

POST-OPERATIVE CRANIAL CRUCIATE LIGAMENT REPAIR REHABILITATION PROGRAM

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Anterior cruciate ligament (ACL) surgeries are common in both humans and dogs. Post-operative rehabilitation has been studied more thoroughly for this condition than any other orthopedic surgery and can be used as a model for post-operative rehabilitative care in general.

Physiotherapy can accelerate or salvage recovery time of some patients and it can make either the best or worst surgical procedure better.²⁵ The goals for any post-operative case are to reduce pain, promote healing, maintain muscle mass and promote muscular development and joint stability, maintain joint flexibility, retrain proprioception, balance and coordination, facilitate early return to function, prevent degenerative joint disease and rebuild cardiovascular endurance.^{11, 12, 21, 25} Physiotherapy is also important for addressing complications that can ensue with any post-operative case such as identification of infections or surgical failure, treatment of secondary tendonitis, or soft tissue adhesions.²¹

In human ACL deficient knees, the sartorius, gracilis and vastus medialis muscles exhibit a small decrease in power, while there is a significant decrease in power of the semi tendinosus, rectus femoris, tensor fascia lata, vastus lateralis and the lateral head of gastrocnemius.²⁷ Muscle firing patterns were also altered and displayed a greater magnitude of co-contractions than normal legs.²⁷ Proprioception is the ability to receive input from muscles, tendons and joints and process info in a meaningful way in the central nervous system and assists in the knowledge of where the limb is in space and ultimately results in the regulation of reflexes and motor control.¹² Human ACL reconstruction results in proprioception deficits in both the involved and non-involved limbs at 3, 6, 9 and 12 months post-operatively.¹²

The general goals for all post-operative rehabilitation will be very similar and can be categorized into stages of healing. A two-part division of physical therapy goals has been documented for dogs.⁴ Phase one; immediately following surgery and in the initial inflammatory stage of tissue healing through to the end of the reparative stage, which could last approximately 3 – 4 weeks. Goals in this stage would be to resolve pain and inflammation, stimulate early tissue healing, preserve muscle mass, joint ROM and articular homeostasis as well as to prevent mechanically dysfunctional compensatory postures and movement strategies by the patient. Phase two; which follows the initial stage and would target challenging the healing tissues during remodeling and maturation stages of healing to improve strength and mobility, and mobilize scar tissue and enhance functional return.^{4, 21, 25} This author feels that it would be more appropriate to divide the post-operative rehabilitation into 4 stages: acute phase, sub-acute phase, mid-stage and end stage. Human post-operative protocols for athletes recovering from ACL reconstruction recognize six stages/phases to a post-operative strengthening program.¹² A combination of goals, theories and suggestions will be presented below.^{1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28.}

Acute Stage (weeks 1 – 3)

Lifestyle management: To reduce the risk of re-injury, it is imperative to educate the owners about avoiding rough play, toileting while on-leash only, short 5 minute walks, building up to 10 minutes by the end of week three, no excessive stair negotiations, no jumping and promotion of non-slip flooring (i.e. rubber-backed slip-rugs). In very early stages post-operatively slings may be necessary to help the dog ambulate to perform toileting tasks.

Manage inflammation: Low doses of modalities (ultrasound, laser or pulsed electromagnetic field) can be useful to reduce inflammation after the first 24 – 48 hours post-op. Cryotherapy can also be used on a regular basis for home management. Grade 1 Maitland's mobilizations for the joint (joint glides, joint distraction or joint compression) may also assist in settling the joint. NMES to the surrounding musculature may also have a positive effect on joint inflammation and adjacent soft tissue swelling.

