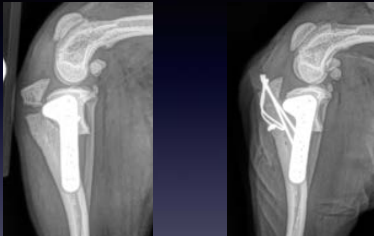


TPLO Complications



David Dycus, DVM, MS, CCRP, DACVS-SA
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Nexus Veterinary Specialists (NVS)
Baltimore, MD

Co-Founder/Co-Director
Veterinary Sports Medicine and Rehabilitation Institute
(VSMRI)

TPLO Complications

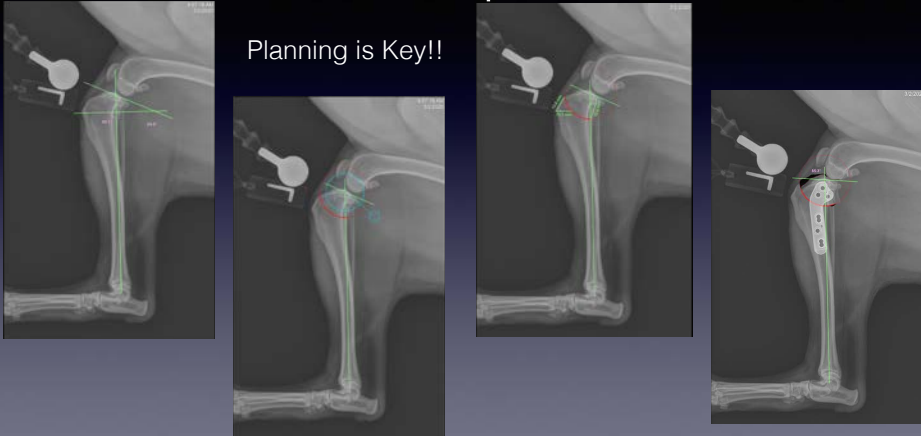
- Most complications are minimized by:

EXPERIENCE

CAREFUL ATTENTION TO DETAIL

TPLO Complications

Planning is Key!!



TPLO Complications

- Overall 10-34% (including minor and major)
- Many are result of surgeon error
 - Tibial tuberosity fracture
 - Post-operative meniscal pathology
 - Intra-articular screw/jig placement
 - Hemorrhage (cranial tibial artery)
 - Broken drill bits/screws/holding pins
 - Fibular fracture
 - Screw placement through osteotomy
 - Retained surgical sponge (gossypiboma)
 - "Rockback"
 - Surgical Site Infection (SSI)
 - Etc. etc., etc.



Tibial Tuberosity Fracture

Risk Factors for Tibial Tuberosity Fracture After Tibial Plateau Leveling Osteotomy in Dogs

MARY SARAH BERGH, DVM, PAIVI RAJALA-SCHULTZ, DVM, PhD, and KENNETH A. JOHNSON, MS, PhD, Diplomate ACVIM

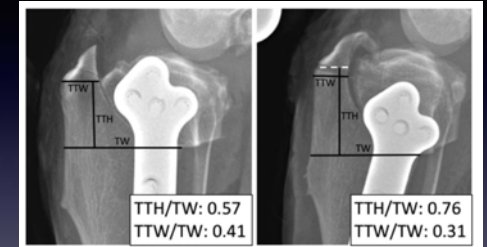
Factors associated with early tibial tuberosity fracture after tibial plateau leveling osteotomy

Lea R. Mehrkens DVM¹ | Caleb C. Hudson DVM, MS, DACVS² | Grayson L. Cole DVM, DACVS²

- ~0.5-5% reported incidence
- Simultaneous bilateral TPLO - 12.4-21.6x ↑ odds
- Dogs with TT width of 7mm sig ↑ risk vs >10mm
- Every 1mm ↑ TTW - ↓ risk by 37%
- Anti-rotational pin placed below insertion of PL - 9.5x ↑ odds
- Tuberosity with narrowest point below the level of insertion of PL - 19.2x ↑ odds
- Multiple pin tracts below the insertion of PL - 15.7x ↑ odds

