Complications – how to approach and solve successfully

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1 General remarks

Upon recognizing, that a complication might have occurred, the orthopedic surgeon should approach the problem as it would the first presentation of the patient. This means, that a thorough diagnostical work up is performed first, ending in a diagnosis. This diagnosis can be implant failure, osteomyelitis, delayed union, neoplasia or any other complication. After that, the veterinarian should reflect on the etiology (e.g. undersized implant, break in surgical principles, diabetes, lack of initial diagnostics) and pathophysiology (e.g. micromotion on the implant, spread of bacteria, poor neovascularisation, missing owner compliance). Only after full awareness of all predisposing, pathogenetic and accompanying factors, a therapeutic plan will be established, together with a controlling plan (e.g. revision surgery, augmentation, change or removal of implants, bone grafts, antimicrobial therapy and others).

In the following paragraphs, some frequently encountered complications, as recognized by the pet owners, are classified in timely order. The list is not complete and must be adapted to the individual case.

2 Most common complications in osteosynthesis: their diagnostical and theurapeutical work up

2.1 Generally diseased animal

Preexisting diseases may affect the outcome of an osteosynthesis or another orthopedic intervention. Long term corticosteroid therapy or Cushing's disease leads to irreversible damage to healing muscle, inhibits repair of fractured bones and promotes infections. When administered sufficiently, high corticosteroid levels delay the appearance of inflammatory cells, fibroblasts, the deposition of ground substance, collagen, regenerating capillaries, contraction, and epithelial migration. If ever possible, the corticosteroid administration should be stopped to avoid delayed healing or the underlying disease should be corrected, before an elective surgery is executed. A similar effect is observed with the use of antineoplastic agents.

Fig. 1: Pathological fracture of the proximal humerus in a cat with secondary nutritive hyperparathyroidism.

Fig. 2: Fixation of the fracture with a reconstruction plate. There is risk of implant loosening due to reduced cortical thickness.

Secondary nutritive or renal hyperparathyroidism is encountered unfrequently. In the case of a young cat suffering from several fractures without major impact, an unsufficient calcium intake from pure meat diet is a possible aetiology. Low blood calcium levels are regulated by depletion of the bony deposits, thereby leading to pathologic fractures. If not recognized on preoperative radiographs, the surgeon will notice very brittle bones and thin cortices while drilling. Implants may have reduced anchorage and fracture repair may fail due to implant loss. Treatment consists in strong measures for postoperative locomotion control and correction of the diet, which leads to normalized calcium and phosphorus levels within 2 to 3 weeks.

Vitamin deficiencies are mostly affected by unbalanced diets or by malabosorption. Low levels of vitamin A, D, K and copper lead to disturbed bone production and delayed union. Vitamin A is known to reverse partially the negative effects of corticosteroids. Vitamin D is an essential part of the calcium turnover in the body and mandatory in the phase of callus formation, Vitamin K plays a general role in the bone formation whereas trace elements as zinc, cobalt, copper or iron all are measured low during the initial phase of fracture healing, demonstrating their necessity. If fed a balanced diet, vitamin or trace elements may not lead to any complications.

Amongst other general problems associated with orthopedic complications, we find nutritional deficiences, neoplasia, diabetes mellitus, renal failure or liver failure. Feline infections peritonitis is known to be activated from a subclinical stage by trauma or surgery.

