doi: 10.17221/7986-VETMED

Computed tomography-guided cementoplasty combined with radiation therapy for an aneurysmal bone cyst in a dog: a case report

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ABSTRACT: Aneurysmal bone cysts are expansile osteolytic bone lesions that can manifest clinically as lameness, pain and swelling. In humans, aneurysmal bone cysts are considered benign tumours that have been classified as primary or secondary to a previous coexisting lesion. Local recurrence after treatment or malignant transformation has been reported in both humans and in a dog. Different treatment options have been proposed. This report describes the treatment of an 11-month-old Irish wolfhound with an aneurysmal bone cyst with a combination of computed tomography-guided cementoplasty and radiation therapy, 30 Gy delivered in 10 fractions. The dog recovered completely, with no lameness observed 30 months after treatment.

Keywords: lameness; CT; benign bone lesion; osteolytic lesion; polymethylmethacrylate

List of abbreviations

ABC = aneurysmal bone cysts, CT = computed tomography, PMMA = polymethylmethacrylate

Aneurysmal bone cysts (ABCs) are expansile osteolytic bone lesions comprised of large vascular sinusoids divided into blood-filled cavities by connective tissue septa that can manifest clinically as non-weight-bearing lameness, pain and swelling (Dowdle et al. 2003; Sarierler et al. 2004; Van De Luijtgaarden et al. 2009).

In humans, the cysts have been classified as primary or secondary ABCs, occurring with or without a previous coexisting bone lesion, respectively (Feigenberg et al. 2001; Van De Luijtgaarden et al. 2009).

The aetiology and pathogenesis of primary ABCs are not completely understood. Since first being described in 1942 (Mendenhall et al. 2006), ABCs were defined as benign, non-neoplastic lesions in the bone, probably as a result of a primary injury such as trauma; a bone tumour or fibrous dystrophy of the bone, which in turn could cause a haemodynamic disturbance that increased the venous pressure; and primary or secondary to arteriovenous malformation and bony reaction (Szendroi et al. 1998; Barnhart 2002; Sarierler et al. 2004; Mei et al. 2009). A hereditary predisposition in Doberman pinchers has also been reported (Sarierler et al. 2004; Dernell et al. 2007).

Recent studies in humans that reported recurrent chromosomal abnormalities in ABCs have provided a better understanding of the pathogenesis and indicate that primary ABCs are true benign neoplasms (Oliveira et al. 2004; Oliveira et al. 2006; Van De Luijtgaarden et al. 2009; Ye et al. 2010). Another study identified the overexpression of insulin-like growth factor-I (IGF-I) as a hallmark of ABCs, indicating a possible role of the IGF-I-system in ABC pathogenesis (Leithner et al. 2001).

ABCs are relatively rare in humans, where they account for only 1% to 2% of primary bone tumours (Feigenberg et al. 2001; Van De Luijtgaarden et al. 2009).

In animals, a few cases, mostly in horses, cattle, dogs and cats, have been reported (Barnhart 2002).

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Most commonly, ABCs appear in the metaphysis of long bones, but they have also been reported in the vertebra, pelvis, rib and scapula (Barnhart 2002). Although the ABC is benign, the risk of local recurrence after treatment has been described in the literature (Feigenberg et al. 2001; Sarierler et al. 2004; Mendenhall et al. 2006). Also, malignant transformation has been reported in humans and in a Labrador retriever previously treated with different surgical procedures (Barnhart 2002; Mei et al. 2009). ABCs do not usually metastasise (Sarierler et al. 2004) but one case of lung, liver and kidney metastasis in a human patient has been described (Van De Luijtgaarden et al. 2009). In humans, treatment options include radiotherapy, *en bloc* resection for expendable bones, curettage, bone graft or bone graft substitute like polymethylmethacrylate (PMMA) filling of the defect, also known as bone cementation. Cryosurgery, phenolisation, cauterisation, arterial embolisation, steroid injection and calcitonin have been used as adjuvants to the classic treatments (Feigenberg et al. 2001; Barnhart 2002; Sarierler et al. 2004). In dogs, treatment options that have been reported include curettage, cancellous bone graft, autograft, filling the lesion with PMMA, and amputation (Barnhart 2002; Dowdle et al. 2003; Sarierler et al. 2004).

