Surgical Oncology: Clinical Perspective

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Surgical oncology is part of a multimodality approach to cancer care. Surgery cures more cancer than any single modality. Multiple disciplines involved include medical oncology, surgical oncology, radiation oncology, immunotherapy, and pathology. When the patient has a lump there are immediate questions that everyone in the exam room wants to answer.

What is it? How do we find out? Fine Needle Aspirate (FNA)/cytology? Biopsy? "Why can't we just remove the tumor without knowing what it is? It would be save so much money!"

How bad is it? Benign vs malignant. Infiltrative? Metastasized? How big is it? Does it matter how big it is? Does it spread by lymphatics or vascular? Has the tumor invaded surrounding tissues and planes? "What is staging anyway?"

Is there a cure? Is a cure part of one or a combination of surgery, chemotherapy, radiation, immunotherapy? Is it surgery alone?

Can it be controlled? Can the local disease and/or metastatic disease be controlled with surgery, chemotherapy, or radiation?

Is palliation possible? Can we just make the patient feel better and have the best quality of life for the time they are alive (whether or not treatment is possible or chosen)?

What if you do surgery and you uncover a pandora's box of a situation? You find out that you did a beautiful job of tumor removal and healing. Then you find out that it was malignant with dirty margins and is expected to grow back fast and furious. What if you find out that if you would have done a small pre op biopsy and removed the mass with larger margins it would have been a cure. What if that lipoma turned out to be a mast cell tumor and just won't heal. What if you discovered a bone tumor on radiographs of that limping dog but didn't insist on that chest radiograph that later revealed chest metastasis? Can't we just give the melanoma vaccine to that patient with the oral melanoma without the expense of surgery and/or radiation? What if those distraught sad guilt ridden clients just don't have the money to do those staging diagnostics? What if we didn't recommend surgery, chemotherapy and radiation to that patient with anal gland adenocarcinoma and it grows back and ultimately metastasizes. What is your Veterinary State Board policy about not documenting diagnostic, staging, and therapeutic recommendations to that client? Why don't tumors just read the book and have predictable behavior?

Bring sanity to the madness by following surgical oncology principles. Finally, fulfill the goal of communicating well with the clients throughout the process of diagnostics and treatment so that they feel confident that "they did what they could." Owner discussion about the "treatment trail" includes diagnostic tests, palliative options, surgical options, adjuvant treatments, costs, postop care, expected function, cosmesis, prognosis, and risks of complications.

Surgical Oncology Principles:

Preoperative issues:

Signalment: age, gender, breed, weight. “Age is not a disease.”

Staging and concurrent disease: CBC, chemistry, urinalysis, thoracic radiographs, and abdominal ultrasound are very important in preoperative evaluation of cancer patients .Revealing an underlying disease may change the plan or provide a more accurate diagnosis. Extent of the surgery may be altered based on the results of staging.

Neoadjuvant therapy: Radiation or chemotherapy may be used to reduce the size of a large tumor prior to surgery. This may decrease the surgical dose required to gain local control. Sometimes this may also help in difficult anatomic locations like the perineum and face. For example, neoadjuant chemotherapy to “downsize” a mast cell tumor prior to surgery with prednisone, vinblastin, or intralesional triamcinolone may reduce the size so that wide excision is successful (risk of local recurrence needs to be studied). Neoadjuvant radiation therapy is used to reduce the surgical dose and increase reconstruction options for a tension free closure. Advantages are reduced radiation field, intact tissue plane, better tissue oxygenation, and decreased number of viable neoplastic cells left in a wound with seroma or hematoma. Potential disadvantage may be poor wound healing. Consult with a radiation oncologist helps to identify good canidates .

