AVST Case Log: #2 **Name/ID#:** Flame, 44317 **Signalment:** 9-month-old, male neutered, Siamese feline, weight 4.4 kg.

Presenting Problem: Weight bearing lameness of the left pelvic limb

Differential Diagnosis: Capital femoral physeal fracture, femoral fracture, pelvic fracture, medial patellar luxation

Pertinent Patient History and Physical Exam

Flame had a weight bearing lameness of the left pelvic limb that was noticed on February 7, 2020, when his owner came home from work. The cat was examined by his primary veterinarian that same day. The examination revealed crepitus and pain on palpation and extension of the left hip. A ventral-dorsal (VD) pelvic radiograph was obtained and a left femoral capital physeal fracture was diagnosed. Flame was prescribed buprenorphine at 0.01 mg/kg PO TID and was referred to an orthopedic specialist the next day. On physical examination, the rectal temperature was 102.9°F, pulses were 130 beats per minute, respirations were 10 breaths per minute, and mucous membranes were pink with a capillary refill time of one second. No heart murmurs or arrhythmias were noted on auscultation, no external wounds were found on exam and the surgeon confirmed crepitus of the hip joint. Flame resisted manipulation and seemed painful during palpation and PROM of the left hip. The neurological exam was WNL.

Tentative Diagnosis

Based on physical exam, patient history and referral radiographs, a left capital femoral physeal fracture was diagnosed. A capital physeal fracture, or slipped capital physis, can occur without great force or trauma and usually occurs in young, skeletally immature animals with open physes.[1] Fractures of the capital femoral physes are overrepresented in cats due to an orthopedic developmental disease called slipped capital femoral epiphysis. While all cats may be affected, it is most often diagnosed in young, overweight male cats that were castrated at a young age and it often presents bilaterally in effected patients.[2]

Diagnostic Imaging Options

Lateral and VD views of the pelvis were taken under general anesthesia by the scrub technician before surgery in order to get accurately positioned radiographs without causing further discomfort to the patient. On a VD pelvis view it is important to make sure the pelvis is straight, symmetrical, and that the femurs are parallel to one another. The hemipelvii should be superimposed on the lateral radiograph. Depending on the surgical procedure chosen, radiographs with proper anatomical positioning and calibration markers are necessary for surgical planning. Poorly positioned radiographs can cause distortion that may lead to the use of inappropriately sized implants. A calibration marker is necessary when using digital radiography so that measurements can be calibrated and corrected for magnification. The calibration device used consisted of two radiopaque ball-bearings suspended a known distance of 10cm apart in a rectangular piece of radiolucent plexiglass, and it was placed in a fixed position, parallel to the radiography table at the same height as the anatomy to be radiographed. All personnel present during radiograph exposure wore appropriate personal protection equipment (lead apron, thyroid shield, gloves, and dosimetry devices at collar level), and non-essential personnel were asked to leave prior to exposure.

Surgical Treatment Options

In order to prevent degenerative joint disease and continued functional lameness with associated pain, surgery was recommended.[1] Three surgical options were discussed: the micro total hip replacement (Micro THR), femoral head ostectomy (FHO), and fracture reduction and fixation. Total hip replacement has been used for over 30 years in medium and large dogs.[3] The Micro THR has been available through Biomedtrix Inc. (Boonton Township, NJ) since June 2005.[4] The goal of the Micro THR is to provide small dogs and cats (<12kg) a pain-free, functional joint. Force plate analysis studies in dogs with THRs showed a return to normal gait and limb function following THR surgery.[5] One study showed the functional outcome (PE, PROM, muscle mass, and client survey results) following THR as excellent in all three operated cats, and in the same study 3/5 cats operated with FHO were reported as having a lesser outcome than with THR.[6] The FHO biomechanically alters the hip joint by removing the femoral head and neck, therefore creating a scar tissue pseudoarthrosis. Femoral head ostectomy is considered a salvage procedure that results in the loss of a functional joint, with a post-operative goal of removing the source of pain, which in this case would be the broken fragment. It is a less expensive and specialized operation that can offer a good outcome, provided appropriate aftercare is given. Physical therapy should begin immediately post operatively to build, or maintain, muscle mass and achieve good PROM.[6] The patient's gait is usually altered due to limb shortening, although it might be imperceptible to owners.[7] Internal surgical reduction and fixation of the fracture was also offered. Repair of a capital physeal fracture can be achieved with Kirschner wires and can provide good function if the fracture is anatomically reduced and stabilized properly and promptly.[1] It has been reported that cats with capital physeal fractures have better function with fracture repair versus the FHO.[8] Following the discussion of options, the owners scheduled Micro THR surgery for the following day with the goal of restoring normal function without future arthritic changes.

