

Cranial internal hemipelvectomy (iliectomy) with limb sparing for a dog with ilial chondrosarcoma: a case report

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Abstract

Objective: To describe the outcome following limb-sparing subtotal hemipelvectomy (iliectomy) in a dog with ilial chondrosarcoma. **Animal:** A 9.5-year-old female spayed Boxer with grade 2 chondrosarcoma of the ilium **Study Design:** Case report.

Introduction

Hemipelvectomy is a procedure that can be performed in companion animals to treat neoplasms involving the pelvis or surrounding soft tissue.¹ Hemipelvectomies can be characterized by type (internal or external) and location (cranial, middle, caudal, total), this terminology was derived from the human literature.^{2,3} External hemipelvectomy refers to removal of a portion of the pelvis and the ipsilateral pelvic limb. In contrast, internal hemipelvectomy spares the associated limb. Lesions can be categorized as either intercompartmental or extracompartmental.^{4,5} A tumor is classified as intercompartmental if the neoplasm is confined within a well-delineated anatomic compartment, whereas, extracompartmental neoplasms extend into other tissue planes or spaces.⁵ The cortical bone and articular cartilage aid as an anatomic compartment.⁵

Osteosarcoma (OSA) and chondrosarcoma (CSA) are the most common primary bone tumors of the canine pelvis.^{6,7} CSA is a malignant neoplasm arising from the cartilaginous tissue, that has a predilection for the medullary cavity of flat bones. The most common occurring pelvic neoplasm in adult humans is CSA.⁸ In veterinary medicine, CSA account for about 10% of bone neoplasms and predominantly occur in dogs.^{9,10} The most common location of pelvic chondrosarcoma in humans is the ilium followed by the pubis and ischium.^{11,12} CSAs in comparison to OSAs tend to be more slower growing and have a lower rate of metastasis in both animals and humans.^{13–15}

In order to reduce the risk of local recurrence and prolong survival time, wide surgical resection is generally recommended for primary bone tumors. As such, the current standard of care for primary proximal femoral and pelvic bone tumors in dogs has been external hemipelvectomy.^{1,16–18} Currently, limited information is published within the veterinary literature regarding internal hemipelvectomy.⁸ If limb function can be retained without compromising surgical margins, a limb sparing procedure may be considered over an external hemipelvectomy.⁶ Three key areas need to be spared if an internal hemipelvectomy (i.e. limb sparing) is to be considered in human patients: the femoral neurovascular bundle, the sciatic nerve, and the acetabulum.⁶ Ideally one intact fascial plane about the circumference of the tumor is preserved.⁴ Internal hemipelvectomy is considered if tumor-free (clean) margins can be achieved, function of the limb is preserved, and the tumor does not involve major neurovascular structures.¹⁹

External hemipelvectomy requires patients to adapt to a novel method of ambulating post-operatively, can be contraindicated in patients with severe osteoarthritis, muscular or neurologic deficits, or may not be a consideration if the owner has a negative perception regarding amputation. Owner concerns may be

influenced by anthropomorphism, concerns over aesthetic appearances, inability of their pet to adapt, or concerns for phantom pain.^{20,21} A phone survey conducted in the Netherlands revealed owners with older dogs reported a significant increase in negative response by acquaintances and were accused of being cruel to their companion for performing a limb amputation.²¹

Cranial internal hemipelvectomy was reported to be a feasible surgical alternative to external limb amputation in one dog with osteosarcoma.²² However, additional case reports are required to document the utility of internal hemipelvectomy for pelvic neoplasia in the veterinary literature. The purpose of this report was to document the long-term outcome of cranial internal hemipelvectomy for a marginally resected ilial chondrosarcoma in a dog followed by adjuvant radiation therapy.

Material and Methods

A 6-year-old female spayed Boxer was presented to the North Carolina State University Veterinary Teaching Hospital for the evaluation of an ilial chondrosarcoma (CSA).

A right hind limb lameness was noticed 4 months prior to presentation. Three months later, a firm mass was appreciated over the dog's right ilium and one week later presented for non-weight bearing lameness. Pelvic radiographs obtained during that visit revealed an osteolytic lesion of the right ilial wing. A complete blood count (CBC) and serum chemistry panel (Chem) were performed prior to bone biopsy, which were both unremarkable. Prior to the biopsy, ceftiofur sodium (2.2 mg/kg, subcutaneously) was administered and anesthesia was induced with thiopental (11 mg/kg, IV). The biopsy results demonstrated disorganized lobules and sheets of neoplastic chondrocytes in a cartilaginous matrix. The cells exhibited moderate to prominent nuclear and cytologic pleomorphism with rare scattered mitotic figures. Histopathology was consistent with the diagnosis of chondrosarcoma. A 14-day course of amoxicillin (15mg/kg, q12hrs, orally) was prescribed. The dog was referred to North Carolina State University Veterinary Teaching Hospital for further evaluation with staging.

