Jus_Ol/shutterstock.com

REHABILITATION

Evaluation After Tibial Plateau Leveling Osteotomy: A Guide for the General Practitioner

Christina Montalbano, VMD, CCRP, CVA
Kelly Deabold, DVM, CVA
Erin Miscioscia, DVM, DACVSMR, CVA
University of Florida College of Veterinary Medicine

Rupture of the cranial cruciate ligament (CCL) is one of the most common causes of hindlimb lameness in dogs. The CCL acts as the primary stabilizer of the canine stifle, resisting cranial tibial translation (cranial drawer), hyperextension, and internal rotation. It also contains mechanoreceptors and proprioceptors and thus contributes to hindlimb proprioception. CCL tear or rupture (CCLR) leads to stifle instability, pain, inflammation, and development of osteoarthritis.[1]

One of the most commonly used and successful surgical stabilization procedures for CCLR is tibial plateau leveling osteotomy (TPLO). The goal of this procedure is to neutralize cranial tibial thrust or subluxation during weight bearing by flattening/leveling the tibial plateau angle, which should eliminate pain during weight bearing and slow the progression of osteoarthritis in the stifle.[1] Although TPLO does not prevent cranial drawer or internal tibial rotation, compared with alternative procedures it has been shown to provide one of the best returns to normal clinical function.[2-4]

EXPECTATIONS AFTER TPLO

The recovery period after TPLO correction of a CCLR can often be long and frustrating. The stages of recovery vary from patient to patient and depend on several patient factors such as age, weight, body condition score, overall health, and fitness level.[2,3,5-8] Recovery may also be influenced by the CCLR severity, concurrent injuries, surgical technique, and postoperative management strategies.[4, 9-14] **TABLE 1** shows postoperative expectations for up to 2 years after TPLO surgery.

The general practitioner is often the main point of contact with the client and patient after

WATCHFUL EYE
An understanding of the potential complications following tibial plateau leveling osteotomy can help guide therapy and enable improved client counseling.

surgery and during re-evaluations may see patients experiencing complications secondary to the TPLO procedure. Complications may affect 10% to 25% of patients.[15] Depending on the identified complication, referral back to the orthopedic surgeon or to a rehabilitation specialist may be warranted. **TABLE 2** demonstrates common TPLO complications, expected timelines, and interventional strategies.

COMMON POST-TPLO COMPLICATIONS

Incisional Complications

Incisional complications include seromas and incision infections; both may appear as peri-incisional swelling. Seromas are typically nonpainful, soft, and dependent; infections may additionally demonstrate serosanguinous or suppurative drainage, erythema, heat, and pain on palpation. Seromas are aseptic and should not be sampled or drained unless an infection is strongly suspected. Seroma treatment revolves around minimizing joint movement by strictly limiting activity, administering sedative medication, and applying warm compresses to reduce swelling. Incision infections should be cultured and treated with appropriate systemic antibiotics.[15]

Infection

Infection can also be associated with the implant or underlying bone, or it can be within the stifle joint.[15] Implant-associated infections can result from development of a biofilm. The implant serves as a nidus for bacterial colonization, which if left untreated can extend to the underlying bone and result in subsequent osteomyelitis. Septic arthritis may occur as an extension of osteomyelitis, may have an iatrogenic etiology from prior arthrotomy or arthroscopy, or may occur spontaneously through hematogenous spread.[16] These deep infections may be evident in the weeks after surgery or may appear years later. Clinical signs associated with these deeper sources of infection include return of progressive joint pain and lameness; pain on palpation of the implant; skin lesions or draining tracts; and signs of systemic infection such as