The goal of this study was to describe the efficiency of computed tomography (CT)-guided bone cementoplasty combined with adjuvant megavoltage radiation therapy for an ABC in a dog.

Case description

An 11-month-old male Irish wolfhound that weighed 59 kg was referred for severe lameness of the right distal ulna. The physical examination showed grade III lameness on the right forelimb, and palpation revealed a painful hard swelling of the distal ulnar metaphyseal region.

Mediolateral and craniocaudal radiographs were taken of the elbows and *antebrachium*, as well as dorsoventral and right lateral projections of the thorax. The radiographic findings showed the presence of a broad lytic and expansile lesion at the distal half of the diaphysis and distal metaphysis of the right ulna, with cortical thinning and thin septa inside the radiolucent cavity. No periosteal reaction and soft-tissue swelling were observed surrounding the ulnar lesion (Figure 1A, B). No radiographic changes

Figure 1. Mediolateral (**A**) and craniocaudal (**B**) radiographs of the right antebrachium at presentation. There is an expansile bone lesion at the distal half of the diaphysis and distal metaphysis of the ulna, with a cortical thinning and thin septa inside the radiolucent cavity. No periosteal reaction and soft-tissue swelling were observed surrounding the ulnar lesion

were noted in the thorax. The radiographic differential diagnoses for the ulnar lesion included ABC, giant-cell tumour and telangiectatic osteosarcoma.

A biopsy of the ulnar lesion was performed with an 8G Jamshidi needle. The sample showed the presence of bony content and brownish liquid and was submitted for histopathological examination, with a result consistent with ABC. The bone sample showed: periosteal tissue in continuity with bone trabeculated tissue; areas of patchy trabecular bone with notched margins, covered by osteoblasts and osteoclasts (osteolysis); a bone marrow cavity with fibroblasts and connective tissue; and areas with trabecular margins covered by an osteoblast line, with bone matrix deposition and a haemorrhagic cavity delineated by fibroblasts and rare osteoclasts. Numerous erythrocytes and macrophages with abundant vacuolised cytoplasm and haemosiderin granules, rare fibroblasts and osteoclasts were contained in the cysts.

The patient underwent minimally invasive CT-guided filling of the lesion with bone cement using a 16 multislice CT unit; the dog was anaesthetised with intramuscular administration of 0.2 mg/kg methadone and 0.2 mg/kg midazolam, followed by

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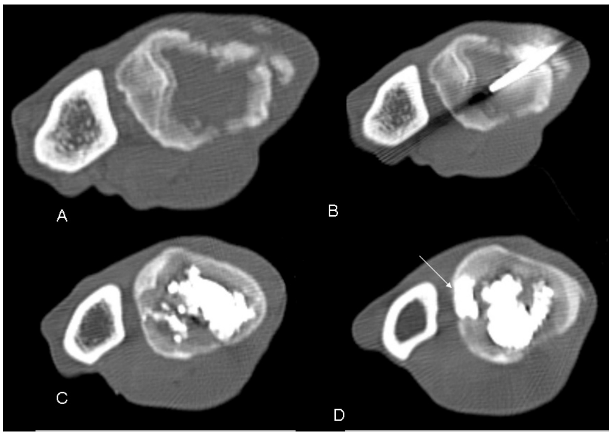

Figure 2. The CT shows an expansile lytic bone lesion of the ulna (**A**). Different phases of the CT-guided cementoplasty: bone needle is visible within the bone (**B**) and two CT slices at different levels of the cyst (**C, D**). Good filling of the cavity is visible. The filling of an area of lytic cortex is also visible (arrow)