Upon presentation, a painful, firm, irregular mass was palpated over the right ilium and measured 5.5 inches x 4.0 inches on physical examination. A minimum database (CBC/Chem/urinalysis (UA)), urine aerobic culture, thoracic radiographs, abdominal ultrasound, and a computed tomography (CT) were performed. Blood work was unremarkable. Urinalysis via cystocentesis revealed a urine specific gravity (1.025; 1.001-1.080), 1+ bacteriuria, and 20-30 red blood cells/hpf. Therefore, the urine was submitted for aerobic culture. Urine aerobic culture grew >100,000 CFU/ml of *Escherichia coli* that was sensitive to all the antibiotics included within the sensitivity panel. Thoracic radiographs demonstrated no evidence of pulmonary metastatic disease. Abdominal ultrasound demonstrated a mildly enlarged spleen with no evidence of parenchymal changes and the medial iliac lymph nodes were assessed to be within normal limits.

CT of the pelvis was performed for treatment planning; the dog received hydromorphone (0.05 mg/kg, IM) as a pre-medication and induced 30-minutes later with thiopental (10 mg/kg, IV); anesthesia was maintained with 1-4% isoflurane in oxygen. An aggressive mass within the region of the right ilium body with lysis from the body of the ilium to the sacrum with medial and lateral displacement of the epaxial muscles within the region of the mass was noted (Figure 1). Given the extent of the tumor, resection with wide margins was not possible. External or internal hemipelvectomy (i.e. iliectomy) with adjuvant radiation versus palliative radiation were discussed. The owner elected to have an iliectomy performed with adjuvant radiation therapy. The patient was discharged with amoxicillin (15 mg/kg, q12hrs, orally) for the urinary tract infection and carprofen (1.7 mg/kg, q12hrs, orally) for pain management.

Two weeks later, the dog represented to North Carolina State University Veterinary Teaching Hospital for iliectomy. A fentanyl patch was applied the evening prior to surgery (100 μ g/hr). The patient was pre-medicated with hydromorphone (0.05 mg/kg, IM) and induced with thiopental (8.5 mg/kg, IV). Anesthesia was maintained with isoflurane as before. An epidural with morphine and bupivacaine was performed prior to surgery (unknown dose). Cefazolin was administered perioperatively (22 mg/kg, IV) and repeated every 90 minutes for the duration of the surgery. The dog was placed in left lateral recumbency. The surgical site was prepared in a routine aseptic fashion with the right pelvic limb prepared for free limb draping. An

eight centimeter curvilinear incision was made through the skin and subcutis three centimeters ventral to the mass. The subcutaneous tissues were dissected down to the underlying musculature. The tumor was seen to be invading the middle gluteal muscle. The middle gluteal muscle was transected caudal to the tumor with electrocautery. The body of the ilium was cleared of soft tissue and an Army Navy retractor was placed medial to the ilium to protect neurovascular structures. A sagittal saw was then used to cut through the ilium. The sacroiliac joint was disarticulated by inserting a periosteal elevator into the joint ventrally. The ilial wing and tumor were reflected dorsolaterally and removed. Remaining suspected neoplastic tissue at the disarticulation site was removed with rongeurs. A closed suction drain was placed at the resection site. A single layer of polypropylene mesh was then sutured to the fascia of the external abdominal oblique ventrally, paraspinal musculature dorsally, remaining middle gluteal muscle and tensor fascia lata caudally with 3-0 Maxon using simple continuous patterns. The subcutaneous and subcuticular layers were closed with 3-0 Maxon in a simple continuous and continuous horizontal mattress patterns, respectively. The skin was closed with stainless steel staples. During anesthesia rare ventricular pre-mature complexes were appreciated. The surgical procedure lasted 184 minutes. Carprofen was administered during recovery (2.2 mg/kg, IV). Post-operatively, the dog received hydromorphone (0.05 mg/kg, IV, PRN), acepromazine (0.02 mg/kg, IV, PRN), carprofen (1.7 mg/kg, q12hrs, orally), and amoxicillin (14 mg/kg, q12hrs, orally). Within twenty-four hours following surgery, the dog was walking and weight bearing on the surgical limb. Seventy-two hours post-operatively, the drain was minimally productive and subsequently removed by the dog. The dog was discharged with carprofen and amoxicillin for an additional ten days (same doses as previous mentioned).