Patient and Equipment Preparation

Preventing infection is imperative with joint replacement surgery. If infection occurs, explantation of the prosthesis may be required, leaving the patient with a modified FHO. It is important to follow a consistent protocol and use highly trained team members to shorten anesthesia/surgery time, as the risk of infection increases by 0.5% per minute of anesthesia.[9] The operating room was steam cleaned the night before. Thirty minutes prior to the incision, cefazolin (22mg/kg) and gentamicin (2.2mg/kg) were administered intravenously. Cefazolin is a first-generation cephalosporin that is a good broad spectrum antibiotic for peri-operative use. Gentamicin is an aminoglycoside antibiotic that is primarily effective against aerobic gram-negative bacteria, and it was chosen to expand the spectrum of the prophylactic antibiotics used peri-operatively.

Shortly after induction, orthogonal radiographs of the pelvis with a Biomedtrix calibration marker were obtained to determine implant selection. Using a Biomedtrix Micro CFX™ digital template, a 12mm acetabular implant and #3 femoral stem implant were deemed most appropriate. After radiographs, the surgical site was prepared using an electrical clipper with a #40 clipper blade. The fur was clipped over the left hip extending just past the vertebral midline, forward to the last rib, to midline medially, and midway between the hock and metatarsus. The clipped area was vacuumed to remove all loose fur. A preliminary aseptic prep was performed

by the circulating technician using clean gauze moistened with 4% chlorhexidine gluconate scrub, three consecutive times for a contact time of two minutes, beginning over the hip and extending to the outer clipped margins. The 4% chlorhexidine gluconate scrub was then wiped off with clean gauze soaked in 0.9% saline solution until all residual scrub was removed. The unclipped portion of the foot was covered with an exam glove and wrapped with bandaging tape. Prior to moving to the operating room (OR), personnel donned caps and masks and removed outer lab coats.

In the OR, the cat was positioned on top of a properly tested and operating ground plate with conductive gel in right lateral recumbency using a vacuum beanbag positioning device to secure the cat in proper position. Patient positioning is vital to THR success, and it is important that the pelvis be aligned with the hemipelvii perfectly superimposed and the vertebral column parallel to the table edge. Incorrect positioning can result in misalignment of the implants at surgery. The left leg was hung to facilitate aseptic preparation of the entire limb and the cat was kept warm using a warm water circulating blanket. A CRI of morphine (0.1mg/kg/hr), lidocaine (20µg/kg/min), and ketamine (5µg/kg/min) was prepared and administered at a rate of 5ml/kg/hr via a fluid pump and a fluid warming device was used. The circulating technician donned sterile gloves via open gloving to begin preparation of the limb. Sterilized gauze moistened with 4% chlorhexidine gluconate scrub was used to perform the scrub in a target pattern starting over the incision site (localized over the greater trochanter) and extending outward to the rest of the clipped area three consecutive times for a contact time of two minutes. Chlorhexidine is a broad-spectrum antiseptic that has a rapid onset time with a minimum two minute contact time and provides residual activity for up to two days.[1] Sterile gauze soaked in 0.9% saline solution was used to remove the residual scrub from the skin.

The two surgical scrub technicians performed an aseptic hand scrub using a 4% chlorhexidine surgical hand scrub with a sterilized scrub brush. Surgical gowns, towels, and gloves were opened by the circulating technician and were donned by the surgical team. Gowns were secured by the circulating technician, and gloves were donned with a closed gloving technique. The circulating technician aseptically opened all surgical packs for the scrub technicians to organize on the main instrument table and one side table. After quarter draping the leg with sterile towels, the scrub technician covered the non-sterile portion of the foot with sterile cohesive bandaging. The tape securing the leg in hanging position was cut and released by the circulating technician. The leg was covered with a double layer of sterile stockinette to minimize contact with the skin during the procedure and two disposable drapes were placed over the patient. The scrub technicians organized the instruments on the instrument table chronologically so that the instruments to be used first were easiest to access. When instruments were no longer needed, they were placed at the back of the instrument table to reduce clutter. A side instrument table was also used for larger surgical instrumentation including the Biomedtrix Micro CFX™ instrumentation set. The surgeon performed the same aseptic scrub prior to gowning, gloving, and entering the OR to begin surgery.

