Thoracic and Abdominal Wall Reconstruction with Polypropylene Mesh after High Grade Infiltrative Fibrosarcoma Resection in a Dog

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ABSTRACT

Background: Soft tissue sarcomas are a group of invasive malignant tumors formed by neoplastic mesenchymal cells. In most cases, the treatment require surgical resection. When sarcoma characteristics disqualify conventional tumor excision, polypropylene mesh can be used for abdominal or chest wall reconstruction. This paper aims to describe the clinical, computed tomography features, histopathological and immunohistochemical aspects of a chest wall fibrosarcoma, as well as to describe the tumor excision technique combined with resection of multiple ribs, diaphragm advancement and reconstruction of thoracic and abdominal wall with a synthetic polypropylene mesh.

Case: An 11-year-old male Boxer was presented with a progressive growth tumor in the left paralumbar area. The invasive tumor measuring 15 cm in diameter, was firm epidermodermal coverage and was adherent to the subcutaneous tissue, having a smooth and non-ulcerative skin surface. Ultrasound of the mass consisted of a heterogeneous structure comprising paralumbar region, invading abdomen and left thoracic wall. Thoracic radiography showed no signs of nodular interstitial pulmonary pattern compatible with metastasis. The dog was submitted to a CT examination of thoracolumbar region, which demonstrated the presence of the circumscribed mass, measuring approximately 17 cm in diameter in the left paralumbar region with involvement of both paraspinal and transversus abdominis muscles in the region of T13 to L4 with a periosteal reaction of the left 13th rib. Cytopathology demonstrated fusiform cells with evident nucleoli, moderate anisocytosis, anisocariose, pleomorphism and mitotic activity. Histopathological analysis revealed infiltrative neoplastic proliferation of elongated oval tumor cells with large nucleus and abundant eosinophilic cytoplasm, confirming undifferentiated sarcoma. Further, the sample was sent for immunohistochemical analysis, which was suggestive of high-grade fibrosarcoma. The patient was referred for paralumbar neoplasia resection and plastic-reconstructive surgery. While in lateral recumbency, the animal was submitted to a circular incision around the tumor. During tumor dissection, it was noted the involvement of 11th, 12th and 13th ribs, lateral abdominal musculature, as well as the pleura, peritoneum and adjacent soft tissues, so, these structures had to be removed. After tumor removal, a 20 cm diameter thoracic and abdominal defect had to be corrected by the advancement and reintegration of diaphragmatic crus in the caudal border of the 10th rib. Closure of the abdominal wall was performed by surgical implantation of a double layer polypropylene mesh, which was fixed by sutures in the adjacent musculature. Cutaneous closure was possible by performing four tension relief incisions parallel the incision line. During postoperative period, the animal developed hypotension and severe blood loss and anemia. Six h after the surgery, the animal presented cardiopulmonary arrest unresponsive to resuscitation protocol.

Discussion: Fibrosarcoma has biological characteristics of high malignancy, low metastasis rates and high invasiveness. The objective of fibrosarcoma treatment is the complete surgical excision of the tumor. En bloc excision is the main chest wall tumor treatment and includes resection of ribs, muscles, pleura and adjacent tissue to obtain clean surgical margins. In this case, primary closure of chest and abdominal wall was not possible due to extension of defect after tumor removal. The use of polypropylene mesh proved to be fundamental to lateral thoracoabdominal muscle layer closure. According to laboratory tests and the presence of hemorrhage and anemia during postoperative period, the authors believe that the patient developed disseminated intravascular coagulation, which significantly contributed to patient’s death.

Keywords: sarcoma, marlex mesh, surgery, oncology, canine.
INTRODUCTION

Soft tissue sarcomas (STS) are a heterogeneous group of malignant neoplasms classified together due to its similar biological behavior and histogenesis [11,13]. Fibrosarcoma can arise from the skin and subcutaneous tissue, representing the malignant proliferation of fibroblasts. Metastasis are rare and occurs in up to 20% of the cases. However, STS presents high infiltrative features and local recurrence after surgical excision is frequent [3].