4 mg/kg of propofol intravenously. After endotracheal intubation, anaesthesia was maintained with isoflurane delivered in oxygen. A dose of cefazolin sodium, 22 mg/kg intramuscularly, and carprofen, subcutaneously, were administered before the procedure. The needle was inserted into the ABC according to a previously described technique (Vignoli et al. 2004). The patient was positioned to allow easy access to the lesion, trimmed in the target area, and prepared for surgery on the CT table. Plain and contrast studies were taken after 800 mg/kg of a non-ionic contrast medium, ioversol, were administered. The CT parameters were 1.25 mm slice thickness, 100 kV, 165 mA, and 0.8 s tube rotation. After the study, the CT table was moved out of the gantry while the lesion was appraised and the target chosen. The CT table was then moved to the target plane, which was indicated by the laser lights. A skin incision of 4 mm was made at the distal metaphysis with a number 11 lancet, and the bone biopsy needle was partially inserted using the same physical path created during the biopsy. The CT table was moved to the target plane again and additional slices were acquired to measure the distance to the end of the bone lesion to evaluate the placement of the needle tip and its position before filling the lesion. In the meantime, the PMMA was prepared in a sterile environment and injected by hand pressure with a 20-ml syringe into the bone lesion. Once the cyst was filled, the needle and syringe were retracted as one and the incision was sutured. A final CT scan and two radiographs were taken to evaluate the distribution of the cement in the cavity and to compare with the CT and radiographic images made prior to surgery. The images showed that the cavity was well-filled with cement, with only minimal leakage (Figure 2). The patient was monitored for complications immediately after his recovery from anaesthesia and for several days following the surgery. The dog did not show any lameness a few hours after the procedure; he did suffer a mild lameness (grade I out of 4) 24 h after treatment, which completely disappeared the following day. The dog was given no anti-inflammatory or other analgesic drugs after the procedure, but 22 mg/kg cefazolin sodium BID *per os* was continued for six days.

Eight days after the procedure, the dog started radiation therapy with a total dose of 30 Gy, divided into 10 fractions of 3 Gy (five days a week), using 12 MeV electrons. The dog was anaesthetised with propofol until tracheal intubation was possible and then maintained with isoflurane delivered in oxygen.

The patient was seen in the clinic at one and three weeks, and at two, seven, and 10 months following treatment. Radiographic studies were taken of the ulna at two and seven months after treatment and showed normal ulnar growth and thickening of the ulnar cortices (Figure 3A, B) and an increased

Figure 3. Mediolateral (**A**) and craniocaudal (**B**) radiographs of the right *antebrachium* two months after treatment. Normal ulnar growth and thickening of the ulnar cortices are present. Minimal cement leakage is visible in the area of the cement injection

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Figure 4. Mediolateral (**A**) and craniocaudal (**B**) radiographs of the right *antebrachium* seven months after treatment. The radiographs show normal ulnar growth. Increased radiopacity of the proximal part of the lesion can be observed

radiopacity in the proximal part of the lesion, probably due to new bone formation within the cavity (Figure 4A, B). Thirty months after treatment, the dog remained clinically asymptomatic, with no lameness, and no sign of pain or any recurrence.

DISCUSSION AND CONCLUSIONS

ABCs are rare in humans (Feigenberg et al. 2001; Van De Luijtgaarden et al. 2009), and only a few cases have been reported in animals (Barnhart 2002). Complications associated with ABCs in dogs include pathological bone fractures, recurrence, and malignant transformation (Barnhart 2002; Sarierler et al. 2004). The same complications have been reported in humans, as well as surrounding bone-tissue invasion and metastasis (Kyriakos and Hardy 1991; Feigenberg et al. 2001; Mendenhall et al. 2006).

To the authors' knowledge, the treatment of an ABC with either CT-guided cementoplasty and its combination with Megavoltage radiation therapy has not been previously reported in veterinary medicine. The combination of these two techniques was performed in order to increase the bone strength (PMMA), give pain relief, and to stop disease progression (radiation therapy).

In humans, treating ABCs with surgical resection achieves very good control rates and the local control rate after *en bloc* resection for expendable bones approaches 100%, according to reports (Feigenberg et al. 2001; Mendenhall et al. 2006). When an *en bloc* resection cannot be performed because of the lesion's location, alternative treatments include curettage, with or without physical adjuvant, bone graft or cement filling of the lesion, with local control rates ranging between 65% and 90% (Feigenberg et al. 2001). However, cementoplasty has been reported as more effective than curettage and bone grafting alone. Curettage followed by cementation and curettage with bone grafting were associated with recurrence rates of 17% and 37%, respectively (Sarierler et al. 2004). Radiotherapy has been reported as effective for patients with incompletely resectable and/or recurrent ABCs, with local control rates ranging from 75% to 100% (Feigenberg et al. 2001; Mendenhall et al. 2006). *En bloc* resection, amputation and curettage followed by bone grafting or cementation have been reported as successful treatments in animals, but only a few reports have described ABC treatment in detail (Barnhart 2002; Sarierler et al. 2004). Amputation is not always feasible due to concurrent orthopaedic or neurological problems, and the owner's refusal. If amputation or limb-sparing surgery is not an option, multimodal treatments are an alternative to euthanasia.

