Complications in Canine Cruciate Ligament Surgery

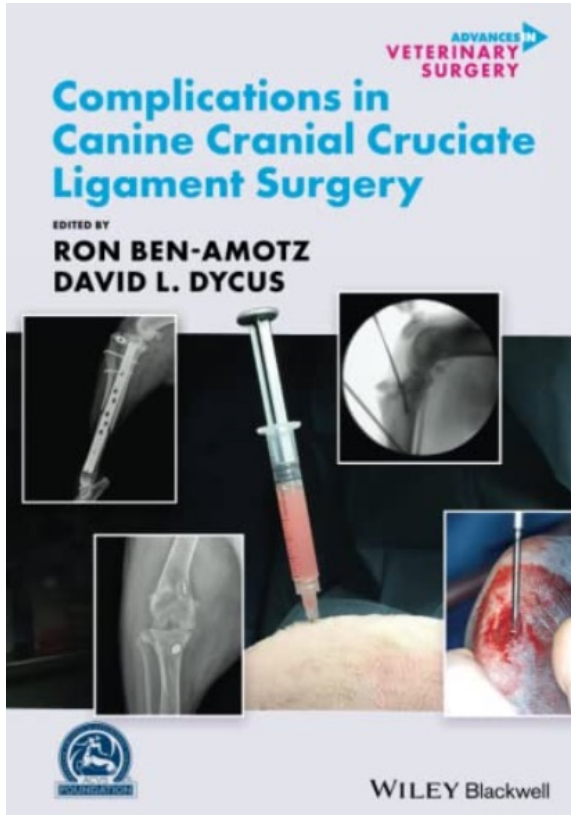
Joshua Zuckerman, VMD, DACVS-SA

Staff Surgeon
Cape Cod Vet Specialists

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Who Am I?

- Native Cape Codder
- University of Pennsylvania, Class of 2013
- Red Bank Veterinary Hospital
  - Rotating Internship 2013-14
- Dallas Veterinary Surgical Center
  - Surgical Internship 2014-15
- Veterinary Specialty and Emergency Center
  - Surgical Residency 2015-18
- Cape Cod Veterinary Specialists
  - Staff Surgeon 2018-Present





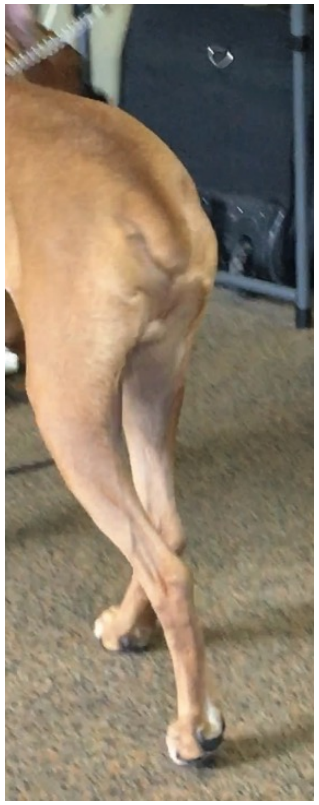
Learning Objectives

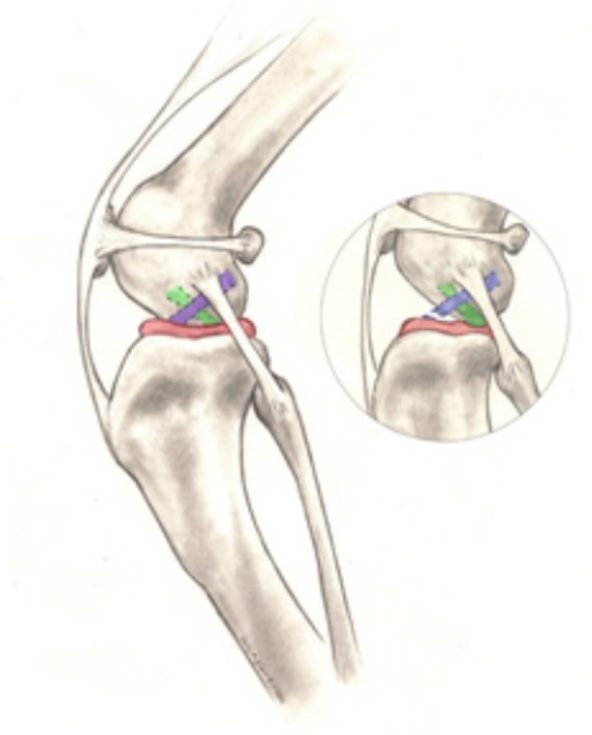
- Understand cranial cruciate ligament disease in dogs
- Recognize expected postoperative findings versus complications
- Use timing, history, examination, and radiographs to prioritize differentials
- Know when rapid surgeon re-evaluation is indicated

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Cranial Cruciate Ligament (CCL) Disease

- Most canine CCL disease is degenerative rather than a single traumatic event
- Chronic synovitis, altered stifle mechanics, conformation, breed predisposition, and body condition contribute