TABLE 1 Expected Timeline for Recovery After TPLO

POSTOPERATIVE PERIOD	EXPECTATIONS
Immediately to 48–72 hours	▪ Patient is often non–weight bearing immediately after surgery and is toe touching and partially weight bearing after 48–72 hours ▪ Extent of muscle atrophy depends on the chronicity of the CCLR ▪ Incision site may be inflamed, painful, warm, and swollen ▪ Patient resists stifle manipulation/ROM, especially extension
10–14 days	▪ Weight bearing continually increases ▪ Skin/incision healing is complete; sutures/staples are typically removed ▪ Comfort on stifle ROM improves
4 weeks	▪ Patient exhibits consistent weight-bearing lameness while walking ▪ Radiographs are typically taken to ensure proper bone healing at the surgical site and to assess TPLO implants
8–12 weeks	▪ Patient may exhibit weight-bearing lameness (intermittent to consistent) to normal gait while walking ▪ Stifle and tarsal joint ROM may return to normal angulation by 12 weeks ▪ Muscles can take 6 weeks to 6 months to heal depending on the degree of surgical damage ▪ Hindlimb muscle hypertrophy will continue as limb use improves and may reach symmetry with the contralateral hindlimb ▪ Repeated radiographs should indicate bone healing at 12 weeks
6 months	▪ Gait at walk and trot is normal ▪ Stifle ROM may or may not continue to improve ▪ Increased consistent weight bearing will lead to significant improvements in muscle mass, and the hindlimbs should be symmetric ▪ Any tendon, ligament, or fascia tissue damage caused during surgery will continue to heal; healing can take up to 1 year
7–9 months	▪ Sporting/working dogs need additional targeted conditioning before returning to work or competition
1–2+ years	▪ Significant progression of osteoarthritis may be seen on radiographs and contributes to subsequently decreased ROM and worsened lameness

CCLR=cranial cruciate ligament rupture; ROM=range of motion; TPLO=tibial plateau leveling osteotomy

increased rectal temperature, lethargy, and reduced appetite. Stifle radiographs and/or referral back to the orthopedic surgeon are typically indicated for these cases. Depending on the source of infection, systemic and/or local antibiotics may be warranted, and implant removal may be required after osteotomy healing if the implant is suspected to be serving as a nidus for biofilm.

Persistent Stifle Instability

Stifle instability may persist or return postoperatively due to implant failure or the pivot shift phenomenon. Implant failure may result from inadequate activity restriction before osteotomy healing. Fracture of the tibial tuberosity or fibula can also contribute to recurrent joint instability.[17-19] Pivot shift is a rotational instability that may follow medial meniscectomy, muscle atrophy, and altered limb use; it may be corrected with a targeted therapeutic exercise program.[20] Persistent instability as evident by the presence of a positive cranial tibial thrust reportedly follows up to 30% of TPLO procedures[5] and predisposes the patient to more rapid and severe progression of osteoarthritis as well as increased risk for meniscal injury. Stifle radiographs and/or referral back to the orthopedic surgeon may be indicated when stifle instability associated with clinical lameness is persistent or recurrent.

Implant-associated infections can result from development of a biofilm. The implant serves as a nidus for bacterial colonization, which if left untreated can extend to the underlying bone and result in subsequent osteomyelitis.

TABLE 2 Potential Complications After TPLO, Timeline, and Interventional Strategies

COMPLICATION	EXPECTED TIME	COMMON CLINICAL SIGNS	INTERVENTIONAL STRATEGIES
Seroma	Days to weeks	▪ Peri-incisional swelling	▪ Warm compresses, activity restriction
Implant failure	Days to weeks	▪ Pain, lameness +/- swelling, stifle instability	▪ Internal/external fixation
Patellar ligament thickening	Days to weeks	▪ May be subclinical ▪ If clinical, will exhibit lameness, pain on direct ligament palpation, or stifle flexion	▪ None required if subclinical ▪ If clinical, may need NSAIDs, activity restriction, rehabilitative modalities (e.g., therapeutic laser, therapeutic ultrasound, shockwave)
Meniscal injury	Preoperatively to years	▪ Joint pain and effusion, lameness, +/- meniscal click	▪ Surgical intervention, some manageable with rehabilitation
Stress shielding	Weeks to months	▪ Incomplete radiographic healing at 12 weeks postoperatively	▪ Rehabilitation exercises
Sarcoma	Years	▪ Lameness, pain on bone palpation +/- pain on implant palpation, bony thickening	▪ Surgical +/- medical oncology consultation
INFECTION			
Incisional	Days	▪ Peri-incisional swelling, heat, erythema, joint pain, lameness	▪ Systemic antibiotics
Implant-associated/ osteomyelitis	Weeks to months	▪ Lameness, pain on implant palpation, skin lesions or draining tract, fever	▪ Systemic antibiotics + explant
Septic arthritis	Weeks to years	▪ Joint effusion, joint pain, lameness, heat, fever	▪ Systemic + intra-articular antibiotics +/- explant