Surgical planning

Fine needle aspirate FNA: FNA is the most minimally invasive diagnostic technique. Accuracy related to tumor type, location, and presence of inflammation. Sensitivity and specificity is 89%/100% respectively. Imaging (ultrasound, fluoroscopy. CT) helps. SQ/ cutaneous aspirates can be performed with minimal discomfort. Correlation with histopath in SQ and cutaneous masses is 91%. Cytology is 89% sensitive/98% specific to diagnose neoplasia. A basic goal of cytology is to differentiate neoplasia vs inflammation . Also, if the result is neoplastic, ideally differentiate benign vs malignant. Cytology may determine specific tumor type or class of tumor (eg.carcinoma). Specific diagnosis is confirmed by histopathology (melanoma vs SCC). FNA is important in the staging process looking for metastasis or paraneoplastic disease and determining surgical dose. Eg . lipoma (minimal surgical dose and staging) vs carcinoma cells (staging includes chest radiographs, abdominal ultrasound (AUS), lymph node (LN) aspirates, larger surgical dose). Internal organs guide diagnostic and treatment choices. Image guided FNA/cytology may be diagnostic.

Lung FNA has sensitivity 77%/specificity 100%. Cranial mediastinal mass diagnosis may be successful with FNA. For example, thymoma has lymphocytes and mast cells vs lymphoma which only has a single population of lymphocytes. Flow cytometry is also available to differentiate thymoma (CD4+ and CD*+) vs lymphoma(one lymphocyte type). Hepatic and splenic cytology is commonly performed.

Liver and Spleen:

Liver tumor cytological diagnostic rates vary to as low as 14% in dogs and 33% in cats. On the other hand cytology of the liver has been reported as high as 80% for multiple pathologies. Splenic aspiration is not recommended for hemangiosarcoma suspect (unlikely to get a diagnosis and possibility of hemorrhage). Splenic mast cell tumor and lymphoma FNA can be diagnostic.

FNA of GI and bony tumors: The accuracy of lymphoma has greater sensitivity than carcinoma /adenocarcinoma or leiomyoma/leiomyosarcoma. Ultrasound guided FNA of osteosarcoma had sensitivity of 97% specificity of 100% for sarcoma. Agreement of cytology with incisional and excisional biopsies of bony lesions occurs in 71% of the cases.

Risks of FNA includes bleeding which is worse in body cavities. Tumor seeding in the needle tract is rare but has been reported in transitional cell carcinomas (TCC). Mast cell tumors must have premedication with benedryl before FNA. Potential death from degranulation can occur. FNA and cytology is effective, inexpensive, and valuable for preop planning.

Biopsy. Obtaining tissue sample for histopathologic interpretation. Pretreatment vs posttreatment (after definitive surgery). Plan carefully! Know patient current illnesses, anatomic location, ddx, technique, neoadjuvant or adjuvant tx that may need to incorporate.

Pretreatment biopsy

Needle core biopsy can be performed for soft tissue, visceral, and thoracic masses. Sedation and local are necessary. Image guided biopsy is recommended in cavities in order to avoid vital structures. General anesthesia often not needed. Procedure: set up includes needle core biopsy instrument, no. 11 blade, local anesthesia, area around mass clipped and prepped aseptically. Intact skin in nonanesthetized animal: infiltrate skin with lidocaine or bupivivaine. 1-2 mm stab. Orient instrument and fire. 22 ga needle to remove sample from instrument.

Punch biopsy is performed for cutaneous , liver, spleen, kidney, SQ (after making skin incision) masses. Instrumentation: punch biopsy instrument, scalpel blade, local anesthetic, suture. Clip fur, aseptic skin prep, local anesthetic, twist punch til device is embedded into the mass to the hub. Grasp tissue with forceps and gently use metzenbaum scissors to sever the deep aspect of the sample and remove it. Place suture in skin if SQ punch biopsy performed. Similar procedure is performed with internal organs (eg.liver) Suture or gel foam may be used for hemostasis.

Incisional (wedge) biopsy can be performed in all locations. Larger sample size is the advantage. Remember that biopsy site will be removed with definitive surgery. Avoid excessive dissection to reduce seroma and hematoma. Risks include bleeding, swelling, and infection. Avoid uninvolved tissues. Instrumentation: no. 11 or 15 scalpel blade, local anesthetic, metzenbaum scissors, forceps, suture, hemostats. Gelpi or other self retaining retractors. Single incision in the skin. Expose mass. 2 parallel incisions meet deep to form a wedge. Remove with forceps and metzenbaum. Close skin with suture.