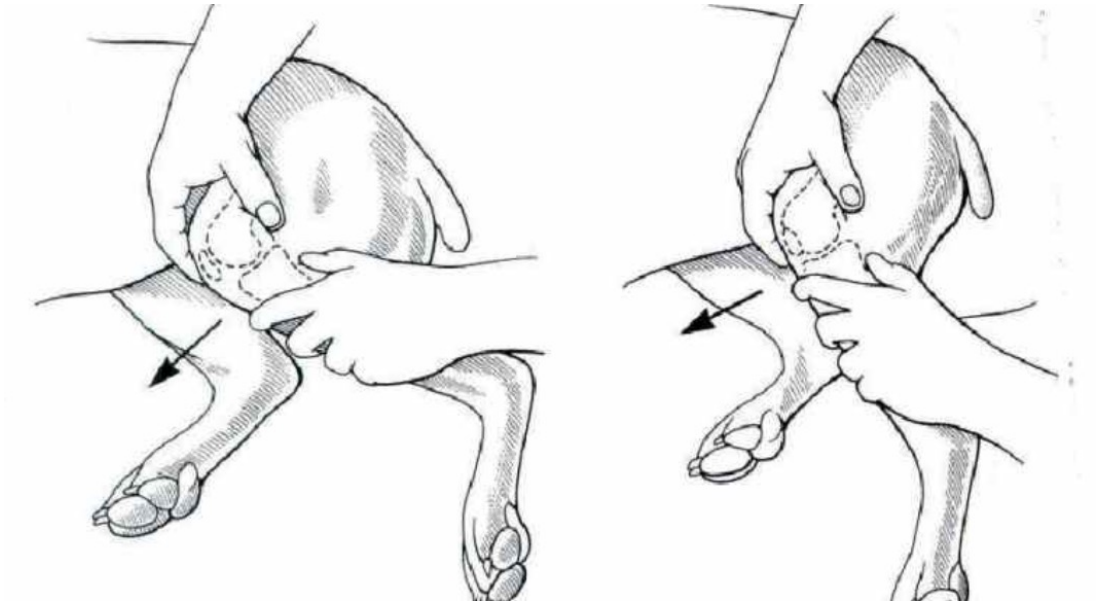


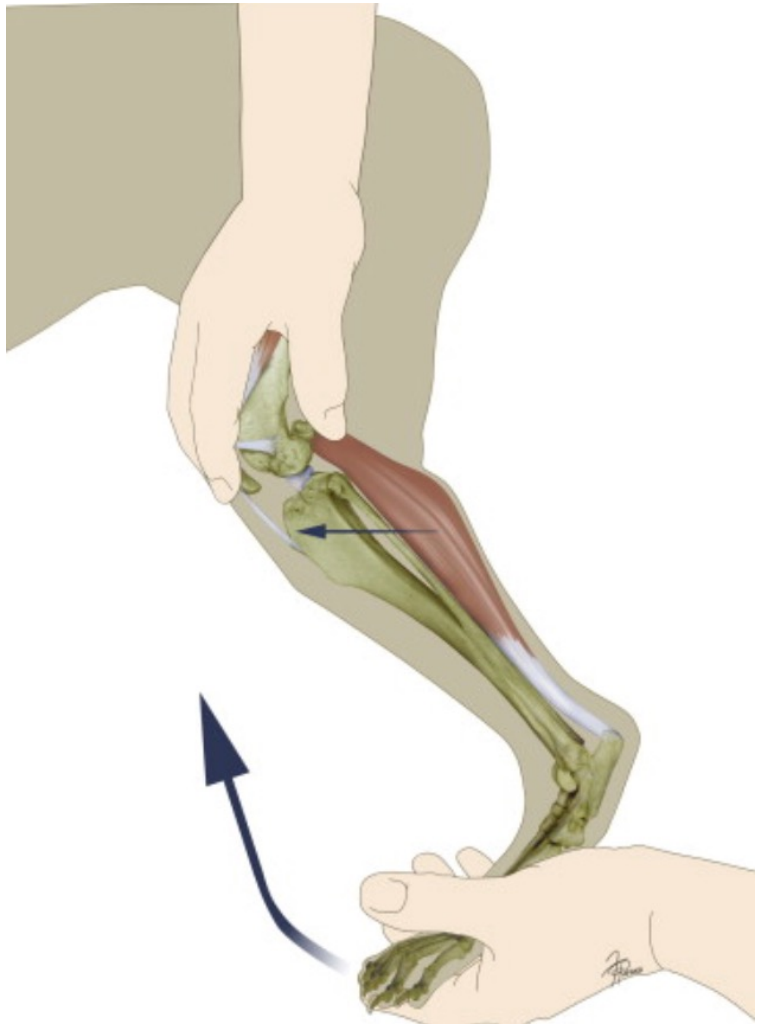


https://www.acvs.org/small-animal/cranial-cruciate-ligament-disease/

Cranial Cruciate Ligament Disease

- Diagnosis based on physical exam
  - Positive cranial drawer
  - Positive cranial tibial thrust



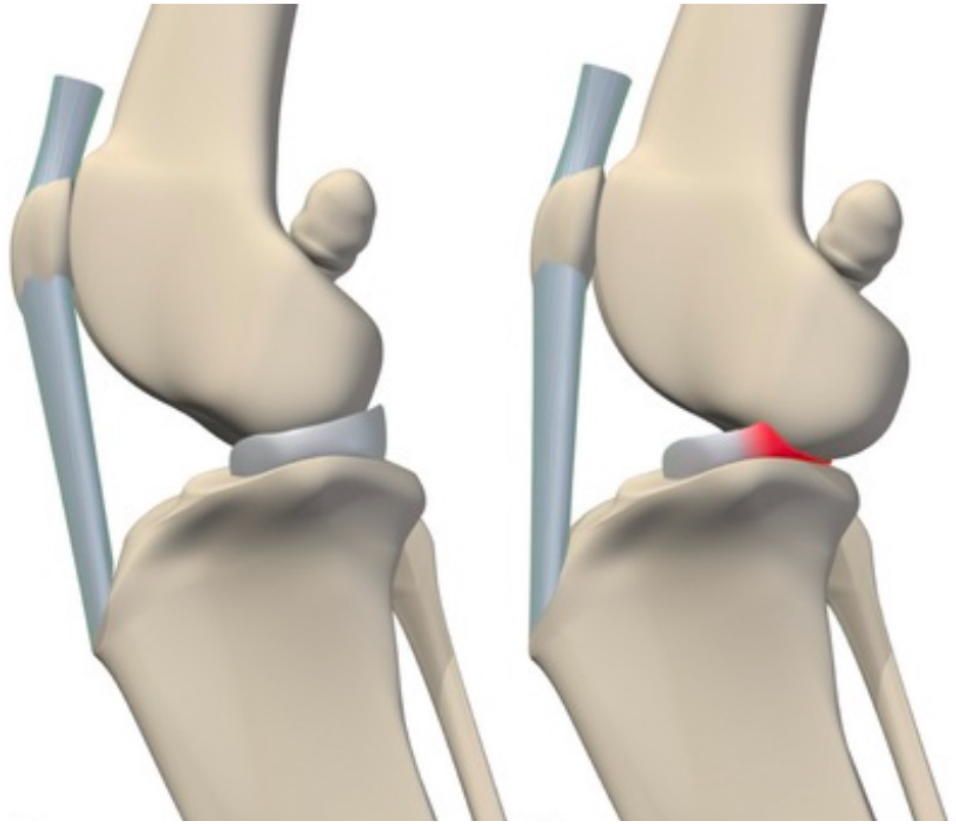


Sherman O. Canapp,The Canine Stifle,Clinical Techniques in Small Animal Practice,Volume 22, Issue 4,2007

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Cranial Cruciate Ligament Disease

- Contralateral stifle disease is common and should be anticipated
- Instability initiates meniscal injury and osteoarthritis



Tobias and Johnston, 2017

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Why Do Surgery?

- CCL insufficiency permits cranial tibial subluxation and internal rotation
- The caudal horn of the medial meniscus becomes a secondary stabilizer—and is vulnerable to injury
- Surgical techniques either add a temporary extracapsular restraint or alter tibial biomechanics
- Technique selection is individualized: patient size, conformation, activity, surgeon experience, implant system, and owner factors
- Improves function but does not “cure” OA

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Surgery

- **Extracapsular stabilization**
  - Temporary restraint while periarticular fibrosis develops
- **Tibial tuberosity advancement (TTA)**
  - Advances the tibial tuberosity to alter the patellar tendon–tibial plateau relationship
- **Tibial plateau leveling osteotomy (TPLO)**
  - Rotates the tibial plateau to neutralize cranial tibial thrust during weight bearing
- All constructs can fail mechanically, biologically, or because of meniscal disease

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Defining a Complication

- **Expected postoperative changes:** transient edema, bruising, mild discomfort, radiographic tendon thickening
- **Minor complication:** managed without additional surgery
- **Major complication:** requires additional surgery or materially changes recovery
- **Catastrophic complication:** unacceptable permanent function, death, or euthanasia related to the procedure





