Introduction

Osteoarthritis (OA) is a progressive, degenerative disease that, in the US, affects as many as 20% of dogs aged 1 year or more (Cimino Brown, 2017). The condition causes chronic pain and decreased joint function, which on the long term severely affects the quality of life. The common treatments for OA-associated pain include long-term administration of nonsteroidal anti-inflammatory drugs (NSAIDs) and nutraceuticals, potentially with the addition of gabapentinoid and opioid analgesics to address unresponsive pain (Pettitt and German, 2015). NSAIDs are associated with gastrointestinal, hepatic, and renal side effects and, often, to inadequate pain relief. The chronic use of opioids in client-owned pets, on the other hand, carries the risk for human drug abuse and, therefore, raises a number of ethical concerns. Within the past decade, there has been an increasing interest in nonpharmacological therapy of both human and canine OAs. Among these therapies, electroanalgesia techniques have been raising a great interest among human doctors and veterinarians. In human medicine, the most promising electroanalgesic techniques to treat OA are those that imply the use of laser. Within the past decade, both low-level laser therapy (LLLT) and high-level laser therapy have been used to treat human OA-associated pain with no adverse effects (Huang et al., 2015; Youssef et al., 2016; White et al., 2017). High-level laser therapy was first introduced only in 2011, and a recent systematic review that included the first six studies conducted in people found that it was effective in reducing pain and providing functional improvements in humans with knee OA (Wyszyńska and Bal-Bocheńska, 2018). Regarding the veterinary literature, one trial performed in 12 dogs investigated the effects of LLLT on bone healing and acute surgical pain after tibial plateau levelling osteotomy (TPLO), with disappointing results (Kennedy et al., 2018). To the best of the authors’ knowledge, only one study carried out in 20 dogs with elbow OA reported the successful
The dogs were observed after each treatment for the occurrence of side effects, namely, itch, redness, swelling, changes in skin/coat pigmentation, and any kind of discomfort perceived by either the dog owners or the clinician. After 2 weeks from the beginning of laser treatment, on the occasion of the first posttreatment pain scores, and then again at Week 8, the pharmacological therapy was reassessed, based on the results of pain assessment, owner interview, and orthopedic examination of each dog, and adjusted, if needed, at clinician’s discretion.

The Kolmogorov–Smirnov test was used to assess the data distribution. Following, the pain scores were analyzed using one-way analysis of variance, with the time point set as a grouping factor, followed by all pairwise multiple comparisons with the Holm–Sidak method. Commercially available software was used (SigmaPlot 10 and SigmaStat 3.5, SYSTAT Software Inc, CA, USA). The p values < 0.05 were considered to be statistically significant.

**Ethical approval**

This study was conducted under the approval of the Social Science Ethical Review Board of the Royal Veterinary College (license number: URN SR 2019–0238). A verbal consent for data publication was obtained by all dog owners.

**Results and Discussion**

The data are represented as means and SD. Seventeen dogs, 11 females (of which, 10 were neutered) and 6 males (of which, one was castrated), aged 134 ± 34 months and weighing 21 ± 11 kg, were included in this report. The represented dog breeds were mixed breed (n = 6), Beagle (n = 2), German Shepherd (n = 3), Border Collie (n = 1), Pug (n = 1), Shetland (n = 1), Cane Corso (n = 1), Labrador Retriever (n = 1), and Pinscher (n = 1). At the time of pretreatment examination, all dogs were on pharmacological analgesic treatment since at least 2 weeks, which included meloxicam, gabapentin, and amantadine in one dog, meloxicam and gabapentin in 5 out of 17 cases, meloxicam alone in 10 out of 17 cases, and gabapentin alone in one dog. The treated joints were the hips (n = 16), stifles (n = 7), elbow (n = 1), and lumbosacral junction (n = 1); 7 dogs presented with more than one affected joint. One dog, a 16-year-old mixed breed male castrated dog weighing 9 kg, affected by chronic renal disease which suddenly deteriorated, died before Week 4 for causes unrelated to OA.