Thoracic wall reconstruction can be done with polypropylene mesh or other synthetic polymer [4]. The mesh can be used alone when the resection do not exceed three ribs [17]. For resections involving the caudal thorax, the diaphragm can be advanced to the cranial ribs in order to decrease requirement of rigid and hermetic reconstruction [17]. There are few complications after polypropylene mesh use, the most common being the seroma formation. However, synthetic material have more risks than the autogenous materials [10]. The criteria proposed previously, for surgical management of thoracic wall tumors are the involvement of no more than four ribs on clinical examination and radiography, no intra-thoracic organ involvement and metastasis absence [1].

Thus, this paper aims to describe the clinical, histological and immunohistochemical features of chest wall fibrosarcoma. As well as detailing the importance of computed tomography in surgical planning and describe the tumor excision technique combined with multiple ribs resection, diaphragmatic advancement and thoracic and abdominal reconstruction with synthetic polypropylene mesh.

CASE

An 11-year-old, intact male, boxer breed dog presented with a tumor in left paralumbar area measuring approximately 15 cm in diameter with rapid growth history, especially in the last two months (Figure 1). The animal presented with appetite loss, lethargy, but with normal physical parameters. The mass was firm, adhered to the subcutaneous tissue, apparently encapsulated with soft intact surface, poor delimited and without peripheral lymph node enlargement. Abdominal ultrasound was performed and showed the presence of internal and external heterogeneous structure comprising left paralumbar, abdominal and thoracic region displacing medially abdominal organs such as stomach, liver and spleen. Color Doppler mapping demonstrated intense internal vascularization of the neoplastic mass. Chest radiograph did not show nodular interstitial lung pattern compatible with metastasis. Due to tumor extent and seeking a future excisional surgery, the animal was referred to perform a Computed tomography (CT) scan of the affected thoracolumbar region.

The CT scan showed the presence of a circumscribed mass, measuring approximately 17 cm in diameter in left paralumbar region with paravertebral and transversus abdominis muscle involvement in T13-L4 region. Periosteal reaction of the 13th left rib and displacement of the spleen and left kidney was also visualized (Figure 2). There was no signs of vertebral destruction or infiltration in the left kidney, spleen and other abdominal organs.

Figure 1. 11-years-old, canine, presenting with large thoracoabdominal left flank tumor with evolution of five months.

Figure 2. Computed tomography of the thoracolumbar region. A) Lumbar region without obvious changes. B) Presence of a circumscribed newly formed mass in thoracolumbar and paravertebral region. Involvement of abdominal muscles are evident. C) Intense infiltration of the neoplasm in the abdominal cavity, although without involvement of internal organs. D) Periosteal reaction and infiltration of the 13th left rib.
Using fine-needle aspiration biopsy, cytopathologic analysis revealed fusiform and oval shaped cells with indistinct edges, basophilic, fibrillar, moderate cytoplasm, paracentral nucleus, loose chromatin, evident nucleoli, moderate anisocytosis, anisocariosis, pleomorphism and mitotic activity. The cytological features suggested neoplastic process, but the cellular origin could not be distinguish. In the sequence, proceeded to deep incisional biopsy. The fragment was fixed in 10% formaldehyde and sent for histologic examination. Histopathology revealed an expansive, infiltrative, neoplastic multinodular proliferation partially covered by fibrous capsule and the presence of elongated neoplastic cells with large oval nuclei and abundant, eosinophilic, poor defined cytoplasm. The neoplastic cells were propagated in a disorderly way forming blocks and compact irregular packs of cells. It was noted anisocariosis, anisocytosis, nuclear atypia and evident nucleoli. The mitotic index was 3 m.f. / 10 fields of 40x. Histopathologic diagnosis was undifferentiated sarcoma. A sample was sent for immunohistochemical analysis, whose result in immunostaining of vimentin, 1A4 and S100. The tumor did not express AE1/AE3, Desmin, CD31, VIII Factor and trypase. The diagnosis after immunohistochemical analysis was suggestive of high-grade fibrosarcoma. After that, the patient proceeded to surgical excision of a thoracoabdominal, paralumbar neoplasm and plastic-reconstructive surgery.