Posttreatment biopsy (excisional biopsy). Approach varies with location, goal of surgery, and predetermined adjuvant therapy. This may be a diagnostic and treatment modality. Caution: minimally, perform a FNA to differentiate neoplasia vs inflammation ; and if neoplastic, benign vs malignant. Excisional biopsy can be performed while leaving option for wide excision if necessary. Issues with excisional biopsy include creating altered tissue planes. Tumor cells may expand deeper and wider into tissues. For curative surgery, take appropriate margin for tumor type. Ex. Lipoma, margin is minimal. For soft tissue sarcoma, margin must be more extensive. Surgeon could compromise the patient by doing too much or too little surgery.

Bone biopsy: Always consider definitive surgery when planning incision and biopsy tract. Remember that biopsy tracts need to be removed with the definitive surgery. Reactive zone of bone exists at the periphery of most bone tumors, so biopsy in this region results in incorrect diagnosis. Target the anatomic center of the bony lesion. Performed with Jamshidi needle or Michele bone trephine. **Trephine** delivers 93.8% accuracy, but has disadvantage of increased chance of fracture. It also requires surgical approach and longer decalcification process. Procedure: Clip, prep , and drape area. Make 1-3 cm incision; dissect soft tissues from the bone. Penetrate cis but not trans cortex. Once inserted to depth of medullary cavity, rock instrument back and forth to loosen and remove sample. Stylet pushes the sample onto gauze sponge. **Jamshidi** has advantage of less invasive method. Smaller stab incision is used for this technique. Fracture is less likely. Correct diagnosis of tumor vs nontumor is achieved with Jamshidi. Instrumentation: no 11 blade, jamshidi needle. Surgical site clipped and prepped with aseptic technique. 1-2 mm stab over bone lesion. Jamshidi placed through incision and against the bony lesion. Stylet removed and the needle twisted until til cis cortex is penetrated ; instrument is rocked back and forth and then removed. Stylet is placed through the tip towards the handle to remove the sample from the Jamshidi onto cassete.

Lymph node biopsy: Biopsy and treatment of lymph nodes in neoplasia is controversial. Must have knowledge of the probable draining lymph node for the mass in a particular location. Removal or incisional lymph node biopsy can aid in staging, prognosis, and treatment options. Superficial lymph nodes include mandibular, prescapular, axillary, inguinal, and popliteal. To remove lymph nodes in the chest or abdomen, exploratory is performed and careful gentle dissection and hemostasis is required. Instrumentation to remove superficial lymph node: No. 10 or 15 scalpel blade, metzenbaum scissors, forcep, suture, suture scissors. Procedure: Clip, aseptic prep and drape. Incision is made over the palpable lymph node. Blunt and sharp dissection of tissue over the lymph node. Grasp lymph node capsule with forceps and dissect around the lymph node to excise it. Vascular ligation. Close SQ and skin.

Endoscopic biopsy: Esophagoscopy, gastroscopy, duodenoscopy, and colonoscopy are performed for biopsies of the GI tract. Smaller samples are obtained. Advantage is reduced morbidity. Laparoscopy, thoracoscopy has been used to attain kidney, bladder, liver, spleen, adrenal gland, pancreas, stomach, intestine, and lung biopsies. Be careful with case selection. For instance, large tumors or highly vascular tumors should undergo an open procedure.

Surgical issues for curative-intent surgery.

Adherence to surgical technique principles improve chance of success and minimize risk of local or distant seeding of tumor cells.

Drape off tumor from rest of the surgical field.

Avoid contact with ulcerated or open areas of the tumor with gloves or instruments

Sharp dissection preferred over blunt dissection. (don’t stray from the margin; don’t leave tumor cells behind)

Avoid tension on the suture lines. Learn best tension relieving sutures or flaps. Important for radiated tissue!