NSAIDs=nonsteroidal anti-inflammatory drugs; TPLO=tibial plateau leveling osteotomy

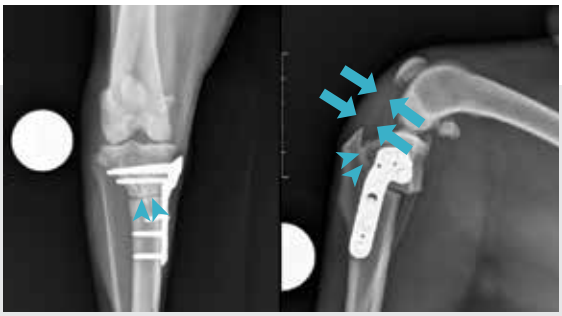

FIGURE 1. Radiographs obtained 4 weeks postoperatively demonstrating stable implants without evidence of movement or lucency; early callus formation **(arrowheads)** indicating ongoing osteotomy healing; and moderate thickening of the patellar ligament **(arrows)**, which is common for this stage of healing and often nonclinical.

Patellar Desmopathy

For 80% to 100% of TPLO patients, thickening of the patellar ligament is commonly evident on examination and radiographs after the procedure (**FIGURE 1**), thought to be caused by the altered biomechanical loading of the ligament, resulting from lengthening of the distance between the patella and tibial tuberosity.[15,21,22] For many patients in which this is identified, the thickening seems to be nonpainful and nonclinical, and it reportedly resolves within 4 to 8 weeks after surgery. A lesser percentage of patients may experience clinical desmopathy characterized by return of lameness and pain on palpation of the ligament and stifle flexion. Treatment considerations include nonsteroidal anti-inflammatory drugs (NSAIDs) and other analgesic medications; exercise restriction; and rehabilitative modalities such as therapeutic laser, ultrasonography, and extracorporeal shockwave therapy.[23]

Meniscal Injury

Meniscal injury may occur before TPLO or after,[15,21] especially in the presence of persistent cranial tibial translation or pivot-shift instability. Patients will often demonstrate an acute, severe return of lameness with significant pain localized to the stifle, often worse on flexion than extension; marked joint effusion; and a meniscal click during joint motion. A suspected meniscal injury may be confirmed via advanced imaging such as ultrasonography, magnetic resonance imaging, or more commonly via surgical exploration using arthroscopy or arthrotomy. Surgery is typically necessary to remove the damaged portion of meniscus, although small tears may be managed conservatively with activity restriction, pain management, and rehabilitative therapies.[24]

A recent study found that proximal tibial osteosarcoma is 40 times more likely in dogs with than without a history of TPLO.[27]

Delayed or Incomplete Osteotomy Healing

Delayed or incomplete healing of the osteotomy site should be suspected if bone healing is insufficient radiographically at 3 months after surgery.[21] Delayed or nonunion healing may result from an underlying systemic metabolic derangement in the patient or from stress shielding. Stress shielding occurs when the rigidity of osteotomy stabilization and lack of forces through the bone result in insufficient stimuli for callus formation and subsequent bone healing. Increasing the mechanical stimuli for appropriate osteotomy healing warrants an appropriate therapeutic exercise program designed under the guidance of a rehabilitation specialist. Further intervention using rehabilitative modalities (e.g., shockwave therapy) or surgical techniques (e.g., bone grafting) may also be indicated for some patients.[25,26] Long-term NSAID use delays bone healing when administered beyond 2 weeks postoperatively and may contribute to delayed osteotomy healing; thus, NSAIDs should be discontinued as soon as reasonably possible.[10]

Sarcoma

Sarcoma of the proximal tibia has recently been associated with prior TPLO. A recent study found that proximal tibial osteosarcoma is 40 times more likely in dogs with than without a history of TPLO.[27] Proximal tibial osteosarcoma after TPLO may be associated with implants made through a casting process or subject to corrosion.[27] Histiocytic sarcomas and synovial sarcomas have also been reported. Clinical signs include acute onset of lameness, pain on palpation of the implant and/or proximal tibia, and possible bony thickening or swelling in this region more than 1 year after surgery. Pathologic fracture of the proximal tibia may also

Courtesy University of Florida Small Animal Hospital, 2021

occur. Radiographic examination is indicated for patients with these clinical signs.