In pre-operative blood test, it was noted severe macrocytic hypochromic regenerative anemia (Hct: 16%, Hb: 4.0 g/dL, RBC: 1,870 million cells/mm³) with anisocytosis and intense polychromasia, increased band neutrophils (1,890 cells/mm³), thrombocytopenia (platelet: 123,000 cells/mm³), high level ALP (329 IU/L) and low albumin (1.93 g/dL). Coagulation test indicated prolonged prothrombin time (11.8 s) and decreased activated partial thromboplastin time (9.65 s).

Preoperative stabilization was carried out with colloid (6% hydroxyethyl starch + 154 mEq/L sodium chloride) administration at a rate of 20 mL/kg/day, 7% hypertonic saline solution at 4 mL/kg rate and after initiate Lactate Ringer’s solution infusion at a rate of 10 mL/kg/h. As preoperative medication it was used midazolam maleate¹ (0.5 mg/kg i.m) and morphine sulfate² (1 mg/kg i.m). Etomidate³ was used for anesthesia induction (1.6 mg/kg i.v) and maintained with inhalational anesthesia (isoflurane⁴).

During surgery a continuous rate infusion of morphine sulfate² (0.02 mg/mL), ketamine⁴ (0.3 mg/mL) and lidocaine² (0.06 mg/mL) (MLK) was used at rate of 10 mL/kg/h for pain control. In order to maintain mean arterial pressure above 60 mmHg, it was necessary to use continuous rate infusion of dobutamine hydrochloride⁵ during surgery at rates ranging from 5-10 µg/kg/min. Intraoperative fresh whole blood transfusion was performed.

At surgery time, the tumor had increased in size, measuring 20 cm in diameter (Figure 3). The animal was positioned in right lateral recumbency and based on palpation, ultrasound and CT data, a sterile marking pen was used to delimit the surgical margins. A circular incision with 3 cm margins around the mass was performed (Figure 4A). After surgical dissection in caudal face of the mass, the neoplastic involvement of the 13th, 12th and 11th left rib was evident, so we proceeded to removal of the three ribs and consequent detachment of the left diaphragmatic crus from its insertion on the edge of the chest wall (Figure 4B) The dissection proceeded in the deeper fascia of the abdominal flank where noted the involvement of the lateral abdominal wall musculature, previously seen on CT, and requires resection of part of the muscles and lateral abdominal fascia attached to the tumor as well as the pleura, peritoneum and adjacent soft tissues. After removing the tumor, a defect on thoracoabdominal wall side wall measuring about 20 cm in diameter remains with exposure of the abdominal cavity, and a major defect measuring 30 cm in diameter on skin and subcutaneous tissue (Figure 4C and D).

On intraoperative macroscopic observation there was no neoplastic involvement in abdominal organs. In sequence, proceeded to left diaphragmatic crus advancement and reintegration at the caudal border of the 10th left rib with Sultan sutures using nylon 1-0 (Figure 5). The negative intrathoracic pressure was reestablished through intercostal thoracentesis.

The exposed abdominal organs were covered by omentum (Figure 5B). For abdominal wall closure, surgical implantation of polypropylene mesh (Marlex®⁶) measuring 26 x 36 cm was chosen. The mesh was positioned so as to occupy the size of the defect in the abdominal wall and then secured to the adjacent musculature through multiple Wolf sutures using 2-0 nylon (Figure 5C). Then the mesh was
folded over the defect forming a second layer and suture the same way as the first layer (Figure 5D). The subcutaneous tissue was closed using Sultan sutures using polyglactin 910 2-0. To repair the skin layer we chose rectangular fashion closure of the injury, starting the skin sutures in the wound angle and moving inward form a suture line in “X” format ending with a longitudinal line, using simple interrupted sutures and nylon 2-0 (Figure 6A and B). The closure was possible by performing four tension relief incisions parallel to the incision line and measuring approximately 1.5 cm and spaced about 2.5 cm from the edge of the wound (Figure 6C). Before the end of the surgery a penrose drain was placed in longitudinal direction of the wound, emerging in the ventral and dorsal area. The dressing was made with a gauze pad contact absorptive layer followed by a cotton wool layer and the outer layer was composed of tubular mesh and bandages.