Tibial Tuberosity Conformation

- Saw blade too big
- Saw blade centered to distal



- Tuberosity taller than 70% of base ↑ fracture
- Want TTH/TW of 0.6 or less
- Want TTW/TW of 0.4 or greater

Effect of Osteotomy Position and Tibial Plateau Rotation on the Tensile Force Required for Failure of the Canine Quadriceps Mechanism

Katie Hamilton¹, BVSc, John Tarlton, PhD, Kevin Parsons¹, BVSc, PhD, DipECVS, Mike Toscano², PhD, and Neil Burton¹, BVSc, DSAS(Orth)

- n=35
- 33/35 constructs failed via TT Fx
- Increasing TT width = Increased tensile force required for failure
- Significantly less force for fx when segment rotated past TT



Anti-Rotation/Holding Pin

- Place just above insertion of patellar ligament
- At or below insertion = stress riser for TT fracture
- Pin should penetrate caudal cortex proximal to osteotomy

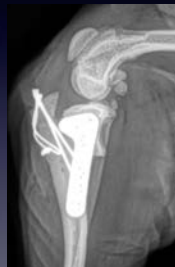


TT Fx Treatment

- Minimally displaced
- Can often attempt conservative therapy
- Displaced proximally (quadriceps)
- Surgery with a pin and tension band

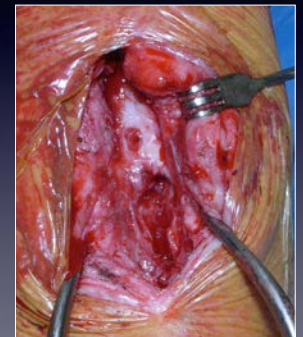


Minimally Displaced TT Fracture



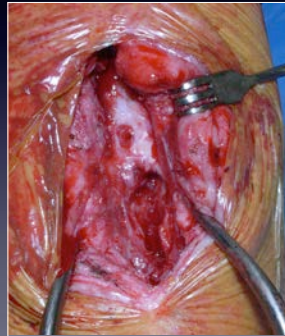
Surgical Site Infection

- May involve implants, joint, or both
- Use CDC criteria to classify
 - Superficial Incisional SSI
 - Deep Incisional SSI
 - Organ/Space SSI
- *Staphylococcus pseudointermedius* most common isolate
- Emerging MDR
- Biofilm formation creates treatment challenge



Surgical Site Infection

- Early detection is key!
- Will require gross assessment
- Implement an active surveillance program
 - Rechecks and owner questionnaire (30 & 90 days)
 - 28-35% of SSI missed without surveillance programs

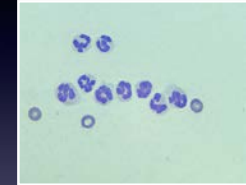


Turk, R, et al Vet Surg 2015
Stickeny DNG, et al Vet Surg 2018

Risk factors for surgical site infection-inflammation in dogs undergoing surgery for rupture of the cranial cruciate ligament: 902 cases (2005-2006)

Tracy N. Frey, DVM; Michael G. Hoelzl, DVM, DACV; Thomas D. Scavelli, DVM, DACV;
Ryan P. Fulcher, DVM, DACV; Richard P. Bastian, PhD

- 8.4% rate of SSI post TPLO
- n=406
- Significantly lower
- Not using staples
- Post operative antibiotics



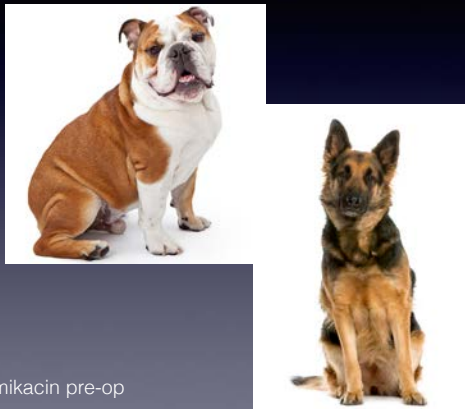
Predictive variables for complications after TPLO with stifle inspection by arthrotomy in 1000 consecutive dogs.