Complication Timing

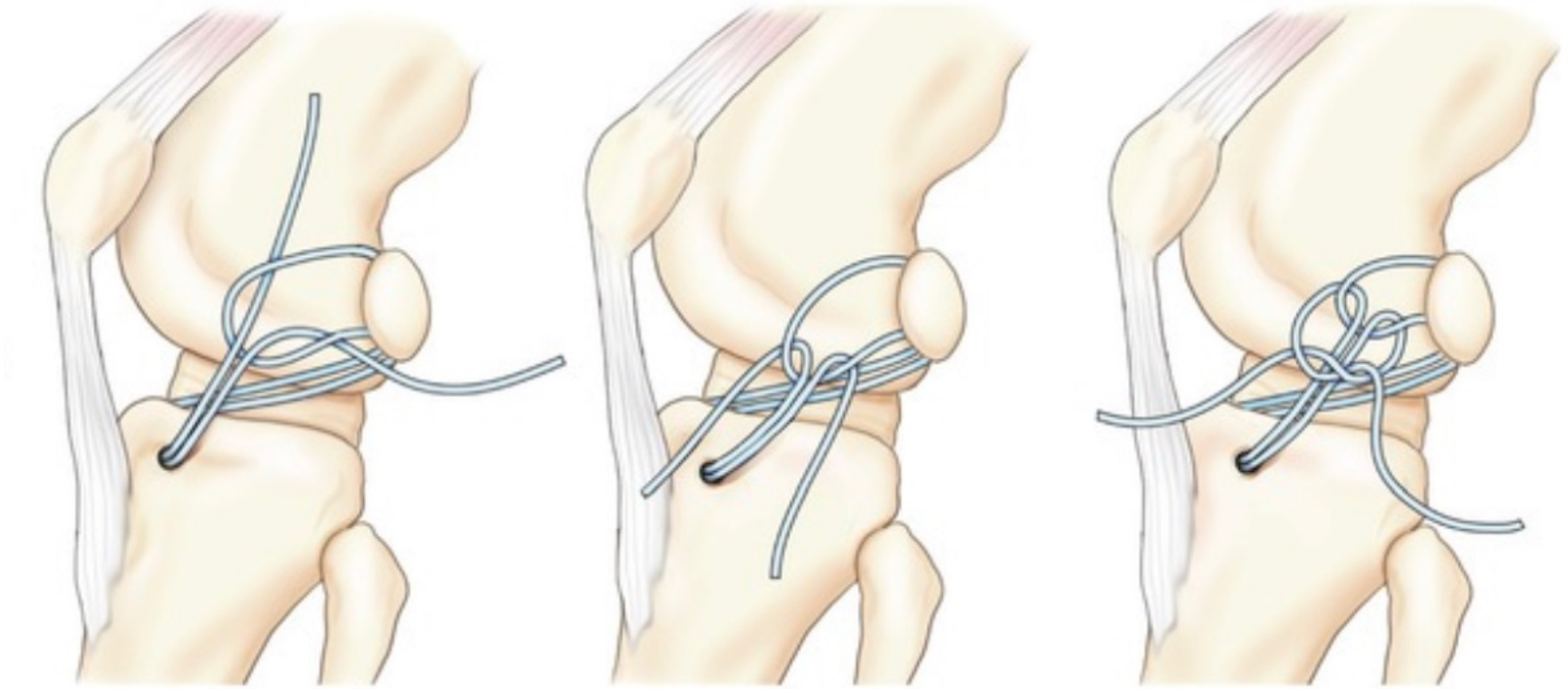
- **Days 0–14**: incision problems, seroma, early infection, acute mechanical failure, postoperative pain control issues
- **Weeks 2–8**: tibial tuberosity/crest fracture, implant failure, fibular fracture, delayed healing, patellar fracture
  - After initial improvement: subsequent meniscal injury, late construct failure, recurrent instability
- **Months to years**: implant-associated infection, implant removal concerns, progressive OA, rare neoplasia





Extracapsular Stabilization

- A lateral fabellar suture provides temporary restraint of cranial drawer and internal rotation
- Periarticular fibrosis becomes increasingly important as healing progresses
- Most commonly selected for smaller dogs and/or lower-demand patients, but patient selection is nuanced



Tobias and Johnston, 2017

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Postoperative Expectations

- Mild-to-moderate lameness should progressively improve over the early weeks
- Some loss of strict drawer restraint is common as the construct stretches or biological stabilization develops
- The goal is functional stability—not replication of native CCL mechanics
- Abrupt worsening or persistent instability is not an expected recovery pattern

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Implant Failure

- Mechanisms: suture elongation/creep, knot or crimp slippage, fabellar soft-tissue pull-through, tunnel-related failure
- Clinical clues: recurrent cranial drawer, pivot-like instability, renewed lameness after initial improvement
- Mild laxity may be tolerated; clinically important instability warrants surgeon reassessment
- Consider concurrent or subsequent meniscal injury when lameness returns



Holsworth, Complications in Canine Cruciate Ligament Surgery, 2021

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Implant-Associated Pain and Infection

- Infection rate 4-17%
- Superficial incision inflammation may respond to local care and directed medical therapy
- Persistent drainage, recurrent swelling, pain over implant material, or fever raises concern for deep infection
- Deep implant-associated infection frequently requires culture, debridement, and implant removal after adequate biological stabilization
- Avoid empiric antibiotic escalation without obtaining a diagnostic plan when the patient is stable



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Meniscal Injury

- New lameness after an initially improving recovery is a common clinical pattern
- Audible click is helpful when present, but its absence does not exclude a tear
- Joint effusion and pain on flexion/extension increase concern
- Prompt surgical reassessment is usually more productive than prolonged activity restriction alone

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Other Complications

- Tibial tunnel enlargement, anchor pull-out, or local bone reaction
- Patellar luxation: may follow malalignment or overcorrection in predisposed stifles
- Peroneal nerve injury/entrapment: uncommon but urgent if neurologic deficits occur
- Progressive OA is expected over time and should be differentiated from an acute complication