COMMON REHABILITATION AND MYOFASCIAL SEQUELAE

In addition to the common complications that can occur after TPLO, the general practitioner should also evaluate postoperative patients for common rehabilitation and myofascial sequelae to CCLR and TPLO. Several studies have described benefits of postoperative rehabilitation after TPLO, although additional large, randomized controlled clinical trials are needed before formal rehabilitation for all postoperative patients can be conclusively recommended.[4,9,11,13,28] To optimize patient outcome, especially for patients that do not meet expected milestones during recovery, referral to a rehabilitation specialist should be considered. **TABLE 3** describes common rehabilitation and myofascial sequelae to CCLR and TPLO that may be detected during re-evaluations, along with expected timelines of occurrence and interventional strategies.

Reduced Stifle Range of Motion

Several studies have reported post-TPLO loss of stifle range of motion (ROM) lasting between 5 weeks and 2 years or more, depending at least partially on postoperative management.[11,28-30] One large, longitudinal study reported that clinical lameness scores were significantly higher for dogs with a loss of extension or flexion of 10° or more than for those with a loss of less than 10°.[30] This study also reported that, compared with stifles with loss of flexion, stifles with a loss of extension of 10° or more had increased radiographic femorotibial osteoarthrosis scores and were less amenable to correction through rehabilitation. One small, prospective clinical trial demonstrated significantly greater stifle ROM at 3 and 6 weeks postoperatively in dogs that received early, intensive postoperative rehabilitation than in dogs that

TABLE 3 Common Rehabilitation and Myofascial Sequelae to TPLO, Timeline, and Interventional Strategies

SEQUELAE	EXPECTED TIME	DESCRIPTION	INTERVENTIONAL STRATEGIES
Reduced stifle range of motion	Preoperatively, with worsening immediately postoperatively	Loss of extension and/or flexion by 10° or more associated with increased lameness	Passive range of motion and rehabilitation therapies. Early intervention is suggested to be most beneficial; loss of extension is less tolerable than loss of flexion
Muscle atrophy	Preoperatively +/- worsening within 4–8 weeks postoperatively	Variable degrees of thigh muscle atrophy in affected +/- contralateral limb	Rehabilitation therapies; in-clinic rehabilitation is superior to home exercises
Progressive osteoarthritis	Variable, expected postoperatively in most dogs	Increased risk for larger dogs and dogs with meniscal injury	Rehabilitation, dietary intervention, and additional strategies (e.g., intra-articular injections, therapeutic modalities) may be beneficial
MYOFASCIAL SENSITIVITY			
Resulting from surgical technique	Immediately postoperatively	Pes anserinus (conjoined tendons of sartorius, gracilis, and semimembranosus muscles)	Rehabilitation therapies; manual therapies, exercises, and therapeutic modalities may help alleviate myofascial sensitivities and hasten return to normal posturing and weight bearing
Resulting from postural compensation	Preoperatively with expected worsening within 4–8 weeks postoperatively	Sartorius, iliopsoas, epaxial, latissimus dorsi, trapezius, +/- other muscles	
ABNORMAL ACTIVE ASSESSMENTS			
Abnormal postures and function tests	Preoperatively with expected worsening within 4–8 weeks postoperatively	Abnormal sitting, standing, or down postures, and/or abnormal transitions	If persistent or progressive, consider referral for rehabilitation therapy
Stifle rotational instability		Pivot shift; internal tibial rotation with lateral tarsal deviation during stance phase of gait	Targeted rehabilitation exercises may yield improvement; if persistent, consider orthopedic referral for potential addition of extracapsular stabilization

TPLO=tibial plateau leveling osteotomy

underwent home exercises. Among those in the rehabilitation group, no difference was found between affected and contralateral stifles by postoperative week 6.[11] Monitoring for asymmetry of ROM between the affected and contralateral stifle joints after TPLO is recommended, as is referral to a rehabilitation specialist if detected, especially when a disparity of 10° or more exists between flexion or extension values.