Both CBPI and VAS decreased after the first laser session compared to pretreatment baseline values and continued to decrease over time until the end of the therapy. For the CBPI, pretreatment baselines (11.8 ± 3.6) were significantly higher than the values recorded at weeks 2 (9.2 ± 3.8; p = 0.018), 4 (7.6 ± 3.3; p = 0.001), 6 (6.8 ± 3.5; p < 0.001), and 8 (4.4 ± 4.0; p < 0.001) after treatment (Fig. 1). Similarly, the baseline VAS scores (7.7 ± 0.8) were higher than those recorded at Weeks 2 (5.2 ± 1.1; p < 0.001) and 6 (3.4 ± 1.4; p < 0.001) after the beginning of laser therapy.
After 2 weeks from the first laser session, based on the outcome (pain scores, repeated orthopedic examination, and client satisfaction), the primary clinician changed the pharmacological analgesic therapy in 15 of 17 dogs. This change consisted of a reduction in 13 of these 15 dogs, an addition in one dog, and a replacement in another one. Systemic analgesics administration was suspended in 6 out of 17 dogs and decreased in 7 out of 17 dogs; of these, four dogs previously receiving meloxicam and gabapentin had the NSAID withdrawn, whereas, in another dog, the daily dose of meloxicam was halved. In one dog previously receiving only meloxicam, the clinician added gabapentin. Finally, in another dog previously on meloxicam, the clinician replaced the NSAID with gabapentin alone. In two dogs, the administration of analgesics remained unchanged. Only six out of 17 dogs were brought to the practice at Week 8 for a follow-up. Of these, three dogs that at Week 6 were still receiving meloxicam and gabapentin alone, and had their therapy withheld; one dog in which meloxicam dose had been halved at Week 6 had the NSAID withheld, and the remaining two dogs remained on gabapentin as at Week 6. The owners of the dogs that did not return to practice were phone interviewed and were satisfied with the clinical improvement of their pets. No side effects of laser therapy were observed at any time in any of the study dogs.

Interestingly, these positive effects could be seen immediately after the first laser therapy session and were enhanced by the repetition of the treatment over the 8-week study period. Overall, the clients appreciated that their dogs seemed to enjoy life more and showed increased general activity and, in most cases, that the systemic administration of analgesics could be reduced. In one patient, a 30-kg mixed breed dog with unilateral hip OA, the clinician added gabapentin to meloxicam 2 weeks after the first laser session. Based on both CBPI and VAS scores, this dog had neither improved nor worsened compared to his pretreatment condition; nevertheless, the therapy was re-evaluated and adjusted on request of the dog owner, who perceived the need for further improvement.

Despite there is convincing evidence that LLLT has a limited efficacy in improving human OA-associated pain (Huang et al., 2015), this seemed not to be the case for the dogs of this report. One reason for this may be that although the laser output used in the study dogs still falls, by definition, within the classification of low-level, the device was set to deliver its output at the highest ranges of “low-level” emittance. By definition, LLLT implies an output whose wavelength is within 600–980 nm and with a power less than 1,000 mW, whereas the output used in this report had a wavelength of 808 nm and a power of 1,000 mW (White et al., 2017). This seems to suggest that high-level laser therapy may produce even more satisfactory results in canine OA and potentially further improve pain management and function.
This study has important limitations, and the lack of objective outcome measures, such as dynamic gait analysis and potentially mechanical thresholds, is the most important one. The positive effects of laser therapy were evaluated mostly based on pain scores, which are subjective and may vary depending on the observer. Moreover, the investigator who performed the VAS was aware of the treatment, and his judgment could have been biased. Unfortunately, due to the retrospective nature of this report, a randomized assignment of the dogs to different treatments, including a placebo or negative control group, as well as blinding of the clinician performing the pain assessments, was not a suitable option.

As it was evaluated by the owners and not by the clinician who performed the treatment – and considering that this scale is validated for OA-associated canine chronic pain – the CBPI might have functioned as a more reliable tool than the VAS in the dogs of this report (Brown et al., 2007). Although dog owners may have been driven by their desire to see their pet improving after therapy, owing to both the expenses incurred and psychological-affective implications, the unavailability of previous scores for comparison should have decreased this bias. Moreover, despite the administration of systemic analgesics was reduced in the majority of the dogs after the first laser session – a variable which may potentially have caused a subsequent worsening of the pain, the owners’ satisfaction continued to increase, which further supports the hypothesis that laser therapy did produce some positive results in the study dogs.

Although the prospective study from Looney et al. (2018) could overcome the aforementioned limitations, it included a small number of subjects and was based on the subjective outcome measures. Therefore, laser therapy in dogs should still be regarded as a mostly unexplored field, and more prospective clinical trials are needed to prove the usefulness of laser therapy to treat OA-associated pain and to refine case-specific protocols. In this perspective, the findings of the current, preliminary retrospective study contribute to provide a basis for future prospective investigations and may be used as a starting point by clinicians who aim to introduce laser therapy to their practice until more evidence is published.

**Author’s contribution**

LB: study design, data collection and interpretation, and preparation of the manuscript; PM: intellectual contribution to manuscript preparation and critical revision; MR: contribution to data collection and revision and approval of the manuscript; CA: study design, data analysis, manuscript preparation, critical revision, and editing of the manuscript.

**Conflict of interest**

The authors declare that there is no conflict of interest. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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