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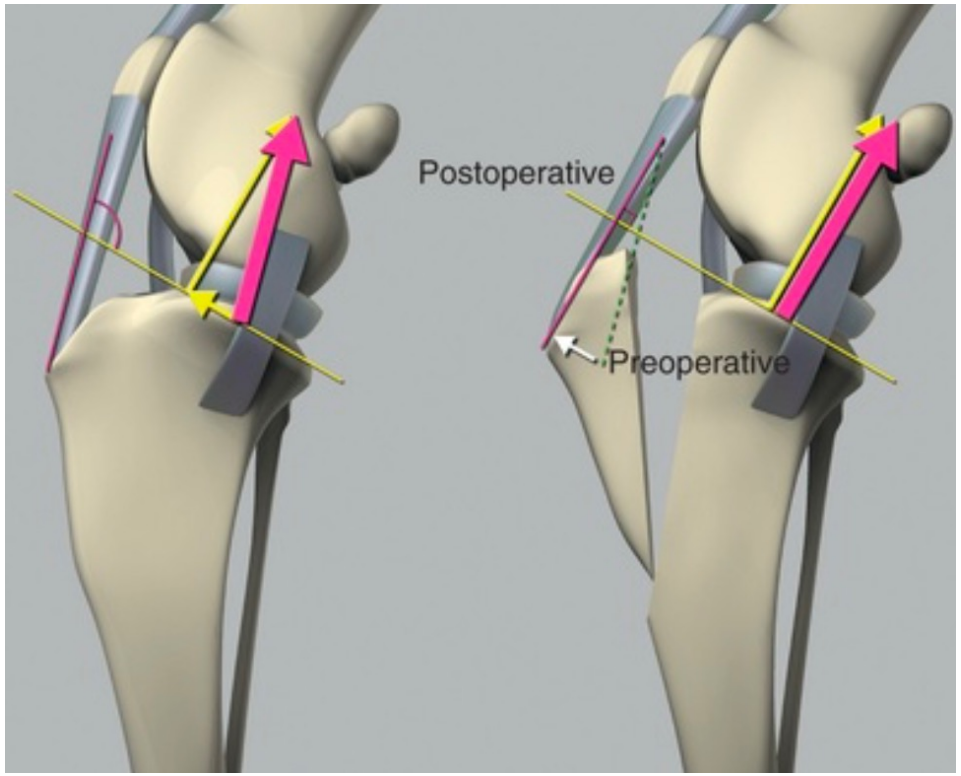
Plan

- Inspect incision; document swelling, drainage, heat, and pain
- Assess effusion, drawer/pivot, patellar tracking, and neurologic function
- Obtain orthogonal radiographs when lameness worsens or fails to improve
- Contact the surgeon urgently for non-weight-bearing lameness, marked instability, or suspected infection

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Tibial Tuberosity Advancement (TTA)

- The tibial tuberosity is advanced so the patellar tendon angle is approximately perpendicular to the tibial plateau in stance
- The construct typically includes a plate/fork or forkless plate and a cage/spacer across the osteotomy



Tobias and Johnston, 2017

TTA

- Preoperative planning determines cage size and implant selection
- Cage position, osteotomy orientation/extent, distal fixation, and tibial crest contact influence construct behavior
- Under-advancement can leave persistent cranial tibial subluxation and may increase subsequent meniscal risk



Matchwick et al, Veterinary Surgery, 2020.

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TTA Complications

- In a large study, major postoperative complications were recorded in 13.4%
- Superficial SSI 6.9%
- Late medial meniscal tear 2%
- Patellar luxation 1.2%
- Implant failure 1%
- Fracture 0.9%
- Deep SSI 1.1%,
- Septic arthritis 0.4%

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Tibial Fracture

- Usually occurs during early healing and may be acute or found incidentally on recheck radiographs
- Technical contributors include stress risers at the distal osteotomy/screw region, insufficient bone stock, malpositioned plate/cage, and inadequate distal bone contact
- Presentation ranges from mild lameness to acute severe lameness with crest displacement





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Tibial Fracture

- Management depends on displacement, function of the construct, and clinical signs—some minimally displaced fractures can be managed conservatively



Barnhart, Complications in Canine Cruciate Ligament Repair, 2021.

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Implant Failure

- Fork or plate failure, broken cage screws, cage lucency, or loss of crest fixation may be incidental—or clinically consequential
- Failure before biological union can permit caudal rotation of the tibial crest and recurrent instability
- Technical positioning and implant selection are major prevention targets
- In the original 101-dog series, early technical errors accounted for several fractures and implant failures





Barnhart, Complications in Canine Cruciate Ligament Repair, 2021.

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Implant Failure



Immediate Post-Op



5 Weeks Post-op

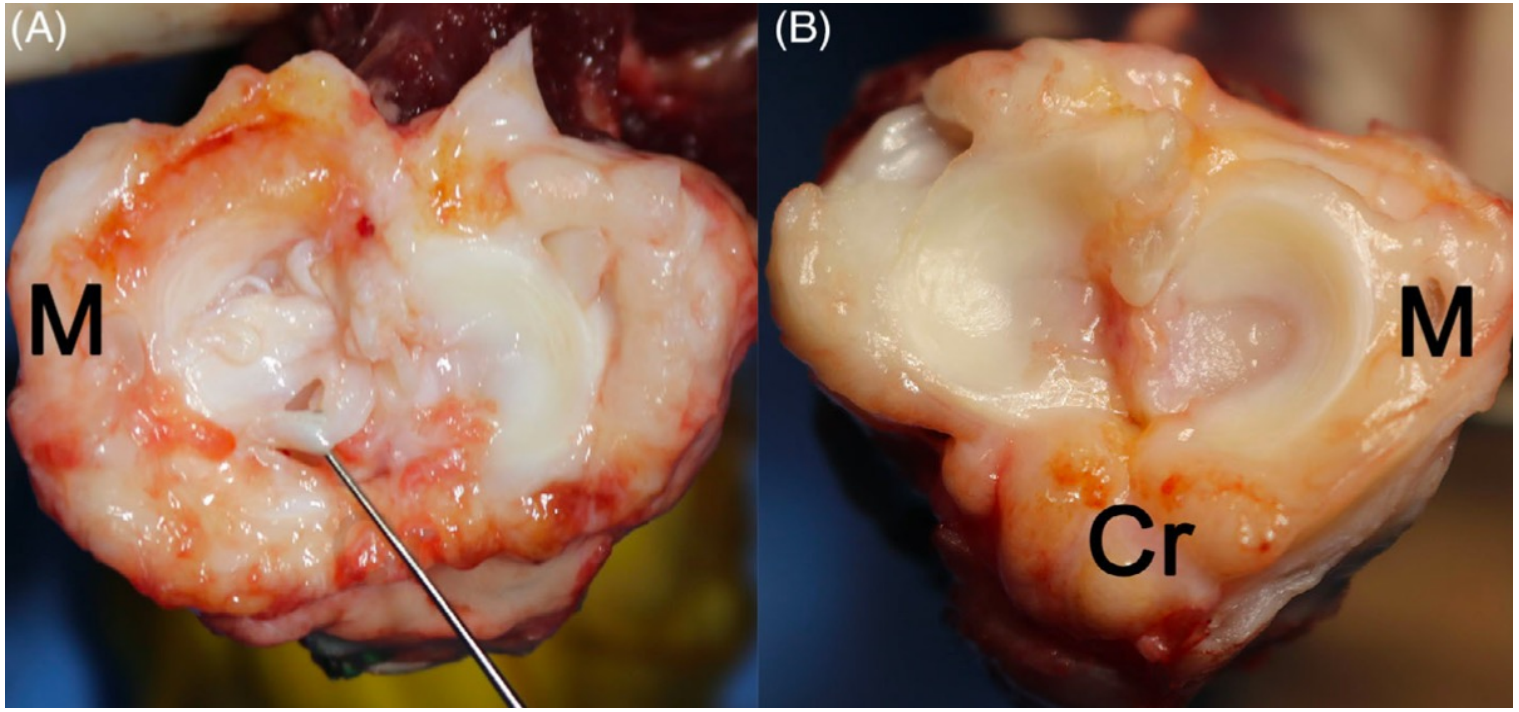


Post-Op Revision

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Meniscal Injury

- Late meniscal injury is a common driver of reoperation after TTA
- In a large series, release of an apparently normal medial meniscus was associated with fewer late tears—but meniscal release remains clinically controversial
- An experimental within-dog study found more subsequent medial meniscal tears and more cartilage injury after TTA than TPLO;



Jeong et al, Veterinary Surgery, 2021.