Fitzpatrick N¹, Solano MA.

- 6.6% rate of SSI post TPLO
- Significantly lower
- Post operative antibiotics
- n=1000

Surgical Site Infection - Risk Factors

- Host Factors
 - Bulldogs and GSD increase risk factor
 - Labrador decrease risk factor
 - Increase BW: 1kg ↑ BW = 1.03x ↑ SSI
- ASA Status/Endocrinopathies
 - Increase of ASA increases SSI
 - Endocrinopathy increases SSI by 8.2x
- MRSP carrier
 - 4.4% animals are carriers (6.72x ↑ SSI)
 - In known carrier consider single dose of amikacin pre-op



Diagnosis of TPLO SSI

- Pain / Increased lameness
- Focal swelling over incision
- Draining tract at or distal to incision
- Radiographs
- Culture and Susceptibility



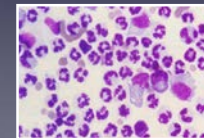
Diagnosis of SSI - Arthrocentesis

- Under-utilized but helpful
- Landmarks are patella and tibial tuberosity
- Needle inserted midway between landmarks
 - ~1 cm medial or lateral to patellar ligament
- Advance toward center of intercondylar notch
- False negative culture is common
 - Diagnostic Yield in 70-80%
 - Possibly increase by putting fluid in blood culture tube



Synovial Fluid Cytology

Condition	Total Cell #	% Mononuclear	% Neutrophils
Normal	<2000 / uL	94 - 100	0 - 6
Osteoarthritis	2000-5000/uL	88 - 100	0 -12
Infective	40-250K /uL	1 - 10	90 - 100
IMPA	40-250K /uL	5 - 85	15 - 95



SSI Prevention

- Assessment of skin is paramount for local AND distant dermatitis
- 17.5% patients have evidence of active local or distant dermatitis
- 16.7% SSI with local
- 10.2% SSI with distant
- Do not consider patients with distant dermatitis to have a lower SSI risk



Photos Courtesy of Dr. Katie Hoddinott

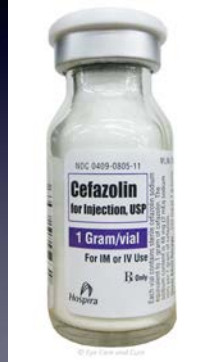
SSI Prevention

- Do not clip until immediately prior to surgery
- Duration of surgery and anesthesia
 - Suppression of immune system
 - Risk of SSI ~ x2 ↑ for every hour of surgery
 - ~30% ↑ per extra hour anesthesia
- Number of people in OR
 - ~30% increase risk per additional person
- Propofol induction may increase risk (3.8 x)
- Peri- and post-operative antibiotics



Peri-Operative Infection Control

- Perioperative antibiotic administration
 - Cefazolin typical choice
 - 1st dose within 30 min prior to skin incision
 - Re-dose every 90 min during surgery
 - Can continue overnight dosing every 6 hrs.
 - If used appropriately can reduced SSI by 6-7x