Coarse fractionated radiotherapy is effective both to relieve lameness and to prolong survival (Yavuz et al. 2004). Radiotherapy has been used conservatively for ABC treatment in humans due to the possible risk of radiation-induced secondary malignancies (Kyriakos and Hardy 1991; Feigenberg et al. 2001; Yavuz et al. 2004). However, most patients who developed radiation-induced bone malignancies were treated with orthovoltage or other low-energy photons. A comparison of reports in the literature showed that orthovoltage irradiation is more likely to be carcinogenic than megavoltage therapy, possibly due to the fact that a higher dose is deposited to the bone (Halperin et al. 2008). This has also been described in dogs treated with orthovoltage radiation for acanthomatous epulis which developed secondary neoplasia within the field of radiation in 18% of cases (Thrall 1984). Nevertheless, indications for treating benign conditions with radiation therapy include conditions with invasive and aggressive growth. Furthermore,

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the treatment in this case was justified because more side effects were reported following amputation of the limb (Seegenschmiedt 2008). Malignant transformation and metastasis of ABC have also been reported after curettage alone, without radiotherapy (Kyriakos and Hardy 1991; Feigenberg et al. 2001; Barnhart 2002; Sarierler et al. 2004; Mei et al. 2009; Van De Luijtgaarden et al. 2009). Other studies over the past decades have described the occurrence of malignant tumours in association with surgical implants, increasing the concern about the carcinogenicity of foreign bodies in orthopaedics (Mei et al. 2009). However, we found no reports of malignant transformation due to the use of PMMA. Some authors suggested that ABCs may occur *per se* as a secondary component of a prior lesion, either benign or malignant, that cannot be identified after the ABC has destroyed its architecture (Kyriakos and Hardy 1991). This additional fact could partly explain the malignant transformation of ABCs (Feigenberg et al. 2001). In the literature, the recommended dose of radiation is 26–30 Gy divided into standard fractions (Feigenberg et al. 2001; Mendenhall et al. 2006). In this case, a total dose of 30 Gy, divided into 10 fractions of 3 Gy (five days a week), using a 12 MeV electron field was prescribed. Radiotherapy is effective both at alleviating the pain associated with the lesion and local control of the tumour (Feigenberg et al. 2001; Boettcher et al. 2009). One study showed that after the cystic cavity ossifies, its size does not change considerably and it never appears normal again (Feigenberg et al. 2001).

The use of PMMA has recently increased because it has many advantages compared with other treatments. The bone cement usually leads to instant, long-lasting, strong pain relief (Boettcher et al. 2009). Cementation will also release some of the mechanical stress and prevent pathological fractures in a bone already predisposed by the osteolytic lesion (Sarierler et al. 2004; Hosoya et al. 2008). Some reports have described progressive thickening of the cortical bone involving the cement, suggesting that the mechanical strength of the bone cement can be increased by bone formation (Sarierler et al. 2004). Pain relief may be achieved by stabilising the bone and destroying the nerve terminals with polymethylmethacrylate because of the thermal heat and cytotoxic effects (Boettcher et al. 2009). The polymethylmethacrylate-related thermal effect is a main factor in the local control of the lesions (Sarierler et al. 2004; Seegenschmiedt 2008) because cementoplasty, combined with megavoltage radiotherapy, achieves local control of the ABC, pain relief and thickening of the cortical bone, which can lead to strengthening of the bone. A similar multimodal protocol can be used to treat other bone tumours, such as alleviation of the pain of osteosarcoma (Boettcher et al. 2009; Vignoli et al. 2011). The use of a multimodal treatment protocol for osteosarcoma using palliative radiotherapy, chemotherapy, pamidronate and cementoplasty under fluoroscopic guidance led to a number of complications during the treatment, including cement leakage, wound infection and suspected thromboembolism (Boettcher et al. 2009). Only minimal cement leakage was seen in our case.