The neoplastic mass weighed about 2.6 kg and was encapsulated, solid with cystic areas of clotted bloody content and fibrous trabeculae, highly vascularized, infiltrated in the deep muscle fascia and multiple ribs (Figure 7).

At immediate postoperative period, the animal was kept in intensive care monitoring system. The animal was conscious with slightly decreased mental state and in lateral recumbency. Regarding the vital signs, the average heart rate was 126.9 ± 9.3 beats per minute, respiratory rate was 51.3 ± 12.5 breath per minute, the average rectal temperature was 35.7 ± 0.4ºC and systolic blood pressure showed a mean of 79.2 ± 12.7 mmHg. Additionally, the animal presented pale mucous membranes and decreased capillary refill time (1 s). Continuous rate infusion of MLF for pain control and dobutamine hydrochloride was maintained. However, no changes in vital parameters, including pale mucous membrane occurred, even after fluid challenge (15 mL/kg Lactate Ringer’s solution i.v in 10 min) and fresh whole blood transfusion. Is also presented episodes of melena. Approximately 6 h after surgery, the animal presented cardiorespiratory arrest unresponsive to the maneuvers of cardio-pulmonary resuscitation protocol and death declared after 15 min.
Figure 6. Trans-surgical, cutaneous synthesis. A) Closing the skin layer of the surgical wound in a rectangular fashion. B) Approximation of the central edges of the wound under great tension. C) Tension relieving incision on both sides of the central wound and closure by apposition with moderate tension. D) Final appearance of the dressing.

Figure 7. Neoplasm after en bloc excision. A) Large neoplastic mass measuring > 20 cm. B) Ventral view of the tumor, there is obvious involvement of the rib’s body. C) Internal appearance of the tumor with several cavitary areas with clots and fibrous trabeculae.

DISCUSSION

The STS are mesenchymal neoplasms arising from connective soft tissue. They can occur anywhere on the body, but often affects the skin and subcutaneous tissue. As in this case, the STS are prevalent in middle-aged medium and large dogs [5].

Fibrosarcoma, as well as other STS, has biological features of high local site malignancy and low metastasis index, mainly observed by the large size of the neoplastic lesion, high invasiveness in lateral and deep layers and absence of pulmonary metastasis without regional lymph node involvement [11]. Although commonly exhibit insidious onset, rapid changes and accelerated growth with intratumoral hemorrhage and necrosis can be seen in some cases [11].

Due to impossibility of determine a neoplastic cell lineage in fine-needle aspirative cytology, presurgical incisional biopsy was recommended, which allowed to obtain adequate samples for histopathological and immunohistochemistry diagnosis. There was no negative interference in subsequent image exams and the biopsy incision could be removed along the surgical excision, which eliminates the risk of tissue contamination [6]. The fibrosarcoma is an uncommon rib tumor, with osteosarcoma and chondrosarcoma being the most common, accounting for 28-63% and 28-35% of all cases, respectively [1,15,18].

CT scan allowed local staging of the tumor, providing vital information for surgical planning as determining the tumor size, location, evaluation of abdominal invasiveness, number of affected ribs, length of dorsal and ventral bone invasion and adherence or infiltration of adjacent body structures [7]. In cats, the lesion severity observed on CT scan associated with other imaging exams aided to choose the surgical procedure, opting for prosthetic use (i.e. polypropylene...
mesh) to structural closure and defect stabilization of the chest wall due to three ribs removal [9,17].