	Diagnostical work up	
	General examination Orthopedic examination Radiographs of limb and thorax Hematology, chemistry, urine analysis, special tests	
Pathogenesis	Pathophysiology	Treatment protocol
Cushing's disease	Poor healing, infections	Fix underlying disease
Renal failure	Indirect effects	Fix underlying disease
Liver failure	Indirect effects and delayed union	Fix underlying disease
Nutritional deficiency	Poor mineralization	Correct diet
Neoplasia	Non-union	-
Sec. hyperparathyreoidism	Brittle bone, refracture	Correct diet
FIP	Ascites or other signs of FIP	-

Table 1: Selected protocols in the management of complications (diseased animal)

2.2 Swelling at the surgical site

Seroma formation is often seen in the elbow, hip or rump regions during the first 3 weeks after surgery. It is caused by the surgeon, who left open fascial planes, dehiscence of sutures in middle layers or uncontrolled activity after the surgery. In most cases, the seroma will disppear with the help of warmth provided by hot packs several times a day. If ever, a puncture must be performed under sterile conditions, because the small piece of skin, which is pushed into the seroma fluid with the tip of the needle, may be the nucleus of an infection.

Fig. 3: Seroma formation on the medial elbow

Hematomas are seen occasionally after poor surgical technique or underlying coagulation problems. The latter needs further diagnostical work up. Hematomas will disappear within a couple of days and do not need further therapy.

Especially after hip interventions, edemas are seen due to interruption of lymph or blood vessels. Physiotherapy is recommended. Edemas caused by bandages however, must be taken serious. Bandages are changed immediately to allow fluid circulation along the limb or no bandage is applied for a couple of days.

Painful and hot regions, sometimes with local red discloration and an animal with signs of general disease (high temperature, elevated heart and respiration rates) may

indicate an infection. If the puncture reveals pus, a revision surgery is indicated. Samples are taken for the installation of a correct antimocribial therapy. Joints are debrided and irrigated constantly for at least 24 hours (ingress with 20 ml / hrs; Ringer's lactate; outflow through drains; slight bandage). Antimicrobial therapy may last for a minimum of 6 weeks. Early infections or osteomyelitis in the region of fracture zones most probably need revision surgery with an external fixator, which allows for local wound control with irrigation and debridement. Late infection or osteomyelitis will lead to implant removal and initiation of a long term antimicrobial therapy. Infection in the vicinity of an implant will seldom heal with antibiotics alone.

The author has encountered some late infections with Pseudomonas spp., mainly after treatment of comminuted fractures in the distal limbs. Dogs may suffer from local and painful swelling, together with lameness. The clinical signs disappear after short time under general antimicrobial therapy and occasionally appear again months or years later. Implant removal is not always a definitive solution as the bug is hidden in the bone itself.

	Diagnostical work up	
	General examination Orthopedic examination Gentle palpation Radiographs Sterile puncture for cytology and bacteria culture	
Pathogenesis	**Pathophysiology**	**Treatment protocol**
Unclosed fascial planes	Seroma	Hot packs, patience
Poor hemostasis Coagulation disorder	Hematoma formation	Patience
Excessive manipulation	Lymphedema	Physiotherapy
Poor surgical technique / immunodeficient animal	Abcessation / infected joints	Drainage or 24 – 48 hrs irrigation with RiLa (20 ml / hr); antibiotics
	Swelling over the fracture with underlying infection	External fixator and local wound control; or implant removal; and antibiotics

Table 2: Selected protocols in the management of complications (swelling)

2.3 Discharge

Early discharge from wounds is related to infections or hematomas and is discussed above.

Discharge from regions over implants or fracture treatment, observed later than 4 weeks after surgery, must derive from tissue, which the body wants to get rid off. Sometimes, this is a strand of braided suture material, on which bacteria have started an infection. Loose sutures also have to tendency to migrate towards the skin.

Unstable implants cause fistula tracts. First, an undefined lameness is observed. Swelling and discharge follow. The discharge is purulent, but not always with bacteria. Serial radiographs help to find the source of infection. Loosened screws or pins are easily identified by dislocation or by loss of bone adjacent to the threads of

the screw. Unstable implants must be removed or replaced if necessary. In most cases, the problem is solved within short time.