Results

Histopathological evaluation was consistent with a chondrosarcoma and the tumor was incompletely excised as expected (Figure 2). The chondrosarcoma was determined to be a grade II based on exhibited moderate pleomorphism with no undifferentiated areas and 1 mitotic figure observed per 10 high magnification fields.²³⁻²⁵

As previously mentioned, the dog was scheduled to begin radiation therapy twenty-seven days after the iliectomy. At that time, the dog had an intermittent non-weight bearing lameness of the right pelvic limb when running but ambulated well otherwise. Physical examination was unremarkable other than mild pain elicited with flexion of the right coxofemoral joint. Diagnostics included a urinalysis and urine culture via cystocentesis, thoracic and pelvic radiographs. CT scan and radiation therapy had to be rescheduled due to technical issues. Urinalysis was unremarkable and the culture recovered very light growth of *Escherichia coli* and *Enterococcus hirae*. Thoracic radiographs revealed no evidence of metastatic pulmonary disease. Pelvic radiographs demonstrated an overlapping fracture of the left pubic bone as well as corresponding fracture of the left ischial arch (Figure 3). There was evidence of callus formation over the fracture sites. Other significant findings included mild bilateral coxofemoral and stifle degenerative joint disease. The fractures did not appear to be causing the dog marked discomfort; but carprofen (1.7 mg/kg, q12hrs, orally) was prescribed.

Fifty-three days after iliectomy, the dog re-presented for initiation of radiation therapy (nineteen 3 Gy fractions). Physical examination was unremarkable. The following diagnostics were performed: urinalysis via cystocentesis and culture, pelvic radiographs, and CT. Urinalysis was unremarkable, and no bacteria were cultured. Pelvic radiographs revealed progressive coxofemoral degenerative joint disease and healed pelvic fractures. The fracture of the left ischium had a callus around the fracture gap. The margins of the remaining right ilium were irregular and consistent with healing. The mesh overlaying the right hemipelvis region was in place. The dog was premedicated with hydromorphone (0.05 mg/kg, IM), induced with thiopental (10 mg/kg, IV), and maintained with isoflurane. CT was acquired with 5mm slices from the cranial aspect of L5 through the entire pelvis (Figure 4). After completion of full-course radiation therapy the plan for re-evaluation was for physical examination and thoracic radiographs to be performed at one month and then every three months for two years. At the one, six, and nine month re-evaluations pelvic radiographs were also recommended. Upon serial re-evaluations neither pulmonary metastases nor tumor recurrence was ever appreciated. Six months post-radiation therapy, there was progression of new bone formation within the

right hemipelvis in the region where the hemipelvectomy was performed cranial to the coxofemoral joint.

Between the fifteen and eighteen month rechecks, the dog was noted to have some stiffness in her right hindlimb. Thoracic and pelvic radiographs were performed. Thoracic radiographs were unremarkable. Pelvic radiographs revealed mild increased new bone at the iliectomy site and osteopenia region of the right proximal femur which was apparent on multiple views (Figure 5). This was thought to be due to late effects of radiation therapy causing decreased vascularity and subsequent decreased mineralization of the right proximal femur. Carprofen that had been discontinued around three months post-operatively was reinstated to help with patient comfort.

The referring veterinarian treated the dog for an abscess that had developed at the surgical site prior to the eighteen month recheck. The prolene mesh was removed, a drain was placed, and a course of Cephalexin (unknown dose) was prescribed. On physical examination there was a ~8 mm open draining tract with a mild amount of purulent discharge was appreciated at the cranial end of her scar.

At 9.5 years of age, almost 42 months post-iliectomy the dog succumbed to a suspected cardiac arrhythmia. The dog suddenly collapsed and was presented to a local veterinary emergency facility. Upon presentation, the dog was tachycardic. No treatments or diagnostics were performed. The dog was discharged with an unknown medication. The dog collapsed again shortly thereafter and died. There was presumably no recurrence of CSA at the time of death, however, a necropsy was not performed for confirmation. The owner was contacted for follow-up and relayed that she was very pleased with the outcome. The dog had some mild atrophy appreciated on the right pelvic limb at the time of death, however, there was no evidence of lameness or pain. Following iliectomy, the dog was able to continue living an apparently normal life that including running and playing.

Discussion

Hemipelvectomy is a complex procedure that requires extensive surgical planning, adherence to surgical oncology techniques, and thorough familiarity with regional anatomy.¹ There is inherent concern for hemorrhage due to the transection of large muscle groups and presence of major vessels. Although an external hemipelvectomy can be performed, an internal pelvectomy can be an alternative for pelvic tumors resections and result in a favorable clinical outcome.⁴ Internal hemipelvectomy may alter the weight bearing axis of the contralateral hemipelvis resulting in fractures.²² The decision regarding which surgery is appropriate should depend on the owner's goals, the surgeons experience, comorbidities, extent of neoplasia, presence of metastasis, and ability to pursue adjuvant radiation therapy.

