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MANAGING FRACTURE COMPLICATIONS

INTRODUCTION

Problems are commonly encountered during the period when the fracture is healing. These problems may be due to inadequate or slow healing of the fracture biologically, infection or problems with the fixation device. Whatever the cause these problems have to be recognised quickly and solved to ensure a successful outcome to fracture repair. Iatrogenic problems usually result when inadequate asepsis is present. When a case management plan has not been formulated or when some of the basic rules of applying fixation devices have been broken. Complications are considered under three separate headings (over)

1. Problems due to fixation device.
2. Problems due to failure of fracture healing.
3. Infection

In many cases, all three of these will be present causing a clinical problem and inadequate healing.

1. PROBLEMS RELATED TO THE FIXATION DEVICE

During assisted fracture repair, we use some method of splinting the healing bone to allow mobility while the fracture repairs. The bone is dependent on the fixation device, for a variable period, until it heals. If rapid healing can be achieved and this time of reliance reduced, then problems may not be encountered. However, if fracture healing is slow then the demands of the implants are amplified and failure may occur. This is especially true of fixation methods which involve other tissues other than the bone itself, for instance casts, external fixators and to a certain extent intra-medullary pins since they become loose with time and can produce irritation and soft tissue damage at the site of entry to the bone. Bone plates produce minimal interaction with surrounding tissue and may be left in place for considerable periods of time.

When implants fail they usually do one of three things:

1. Break
2. Bend
3. Loosen

Failure usually results from technical mistakes rather than material problems.

i) Inappropriate selection of implant
ii) Inappropriate fracture assembly
iii) Inappropriate demands on implant

i) If an implant is selected which is not strong enough to deal with the forces applied through it then failure is very likely.

ii) The bone and implant act as a unit for maximum strength. To allow this the bone's tubular structure must be preserved. Failure to do this will mean that the implant will have to resist all the forces on its own. Under these circumstances failure is likely. If gaps are left at the fracture site additional stresses will be produced in the implant. Similarly, if the implant is applied without regard to the biomechanical forces acting through the bone i.e. plate applied to the compression side of bone failure is likely.

iii) If fracture healing is delayed then the fixation method must be retained until healing is achieved. This may produce problems. Soft tissue damage, biological rejection and material failure are all seen. Material failure due to cyclic stresses acting on metal must be considered. Many of the rules that we use in fracture repair exist to protect the metal implants from metal fatigue and so, failure of fixation.

2. PROBLEMS RELATED TO HEALING

If fracture healing has not been achieved within a reasonable period then a diagnosis of **Delayed union** can be implied.

If fracture healing is not taking place and will not succeed no matter how long one waits then a diagnosis of **Non-union** can be made.

If fracture healing occurs but normal anatomy is not restored then the problem may be **Mal-union** with the fracture healed at an incorrect angle.

When a mal-union has occurred it may or may not require further attention. Correction usually means re-fracturing and resetting the bone. This is only necessary if functional problems are produced by the new anatomy, for instance in the adjacent joints.

In both delayed union and non-union the case must be reviewed to determine if a biological or mechanical problem exists and this must be reversed. This may be achieved simply by altering the implant or changing the management of the dog. Whenever this problem is faced the surgeon should ensure that all variables are removed to guarantee eventual healing. This includes:

1. Ensuring implant used is providing immobilization, if not - replace
2. Mechanical environment -
   1. secure fixation
   2. compression
3. Biological boost - Bone grafts

NON-UNIONS

These are classified on the basis of biological activity. Two groups are recognised namely Viable and Non-Viable non-union. This is a useful classification as it will influence treatment regime selected.

Viable Non-Union

There is still biological activity present so these are biologically active but union is not being achieved due to some other problem, usually instability or poor reduction of the fracture. Three types of viable non-unions are described

1. Hypertrophic - typified by the 'elephant foot callus'
2. Slightly Hypertrophic mild callus
3. Oligotrophic no obvious callus but fracture bridged by viable fibrous tissue.

The significance of this differentiation is if viable, healing can easily be achieved by the correction of the other recognised problems.

Non-Viable Non Union

In these situations considerable alteration has occurred to the blood supply which means that healing is greatly impaired. Four types are described (Weber and Cach 1976)

1. Dystrophic: poor vascularisation at fracture ends seen in aged animals
2. Necrotic: dead pieces of bone in the fracture gap
3. Defect Non-Unions: Gap at fracture which the body is unable to bridge.
4. Atrophic: Bone resorption at fracture ends leading to an increased gap.

When a non-union is diagnosed the clinician must try to ascertain what factors have resulted in failure of fracture healing. These factors must then be eliminated or corrected. In general terms the problem is dealt with surgically and as a rule the surgeon optimises all of the conditions for fracture healing to try and ensure a rapid conclusion to the problem. This is usually done by following two basic principles:

1. Optimal stability: using compression fixation
2. Optimal biology: Altering the fracture ends and adding a cancellous bone graft.