Muscle Atrophy

As a measure of muscle atrophy in postoperative TPLO dogs, several studies have evaluated thigh circumference.[9,11,28,30] Three of these studies demonstrated preoperative reductions in affected limb circumference, with either no change or no further circumference reductions during the first 8 postoperative weeks, which could be improved through in-clinic rehabilitation.[11,28,30] Especially for patients with both persistent muscle atrophy and stifle rotational instability, referral to a rehabilitation specialist is recommended to optimize patient outcomes.[5,20]

Myofascial Sensitivity

The veterinary literature contains little data describing postoperative myofascial pain resulting from surgical technique and/or compensatory postural changes and weight shifting after CCLR and TPLO. Kirkby Shaw et al. recently described the typical elevation of the pes anserinus (the conjoined tendons of the sartorius, gracilis, and semimembranosus muscles) during TPLO and subsequent postoperative restrictions and sensitivities in these muscles.[5] The same review also describes the potential for increased compensatory loading and subsequent myofascial sensitivity and trigger point development in overloaded muscles. In the authors' experience, most commonly detected muscle sensitivities are in the affected limb's sartorius and iliopsoas, bilateral thoracolumbar epaxial, latissimus dorsi, and trapezius muscles. A combination of manual therapies, exercises, and therapeutic modalities may help alleviate myofascial sensitivities and hasten return to normal posturing and weight bearing.

Abnormal Function

During evaluation of postoperative TPLO dogs, function (e.g., walking and changing postures) should be assessed. Abnormalities, such as walking with a pivot shift or sitting with reduced stifle and/or tarsal flexion or with external rotation of the hindlimb, indicate persistent compensation.[5] Persistent compensatory postures may indicate continued pain or instability, reduced ROM, or altered proprioception and should prompt further evaluation and potential referral to a rehabilitation specialist or orthopedic surgeon.

Progressive Osteoarthritis

Osteoarthritis progression after CCLR is expected, and several studies have evaluated the effects of TPLO stabilization on this progression.[7,14,31] The longest study reported significant radiographic progression of osteoarthritis in all dogs by 24 months postoperatively.[30] Shorter studies reported significantly higher radiographic osteoarthritis scores in affected stifles compared with preoperative scores for 77% of dogs at 8 weeks and 40% at 6 months postoperatively.[7,14] Overall, these studies demonstrate continued progression of stifle osteoarthritis in most dogs after TPLO. Osteoarthritis scores were higher for larger than for smaller dogs[7] and for dogs with meniscal injury than without.[14] An additional study of the potential effects of rehabilitation and/or a diet supplemented with omega-3 fatty acids and protein on stifle osteoarthritis progression after TPLO reported that both of these interventions significantly reduced postoperative osteoarthritis scores.[14]

SUMMARY

TPLO is one of the most commonly recommended and most successful surgical procedures for CCLR. Recovery after TPLO can be long and oftentimes frustrating for clients but can also result in the best return to function, given that complications arise in only 10% to 25% of patients.[15] An understanding of the potential complications and sequelae can help guide therapy postoperatively and enable improved counseling of clients on what to expect after surgery. Mild routine complications may be handled by the general practitioner; however, with regard to more severe complications, it is important to know when a patient should be referred back to the orthopedic surgeon or to a rehabilitation specialist. TVP

References

1. Kowaleski M, Boudrieau R, Pozzi A. Stifle joint. In: Johnston S, Tobias K, Peck J, Kent M, eds. *Veterinary Surgery: Small Animal*. Vol 1. 2nd ed. St. Louis, MO: Elsevier; 2018:1071-1168.
2. Bergh MS, Sullivan C, Ferrell CL, et al. Systematic review of surgical treatments for cranial cruciate ligament disease in dogs. *JAAHA*. 2014;50(5):315-321.