If drain is necessary, must exit so that it can be easily resected with margins in subsequent surgery or easily included in the radiation field.

Control hemostasis and prevent seroma or abscess by control of dead space. Tumor cells could be dispersed beyond the surgical field when increased SQ space develops.

Decrease risk of recurrence after tumor resection by doing the following:

Remove biopsy or drain tracts with definitive surgery. Remove the tract as if it is part of the tumor and remove en bloc.

Adhesions should be removed with the tumor.

When surgical margin is established, margin must be maintained down to the deep margin (eg.fascia).

Pseudocapsule must not be penetrated since it is made of compressed tumor cells. Seeding of these cells may result in recurrence and inhibit healing.

New set of instruments, gloves, and drapes are recommended for closure of wound created by tumor removal or reconstruction. Very important to do on all tumors removed on the same patient so as to avoid tumor seeding from one tumor site to the next.

Surgical margins

Definition of surgical margin: a tissue plane established at surgery; tissue beyond stays in the patient. Submit all masses in their entirety to evaluate for completeness of excision. Mark margins with ink or sutures before placing in formalin. This aids pathologist in identifying margin. Larger tissue is trimmed by a technician. Pathologist may not distinguish between a surgical margin and a "sectioned" margin. Ink is present through all processing and is seen on the slide under the microscope. If tumor cells are seen at the inked edge, the tumor is considered "dirty" or incomplete.

Surgical techniques define the type and magnitude of the surgical margin. **Intracapsular** technique involves dissection within the dimension of the tumor. Residual disease always left behind. **Marginal** excision refers to excision with preferably a 10 mm or less cuff of normal tissue around the mass. Marginal excision is appropriate for lipomas. **Wide** Excision (intracompartmental) involves tumors removed with 1-3 cm of normal tissue in all directions, including deep. The mass is removed en bloc with pseudocapsule and reactive zone completely contained with a cuff of normal tissue. It is intracompartmental which distinguishes from radical excision. **Radical** excision (entire anatomic compartment) is removal of normal tissue greater or equal to 3 cm around the mass or entire anatomical compartment (eg. amputation). **Extracompartmental** excision defined by excision plane beyond the anatomic compartment considered to have cancer resistant tissue barrier (eg. Hemipelvectomy).

Mast cell tumors and soft tissue sarcomas have microscopic projections or tendrils of tumor cells extending from the main tumor bed. Mast cell tumors (MCT) require at least 2 cm margins in a grade 2 MCT and tissue plane deep. Soft tissue sarcomas generally require 3 cm margins and tissue plane deep. Controversy exists over surgical dose for low grade sarcomas. Deep margins may be a fascial plane and thus 2-3 mm.

Incomplete margin is evaluated on histopathology. If incomplete margin occurs, the next step is monitoring of recurrence, re-excision, and possible chemotherapy and/or radiation therapy. Goal of re-excision surgery is to achieve tumor-free margins. The entire previous wound bed is then removed as "dirty" and is removed with a margin of normal tissue to include all microscopic extensions. CT can be performed to help with surgical planning.

Palliative and cytoreductive surgery must be selected with the clear goal of making the patient feel better. Tumor cells will be left behind. Piecemeal removal or debulking is only considered if the tumor is obstructive or altering function. This may increase quality of life temporarily. Other complications may be excessive bleeding and dehiscence. Debulking has little advantage unless removal to microscopic disease. Adjunctive therapies must be discussed at the same time.

Postoperative issues

Tissue marking is performed so that the pathologist can evaluate for complete excision. Techniques include specialized sectioning techniques, suture marker, inking, and submission of adjacent tissue as a separate sample. Inappropriate sectioning can lead to false-positive result. Suture is good for tissue orientation or to mark an area of interest. Suture is removed before sectioning. Remember that submission of additional tissue increases the size of the wound bed and adds expense. Inks and dyes are recommended to mark margins. Alcian blue is best but india ink and commercial kits are adequate. Multiple colors are available in commercial kits (Davidson Marking System, IMEB Inc, San Diego, CA). At a minimum, the lateral margin is inked with one color and deep margin with another. Yellow, black, and blue are best colors. Red and Green are less ideal.