3. INFECTION AND BONE HEALING (OSTEOMYELITIS)

Osteomyelitis is defined as infection of all of the elements of bone, including the medullary canal, cortex and periosteum. It is recognised in two forms:

1. Acute osteomyelitis
2. Chronic osteomyelitis

Infection of bone can result from:

1. Haematogenous spread
2. Local spread from an infected site
3. Open Wounds
4. Iatrogenic post-operative

Unfortunately, iatrogenic osteomyelitis is the most common aetiological method seen. Surgery can allow contamination and subsequent infection due to the existence of certain predisposing factors.
1. Poor asepsis
2. Prolonged operating time
3. Soft tissue damaged before or at the time of surgery
4. Debilitated patients
5. Insertion of implants

PATHOGENESIS OF OSTEOMYELITIS
It is obvious that the presence of bacteria alone on bone will not lead to infection without other predisposing factors such as bone necrosis and vascular stasis. Bacteria can also absorb onto the surface of biomaterials or implants. On this surface these bacteria secrete and surround themselves with a coating called glycocalyx. This coating inhibits cellular invasion by the macrophages, lymphocytes and neutrophils of the body and also acts as a barrier to antibacterial medications. In situations where both dead bone and implant are present it is easy to understand why infections are so difficult to eliminate. Osteomyelitis is commonly defined as a disease of ischaemia with concurrent bacterial colonisation.

ACUTE OSTEOMYELITIS
This occurs within a short time of surgery

Clinical signs
1. Acute Inflammation
2. Pain
3. Lameness
4. May be sinus formation

Radiological Appearance
1. May be no obvious changes on radiographs
2. Periosteal reaction

Diagnosis
Deep culture from bone

Treatment Of Acute Osteomyelitis
1. High dose bactericidal antibiotics
2. Ensure stability of fracture
3. Evacuate or close down dead space
4. Lavage and drainage

The majority of infections are Gram +ve, staphylococcal or streptococci. Other common agents include E. coli, Pseudomonas, Proteus and Klebsiella. Antibacterials which have good activity against Streps and Staphs should be used as a first line i.e. Cephalosporins, or clavulonate amoxycillin preparations until a culture has been established.

CHRONIC OSTEOMYELITIS
Chronic osteomyelitis usually results from inadequate treatment of acute osteomyelitis and is characterised by dead bone or sequestrae and loose implants if implants are present.

Clinical signs
1. Discharging sinuses
2. Intermittent or constant lameness
3. Muscle atrophy
4. Characteristic radiographic appearance

Often there is a history of alleviation of the signs by antibiotic therapy, but relapse occurs once the antibiotic is suspended.

Pathology
Sequestrae characterise chronic osteomyelitis. These are dead islands of bone which are usually separated from the surrounding bone by a space, but dead bone can still be incorporated in the cortex. They are avascular and as such cannot be removed by the body. They provide an excellent nidus for bacterial colonisation. The body usually walls

these areas off by forming a cavity and surrounding it with selective bone. This is an involucrum.

Radiography

The presence of osteomyelitis can be strongly suspected from the radiological appearance. In particular the recognition of sequestrae or an involucrum is important. Sequestrae are more dense than surrounding bone and have very smooth borders without periosteal reaction.

1. Sequestrum
2. Involucrum
3. Loose implants
4. Periosteal reaction

Treatment of Chronic Osteomyelitis

Chronic osteomyelitis is a surgical condition. The problem cannot be resolved until the sequestrae are removed. Similarly, although bone can heal in the face of infection if stabilised adequately, infection cannot be resolved whilst the fracture is unstable. Therefore the seemingly logical method of trying to control infection before reoperating does not bring success. Sequestrae are easily identified at the time of surgery and can be removed. Methylene blue can be injected into sinus tracts to try and pinpoint the site of sequestrum.

1. Debridement of fracture and removal of sequestrum
2. Stabilize fracture (Rigid)
   - definitive
   - temporary
3. Lavage and drainage
4. Deep culture
5. Bactericidal antibiotic

If the fracture is unstable it must be stabilised. This can be done by applying a bone plate using compression principles. Alternatively, temporary stabilisation may be achieved using an external fixator. In these situations the surgical incision is often left open to drain. A second surgery is then carried out seven days later when healing granulation tissue start filling the wound. Cancellous grafts can be used at this stage.

Chronic osteomyelitis can be an extremely difficult condition to manage. Success depends on a good understanding of the problems and a radical approach. In general terms chronic osteomyelitis is much more easily prevented than cured.