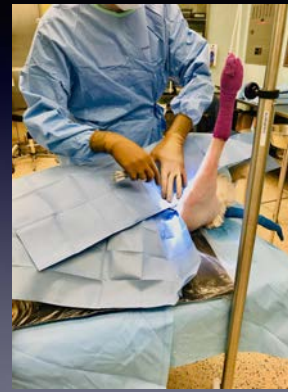
Prevent Infection - Personal

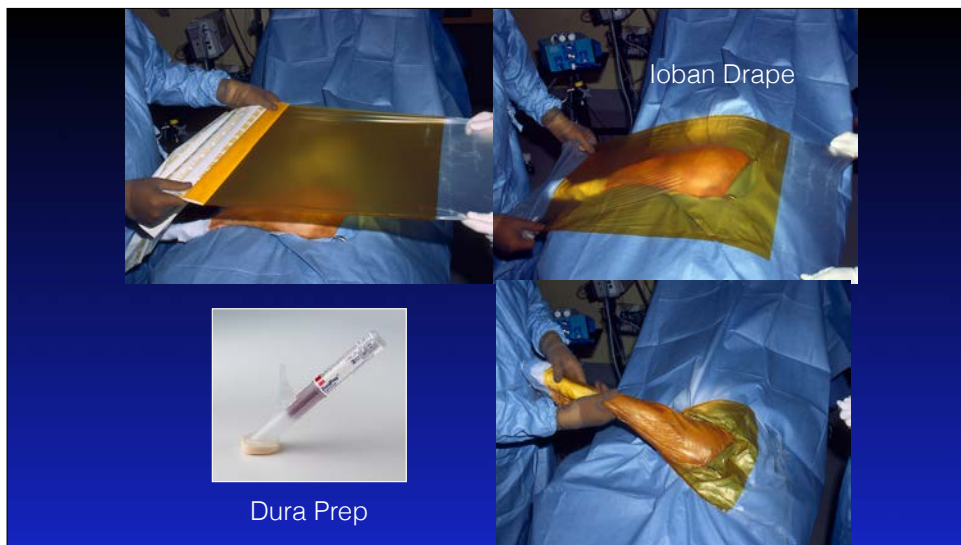


Prevent Infection - Prep/Drap



Prevent Infection - Prep/Drap





Resolution of Infection

- Systemic antibiotic therapy
 - Culture & sensitivity results
- Local therapy options
 - Antimicrobial impregnated beads
 - Antibiotic gel
- Implant removal
- Healed osteotomy

Hemorrhage

- Laceration of the cranial tibial artery (1-2%)
- During the osteotomy or during muscle elevation

Evaluation of vascular trauma after tibial plateau levelling osteotomy with or without gauze protection
A cadaveric angiographic study

A. Pozzi^{1,4}, V. Samii², M. B. Horodyski^{3,4}

VCOT 2011

Anatomical investigation of the canine cranial tibial artery
A potential source of severe haemorrhage during proximal tibial osteotomies

A. Males¹, M. Glyde

Murdoch University Veterinary Hospital, Small Animal Surgery, Murdoch Western Australia, Australia

VCOT 2009

Hemorrhage Prevention

- Pack gauze sponge between tibia and muscles caudally and laterally
- Support osteotomy as you cut
- Fingers
 - Proximal and lateral on fibular head
 - Medial and distal on tibia

Ex Vivo Evaluation of the Effect of Tibial Plateau Osteotomy on the Proximal Tibial Soft Tissue Envelope With and Without the Use of Protective Gauze Sponges

MICHAEL FARRELL, BVSc, MSc, CertVA, CertAB, Diplomate RCVS, IGNACIO CALVO, DVM, Stephen P. CLARKE, BVMS, DVM, Diplomate RCVS, RONNIE BARRON, DVM, DABVP, EMILY COURCIER, BVetMed, and STUART CARMICHAEL, BVMS, MVM, DABVP

Objective—To investigate the effect of tibial plateau leveling osteotomy (TPLO) on the proximal tibial soft tissue envelope with and without use of protective gauze sponges, and to determine whether the action of an oscillating saw blade on the gauze sponges would result in retention of particulate cotton debris.

Study Design—Cadaveric study.

Animals—Medium to large breed dog cadavers (n = 10; 20 pelvic limbs).

Methods—TPLO was performed using the currently recommended technique involving dissection of the proximal tibial soft tissue envelope and its protection using cotton gauze sponges. In paired limbs, the procedure was repeated but no attempt was made to retract and protect the proximal tibial soft tissue envelope. Damage to the soft tissue envelope and presence of gross particulate cotton debris were investigated by direct observation and photographic analysis. Presence of microscopic cotton debris was investigated using light microscopic analysis of wound lavage fluid.

Results—No soft-tissue trauma was found in gauze sponge-protected specimens. When protective gauze sponges were not used, full-thickness (sagittal plane) lacerations to the caudoproximal tibial muscle group occurred in all specimens with a mean craniocaudal width of 9.5 mm (range 2–12 mm). The cranial tibial muscle was traumatized in only 1 specimen without protective gauze sponges. Trauma to the popliteal vessels was not identified in any specimen. No gross cotton debris was identified, but microscopic cotton fibers (diameter, 7–35 µm) were identified in lavage fluid from all gauze sponge-protected specimens.