CT-guided cementoplasty, combined with radiation therapy, for the treatment of ABCs appears to be safe and minimally invasive. The dog's lesion is stable and his lameness has been resolved. A follow-up after a longer period of time could reveal the delayed effects of such a treatment.

REFERENCES

Barnhart MD (2002): Malignant transformation of an aneurysmal bone cyst in a dog. Veterinary Surgery 31, 519–524.

Boettcher P, Krastel D, Hierholzer J, Westphalen K, Florian S, Hildebrandt G, Vera G, Oechtering G (2009): Percutaneous cementoplasty in the palliative, multimodal treatment of primary bone tumors of the distal aspect of the radius in four dogs. Veterinary Surgery 38, 888–901.

Dernell WS, Erhart NP, Straw RC (2007): Tumors of the skeletal system. In: Withrow V, (ed.): Small Animal Clinical Oncology. 4th ed. Saunders Elsevier. 540–582.

Dowdle SM, Spotswood TC, Lambrechts NE, Duncan NM (2003): Aneurysmal bone cyst in the distal radius of a dog: Diagnostic imaging and surgical treatment. Veterinary and Comparative Orthopaedics and Traumatology 16, 116–121.

Feigenberg SJ, Marcus RB Jr., Zlotecki RA, Scarborough MT, Berrey BH, Enneking WF (2001): Megavoltage radiotherapy for aneurysmal bone cysts. International Journal of Radiation Oncology, Biology, Physics 49, 1243–1247.

Halperin EC, Perez CA, Brady LW (2008): The discipline of radiation oncology, radiation-induced second primary malignant tumors. In: Halperin EC, Perez CA, Brady LW (eds.): Principles and Practice of Radiation Oncology. Lippincott Williams & Wilkins, Philadelphia. 54–55.

doi: 10.17221/7986-VETMED

Hosoya K, Poulson JM, Azuma C (2008): Osteoradionecrosis and radiation induced bone tumors following orthovoltage radiation therapy in dogs. Veterinary Radiology and Ultrasound 49, 189–195.

Kyriakos M, Hardy D (1991): Malignant transformation of aneurysmal bone cyst, with an analysis of the literature. Cancer 68, 1770–1780.

Leithner A, Lang S, Windhager R, Leithner K, Karlic H, Kotz R, Haas OA (2001): Expression of insulin-like growth factor-I (IGF-I) in aneurysmal bone cyst. Modern Pathology 14, 1100–1104.

Mei J, Gao YS, Wang SQ, Cai XS (2009): Malignant transformation of aneurysmal bone cysts: A case report. Chinese Medical Journal (Engl.) 122, 110–112.

Mendenhall WM, Zlotecki RA, Gibbs CP, Reith JD, Scarborough MT, Mendenhall NP (2006): Aneurysmal bone cyst. American Journal of Clinical Oncology 29, 311–315.

Oliveira AM, Hsi BL, Weremowicz S, Rosenberg AE, Dal Cin P, Joseph N, Bridge JA, Perez-Atayde AR, Fletcher JA (2004): Usp6 (tre2) fusion oncogenes in aneurysmal bone cyst. Cancer Research 64, 1920–1923.

Oliveira AM, Chou MM, Perez-Atayde AR, Rosenberg AE (2006): Aneurysmal bone cyst: A neoplasm driven by upregulation of the usp6 oncogene. Journal of Clinical Oncology 24, e1; author reply e2.

Sarierler M, Cullu E, Yurekli Y, Birincioglu S (2004): Bone cement treatment for aneurysmal bone cyst in a dog. Journal of Veterinary Medical Science 66, 1137–1142.

Seegenschmiedt MH (2008): Radiotherapy of nonmalignant diseases. In: Halperin EC, Perez CA, Brady LW (eds.): Principles and Practice of Radiation Oncology. Lippincott Williams & Wilkins, Philadelphia. 1933–1958.

Szendroi M, Arato G, Ezzati A, Huttl K, Szavcsur P (1998): Aneurysmal bone cyst: Its pathogenesis based on angiographic, immunohistochemical and electron microscopic studies. Pathology Oncology Research 4, 277–281.

Thrall DE (1984): Orthovoltage radiotherapy of acanthomatous epulides in 39 dogs. Journal of the American Veterinary Medical Association 184, 826–829.