Guidelines for fixation of surgical tissue specimens: Place small samples immediately in formalin to avoid drying. This will prevent autolysis and bacterial changes. Large samples can be sliced evenly to provide more complete fixation. 10% buffered formalin is adequate for most biopsies. Sample should be fixed in 1:10 solution tissue to formalin.

Frozen sections result in accurate diagnosis in more than 97% of human samples. Facilities in veterinary medicine with this capability are limited. One veterinary study showed 93% accuracy in frozen sections differentiating neoplastic from nonneoplastic tissue and 83% accuracy in determining a specific diagnosis.

Wound healing complications: Nutritional compromise and simultaneous disease can complicate healing. Tumor type and completion of tumor excision can also impede healing. Chemotherapy and radiotherapy have also been documented to impair healing. Good surgical technique will decrease the chance of complications. Good client communication is important to prepare the client for potential complications. Clients must know how to evaluate for complications and recheck immediately if detected. Prevention of self trauma with elizabethan collars and bandaging may need to be included in post operative care.

Adjunctive therapy must be discussed prior to surgical intervention. Owners can make informed decisions for expense and additional complications associated with other treatment modalities. It's important to prevent the client feeling overwhelmed, underinformed, delayed patient treatment and needless morbidity. Chemotherapy is generally administered after suture removal. If administered before or time of surgery, it can delay wound healing. Radiation therapy may be administered before or after surgery. Radiation will slow healing. Minimal tension on the suture line is very important.

Dehiscence or infected wounds must be treated before radiation is performed. Radiation is usually recommended after wound is healed. When gross tumor is present in a wound it may be necessary to radiate even in an open wound for palliative purposes.

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Pain management in the cancer patient - DOGS

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Table of suggested doses of analgesics that may be used for the **alleviation of chronic cancer pain in the *DOG***.
None of the drugs have been evaluated for efficacy in the treatment of cancer pain. **None of these drugs are approved or licensed for use in chronic cancer pain**. The NSAIDs have not been included in this table. NSAIDs should be used as a first line of pain relief if it is clinically appropriate to use them, and should be used at their approved dose.
The doses given come from the authors' experience, and the experience of others working in the area of clinical cancer pain control

Drug	Dose for DOGS	Comments
Paracetamol (acetaminophen)	10-15 mg/kg PO q 12 hrs	Associated with less gastro-intestinal side effects than regular NSAIDs, and not been noted to be associated with renal toxicity. Toxicity has, however, not been evaluated clinically in dogs. Can be combined with regular NSAIDs in severe cancer pain, but this combination has not been evaluated for toxicity
Paracetamol (acetaminophen) + codeine (30 or 60 mg)	10-15 mg/kg of acetaminophen.	Sedation can be seen as a side effect with doses at or above 2mg/kg codeine
Amantadine	4.0-5.0 mg/kg PO q 24 hrs	Loose stools and excess GI gas can be seen at higher doses for a few days. Should not be combined with drugs such as selegiline or sertraline until more is known about drug interactions. Should not be used in seizure patients, or patients in heart failure.
Amitriptyline	0.5 – 2.0mg/kg PO q 24 hrs	Amitriptyline has not been evaluated for clinical toxicity in the dog. Should be used cautiously in combination with tramadol.
Butorphanol	0.2 – 0.5 mg/kg PO up to q 8 hrs	May produce sedation at higher doses. Not a very predictable analgesic, especially in the dog, and best when used in combination with other analgesics, e.g. NSAIDs
Codeine	0.5 – 2.0 mg/kg PO q 8-12 hrs	Sedation can be seen at the higher doses. Like all oral opioids, it is subject to significant first-pass effect at the liver, likely very much limiting its analgesic effect
Fentanyl, transdermal	2-5 mcg/kg/hrs	Can be very useful in the short-term control of cancer pain. For long-term therapy, usefulness is limited due need to change the patch every 4 to 7 days
Gabapentin	3-10 mg/kg PO q 6-12 hrs	Has not been evaluated in dogs as an analgesic. The most likely side effect is sedation
Glucosamine and chondroitin sulfate	13-15mg/kg chondroitin sulfate PO q 24 hrs	Can be used in a variety of cancer pains due to its mild anti-inflammatory and analgesic effects.