The STS prognosis is usually based on histological tumor grade [13]. Although clinically and macroscopically well-defined, STS exhibit a pseudocapsule that apparently separates the tumor from the tissue around, so when excised borderless there is a high incidence of local recurrence [8,11]. Due to aggressive local behavior, surgical resection with wide margins ≥ 3 cm is indicated [1,15,18]. The main objective is complete surgical excision of the tumor, because incomplete removal significantly increases the risk of local recurrence and reduces the average survival time [18]. En bloc excision is the main method of treatment of chest wall tumors and includes resection of ribs, muscle, fascia, pleura and adjacent skin to obtain clean surgical margins [1]. As described in this case, a retrospective case review reports rib tumors excised with a cranial and caudal rib minimum, ≥ 3 cm dorsal and ventral margins to the tumor and the average number of excised ribs was three [10,12]. The complete excision of the affected rib was performed in this case, replacing the previous recommendation of 3 cm normal costal bone removal dorsal and ventral to the tumor. This is recommended due to the possibility of intramedullary spread of cancer cells beyond the palpable and seen externally [7,10]. Due to adherence free abdominal and thoracic parenchymal organs, en bloc excision of these tissues was not required, however when perfomed, there is no association of pulmonary lobectomy with increased risks of perioperative complications in dogs, unlike occurs in humans [1,12].

As in most chest wall defects, primary closure was not possible in this case due to its large size. It is important to consider that survival rate is significantly reduced when primary closure is performed, compared with reconstructive techniques [16]. Chest wall defects involving the caudal ribs (9th-13th) does not necessarily need to be rebuilt in order to re-establish the chest physiology, as this can be achieved by diaphragm advancement technique [1,15,18]. The use of polypropylene mesh proved fundamental for muscle layer closure of the lateral thoracoabdominal transition due to its large size (> 5 cm) and involvement of three ribs [2]. The mesh, when folded double layer, was a reliable support anchor for subcutaneous and skin sutures, allowing a good approximation of injured muscle borders even after last ribs resection. Despite last ribs resection, additional rigid prostheses was not necessary due to diaphragm advancement to the next rib which guarantee hermetic closure of the thoracic cavity without compromising respiratory function [17]. The characteristics of prosthetic materials for chest reconstruction include rigidity, flexibility, radiolucency and resistance to infection [20]. Polypropylene mesh has high tensile strength and low permeability to gases and liquids [20]. It also has small pores which allow rapid growth of vascularized tissue, and after 6 weeks, there is 3-4 mm of fibrous tissue infiltration [20]. The excision of the tumor with surgical margin was only possible due to malleable prosthesis use, otherwise would be impossible to perform hermetic closure, especially the muscular layer. The alternative to use of synthetic prostheses, is the autogenous reconstruction technique, such as latissimus dorsi flap [10]. The application of autogenous reconstruction was not possible in this case because latissimus dorsi was affected and was partially excised during removal of the neoplastic mass. This is the main limitation of the muscle flap use and necessarily require implantation of synthetic mesh for correct reconstruction [10]. Longitudinal parallel tension-relief incision allowed moderate tension closure of the skin layer without flaps and grafts.

Based on patient’s history, neoplasm clinical features and laboratorial tests, which showed thrombocytopenia and high prothrombin time (PT) and partial thromboplastin time (PTT), the authors believe the patient developed disseminated intravascular coagulation (DIC) and this condition significantly contributed to patient death. According to Ralph and Brainerd (2012) DIC in veterinary medicine is diagnosed based on a clinical condition that could induce it and two or more laboratory abnormalities, such as thrombocytopenia, prolonged PTT and PT, and hypofibrinogenemia, high fibrinolysis markers number or fragmentation of erythrocytes in a blood smear (schizocytes, keratinocytes and acanthocytes) [19]. Neoplasia, inflammation and vascular wall lesions are causes of DIC, all this factors may be trigger DIC in this case due to surgical manipulation of a solid, large and highly vascularized neoplasm. DIC occurs in about 12% of dogs with solid tumors [14].

The use of flexible synthetic prosthesis, such as polypropylene mesh, is essential in thoracic and abdominal wall reconstruction of dogs after resection of large neoplasms, especially in cases where there is excision of several ribs. The use of polypropylene mesh when combined with other reconstructive techniques
such as diaphragmatic advancement and tension relief incisions allows satisfactory closure of body wall defects. Due to animal’s death, short and long term follow up for inflammatory reaction, postoperative infection, suture dehiscence and adherence on abdominal organs was not possible. Additionally, patients with large malignant tumors are on imminent risk of developing DIC before, during and after surgery and this fact should be considered to begin treatment as early as possible.

REFERENCES