Conclusion—Use of protective gauze sponges is effective in protecting the proximal tibial soft tissue envelope from an oscillating TPLO saw blade, but results in retention of microscopic cotton particulate debris within the operative site. Significant soft tissue trauma is seen only in the caudoproximal tibial muscle group if protective gauze sponges are not used.

Clinical Relevance—Retraction and protection of the caudoproximal tibial soft tissue envelope is recommended during TPLO; however, to prevent retention of microscopic particulate cotton debris, alternatives to cotton gauze sponges should be considered as protective devices.

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Retained Surgical Sponge

McDougal R, Dycus DL. What's Your Diagnosis: Gossypiboma? J Am Vet Med Assoc 254:1045–1047, 2019.



Evaluation of vascular trauma after tibial plateau levelling osteotomy with or without gauze protection

A cadaveric angiographic study

A. Pozzi^{1,4}; V. Samii²; M. B. Horodyski^{3,4}

VCOT 2011

Summary

Objective: To evaluate the integrity of the cranial tibial artery after performing the tibial plateau levelling osteotomy (TPLO) with or without soft tissue dissection and protection with gauze sponges.

Study design: Experimental cadaveric study.

Animals: Ten dogs weighing 28 to 35 kg.

Methods: Ten pairs of normal pelvic limbs were divided randomly into two groups in which a TPLO was performed with or without soft tissue protection with gauze sponges respectively. Angiography was used to evaluate the integrity of the cranial tibial artery after TPLO in each group. Contrast angiography was performed for each group: 1) before TPLO [Control]; 2) after TPLO [Osteotomy]; and 3) after intentional laceration of the cranial tibial artery [Arteriotomy]. A 'yes or no' was used to

pleted to assess the score and the area, respectively, for each of the surgical treatments (Control, Osteotomy, and Arteriotomy) between the conditions of dissection with respect to the cranial tibial artery. A value of p < 0.05 was considered significant.

Results: The differences between the two groups (with and without protection) for scores and areas of leakage were not significant (p > 0.05). However, significant differences were noted between Control and Arteriotomy (p < 0.01) and Osteotomy and Arteriotomy (p < 0.01), but not between Control and Osteotomy (p > 0.05).

Conclusions and clinical relevance: A TPLO without protection of the cranial tibial artery can be performed without increased risk of arterial trauma.

- May sacrifice important periosteal blood supply to proximal tibial metaphysis
- Excessive dissection of popliteal muscle can contribute to rotary instability ("pivot shift")

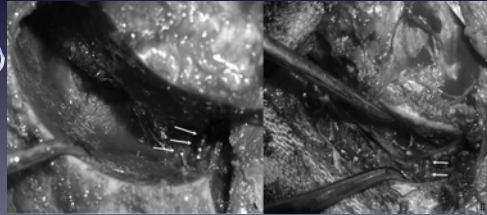
Hemorrhage

- If hit.... FINISH CUT!!
- First rotate as this will can help collapse vessel to stop or slow bleeding
- If this is not successful pack off area caudal to tibia, wrap limb from proximal to stifle to mid-tibia and wait 10 minutes
- After 10 min carefully remove wrap to see if still bleeding
- If still bleeding then use suction and locate vessel to be ligated

Control of hemorrhage through the osteotomy gap during tibial plateau leveling osteotomy: 9 cases

Luis Matres-Lorenzo, Ldo Med Vet¹ | Aidan McAlinden, MVB, Diplomate ECVS² |
Antoine Bernardé, DMV, MS, Diplomate ECVS¹ | Fabrice Bernard, DMV, Diplomate ECVS¹

- Digital pressure over the femoral artery
- Remove jig
- Distraction of the osteotomy
 - Gelpis
 - Lamina spreaders
- Hemoclips*, suture, cautery