Infection

- Infection rate ~5%
  - ~15% for dogs >50kg
  - Postoperative antibiotics did not reduce infection rate in a 1,768-stifle retrospective TTA study; oxacillin-resistant infections were more likely to require implant removal

- Superficial signs: erythema, swelling, discharge, or focal irritation
- Deep infection may involve plate/fork/cage and can present months after surgery



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Implant Removal

- TTA plate/screw removal may be sufficient in some infected cases; cage removal is more technically demanding
- Cage removal leaves a proximal tibial defect and can be followed by tibial tuberosity fracture
- In a cage-removal series, postoperative complications occurred in **40%** of stifles; most owners still reported resolution of infection-related signs



Serratore et al, Veterinary Surgery, 2017

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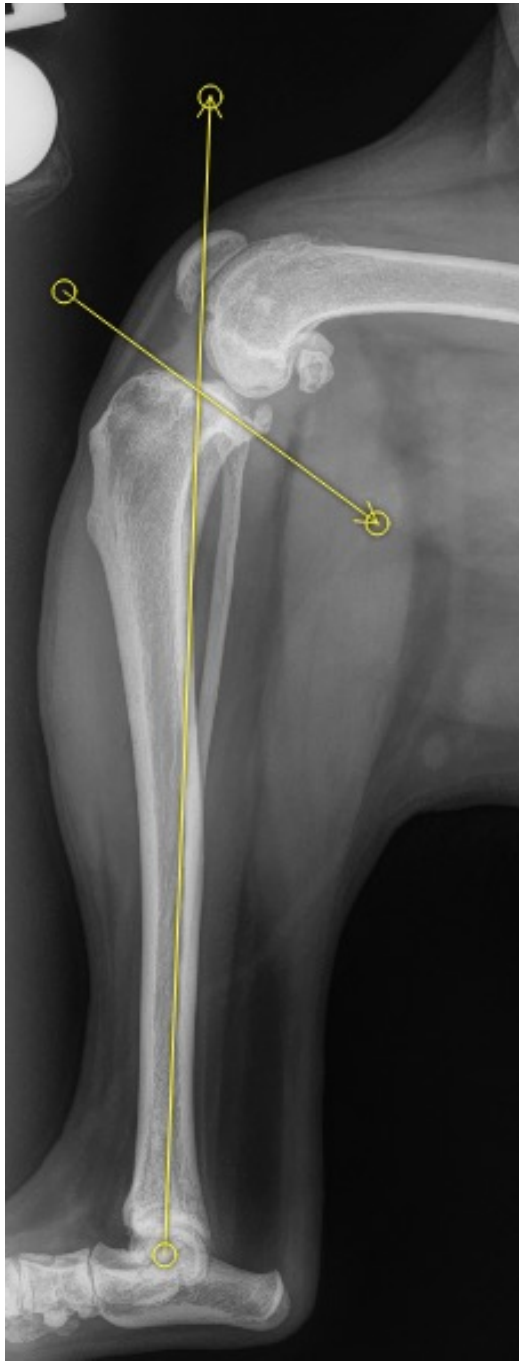
Warning Signs !!!

- Acute lameness after initial improvement → meniscal injury or crest/implant problem
  - Recurrent effusion/click/instability → surgeon re-evaluation for meniscal pathology
- New non-weight-bearing lameness in first 6–8 weeks → radiographs and surgeon contact
- Persistent drainage, deep swelling, fever, or implant-site pain → culture-oriented infection workup
- Persistent swelling, delayed healing, and chronic poor performance should not be dismissed as “normal TTA recovery”

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Tibial Plateau Leveling Osteotomy

- A radial proximal tibial osteotomy permits rotation of the plateau to reduce the tibial plateau angle
- Fixation must hold the rotated segment until union
- Most complications require understanding of the radiographs
- Recognize concerning implant and alignment patterns





Intraoperative Complications

- Hemorrhage associated with caudal structures/popliteal vessels
- Patellar tendon injury
- Inadequate/excessive rotation or malalignment
- Fibular fracture during rotation
- Intra-articular or osteotomy-line screw placement









Moles, VCOT 2009

Postoperative Complications

- Mechanical: tibial tuberosity fracture, fibular fracture, screw/plate failure, rock-back, fracture propagation
- Biologic: delayed union, SSI/osteomyelitis, implant-associated infection
- Joint-related: late meniscal injury, patellar tendon thickening, patellar fracture/luxation
- Rare: implant-associated neoplasia should remain on the late differential

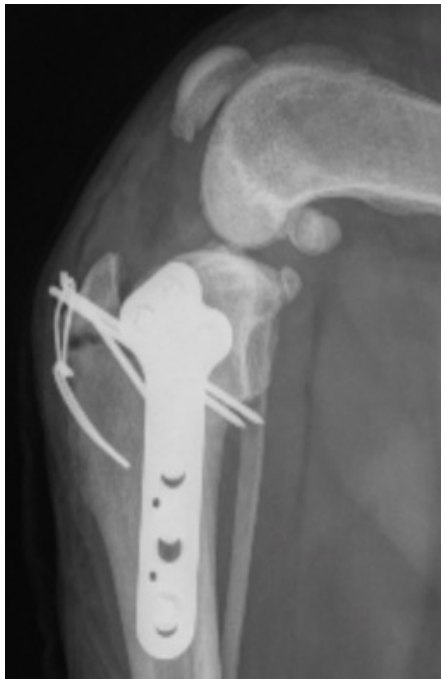
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Tuberosity Fracture

- Risk of TT fracture: ~1-4%
- Risk factors
  - Thin tuberosity
  - Distal placement of antirotational pin
  - Multiple distal pin tracts
  - Simultaneous bilateral TPLO