Operative Report

Sharp-sharp utility scissors were used to cut an opening in the stockinette just before the incision was made. An incision was made with a #15 blade on a Bard-Parker #3 blade handle cranial to the greater trochanter of the femur and extended to the middle of

the femoral diaphysis. The surgeon sewed sterile water-proof plastic ophthalmic drapes into the incision using 4-0 nylon to prevent contamination from the skin. The blade handle, Mayo-Hegar needle holders, and Adson tissue forceps used on the initial skin incision were set aside and not used for the rest of the procedure. Curved Mayo dissecting scissors and a new #15 blade and handle were used to dissect through adipose tissue, fascia, and muscle while monopolar electrocautery aided in hemostasis. Two baby Gelpi retractors allowed visualization of the hip joint, then the round ligament was transected with Mayo scissors and the fragment of the capital femoral epiphysis was grasped and removed with a small Stefan bone reduction forceps. A Biomedtrix femoral neck template was utilized to guide the surgeon in making the appropriate femoral neck ostectomy line. A battery powered oscillating saw with a 0.5cm wide saw blade was used to perform the femoral neck ostectomy while a single action Lempert rongeur aided in the removal of the fragment. A finger Hohmann and a finger Meyerding retractor allowed visualization of the acetabulum as a single action Lempert rongeur was utilized to remove remnants of the round ligament. A nitrogen-powered high speed drill with a 4mm burr was used to prepare the acetabulum and a 12mm Micro CFX™ acetabular trial was used to ensure proper preparation and sizing. A 20g dose (½ dose) of Surgical Simplex™ P bone cement with 1g of cefazolin was prepared by the scrub technician in a cement mixer until dough phase consistency was reached. The mixer was compromised of a charcoal vapor absorber and connected to the OR suction to reduce inhalation of chemical fumes. Dough phase consistency should not be sticky when manipulated, similar to craft dough. Surgical Simplex™ P (ingredients: 75% methylmethacrylate, 15% polymethylmethacrylate, and 10% barium sulfate) is low viscosity bone cement with a long liquid phase (mixing phase) and a short working phase. Cement preparation to a workable phase requires about five minutes mixing time, dependent on OR temperature, cooler temperatures increase mixing time. The surgeon changed gloves prior to implantation; then applied the cement into the prepared acetabular bone bed, and implanted a 12mm Micro CFX™ acetabular cup. A Freer elevator was used to remove excess cement around the implant while a remaining piece of bone cement was kept on the table to be monitored for cement hardening by the scrub assistant. When the cement was hardened, a piece of sterile gauze was placed in the acetabular cup to protect the polyethylene surface during stem preparation.

A small Stefan bone reduction forceps was placed around the proximal 90° externally rotated femur while a large A-O periosteal elevator was used as a lever to lateralize the proximal femur. The femoral bone bed preparation for the stem was made using an awl to open the canal, followed by #1-2, and #2-3 femoral reamers. All reaming was done with the reamers on a Jacobs hand chuck. A #3 Micro CFX™ femoral trial was utilized to ensure proper implant sizing. Cement was prepared as before and was hand packed into the femoral canal by the surgeon. A #3 Micro CFX™ femoral stem was implanted using a micro femoral impactor and a bone mallet. The stem was held in compression with the impactor by the surgeon until the cement hardened. A remaining piece of unused bone cement was kept on the table to monitor cement hardening by the scrub assistant. Once the cement had hardened, the A-O elevator was removed and excess bone cement was extracted using a Freer elevator. The gauze previously packed in the acetabulum was taken out and discarded. An 8mm +2 femoral trial head and neck length was placed on the stem neck to confirm the desirable femoral neck length and then the Stefan bone reduction forceps was removed, implant reduction was completed, confirmed

appropriate, disarticulated, and the trial head removed. An 8mm +2 femoral head prosthesis was secured onto the femoral stem with a head impactor and mallet and the acetabulum was lavaged with 0.9% saline irrigation and suctioned with a 7 French Frazier suction tip. Caution was used with the suction tip, and all instruments, to ensure the implant surfaces were not scratched. The implants were rearticulated and the implant was inspected for proper alignment and PROM. Capsulorrhaphy and deep gluteal muscle closure were performed using a Halstead vertical mattress pattern with 2-0 polydioxanone (PDS) suture, a slow absorbing monofilament suture that provides adequate tensile strength for up to six weeks. The fascia was closed with 2-0 PDS in a simple continuous pattern. The subcutaneous layer was closed with 4-0 PDS in a simple continuous pattern, and the skin closed with 4-0 nylon monofilament non-absorbable suture. Nylon is a pliable, non-absorbable suture commonly used for skin closure. A lateral and VD radiograph of the pelvis were obtained postoperatively in the same manner as the pre-operative radiographs to ensure proper implant placement prior to moving the patient to recovery.