Enhance or maintain range of motion (ROM): Passive ROM, avoiding pain at end ranges, can help to maintain normal joint ROM, and may also improve circulation and via stimulation of proprioceptive mechanoreceptors may aid in sensory awareness. Active ROM may be accomplished through easy weight shifting activities to regain some extension in the stifle or hock. Easy, active hip extension may be accomplished by 'tummy rubs' at this stage. Gentle active flexion could be accomplished by creating a 'scratching' reflex for the hind leg or by gently pinching the toes of the affected leg to stimulate a reflexive pulling away response. Additionally, active hind limb flexion can be accomplished by proper 'sit' training; having the owners give a verbal command to sit, correct any improper postures such as side sitting (which avoids flexing the hind limb) by tapping on the offending limb or re-verbalizing the command until a proper 'sit' is given before giving a treat reward.

Proprioception: At this stage, ROM and grade 1 Maitland's mobilizations may stimulate ruffini ending, or pacinian corpuscles within the joint capsule that can re-awakening the mind's awareness of the body which is necessary after any surgical intervention. Massage to the affected limb may stimulate golgi tendon organs and muscle spindles. Weight shifting activities and the allowance of partial weight bearing will not only aid in return to normal function, but is also a proprioceptive stimuli. The use of a NMES with the weight shifting activities may target both early strengthening as well as proprioception.

Address Axial skeleton Issues: Clinically, physical therapists have reported finding spinal or sacroiliac joint dysfunctions subsequent to prolonged lameness issues.^{8, 15} A study of a population of horses with orthopaedic problems found that 74% of horses with back problems had lameness and that back problems were diagnosed in 32% of the lame horses. These findings were significantly higher than those recorded in a control population.¹⁷ This would mean that the post-operative animal could be at risk of developing back pain secondary to postural alterations following surgery. This author recommends evaluating the spine and pelvis on a regular basis throughout the rehabilitation process.

Subacute Phase (4 – 6 weeks)

Strengthening: In this stage, the animal must start to build its muscular support surrounding the affected joint. Both closed-chain and open chain exercises have been recommended and found to be of benefit when combined in a post-operative exercise program. The therapist may prescribe slowly beginning to challenge the weight bearing status of the limb with activities such as static balancing by lifting one or two of the unaffected limbs off the ground (with or without the additional use of NMES on those muscle mentioned above which are most prone to atrophy following cruciate repair), walking up or down gradually sloping hills, or stepping over poles or objects (closed-chain). Muscular endurance should also be targeted and increasing walking times / distances should begin; gradually increasing to 20 minutes by the end of this stage. Use of a hydro-treadmill or pool swimming may be effective for strengthening at this stage as well (open-chain).

Soft tissue stretching and ROM: Care should be taken to not only address ROM deficits of the stifle joint, but to also manage ROM of the joints above and below. Compensatory gait alteration may have affected the adjacent joints. Hock flexion in particular should be encouraged and monitored. Muscle stretching of two-joint muscles should also be undertaken, as they will not be stretched with simple ROM (i.e. sartorius, the hamstring muscle group and the calcaneal tendon and the muscles which comprise it should be addressed / stretched with stifle surgeries).

Proprioception: Proprioception can be challenged to a greater extent in this phase. Use of balance boards, slow walking on uneven or unstable surfaces, or walking over obstacles may target this goal. Nearer the end of this stage, the static balancing exercises described above can be progressed to include small manual balance perturbations while holding positions.

Mid Stage (7 – 9 weeks)

Strengthening and Proprioception: Increasing time, distances, speed or terrain traversed during leashed-walks will aid in strengthening. Steeper hill and/or walking of stairs may aid in advanced strengthening. Trotting exercises may be appropriate. Use of static balancing on two legs (this author prefers making the animal balance on the surgical leg and its opposite front limb by holding the other diagonal pair off the ground) with manual displacement or while on a novel surface (i.e. foam or mini trampoline) can challenge both strength and proprioception. Stepping-over exercises moving both laterally, rotationally, or backwards may also increase the difficulty. Walking on a plank of wood elevated a few inches above the ground will address coordination issues, and may be combined with volitional balance disturbances (i.e. such as making the dog turn to take treats from side to side).