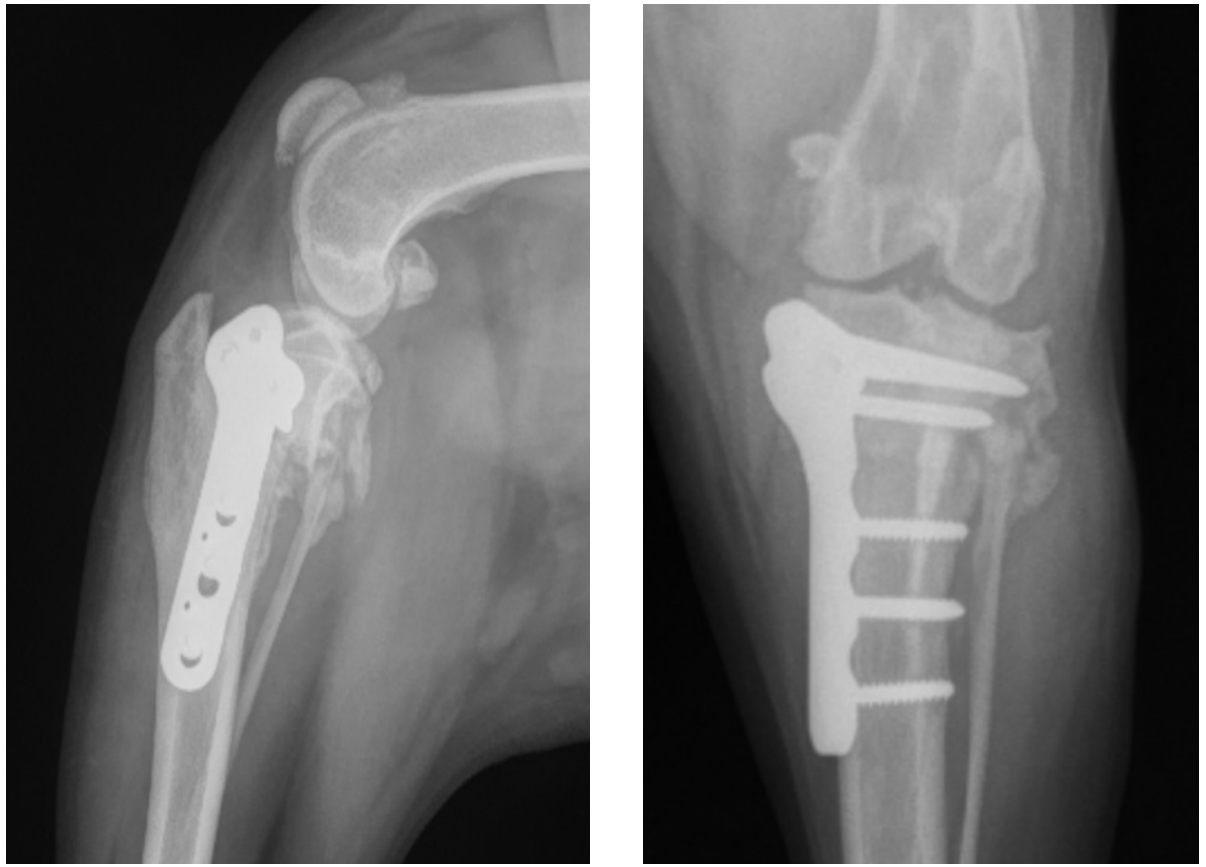


Fibular Fracture

- Risk of fibular fracture
  - Intra-op 0.1-2.4%
  - Post-op 0.4-15%

- Fibular fracture may be incidental—or signal instability and risk of loss of rotation

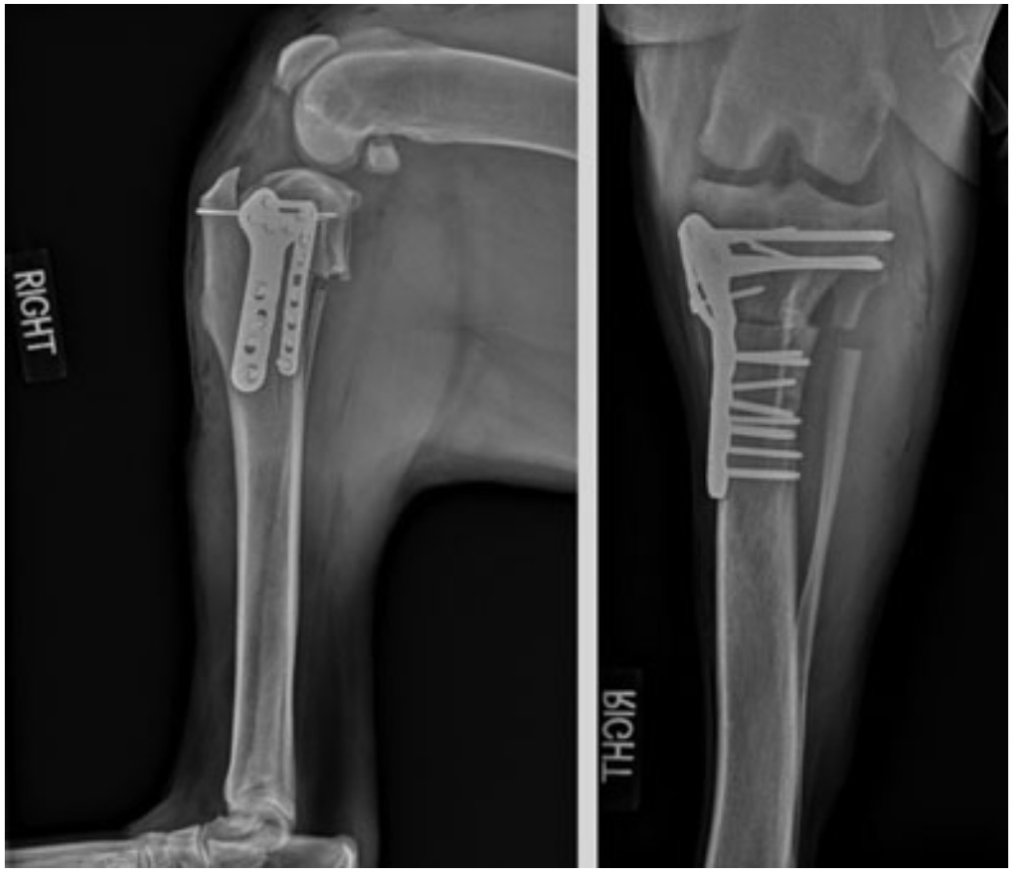
- Risk is increased by an open fibular drill hole and greater body weight in one large retrospective study



Inadequate Rotation and Fibular Osteotomy

- Failure to level the plateau may result in persistent lameness
- Proximal tibiofibular synostosis and a relatively wide fibula can restrict plateau rotation; fibular osteotomy may be used selectively by the surgeon

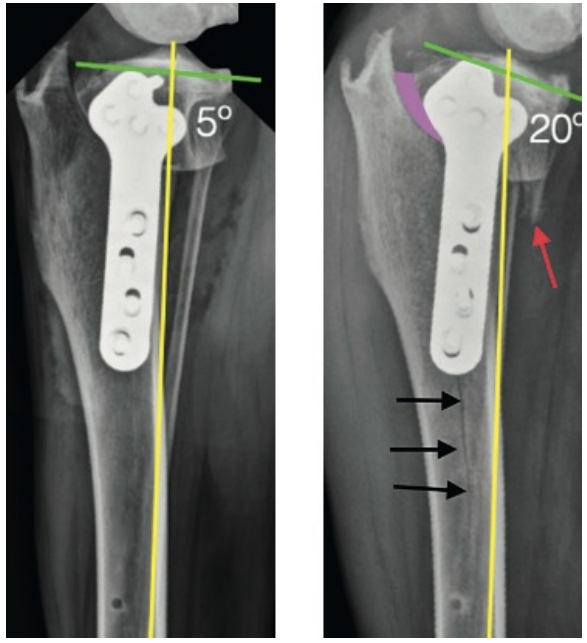




Rockback

- A rising TPA on follow-up radiographs indicates loss of plateau rotation
- Consider fixation failure, poor screw purchase, fibular fracture, fracture propagation, inadequate construct stability, or patient overactivity
- Clinical concern rises with new lameness, valgus/varus change, implant bending/breakage, or osteotomy collapse