In the present literature the general precedents are that an internal hemipelvectomy should only be considered when tumor resection and margins can be achieved as well as a functional limb.⁶ Canine appendicular CSA is often treated effectively with limb amputation. In contrast, pelvic CSA margins are not always achievable.²⁶ Chondrosarcomas, due to their generally poor vascularity and low rate of mitosis (as in this case), can have an inherent resistance to chemotherapy and radiation therapy.²⁷ Radiation therapy is considered for chondrosarcomas if a tumor is deemed non-surgical or incomplete margins are achieved.²⁷ In some human reports, greater than 60 Gy of radiation was required for local disease control.^{15,27} The dog in this case report received nineteen three Gy fractions for a total of 57 Gy over the course of a month with no evidence of local recurrence. The dog presumably succumbed to an unrelated disease 1271 days later. This dog's survival time was similar to the median survival time previously described for pelvic CSA.¹⁷ Likewise, ischiectomy with limb preservation for an ischial chondrosarcoma in an 11-year-old FS mixed breed dog provided a satisfactory clinical outcome with no evidence of local recurrence or metastatic spread over 500 day postoperative period.²

In a retrospective study of long-term outcomes for dogs and cats after hemipelvectomy for surgical excision of a variety of tumor types, almost a third of cases had incomplete margins (dogs: 29/84; cats: 4/16; 100 cases total) with local tumor occurrence occurring in 16% and 12.5% of dogs and cats respectively. Six dogs out of nine, had CSA with incomplete margins, four (66%) of which developed metastases and two (33%) deaths were related to the tumor. Regardless of surgical margins, one (11%) had local recurrence and five (56%) had metastatic disease.¹⁷ In human medicine (n=67), patients with chondrosarcoma of the pelvis that

were treated with definitive surgery 28% developed local recurrence and 36% developed distant metastasis; a high histologic grade was predictive for recurrence ($p=0.005$).¹¹ Grading chondrosarcoma is prognostic for humans and is based primarily on cellularity and cellular atypia. However, grading chondrosarcomas in dogs is not routinely performed. Grading systems for skeletal chondrosarcomas based on histologic features of malignancy and mitotic count have been described and correlated with prognosis in 35 dogs and 31 dogs.^{23–25} These histologic features of this case were consistent with an intermediate grade (Grade II) using the criteria of the studies previous mentioned.

Post-operative complications following hemipelvectomy in dogs and cats are generally minor but can include seroma, wound complications (infection at the surgery or incision site, dehiscence, discharge, incisional hernia, etc.), fecal or urinary incontinence, fecal obstipation, pressure sores, and reoccurrence.^{4,17} In this case, secondary fracture of the left pubis and ischium were appreciated approximately thirty days postoperatively and were presumed to have occurred due to increased weight bearing of the contralateral side. These fractures went on to heal without incident. Implant associated infection occurred eighteen months postoperatively and resolved with prolene mesh removal.

The main purpose of this paper was to document the long-term outcome of an internal cranial hemipelvectomy for a chondrosarcoma of the pelvis. The good outcome in this case study may help veterinarians considering a limb-sparing iliectomy over external hemipelvectomy.¹⁹

Conflicts of Interest

The authors report no financial or conflicts of interest related to this report.

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Figure Legend

Figure 1: Preoperative CT exam of the pelvis revealed an aggressive mass involving the right ilium (arrow) and lateral sacrum (arrowhead).

Figure 2: Histopathologic image (hematoxylin and eosin stain) of the tumor exhibiting moderate pleomorphism and moderate mitotic activity with no undifferentiated areas - consistent with a grade II chondrosarcoma (10x magnification; bar = 100µm)

Figure 3: Lateral and ventrodorsal pelvic radiographs twenty-seven days following iliectomy pelvic radiographs demonstrated an overlapping fracture of the left pubic bone as well as corresponding fracture of the left ischial arch with evidence of callus formation over the fracture sites.

Figure 4: CT image of the pelvis fifty-three days after iliectomy for marginal excision of ilial chondrosarcoma. A portion of the prolene mesh can be seen as a linear serpiginous region of hyperattenuation (arrow).

Figure 5: Pelvic radiographs 488 days post-iliectomy revealing new bone formation within the right hemipelvis region where the hemipelvectomy was performed cranial to the coxofemoral joint. The prolene mesh implant can be visualized. The right proximal femur is slightly more osteopenic compared to the left.

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