3. Krotscheck U, Nelson SA, Todhunter RJ, et al. Long term functional outcome of tibial tuberosity advancement vs. tibial plateau leveling osteotomy and extracapsular repair in a heterogeneous population of dogs. *Vet Surg*. 2016;45(2):261-268.
4. Romano LS, Cook JL. Safety and functional outcomes associated with short-term rehabilitation therapy in the postoperative management of tibial plateau leveling osteotomy. *Can Vet J*. 2015;56(9):942-946.
5. Kirkby Shaw K, Alvarez L, Foster SA, et al. Fundamental principles of rehabilitation and musculoskeletal tissue healing. *Vet Surg*. 2020;49(1):1-11.
6. Lee JY, Kim G, Kim JH, Choi SH. Kinematic gait analysis of the hind limb after tibial plateau leveling osteotomy and cranial tibial wedge osteotomy in ten dogs. *J Vet Med A Physiol Pathol Clin Med*. 2007;54(10):579–584.
7. Hurley CR, Hammer DL, Shott S. Progression of radiographic evidence of osteoarthritis following tibial plateau leveling osteotomy in dogs with cranial cruciate ligament rupture: 295 cases (2001-2005). *JAVMA*. 2007;230(11):1674–1679.
8. Heldorn SN, Canapp SO, Zink CM, et al. Rate of return to agility competition for dogs with cranial cruciate ligament tears treated with tibial plateau leveling osteotomy. *JAVMA*. 2018;253(11):1439–1444.
9. Baltzer WI, Smith-Ostrin S, Warnock JJ, Ruaux CG. Evaluation of the clinical effects of diet and physical rehabilitation in dogs following tibial plateau leveling osteotomy. *JAVMA*. 2018;252(6):686–700.
10. Gallaher HR, Butler JR, Wills RW, et al. Effects of short- and long-term administration of nonsteroidal anti-inflammatory drugs on osteotomy healing in dogs. *Vet Surg*. 2019;48(7):1318–1329.
11. Monk ML, Preston CA, McGowan CM. Effects of early intensive postoperative physiotherapy on limb function after tibial plateau leveling osteotomy in dogs with deficiency of the cranial cruciate ligament. *Am J Vet Res*. 2006;67(3):529–536.
12. Thieman KM, Tomlinson JL, Fox DB, et al. Effect of meniscal release on rate of subsequent meniscal tears and owner assessed outcome in dogs with cruciate disease treated with tibial plateau leveling osteotomy. *Vet Surg*. 2006;35(8):705-710.
13. Verpaalen VD, Baltzer WI, Smith-Ostrin S, et al. Assessment of the effects of diet and physical rehabilitation on radiographic findings and markers of synovial inflammation in dogs following tibial plateau leveling osteotomy. *JAVMA*. 2018;252(6):701–709.
14. Wayward RM, Thomson DG, Davies JV, et al. Progression of osteoarthritis following TPLO surgery: a prospective radiographic study of 40 dogs. *J Small Anim Pract*. 2004;45(2):92–97.
15. Bergh MS, Peirone B. Complications of tibial plateau leveling osteotomy in dogs. *Vet Comp Orthop Traumatol*. 2012;25(5):349–358.
16. Marchevsky AM, Read RA. Bacterial septic arthritis in 19 dogs. *Aust Vet J*. 1999;77(4):233–237.
17. Bergh MS, Rajala-Schultz P, Johnson KA. Risk factors for tibial tuberosity fracture after tibial plateau leveling osteotomy in dogs. *Vet Surg*. 2008;37(4):374–382.
18. Taylor J, Langenbach A, Marcellin-Little DJ. Risk factors for fibular fracture after TPLO. *Vet Surg*. 2011;40(6):687–693.
19. Tuttle TA, Manley PA. Risk factors associated with fibular fracture after tibial plateau leveling osteotomy. *Vet Surg* 2009;38(3):355–360.
20. Gatineau M, Dupuis J, Plante J, Moreau M. Retrospective study of 476 tibial plateau levelling osteotomy procedures: rate of subsequent 'pivot shift', meniscal tear and other complications. *Vet Comp Orthop Traumatol*. 2011;24(5):333–341.
21. Fitzpatrick N, Solano MA. Predictive variables for complications after TPLO with stifle inspection by arthrotomy in 1000 consecutive dogs. *Vet Surg*. 2010;39(4):460-474.