Screw in Joint

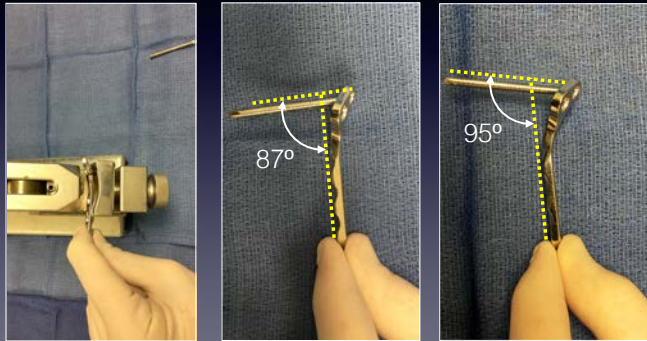
- Inappropriate screw insertion
- Proximal plate position
- Plate contouring
- Options
 - Replace with shorter screw
 - Redirect screw/place cortical screw
 - Remove screw
 - Reposition plate



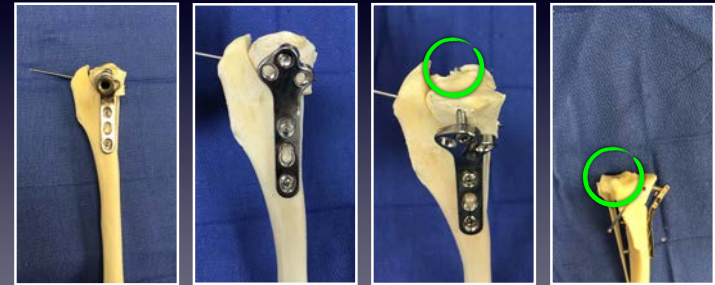
Contouring Locking Plates



Contouring Locking Plates



Contouring Locking Plates



Screw in Joint



Revised With Shorter Screw

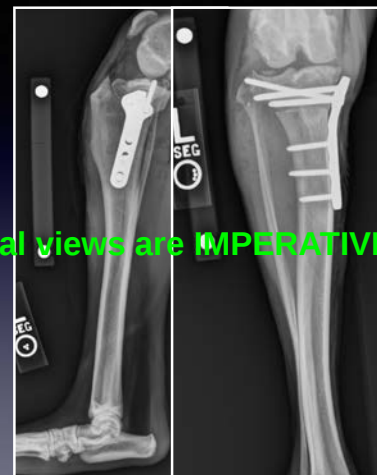


Broken Drill Bit or Pin

- Drilling into previously placed screw
- Impingement between screw and anti-rotational pin
- Remove if practical
 - May require burr
 - Remove caudally
- May leave in place



Orthogonal views are IMPERATIVE



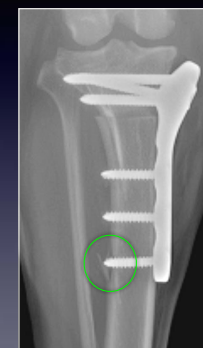
Stripped Screw

- Screw head stripped
 - Remove and replace
- Bone tunnel stripped
 - replace with locking screw
 - Redirect screw
 - Upsize screw
 - Leave hole unfilled
- Avoid over tightening screws
- Insert screw in same direction as drill hole
- Proper screw length



Trans Cortical Fracture

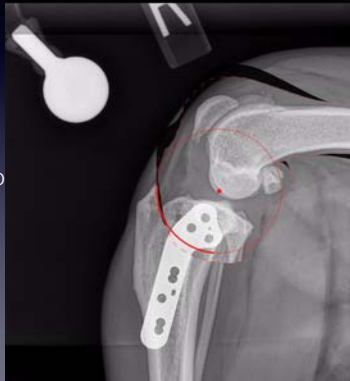
- Outer portion of trans cortex
- Fractures during screw insertion
- Common with self tapping screws
- No treatment necessary



Boekhout et al. Vet Surg 2012

Distal Screw Placement

- Problem with large rotation and traditional TPLO plates
- Plate tilt positions distal screw at cranial tibial cortex
- Weakens cranial cortex leading to fracture
- Direct screw caudally if needed



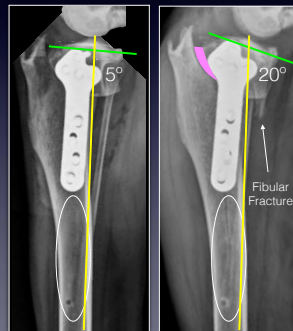
Pivot Shift

- How important is preventing internal rotation?



