Intratumoral injection of radioactive holmium (166Ho) microspheres for treatment of soft tissue sarcomas in dogs and cats
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Introduction
A “microbrachytherapy” was developed as treatment option for inoperable tumors by direct intratumoral injection of radioactive holmium (166Ho) microspheres (Ø 20-30 µm). 166Ho emits β-radiation (Eβ,max=1.84 MeV; T1/2=26.8 h) with a mean tissue penetration depth of 3 mm and a maximum of 8 mm, which enables a high, ablative, radioactive-absorbed dose on the tumor while sparing surrounding tissues.

Materials and Methods
Twelve client-owned patients (8 dogs, 4 cats) with soft tissue sarcomas of several histologic types for which complete surgical excision was no option received 166Ho-microbrachytherapy (Figure 1). Standard disease staging protocol included CT evaluation of the tumor, thorax, and abdomen. Tumor response and side effects were evaluated using a standard follow-up protocol.

Results
Treatment was well tolerated. Tumor-absorbed dose varied from 36 to >1000 Gy. A tumor volume reduction of >50% was observed in 6 animals; 20-50% in 4 animals; and <20% in 2 animals. Subsequent surgical excision was performed in 9/12 patients resulting in complete local remission (Figure 2). Local recurrence occurred in 5 animals after 121 – 1919 days. One patient received a second 166Ho-microbrachytherapy. Median survival time for all patients was 755 days (range 93–1919 days; Figure 3). Four animals were alive at the time of writing, seven died and one was lost to follow-up. Three deaths were disease-related. Side effects were minimal and not associated with radiation dose. Possible side effects consisted of one case of chronic skin ulceration at the injection site, 2 cases of delayed wound healing after surgery, and one case of chronic wound infection after surgery.

Conclusion
166Ho-microbrachytherapy is a safe and effective treatment for downstaging of soft tissue sarcomas allowing subsequent surgical excision.

Figure 1. Typical example of 166Ho-microbrachytherapy. Cat with interscapular fibrosarcoma (a) is staged using contrast-enhanced CT imaging (b) to rule out metastasis, evaluate 3D tumor dimensions, and determine treatment dose. Treatment consists of multiple intratumoral injections of 166Ho microspheres (c). Bi-planar scintigraphy is performed directly after treatment (d, e).

Figure 2. Examples of soft tissue sarcomas before (a, b) and after (c, d) 166Ho injections and subsequent surgical excision resulting in complete remission.

Figure 3. Kaplan-Meier survival curve. Median survival time was not reached because only three deaths were disease-related.