Implant loosening mostly occurs in the distal extremities, where the small bones do not allow many screws of be placed distal or proximal to the fracture or luxation. The absence of abundant soft tissue naturally leads to slow healing and gives no extra stability. Technical failures leading to implant loosening are insufficient cooling during drilling or pin insertion, destruction of the pin-bone interface during tapping, incorrected insertion of screws or pins with too high torque forces or repetitive withdrawal of pins. Pins exceeding 2.0 mm should only be placed after predrilling with about 80 % of the pin core diameter. Fixed angle plating systems such as LCP guarantee superior overall stability of the implant and should lead to lower numbers of implant loosening.

Fig. 4: Loosened screw, causing discharge.

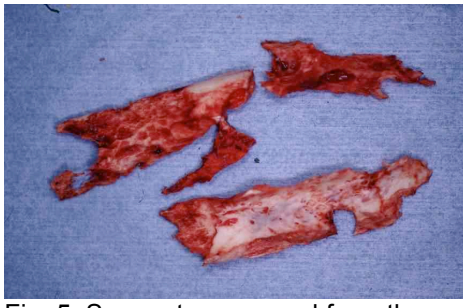

Fig. 5: Sequestra removed from the tibia 6 weeks after initial surgery

A dead piece of bone (sequestrum) can also cause discharge. The diagnosis is sometimes diffult to establish and may need radiographs from different angles, avoiding superimposition with the implant. Ultrasound and computed tomography may be of superior diagnostical use. Fistulograms are difficult to interpret. The devascularized tissue must be removed, the area debrided and filled up with cancellous bone graft. In many cases, the original implants are replaced by external fixators or fixed angle implants.

Sequestra are caused by the original trauma or by the surgeon. If a bony fragment is deprived of vascular supply, it should not be used for the repair. Therefore, the orthopedic surgeon should always take extra care during approach (spare vessels) and surgical manipulation (do not sever muscular attachments) in highly comminuted fractures and in regions, where the blood supply is critical, such as the distal radius, the midshaft of the tibia, the distal extremities and the mandible.

	Diagnostical work up	
	General examination General examination Sequential radiographs Ultrasound or CT if necessary	
Pathogenesis	**Pathophysiology**	**Treatment protocol**
Destroyed implant-bone interface or poor overall stability	Implant loosening	Removal of the screw, pin, implant and/or additional implant
Stripping of bone fragment; comminuted fracture	Bone sequestrum	Removal of the sequestrum; cancellous bone graft

Table 3: Selected protocols in the management of complications (discharge)

2.4 Persistent lameness/malfunction

Delayed union, non union or even necrosis at the surgical site are some of the reasons for persistent lameness. Devascularisation and preexisting critical blood supply (e.g. distal radius, femur neck in young animals, phalanges) are the main originators. They have been addressed in detail in other chapters and presentations. Serial radiographs are needed to indentify the cause of the problem, as the diagnosis for retarded fracture healing is not a simple issue. Doppler flow ultrasound may be helpful assessing the amount of devascularization.

The so called dynamization of the fracture region by removing parts of external fixators or screws from a plate will not lead to improved vascularisation and induction of accelerated bony healing. The best idea is to osteotomize the fragment ends, bring in cancellous bone graft and stabilize the bone adequately with modern and soft tissue sparing implants (such as LCP or external fixators).

It is obvious, that a malalignment may lead to persistent lameness or malfunction. Valgus malposition of an extremity causes more discomfort than varus malformation. Rotation failures of more than 15° should be corrected.

Shortening of the hindlimb is better compensated by a slighty more extended stifle joint than a shortening of the frontlimb, which in addition must also take two thirds of the whole body weight. Therefore, the use of lengthening procedures must be considered.

Pelvic narrowing in cats after conservative or surgical treatment of ilium fractures is frequently observed. If detected early enough, osteotomy of the ilium and widening with the help of plates may help. Unfortunately, most of the cats are only presented, when they are severely constipated. A subtotal colectomy is indicated together with a pelvic widening procedure, which also must include osteotomy of the pubic symphysis.