Van De Luijtgaarden AC, Veth RP, Slootweg PJ, Wijers-Koster PM, Schultze Kool LJ, Bovee JV, Van Der Graaf WT (2009): Metastatic potential of an aneurysmal bone cyst. Virchows Archiv 455, 455–459.

Vignoli M, Ohlerth S, Rossi F, Pozzi L, Terragni R, Corlazzoli D, Kaser-Hotz B (2004): Computed tomography-guided fine-needle aspiration and tissue-core biopsy of bone lesions in small animals. Veterinary Radiology and Ultrasound 45, 125–130.

Vignoli M, Rossi F, Rohrer Bley C, Cancedda S, Leone VF, Laganga P, Stefanello D, Terragni R, Marconato L (2011): Combination of computed tomography-guided cementoplasty and radiation therapy for the treatment of lytic bone lesions in canine extremities. Preliminary Study. In: Proceedings of the European Association of Veterinary Diagnostic Imaging, British Irish Division Autumn Meeting, Cambridge, UK, 45.

Yavuz AA, Sener M, Yavuz MN, Kosucu P, Cobanoglu U (2004): Aneurysmal bone cyst of the sternum: A case report of successful treatment with radiotherapy. British Journal of Radiology 77, 610–614.

Ye Y, Pringle LM, Lau AW, Riquelme DN, Wang H, Jiang T, Lev D, Welman A, Blobel GA, Oliveira AM, Chou MM (2010): Tre17/usp6 oncogene translocated in aneurysmal bone cyst induces matrix metalloproteinase production via activation of nf-kappab. Oncogene 29, 3619–3629.

Received: 2014–08–15
Accepted after corrections: 2015–01–09

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VETERINÁRNÍ MEDICÍNA
INTERNATIONAL JOURNAL FOR VETERINARY AND BIOMEDICAL SCIENCE
VETERINARY MEDICINE (PRAGUE)

Vignoli M, Stehlik L, Terragni R, Cavallo L, Proks P (2015)
Computed tomography-guided cementoplasty combined with radiation therapy for an aneurysmal bone cyst in a dog: a case report
Veterinarni Medicina, 60, 109-114
Additional material

References (available DOI included):

Barnhart M D. (2002): Malignant Transformation of an Aneurysmal Bone Cyst in a Dog. Veterinary Surgery 31, 519-524 <doi:10.1053/jvet.2002.36014>

Böttcher P, Krastel D, Hierholzer J, Westphalen K, Florian S, Hildebrandt G, Vera G, Oechtering G (2009): Percutaneous cementoplasty in the palliative, multimodal treatment of primary bone tumors of the distal aspect of the radius in four dogs. Veterinary Surgery 38, 888-901 <doi:10.1111/j.1532-950X.2009.00596.x>

Dernell WS, Erhart NP, Straw RC (2007): Tumors of the skeletal system. In: Withrow V, (ed.): Small Animal Clinical Oncology. 4th ed. Saunders Elsevier. 540–582.

Dowdle SM, Spotswood TC, Lambrechts NE, Duncan NM (2003): Aneurysmal bone cyst in the distal radius of a dog: Diagnostic imaging and surgical treatment. Veterinary and Comparative Orthopaedics and Traumatology 16, 116–121.

Feigenberg Steven J, Marcus Robert B, Zlotecki Robert A, Scarborough Mark T, Berrey B.Hudson, Enneking William F (2001): Megavoltage radiotherapy for aneurysmal bone cysts. International Journal of Radiation Oncology*Biology*Physics 49, 1243-1247 <doi:10.1016/S0360-3016(00)01462-0>

Halperin EC, Perez CA, Brady LW (2008): The discipline of radiation oncology, radiation-induced second primary malignant tumors. In: Halperin EC, Perez CA, Brady LW (eds.): Principles and Practice of Radiation Oncology. Lippincott Williams & Wilkins, Philadelphia. 54–55.

