third visits. After the third treatment, gait analysis was performed. The owners were sent home with a home treatment plan to improve their awareness of the hind legs. This included stepping over a lying ladder, 2 min of balance work on a small wobble board, and increased walks.

Fig. 4: Placement of the ESWT probe onto the fracture gap.

Fig. 5:.Focus area of the electromagnetic shockwave (Storz DUOLITH® SD1

Results

Gait analysis showed increased loading after three sessions of shockwave treatment which was in agreement with the findings of the owners. The dog used the right hind leg increasingly more, was more agile, and offloading during stance decreased. We did a follow-up on the pressure-sensitive treadmill. Max. Force in % of body weight increased by 4% (a), and compensatory loading on the hind left decreased by 3 % (b). The angle of the whole body center of pressure (COP)(c) decreased from -5,8° to -0,9°. In Fig. 6, the average force curves‘ shape normalized over the time of treatment and until the follow-up x-ray was taken. The dog could load the injured right hind limb almost equally to the left hind (d). In comparison, the peak load on the left hind limb decreased. The owner had not seen any skipping after the last ESWT session, and the dog had become more agile and stable.

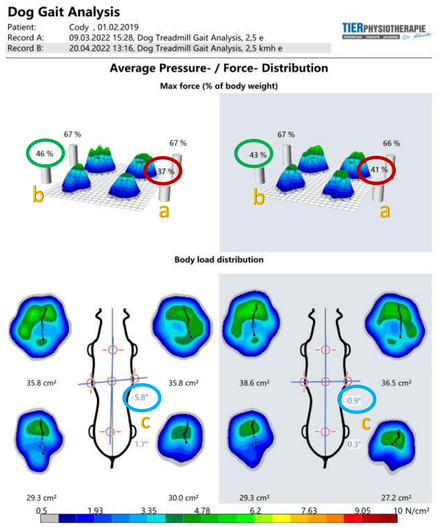

Fig. 6: Comparison of body load distribution before and four weeks after the last ESWT treatment.

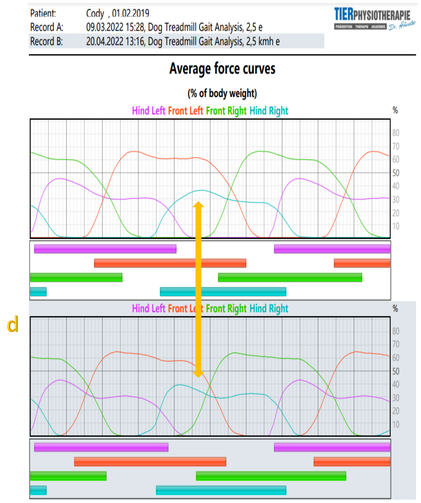

Fig. 7: Comparison of average force curves before and four weeks after the last ESWT treatment.

CONCLUSION

Fracture healing is a complex process facilitated by the interaction of cellular elements activated by cytokines and other molecular mediators, resulting in the formation of new bone structurally and mechanically similar to the pre-fracture state. The fracture healing process has been extensively studied, and much progress has been made in understanding the mechanisms involved.

Extracorporeal shockwave therapy (ESWT) is a relatively new non-invasive treatment method that has shown to be effective in various medical fields, including orthopedics in small animals. First, animal studies on ESWT were carried out in Germany by Haupt et al. (1992)[3]. In recent years, ESWT has been used to treat non-union in dogs with promising results[4]. This case study will provide further evidence using ESWT to treat non-union in dogs and the potential benefits of minimizing compensatory gait and movement patterns throughout the body.

There is an urgent need for further studies on this indication and its use in canines.

Fig. 8: X-ray after three sessions of shockwave and a follow-up visit to the vet on 18.04.2022

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Contact

Kirsten Häusler, PhD, CCRP

Lambertweg 36, 70565 Stuttgart, Germany

Email: info@dr-haeusler.com