Immediate Post-Op



Several Weeks Post-Op

Ben-Amotz, Complications in Canine Cruciate Ligament Surgery, 2021

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Infection

- ~2-10% risk of superficial SSI
- 3% risk of deep infection requiring implant removal

- Implant-associated infections may present late, including months to years after surgery
  - Mean 279 days post-op

- Male dogs and German Shepherd Dogs were associated with increased odds of deep SSI requiring plate removal





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Postoperative Antibiotics?

- The highest-level prospective studies reviewed did not demonstrate a clear reduction in SSI with extended postoperative antibiotics
- Several retrospective studies report a protective association
- A systematic review concluded that evidence supporting routine postoperative antibiotics is limited and conflicting
- Antimicrobial choices should be individualized and stewardship-conscious

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Patellar Tendon Thickening

- Radiographic tendon thickening is common after TPLO and is often clinically insignificant
- When accompanied by progressive pain, marked lameness, or patellar fracture, it becomes more relevant
- Avoid overinterpreting the radiographic finding in an otherwise improving patient
- Use the full clinical picture: timing, pain, function, effusion, and radiographs





Ben-Amotz, Complications in Canine Cruciate Ligament Surgery, 2021

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Patellar Fracture

- ~2% risk of patellar fracture
- Distal-pole patellar fracture is uncommon, often identified weeks to months after surgery
- Some dogs improve clinically with conservative treatment despite incomplete radiographic union
- Lower final TPA has been associated with increased odds of patellar fracture; avoid excessive plateau rotation



Geier et al, Veterinary Surgery, 2020

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Patellar Luxation

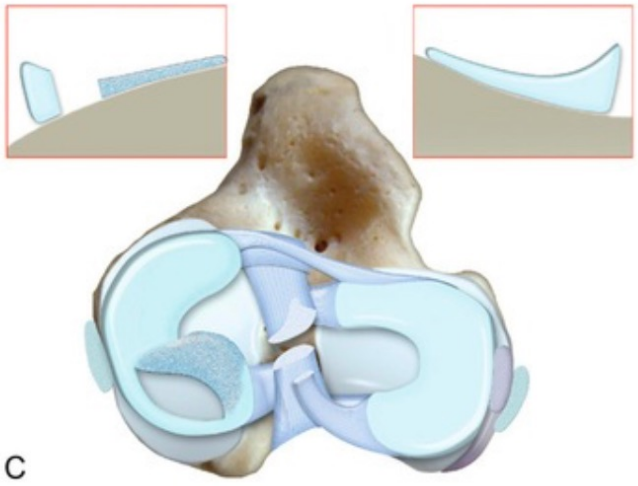
- Risk 0.3-1%
- Aggressive medial arthrotomy closure
- Inadequate fixation





Meniscal Injury

- New lameness after a period of improvement remains a leading concern
- Clinical features can be subtle; a palpable click is neither required nor perfectly sensitive
- Meniscal injury, implant infection, and mechanical failure can overlap clinically—orthogonal radiographs plus physical assessment are often needed
- **A stable-looking TPLO radiograph does not exclude a meniscal tear**



Tobias and Johnston, 2017



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Implant-Associated Sarcoma

- Late recurrent lameness or a growing mass near the implant warrants radiographs and oncologic/orthopedic consideration
- Implant-associated sarcoma is rare but should remain on the differential for late focal pain, swelling, lysis, or mass effect
- **Do not label a late painful limb as “OA only” without reassessment**