22. Mattern KL, Berry CR, Peck JN, De Haan JJ. Radiographic and ultrasonographic evaluation of the patellar ligament following tibial plateau leveling osteotomy. *Vet Radiol Ultrasound*. 2006;47(2):185–191.
23. Gallagher A, Cross AR, Sepulveda G. The effect of shock wave therapy on patellar ligament desmitis after tibial plateau leveling osteotomy. *Vet Surg*. 2012;41(4):482–485.
24. Case JB, Hulse D, Kerwin SC, Peycke LE. Meniscal injury following initial cranial cruciate ligament stabilization surgery in 26 dogs (29 stifles). *Vet Comp Orthop Traumatol*. 2008;21(4):365-367.
25. Barnes K, Lanz O, Werre S, et al. Comparison of autogenous cancellous bone grafting and extracorporeal shock wave therapy on osteotomy healing in the tibial tuberosity advancement procedure in dogs. *Vet Comp Orthop Traumatol*. 2015;28(3):207-214.
26. Kieves NR, MacKay CS, Adducci K, et al. High energy focused shock wave therapy accelerates bone healing. *Vet Comp Orthop Traumatol*. 2015;28(6):425-432.
27. Selmic LE, Ryan SD, Ruple A, et al. Association of tibial plateau leveling osteotomy with proximal tibial osteosarcoma in dogs. *JAVMA*. 2018;253(6):752-756.
28. Varcoe GM, Manfredi JM, Jackson A, Tomlinson JE. Effect of tibial plateau levelling osteotomy and rehabilitation on muscle function in cruciate-deficient dogs evaluated with acoustic myography. *Compar Exerc Physiol*. E-pub ahead of print June 10, 2021. doi: 10.3920/CEP200085
29. Gordon-Evans WJ, Dunning D, Johnson L, Knap KE. Randomised controlled clinical trial for the use of deracoxib during intense rehabilitation exercises after tibial plateau levelling osteotomy. *Vet Comp Orthop Traumatol*. 2010;23(5):332-333.
30. Jandi AS, Schulman AJ. Incidence of motion loss of the stifle joint in dogs with naturally occurring cranial cruciate ligament rupture surgically treated with tibial plateau leveling osteotomy: longitudinal clinical study of 412 cases. *Vet Surg*. 2007;36(2):114-121.
31. Au KK, Gordon-Evans WJ, Dunning D, et al. Comparison of short- and long-term function and radiographic osteoarthrosis in dogs after postoperative physical rehabilitation and tibial plateau leveling osteotomy or lateral fabellar suture stabilization. *Vet Surg* 2010;39(2):173-180.

Christina Montalbano

Dr. Montalbano is a sports medicine and rehabilitation/integrative medicine resident at the University of Florida. She received her VMD degree from the University of Pennsylvania and completed a specialty internship in integrative medicine at the University of Florida before pursuing residency. She has a special interest in injury prevention and recovery in sporting and working dogs.

Kelly Deabold

Dr. Deabold is a sports medicine and rehabilitation/integrative medicine resident at the University of Florida. She received her DVM degree from St. George's University in Grenada and completed a small animal rotating internship at Pittsburgh Veterinary Specialty and Emergency Clinic, BluePearl. She has diverse clinical interests and a special interest in management of canine osteoarthritis, neurologic diseases, and postoperative rehabilitation.

Erin Miscioscia

Dr. Miscioscia is a clinical assistant professor of integrative medicine at the University of Florida College of Veterinary Medicine. She received her DVM degree from Cornell University and completed her residency in canine sports medicine and rehabilitation/integrative medicine at the University of Florida. Her primary research focus is the efficacy of integrative therapies in veterinary medicine, especially for the management of canine osteoarthritis and mobility.