Hosoya K, Poulson JM, Azuma C (2008): Osteoradionecrosis and radiation induced bone tumors following orthovoltage radiation therapy in dogs. Veterinary Radiology & Ultrasound 49, 189-195 <doi:10.1111/j.1740-8261.2008.00349.x>

Kyriakos M, Hardy D (1991): Malignant transformation of aneurysmal bone cyst, with an analysis of the literature. Cancer 68, 1770-1780 <doi:10.1002/1097-0142(19911015)68:8<1770::AID-CNCR2820680821>3.0.CO;2-7>

Leithner A, Lang S, Windhager R, Leithner K, Karlic H, Kotz R, Haas OA (2001): Expression of insulin-like growth factor-I (IGF-I) in aneurysmal bone cyst. Modern Pathology, 14, 1100-1104 <doi:10.1038/modpathol.3880443>

Mei J, Gao YS, Wang SQ, Cai XS (2009): Malignant transformation of aneurysmal bone cysts: A case report. Chinese Medical Journal (Engl.) 122, 110–112.

Mendenhall WM., Zlotecki RA., Gibbs C Parker, Reith JD., Scarborough MT., Mendenhall NP (2006): Aneurysmal Bone Cyst. American Journal of Clinical Oncology 29, 311-315 <doi:10.1097/01.coc.0000204403.13451.52>

Oliveira AM (2004): USP6 (Tre2) Fusion Oncogenes in aneurysmal bone cyst. Cancer Research, 64, 1920-1923 <doi:10.1158/0008-5472.CAN-03-2827>

Oliveira AM, Chou MM, Perez-Atayde AR, Rosenberg AE (2006): Aneurysmal bone cyst: A neoplasm driven by upregulation of the usp6 oncogene. Journal of Clinical Oncology 24, e1; author reply e2.

Sarierler M, Cullu E, Yurekli Y, Birincioglu S (2004): Bone cement treatment for aneurysmal bone cyst in a dog. Journal of Veterinary Medical Science 66, 1137-1142 <doi:10.1292/jvms.66.1137>

Seegenschmiedt MH (2008): Radiotherapy of nonmalignant diseases. In: Halperin EC, Perez CA, Brady LW (eds.): Principles and Practice of Radiation Oncology. Lippincott Williams & Wilkins, Philadelphia. 1933–1958.

Szendroi M, Arato G, Ezzati A, Huttl K, Szavcsur P (1998): Aneurysmal bone cyst: Its pathogenesis based on angiographic, immunohistochemical and electron microscopic studies. Pathology & Oncology Research 4, 277-281 <doi:10.1007/BF02905218>

Thrall DE (1984): Orthovoltage radiotherapy of acanthomatous epulides in 39 dogs. Journal of the American Veterinary Medical Association 184, 826–829.

van de Luijtgaarden Addy CM., Veth Rene PH., Slootweg Piet J, Wijers-Koster Pauline M, Schultze Kool Leo J, Bovee Judith VMG., van der Graaf Winette TA (2009): Metastatic potential of an aneurysmal bone cyst. Virchows Archiv 455, 455-459 <doi:10.1007/s00428-009-0845-4>

Vignoli Massimo, Ohlerth Stefanie, Rossi Federica, Pozzi Luigi, Terragni Rossella, Corlazzoli Daniele, Kaser-Hotz Barbara (2004): Computed tomography-guided fine-needle aspiration and tissue-core biopsy of bone lesions in small animals. Veterinary Radiology <html_ent glyph="@amp;" ascii="&"/> Ultrasound, 45, 125-130 <doi:10.1111/j.1740-8261.2004.04020.x>

Vignoli M, Rossi F, Rohrer Bley C, Cancedda S, Leone VF, Laganga P, Stefanello D, Terragni R, Marconato L (2011): Combination of computed tomography-guided cementoplasty and radiation therapy for the treatment of lytic bone lesions in canine extremities. Preliminary Study. In: Proceedings of the European Association of Veterinary Diagnostic Imaging, British Irish Division Autumn Meeting, Cambridge, UK, 45.

Yavuz AA, Şener M, Yavuz MN, Kosucu P, Cobanoglu U (2004): Aneurysmal bone cyst of the sternum: a case report of successful treatment with radiotherapy. The British Journal of Radiology 77, 610-614 <doi:10.1259/bjr/69860747>

Ye Y, Pringle LM, Lau AW, Riquelme DN, Wang H, Jiang T, Lev D, Welman A, Blobel GA, Oliveira A M, Chou M M (): TRE17/USP6 oncogene translocated in aneurysmal bone cyst induces matrix metalloproteinase production via activation of NF-κB. Oncogene 29, 3619-3629 <doi:10.1038/onc.2010.116>