Gait retraining: Often dogs will develop compensatory postural or movement strategies following a surgery. Many of the exercise and proprioceptive techniques described above can address these issues, but other therapeutic interventions might include taping or bandaging techniques to promote proper limb usage.

End Stage (10 weeks +)

Strengthening and Proprioception: If healing has been occurring appropriately and according to schedule, then advanced strengthening techniques can be encouraged, such as destination jumping (i.e. on to a bed or over a jump). Longer trotting sessions may be necessary to build up muscular and cardiovascular endurance. A gradual return to off-leash activities may begin after 12 weeks, dependent upon the safety issues (i.e. time of the year and condition of the ground for non-slip footing, only when not near other dogs that might initiate rough play, etc). Owners need to be instructed to allow for a long warm up (10 minute or more) before allowing a short off-leash run (consisting of just 5 minutes off-leash to start) or that the initiation of the off-leash time should occur in the middle of the dog's walk. Straight line running can be attempted (i.e. asking the animal to run back and forth between two people).

Return to Sports (14 weeks +)

Strengthening and Proprioception: As mentioned above, if healing has not been compromised during the post-operative period and the owners are determined to return the animal to sporting activities, then advanced training and intensive rehabilitation must be accomplished. Plyometrics, jumping, agility training, sport specific training, sprints, training using greater balance perturbations, quick directional changes/pivoting/ figure of 8 exercises at sub maximal effort at first, then progressing to greater speeds, cardiovascular endurance and a continuation of strength training should be targeted.

Important to note for post-operative rehabilitation

Not all surgical interventions will progress at the same rate although they will go through the same healing stages. It is important to make the post-operative rehabilitation specific to the extent of the surgery and the animal's rate of healing. The physiotherapist should regularly assess when it is appropriate to progress through the various stages/phases of rehabilitation or to determine if a referral back to the surgeon is required.

References:

1. Berend KR, Lombardi AV JR, Mallory TH. (2004) 'Rapid recovery protocol for peri-operative care of total hip and total knee arthroplasty patients.' *Surg Technol Int.* 13: pp 239 – 247.
2. Bocobo C et al. (1991) 'The effect of ice on intra-articular temperature in the knee of the dog.' *Am J Phys Med Rehab.* 70 (4): pp 181.185.
3. Bowditch M. (2001) 'Anterior cruciate ligament rupture and management.' *Trauma.* 3 (4): pp 249 -262.
4. Clark B, McLaughlin RM. (2001) 'Physical rehabilitation in small-animal orthopedic patients.' *Vet Med.* March: pp 234 – 247.
5. Davidson JR, Kerwin SC, Millis DL. (2005) 'Rehabilitation for the orthopedic patient.' *Vet Clin Sm Anim Pract.* 35 (6): pp 1357 – 1388.
6. Delitto A et al. (1988) 'Electrical stimulation versus voluntary exercise in strengthening thigh musculature after anterior cruciate ligament surgery.' *Phys Ther.* 68 (5): pp 660 -663.
7. Edge-Hughes LM. 'Introduction to Canine Rehabilitation.' Course manual. Copyright 2006, Laurie Edge-Hughes, BScPT.
8. Edge-Hughes LM. (2001) 'Check out that pelvis'. *CHAP Newsletter.* Summer/Fall: pp 4 – 5.