Post-Operative Care

The patient was moved to recovery and extubated in a heated recovery cage with non-slip flooring. The incision was cold compressed for 20 minutes, but passive cryotherapy was not tolerated overnight. Flame was administered oxymorphone (0.1mg/kg) IV on extubation and placed on maintenance crystalloid fluids overnight. Cefazolin was administered IV every six hours for a total of four doses. Within twelve hours after surgery, he was using the leg well and eating, drinking, and urinating. Twenty-four hours after surgery, Flame was started on 50 mg cefpodoxime (10 mg/kg, off label) PO once daily for 10 days and buccal buprenorphine (0.1mg/kg) TID for 10 days. He was discharged the following day.

Client Education and Prognosis

The owners were given verbal and written discharge instructions. An Elizabethan collar was sent home to prevent licking and chewing at the incision. They were instructed to monitor the incision daily for any drainage and to keep the Elizabethan collar on until suture removal. Sutures were to be removed after two weeks during the follow up examination. The prognosis was very good with proper aftercare and owner compliance. Activity was limited for six weeks with no running, jumping, or playing with other cats in order to avoid post-operative complications including luxation, implant loosening or femoral fracture. The owners were instructed to prevent jumping and keep Flame indoors, confined to a crate or small room with non-slip surfaces.

At six weeks, pelvic radiographs were obtained. Flame was doing very well, and recheck radiographs revealed stable implant positioning with solid bone-cement interfaces. At this time, he was allowed to return gradually to a more normal activity level, and the client was advised to avoid activities that may result in a fall indefinitely, to prevent luxation or femoral fracture, and to alert their veterinarian about infections or dental procedures in the future, so prophylactic antibiotics could be administered. The American Academy of Orthopaedic Surgeons states: “Given the potential adverse outcomes and cost of treating an infected joint replacement, the AAOS recommends that clinicians consider antibiotic prophylaxis for all total joint replacement patients prior to any invasive procedure that may cause bacteremia.”[10] Flame was prescribed yearly examinations to monitor function and implant integrity.

AVST Instrument and Equipment List

Steam: pre-vacuum autoclave with cycle settings: 270°F, 17-20 psi, 4-minute cycle.

Linen Pack: Sterilized by manufacturer

(4) 24" x 32" quarter drapes
(1) 8' x 6'blue paper overdrape
(1) OR instrument table cover
(10) 4x4 gauze sponges (radiopaque)
Suction tubing
Plastic irrigation bowl

Disposables: Sterilized by manufacturer

(2) #15 surgical blades
Monopolar electrocautery pencil
Bi-polar electrocautery forceps
(2) Half dose Surgical Simplex™ P bone cement
(2) Converters® Drapes (60in x 76in)
(2) Plastic ophthalmic incise drapes (121cm x 129cm)

General Surgical Pack: Sterilized with steam, double wrapped in KenVet Drape

(8) Backhaus towel clamps
Curved Mayo scissors
Curved Metzenbaum scissors
(2) Mayo-Hegar needle holders
(1) Allis tissue forceps
(2) Brown Adson thumb forceps
(2) Bard-Parker #3 handle
(3) Halstead mosquito curved hemostats
(3) Curved Kelly hemostats
#7 Frazier suction tip
Sharp/blunt OR scissors

Biomedtrix Micro THR CFX™ Set: Sterilized steam, double wrapped in blue polypropylene sheets

Femoral neck template
Acetabular trials: 12mm, 14mm, 16mm
Femoral stem trials: #2, #3
Femoral head trials: 8mm+0, 8mm+2
Micro stem impactor
Femoral reamers: 1-2, 2-3
(2) Awls
Mead mallet

Additional steam sterilized instruments:
Elevators: Adson, A-O, Freer
Retractors: baby Gelpi, finger Hohmann, finger Meyerding, Senn
Stefan Bone reduction forceps
Hall's 3M high speed burr and nitrogen cable
Stryker oscillating sagittal saw
Double layer small stockinette
Jacob's hand chuck and key
Co-flex bandaging tape
Single action Lempert rongeur

Quality Control Methods

Class 1 external chemical indicator tape; steam: Comply™ indicator tape
Class 5 / Other internal chemical indicator strips; Steam: Comply™ SteriGage,
Chemical indicator strips were placed in the least accessible/most dense part of the pack or inside the innermost wrap or pouch

References

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