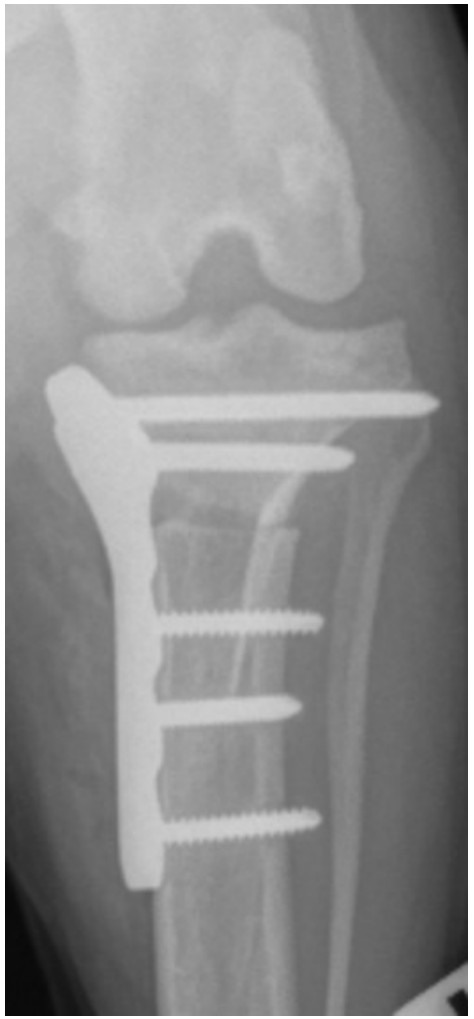


Selmic et al, JAVMA 2014

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Implant Failure





Immediate Post-op

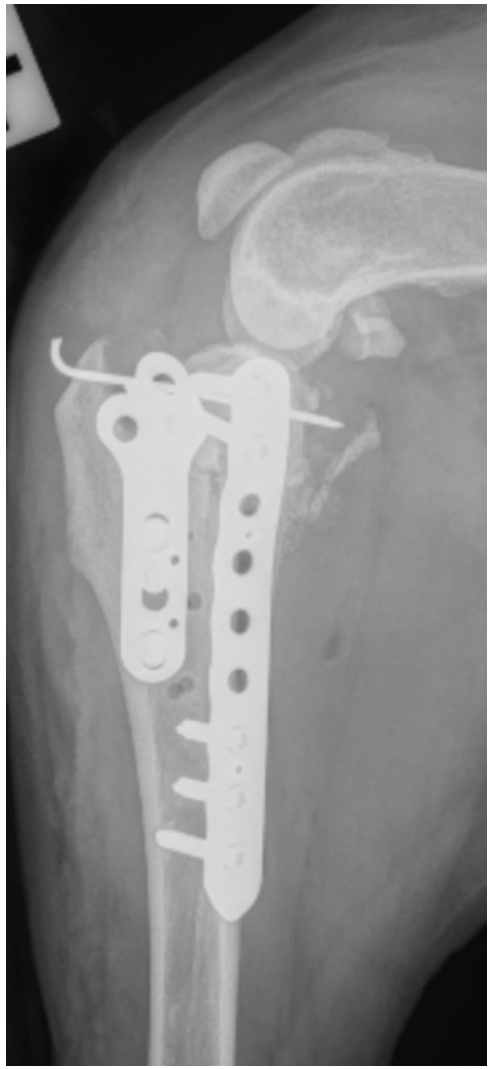




4 Weeks Post-op

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Implant Failure





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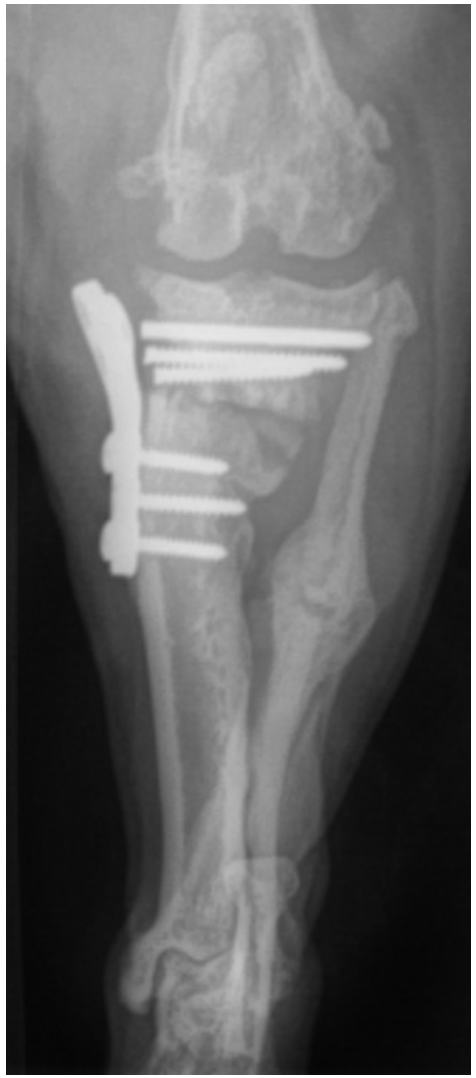
Implant Failure





Immediate Post-op





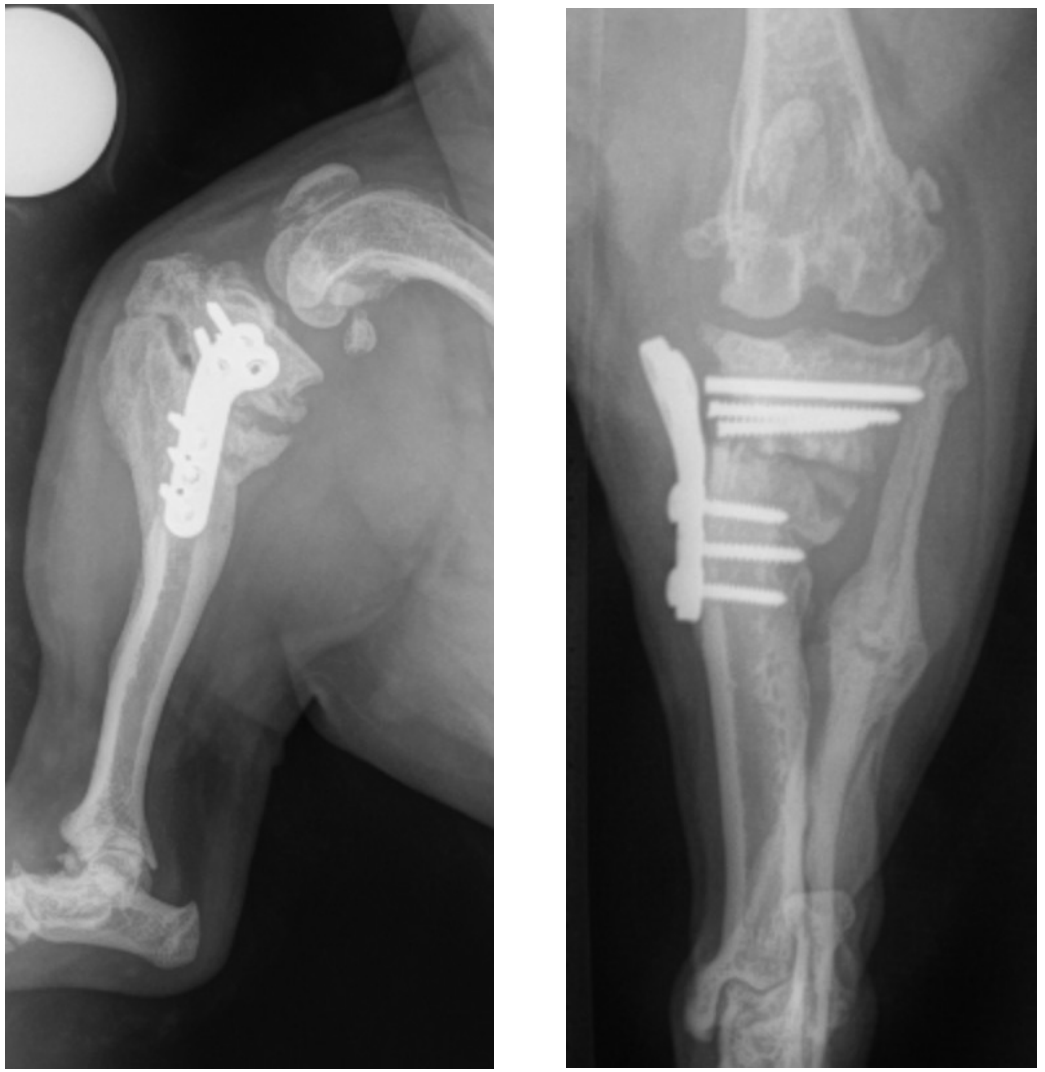
8 Weeks Post-op

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Implant Failure



8 Weeks Post-op



12 Weeks Post-op

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Warning Signs !!!

- Non-weight-bearing lameness or sudden worsening at any point → same-day surgeon communication
- Persistent drainage, fever, marked pain, or deep swelling → culture and implant-associated infection assessment
- Radiographic plate/screw change, loss of rotation, fracture, or progressive osteolysis → urgent referral
- New effusion/click after initial improvement → meniscal injury until proven otherwise

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Helpful Communication

- State procedure type, surgery date, recovery timeline, and date of deterioration
- Send radiographs
- Report incision findings, temperature, current medications, and antibiotic exposure
- Describe whether pain is focal to implant/osteotomy versus intra-articular

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Take Home Messages

- There is no zero-complication CCL procedure—early recognition changes outcome
- Meniscal disease is a leading explanation for lameness after initial improvement
- Infection may present early or late; chronic implant-related signs deserve serious attention
- Radiographs answer construct questions; they do not rule out meniscal disease
- **YOU are essential partners in surveillance, triage, and timely referral**

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QUESTIONS?

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References

- A complete list of references is available upon request

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