Conservative pelvic fracture treatment or inadvertent screw placement may also lead to sciatic nerve entrapment in the callus or direct nerve damage. Unfortunately, the

prognosis is very guarded, even when the implants are removed. Physiotherapy can improve nerve conduction. Amputation may be an option.

Malocclusions are mainly seen after plate fixation and conservative treatment of mandibula fractures. As the animals will not eat sufficiently and the owner recognized the problem early enough, the revision takes place quite soon and seldom requires an osteotomy but simple rearrangment of the fragment ends. Implants are fixed while closing the jaw in correct occlusion.

Fig. 6: Six weeks (left) und 6 months (right) control radiographs of a feline tibia showing delayed union

Fig. 7: Pelvic narrowing after implant failure (left iliosacral joint) and inadequate contouring of the plate (right pelvis). Additional right femur head fracture.

In young animals sustaining a femur fracture, the quadriceps muscle may undergo severe contracture, if the fixation is not performed within 72 hours or physiotherapy is not initiated soon after the surgery. The author has seen some cats with Salter-Harris fractures of the distal femur, which have been stabilized correctly with cross pins, but were not willing to use the leg for 10 days. In case of such circumstances, the pet owner must be encouraged to start physiotherapy immediately. Three weeks of non-weight bearing may result in definitive fibrosis and the inability to flex the stifle sufficiently.

	Diagnostical work up	
	General examination Orthopedic examination Serial radiographs (3 weeks) Doppler flow ultrasound	
Pathogenesis	**Pathophysiology**	**Treatment protocol**
High velocity trauma; large surgical approach; several attempts for fixation	Vascular compromise, delayed union, non-union, necrosis	Revision surgery (osteotomy, osteostyxis, cancellous bone graft or BMP, stability)
Malfixation, unsufficient stability	Unphysiological load on joint; pelvic narrowing,	Revision surgery (osteotomy, osteostyxis, stability)
Inactivity after surgery	Muscle contracture; joint fibrosis	physiotherapy

Table 4: Selected protocols in the management of complications (persistent lameness/malfunction)

2.5 Acute lameness/malfunction

Acute lameness after a successful first period of bone healing is most probably the sequel of implant breakage. Implants normally break after they have been weakened by micromotion. All implants undergo micromotion. However, if the overall stability of the implant construction was unsufficient to withstand the forces generated by the patient (undersized implant, poor implant quality, wrong side of fixation, lack of load sharing with the bone, bone necrosis after devascularisation, bilateral problems), the micromotion leads to catastrophic implant failure. See another chapter for further information.

After systemic analysis and understanding of the causes of the implant failure, the fracture is approached again with uppermost precautions not to further destroy the blood supply. If the failure was biological in nature, the fragment ends must be osteotomized and cancellous bone graft packed in between. Mechanical stabilization is applied avoiding the mistakes made in the first surgery.

Fig. 8: DCP failure after multiple plate bending through plate hole

Fig. 9: Implant break in a 65 kg Cane Corso with the use of a too weak implant (standard 3.5 DCP instead of veterinary 3.5 DCP)

A common error is the fixation of long bone fractures with a too small intramedullary rod and several cerclages. Rotational and axial forces may not be neutralized leading to either immediate breakage of the cerclage wire or periosteal devascularisation with subsequent loosening of the wire. Fractures on multiple extremities need extra strong fixations, because the animal will bear weight on one of the legs immediately after the surgery. Large fracture gaps in long bone fractures of adult dogs require implants with good bending properties, because load can not be shared with the fragment ends. Type II or III external fixator, double plating or the addition of an intramedullary rod may be indicated.