Morphine, liquid	0.2-0.5mg/kg PO q 6-8 hr	Can be useful for dosing smaller dogs where the morphine tablets are not suitable. Sedation and (particularly) constipation are side effects that are seen as the dose is increased. Like all oral opioids, it is subject to significant first-pass effect at the liver, likely very much limiting its analgesic effect
Morphine, sustained release	0.5 – 3.0mg/kg PO q 8-12 hr	Doses higher than 0.5-1.0 mg/kg are often associated with unacceptable constipation according to owners, so suggest using 0.5 mg/kg several times a day. Like all oral opioids, it is subject to significant first-pass effect at the liver, likely very much limiting its analgesic effect
Pamidronate	1 – 1.5 mg/kg slowly IV diluted in 4mls/kg normal saline, administered over 2 hrs. Repeat every 4-6 weeks	This drug inhibits osteoclast activity, and thus only provides analgesia in cases suffering from a primary or metastatic bone tumor that is causing osteolysis.
Prednisolone	0.25-1mg/kg PO q 12-24 hrs; taper to q 48 hrs if possible after 14 days	Do NOT use concurrently with NSAIDs. Can be particularly useful in providing analgesia when there is a significant inflammatory component associated with the tumor, and for CNS or nerve tumors
Tramadol	4-5mg/kg PO q 6-12 hr	This drug has not been evaluated for efficacy or toxicity in dogs.

Pain management in the cancer patient - CATS

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Suggested doses of analgesics that may be used for the **alleviation of chronic cancer pain in the CAT**.
None of the drugs have been evaluated for efficacy in the treatment of cancer pain.
None of these drugs are approved or licensed for use in chronic cancer pain.
Some drugs are approved for inflammatory or painful conditions in the cat in certain countries, and doses for the control of cancer pain are extrapolated from these.
The doses given come from the authors' experience, and the experience of others working in the area of clinical cancer pain control.

Drug	**Cat Dose (mg/kg)**	Notes
Paracetamol (acetaminophen)	Contraindicated	Contraindicated—small doses rapidly cause death in cats.
Amantadine	3.0-5.0 mg/kg PO q 24 hrs	This drug has not been evaluated for toxicity but is well tolerated in dogs and humans, with occasional side effects of agitation and GI irritation. May be a useful addition to NSAIDs in the treatment of chronic cancer pain conditions. Amantadine powder can be purchased and formulated into appropriately sized capsules. The kinetics have recently been evaluated in cats.
Amitriptyline	0.5-2.0 mg/kg PO q 24 hrs	This drug appears to be well tolerated for up to 12 months of daily administration. May be a useful addition to NSAIDs for treatment of chronic pain conditions.
Aspirin	10 mg/kg PO q 48 hrs	Can cause significant gastro-intestinal ulceration

