Rehabilitation of companion animals following orthopaedic surgery

WI Baltzer [*§]

[*]School of Veterinary Science, Massey University, Palmerston North, 4442, New Zealand
Author for correspondence. Email: w.baltzer@massey.ac.nz

Supplementary Table 1. Summary of published studies evaluating different therapies used for rehabilitation during the immediate (first 72 hours), subacute (3 days to weeks), and chronic (weeks to months) phases following orthopaedic surgery.

Therapy	Phase of recovery	Goals of therapy	Method	Outcomes	References
Joint surgery					
Cryotherapy	Immediate	Reduce inflammation and pain. Improve mobility and limb use	CCL repair surgery, ice pack around the limb from the stifle to the hock and secure with an elastic bandage, 20 minutes, every 4-6 hours	Improved weight bearing and ROM	Rexing *et al.* 2010 Kieves *et al.* 2016 Ho *et al.* 1994 Martin *et al.* 2001
Cold compression system cryotherapy	Immediate	Reduce inflammation and pain. Improve mobility, and limb use	CCL repair surgery, immediately pre- and post-operative or every 4-6 hours for up to 72 hours	Improved weight bearing, ROM and reduced pain scores	Ho *et al.* 1994 Kirkby Shaw *et al.* 2019 Freeden *et al.* 2017 Critti *et al.* 2016
Early limited mobility	Immediate Subacute	Restore weight-bearing, balance and proprioception Develop normal gait patterning	Experimental CCL transection, crate rest without external coaptation for 6 weeks	Increased weight bearing and functional recovery	Piper and Whiteside 1980
Early limited mobility with electrical stimulation and swimming	Immediate Subacute Chronic	Reverse arthrogenic muscle inhibition. Restore weight bearing, balance, proprioception, flexibility, ROM and muscle strength. Return normal neuromuscular patterning. Reverse compensatory patterns in other limbs. Restore level of activity	Extracapsular suture repair CCL: Walking 15-30 minutes, 3-4x daily for 6 weeks versus 2-4x weekly swimming and daily electrical stimulation	No difference in outcome	Jerre 2009

			Extracapsular suture repair CCL: Passive ROM, electrical stimulation, swimming for 2 weeks vs. walking	Increased thigh mass and ROM	Millis *et al.* 1997
Early limited mobility, passive ROM exercises and swimming	Immediate Subacute Chronic	As above	Extracapsular suture repair CCL: Every other week twice daily Passive ROM, massage, swimming 10 minutes weeks 3, 5, 7 versus walking 0.3 miles daily	Improved weight bearing.	Marsolais *et al.* 2002
			TPLO repair for CCL rupture: Cryotherapy, massage, Passive ROM, therapeutic exercise daily and 3x weekly UWT for 6 weeks versus walking 5-30 minutes 2x daily	Increased thigh mass and range of motion	Monk *et al.* 2006
Aquatic therapy	Subacute Chronic	As above	Extracapsular suture repair CCL: Cryotherapy, Passive ROM, electrical stimulation, aquatic therapy	Improved functional recovery (eight dogs)	Berte *et al*. 2012
			TPLO repair for CCL: rupture Therapeutic exercise (sit to stands), UWT 1-3x weekly for 8 weeks versus leash walks	Improved weight bearing, increased activity, reduced osteoarthritis progression	Baltzer *et al.* 2018 Verpaalen *et al.* 2018
Neuromuscular electrical stimulation	Immediate Subacute	Reduce inflammation and pain. Improve mobility and ROM. Promote controlled limb use. Recruit muscle activation	Once daily to 3 times per week for 8 weeks	Improved lameness, reduced radiographic osteoarthritis, but increased meniscal damage	Johnson *et al.* 1997
Photobiomodulation (laser therapy)	Immediate Subacute	Reduce inflammation and pain. Facilitate healing Improve mobility and ROM	Single treatment immediately preoperative TPLO for CCL rupture, 800- 970 nm duel energy, 3.5 j/cm^2	Improved weight-bearing at 8 weeks postoperatively	Rogatko *et al.* 2017
			Daily postoperative TPLO for CCL rupture: 635 nm wavelength, 2.25 j/cm^2	No significant effect *vs.* controls	Kennedy *et al.* 2018
Tendon, ligament repair					
Passive ROM exercises	Immediate Subacute Chronic	Recruit muscle activation. Restore weight-bearing, proprioception, and normal gait patterning	Flexor tendon repair surgery, Passive ROM 12 cycles per minute for 5 minutes once a day	Increased joint ROM and weight bearing	Takai *et al.* 1991

Bone fracture healing					
Extracorporeal shockwave therapy	Immediate Subacute	Reduce inflammation and pain. Facilitate healing	Experimentally induced tibial fracture 2000 pulses at 14 kV	Increased bone union at 12 weeks	Wang *et al*. 2001
			CCL repair following TPLO or TTA 1,000 pulses, 0.15 mJ/cm^2 repeated once at 2 or 4 weeks	Increased bone density compared to sham-treated	Barnes *et al*. 2015 Kieves *et al*. 2015
Therapeutic ultrasound	Immediate Subacute Chronic	Reduce inflammation and pain. Facilitate healing.	Following osteochondral autograft for joint defects 6 days/week for 6 weeks (30 mW/cm^2, 1.5 MHz, burst width 200 microseconds)	Enhanced transplant survival	Cook *et al*. 2008
			20 minutes daily for 4 weeks (1 MHz, 200 microsecond burst, 50 mW/cm^2 induced bone defect in dogs	Increased bone production *vs*. control	Yang 2001
			Post-TPLO for CCL repair: 20 minutes daily for12 weeks (1.5 MHz, 30 mW/cm2, 20% duty cycle)	No difference in outcome or bone production	Kieves *et al*. 2018
Hemilaminectomy [a]					
Photobiomodulation (laser therapy)	Immediate Subacute	Reduce inflammation and pain. Improve mobility, ROM. Return normal neuromuscular patterning.	810 nm wavelength, 5x200 mW, pulsed mode once daily for 5 days	Ambulatory in 3 days *vs*. 14 days in controls	Draper *et al*. 2012
			635-nm wavelength, 4x5 mW, pulsed mode once daily for 4 days	No significant effect	Bennaim *et al*. 2017

[a] For thoracolumbar intervertebral disc herniation

CCL=cranial cruciate ligament; ROM=range of motion, TPLO=tibial plateau levelling osteotomy, TTA=tibial tuberosity advancement; UWT=underwater treadmill therapy