Fixation Failure - “Rock Back”

- Significant increase in TPA post-op
- Inadequate stabilization
 - Implant failure (screw breakage)
 - Bone failure
 - Converging screws
 - Screws too cranial (weaker bone)
- Treatment
 - May need revision



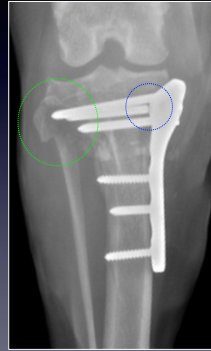
“Rock Back” Prevention Locking TPLO Plate

- Maintenance of plateau position significantly superior for locking screw construct
Leitner M, et al. Vet Surg 2008
- Significantly less change in post-operative TPA for locking vs. conventional screw and plates
Conkling AL, et al. Vet Surg 2010
- Significantly higher grades of osteotomy healing locking vs. conventional
Conkling AL, et al. Vet Surg 2010



Fibular Fracture

- Relatively common complication
- Risk factors
 - Drilling through fibular head
 - Steep pre-op TPA
 - Increased body weight
- Look for broken screws



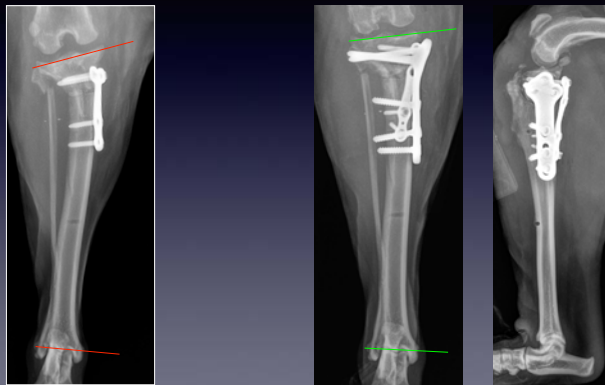
Taylor et al. Vet Surg 2011
Tuttle et al. Vet Surg 2009

Fibular Fracture

- May result in osteotomy collapse
 - Valgus deformity
- Management options
 - Conservative if well aligned
 - Revision surgery if unstable or poor alignment



Post Revision

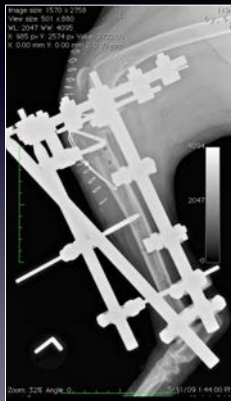


Tibia and Fibular Fracture

- Severe instability
- Rock back
- Excessive force
- Converging screws
- Screws near cranial osteotomy
- Difficult Revision
 - double locking plates
 - external fixator



Revision Strategy



Patellar Ligament Thickening

- Most severe distally
- Often incidental finding
- Grade:
 - 0 - Mild: Normal up to double thickness
 - 1 - Moderate: 6 to 11 mm
 - 2 - Severe: ≥ 12 mm or no identifiable borders



Carey et al. VCOT 2005

Patellar Ligament Desmitis

- Inflammation or remodeling?
- Fat pad or joint capsule?
- Clinical signs
 - Lameness
 - Pain on palpation +/-
- Diagnosis of exclusion



Gallagher et al. Vet Surg 2012

Patellar Ligament Thickening

- Treatment:
 - Needed?
 - Shock Wave Therapy
 - Significant (radiographic) decrease in PLT at 6 and 8 weeks post-op
- Gallagher et al. Vet Surg 2012
- NSAIDs, Rest and Slow return to normal activity
 - Platelet Rich Plasma



Late Meniscal Tear

- Incidence varies 2-40%
- May cause severe lameness
- May be asymptomatic
- Partial meniscectomy



Conclusions

- Many potential complications with TPLO
- Most can be avoided by careful preoperative planning and meticulous surgical technique
- Reassess patient if function deteriorates post-op
- Address complications promptly



Questions

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