Buprenorphine	0.01-0.02 mg/kg sublingual q 8 - 12 hrs	The sublingual route is not resented by cats and may be a good way to provide postoperative analgesia at home. Feedback from owners indicates that after 2-3 days dosing at this dose, anorexia develops. Smaller doses (5-10 mcg/kg) may be more appropriate for "long-term" administration, especially in combination with other drugs.
Butorphanol	0.2-1.0 mg/kg PO q 6 hrs	One study suggests using oral butorphanol after surgery may be beneficial. Generally considered to be a poor analgesic in cats except for visceral pain, however the author has found it to be useful as part of a multimodal approach to cancer pain therapy
Carprofen	Not enough data to enable recommendations for long term administration	—
Etodolac	Not recommended	—
Firocoxib	—	Firocoxib use has not been reported in clinical cases, but it has a half-life of 8-12 hours in the cat, and at 3mg/kg provided anti-pyrexia effects in a pyrexia model.
Flunixin meglumine	1 mg/kg PO daily for 7 days	Daily dosing for 7 days results in increased rate of metabolism of the drug, but a rise in liver enzymes, suggesting liver toxicity may be a problem with prolonged dosing.
Gabapentin	10mg/kg q 12 hours	Appears to be particularly effective in chronic pain in cats where an increase in sensitivity has occurred, or where the pain appears to be excessive in comparison to the lesion present.
Glucosamine / Chondroitin sulphate combinations	Approx. 15mg/kg chondroitin sulphate PO q 12 to 24 hrs	May be associated with mild analgesic effects
Glucosamine / Chondroitin sulphate combination with avocado / soya extracts	Labeled dose	May be associated with mild analgesic effects
Ketoprofen	1 mg/kg PO q 24 hrs	Probably well tolerated as pulse therapy for chronic pain, with a few days "rest" between treatments of approx. 5 days. Has also been used by some at 1mg/kg every 3 days long term. Another approach has been to use 0.5mg/kg daily for 5 days (weekdays) followed by no drug over the weekend, and this is repeated.

Meloxicam	0.1 mg/kg PO on day 1, followed by 0.05mg/kg PO daily for 4 days, 0.2 then 0.05 mg/kg every other day thereafter (Approval in the EU at 0.05mg/kg daily indefinitely for musculoskeletal pain)	This drug is well received by cats due to its formulation as a honey syrup. Also, the drop formulation makes it very easy to gradually and accurately decrease the dose. A decreasing regimen has not been evaluated for efficacy in cats, but has been found to be successful in dogs. Meloxicam should be dosed accurately using syringes.
Morphine (oral liquid)	0.2-0.5 mg/kg PO t.i.d.-q.i.d.	Best compounded into a palatable flavored syrup; however, cats usually strongly resent this medication. Morphine may not be as effective in cats as it is in dogs.
Morphine (oral sustained release)	Tablets too large for dosing cats	—
Piroxicam	1 mg/cat PO daily for a maximum of 7 days. If longer term medication is considered, suggest every other day dosing	Daily dosing for 7 days results in a slight increase in the half -life.
Prednisolone	0.5-1.0 mg/kg PO q 24 hrs	Can be very effective. **NOT to be combined with concurrent NSAID administration**

Drug	**Cat Dose (mg/kg)**	**Notes**
PSGAGs (polysulphated glycosaminoglycans) (Adequan)	5mg/kg sub-cutaneously twice weekly for 4 weeks; then once weekly for 4 weeks; then once monthly (other suggested regimens call for once weekly injections for 4 weeks, then once monthly)	There is no evidence based medicine that it provides any effect, but anecdotal information suggests improvement can be seen after a few injections.
Robenacoxib	1-2mg/kg q24	Robenacoxib has varying approvals in different parts of the world, being approved for up to 11 days administration (Switzerland). It is the first NSAID that is a coxib, has a short half-life and demonstrates tissue selectivity.
Tepoxalin	5-10mg/kg q24	The author has used this successfully long-term in cats, likely due to its short half-life (5 hours) and true dual inhibition characteristics.
Tolfenamic acid	4 mg/kg PO q 24 hrs for 3 days maximum	Has not been evaluated for chronic pain, but recent objective measurements demonstrate analgesia in the cat when administered perioperatively
Tramadol	1-2 mg/kg once to twice daily	The main problem with tramadol is dosing cats – the tablets are very bitter and aversive to cats

Transdermal fentanyl patch	2-5 mcg/kg/hrs	The patches may provide 5-7 days of analgesia in some cases and should be left on for longer than 3 days. Following removal, the decay in plasma levels following patch removal is slow.
Vedaprofen	0.5mg/kg q 24 hrs for 3 days	Has not been evaluated for chronic pain, but was evaluated for controlling pyrexia in upper respiratory infection, and for controlling post-operative pain following ovariohysterectomy

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