9. Fitzgerald GK, Axe MJ, Snyder-Mackler L. (2000) 'Proposed practice guidelines for non-operative anterior cruciate ligament rehabilitation of physically active individuals.' *J Orthop Sports Phys Ther.* 30 (4): pp 194 – 203.
10. Fitzgerald GK, Piva SR, Irrgang JJ. (2003) 'A modified neuromuscular electrical stimulation protocol for Quadriceps strength training following anterior cruciate ligament reconstruction?' *J Orthop Sports Phys Ther.* 33: 492 – 501.
11. Francis DA, Millis DL, Stevens M et al. (2002) 'Bone and muscle loss from disuse following cranial cruciate ligament transection and stifle stabilization surgery.' In *Proceeding of the 2nd International Symposium on Rehabilitation and Physical Therapy in Veterinary Medicine.* pp 203 - 204. (Knoxville, TN, USA).
12. Hewett TE, Paterno MV, Myer GD. (2002) 'Strategies for enhancing proprioception and neuromuscular control of the knee.' *Clin Orthop Rel Res.* 402: pp 76 – 94.
13. Johnson JM et al. (1997) 'Rehabilitation of dogs with surgically treated cranial cruciate ligament-deficient stifles by use of electrical stimulation of muscles.' *Am J Vet Res.* 58 (12): pp 1473 – 1478.
14. Johnson JM, Johnson AL. (1993) 'Cranial cruciate ligament rupture. Pathogenesis, diagnosis and postoperative rehabilitation.' *Vet Clin N Am Sm Anim Pract.* 23 (4): pp 717 – 733.
15. Kerfoot L. (1997) 'An introduction to topline dysfunction in the equine athlete.' *CHAP Newsletter.* Fall: pp 8 – 10.
16. Kvist J. (2004) 'Rehabilitation following anterior cruciate ligament injury. Current recommendations for sports participation.' *Sports Med.* 34 (4): pp 269 – 280.
17. Landman MA, de Blaauw JA, van Weeren PR et al. (2004) 'Field study of the prevalence of lameness in horses with back problems.' *Vet Rec.* 155 (6): pp 165 – 168.
18. Lephart SM et al. (1997) 'The role of proprioception in the management and rehabilitation of athletic injuries.' *Am J Sports Med.* 25 (1); pp 130 – 137.
19. Marsolais GS, Dvorak G, Conzemius MG. (2002) 'Effects of postoperative rehabilitation on limb function after cranial cruciate ligament repair in dogs.' *J Am Vet Med Assoc.* 220 (9): pp 1325 – 1330.
20. Marsolais GS et al. (2003) 'Kinematic analysis of the hind limb during swimming and walking in healthy dogs and dogs with surgically corrected cranial cruciate ligament rupture.' *J Am Vet Med Assoc.* 222 (6): pp 769 – 743.
21. Nwadike BS, Hesback A. (2004) 'Rehabilitation of fracture patients.' In *Proceedings of the 3rd International Symposium on Rehabilitation and Physical Therapy in Veterinary Medicine.* pp 141 – 144. (Research Triangle Park, NC, USA).
22. Perry MC, Morrissey MC, King JB et al. (2005) 'Effects of closed versus open kinetic chain knee extensor resistance training on knee laxity and leg function in patients during the 8- to 14-week post-operative period after anterior cruciate ligament reconstruction.' *Knee Surg Sports Traumatol Arthrosc.* 13: pp 357 – 369.
23. Ross MD, Denegar CR, Winzenried JA. (2001) 'Implementation of open and closed kinetic chain quadriceps strengthening exercises after anterior cruciate ligament reconstruction.' *J Strength Cond Res.* 15 (4): pp 466 – 473.
24. Shaw T, Williams MT, Chipchase LS. (2005) 'Do early quads exercises affect the outcome of ACL reconstruction? A randomized controlled trial.' *Aust J Physio.* 51 (1): pp 9 – 17.
25. Taylor RA, Adamson CP. (2002) 'Stifle surgery and rehabilitation.' In *Proceeding of the 2nd International Symposium on Rehabilitation and Physical Therapy in Veterinary Medicine.* pp 143 – 146. (Knoxville, TN, USA).
26. Uthoff HK, Sekaly G, Jaworski ZF. (1985) 'Effect of long-term non-traumatic immobilization on metaphyseal spongiosa in young adult and old beagle dogs.' *Clin Orthop.* 192: p 278 – 284.
27. Williams GN et al. (2003) 'Specificity of muscle action after anterior cruciate ligament injury.' *J Orthop Res.* 21: pp 1131 – 1137.
28. Zink MC. (1997) *Peak Performance. Coaching the Canine Athlete.* (Canine Sports Productions: Lutherville, MD, USA).