	Diagnostical work up	
	General examination Orthopedic examination Radiographs	
Pathogenesis	**Pathophysiology**	**Treatment protocol**
Insufficient stability and load sharing	Micromotion and subsequent implant failure	Revision surgery (debridment, osteotomy, osteostyxis, cancellous bone graft; excellent quality implants and good stabilty)
Bone loss due to vascular problems or osteomyelitis	Implant failure or migration	Removal of implants; possibly revision surgery (see above)

Table 5: Selected protocols in the management of complications (acute lameness/malfunction)

3 Common complications in joint surgery

Joint surgery includes a wide field of different techniques and philosophies. It is therefore not comparable to osteosynthesis, where some AO guidelines have been established and accepted over the last decades. Nevertheless, many of the above mentioned problems are seen in joint surgery, where implants are used. Some of other serious complications are listed here

3.1 Bacterial infections

In case of a bacterial infection in a joint, all implants must be removed. A bacterial culture is taken. The joint is irrigated during surgery and at least for another 48 hours with Ringer's solution (ingress with feeding tube, egress with drains, 20 ml / h). The antimicrobial therapy is adapted. If ever, implants are only inserted six months later. Monofilament suture material is preferred.

Salvage procedures such as joint excisions are possible in the hip joint, the shoulder joint and in the phalangeal joints.

3.2 Implant failure in arthrodesis

The most common reason for implant failure over arthrodesis is lack of biomechanical knowledge of the surgeon. Plate breakage comes after micromotion in undersized implants, implants on the wrong side or after screw loosening. The revision surgery consists of removal of all implants, reestablishing of a fresh vascularisation at the arthrodesis site and the use of stable implants.

Fig. 10: Implant breakage because of too weak implant

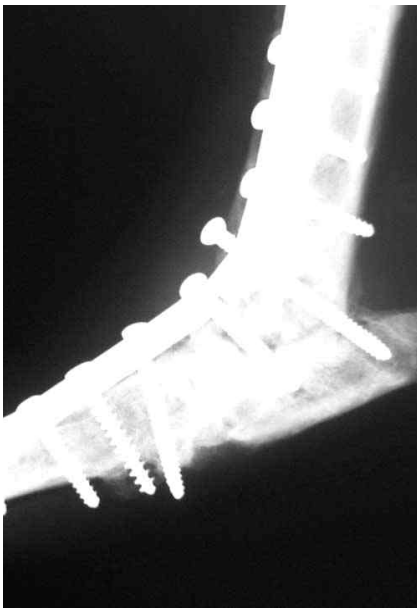

Fig. 11: Screw loosening as a result of inadequate stabilization of the calcaneus

3.3 Severe osteoarthritis after joint surgery

In the hip joint, a prosthesis or a femoral head and neck resection is the method of choice, depending on the body weight. Modern hip prosthesis are offered to a minimum body weight of 18 kg, whereas femoral head and neck resection are perfect interventions in cats and small breed dogs.

Stifle osteoarthritis very seldom demands a further therapy than stabilization of the cruciate ligaments or the patella. Stifle prosthesis is technically possible, but not used very often.

Shoulder osteoarthritis is not seen very often. Arthrodesis is possible.

Elbow osteoarthritis is a severe problem because the dog's main body load is on the forelegs. Most degenerative alterations in the elbow are the sequelae of an untreated or insufficiently treated elbow dyslplasia. Conservative treatment with analgetics, chondroprotectiva, weight control, locomotion control and physiotherapy is established as long as possible. Elbow prosthesis and medial compartment semiprosthesis will be at disposition in short time. Pressure reduction on the medial compartment by olecranon lateralization is a promsing new idea.

Osteosarthritis in the tarsus and carpus can be managed by arthrodesis, whereas interphalangeal or metatarso (metacarpo-) phalangeal osteoarthritis is best treated with amputation or joint excision.

Fig. 12: Total hip replacement as a salvage procedure after hip luxation, complications after osteosynthesis or uncontrolled coxarthrosis

Fig. 13: Femoral head and neck resection give excellent results, if the animal has less than 18 kg body weight and physiotherapy is installed soon after the intervention.

Suggested references

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