

SUPPLEMENT 1. Non-operative treatment protocol for acute ACL injury in SMC (Samsung Medical Center) Knee Clinic (version 1.0.)

Phase (weeks)	I (-2 weeks) Immediate Intervention	II (2-6 weeks) Early Intervention	III (6-8 weeks) Late Intervention	IV (8-12 weeks) Transitional Phase		V (3-6 months) Preparation Phase	VI (6-12 months) Return to Sports
				(8-10 weeks)	(10-12 weeks)		
1. Management of pain and swelling	- Cryotherapy - Compression and elevation	- Cryotherapy	- Cryotherapy				
2. Protection	- Brace 0-90 - Crutches - Wt bearing ambulation as tolerable	- Brace application (~ 4 weeks: 0-120, ~ 6 weeks: 0-135) - Crutches: (*cease during 2~4 weeks) - Full wt bearing ambulation	- Brace application (~ 8 weeks: 0-135) - No Crutches - Full wt bearing ambulation	- Brace, (as required) :**Instability(+) → apply Instability(-) → no brace - Full wt bearing ambulation	- Brace, (as required) : Instability(+) → apply Instability(-) → no brace - Full wt bearing ambulation		
3. ROM and stretching	- ROM full extension - ROM 0-90 - Patellar mobilization - Stretching calf and hamstring	- ROM full extension - PROM and AAROM - Patellar mobilization - Stretching calf and hamstring	- ROM full extension - PROM and AAROM - Full ROM - Stretching calf and hamstring	- ROM full extension: - AAROM - Full ROM - Stretching calf and hamstring	- ROM full extension: - AAROM - Full ROM - Stretching calf and hamstring	- ROM full extension: - Full ROM - Stretching required	- ROM full extension: - Full ROM - Stretching required
4. Muscle strengthening exercise	- Q set and SLR (brace applied state)	- Q set and SLR (brace applied state 15-75) - Heel-raise/toe-raise - Isometric training (60,30) - OKC exercise 1) Active knee flexion (hamstring curls) light resistance 10-70	-Resistance SLR as tolerable (ankle wt. < 10% of body wt.) - Heel-raise/toe-raise - Isometric training (90,60, 30) - OKC exercise 1) Active knee extension 2) Active knee flexion	- SLR with rubber tubing - Isometric training (90, 60, 30) - OKC exercise 1) Active knee extension with resistance, 90-30 2) Active knee flexion (hamstring curls) with resistance 0-90 - Progressive, resistance to weight machine as tolerated - † Aerobic conditioning	- SLR with rubber tubing - Isometric training (90, 60, 30) - CKC exercise 1) Mini-squats 10-70 2) Wall slides 10-70 3) Leg press 10 –70 - OKC exercise 1) Active knee extension 9-0 2) Active knee flexion Progressive, resistance to weight machine as tolerated - Aerobic conditioning	- Muscle strengthening advancement (OKC/CKC) 1) Bilateral to unilateral (CKC) 2) Increasing resistance 3) Increasing to full arc -Aerobic conditioning	- Muscle strengthening - Aerobic conditioning
5. Neuromuscular training		-Weight shifting exercise	- Balance training 1) Balance board (two-legged) 2) Perturbation (two-legged)	- Balance training 1) Balance board (two-legs) 2) Perturbation (two-legs) 3) Resistance band walking 4) Plyoback ball toss 5) Lateral step-up	- Balance training 1) Balance board (single-leg) 2) Perturbation (single-leg) 3) Resistance band walking 4) Plyoback ball toss 5) Lateral step-up	- Balance training - Perturbation training	- Advance to balance and perturbation training (training depending on quad index) - Advance to single-leg activities eg.) balance with secondary activity
6. Tech to increase muscular strength, power and endurance					- Fast walk, Backward walk (straight, no jumping or cutting) - Stair stepper/NordicTrack - Bicycle exercise	- In-line jogging (no jumping or cutting) * progression of speed : 1/2~full, backward run	- Start agility exercises : gradually progress to sprinting and cutting drills (training depending on quad index)

7. Functional exercise					- Functional training 1) Carioca 2) Lunges with sport cord 3) Forward/ backward running 4) In-place jogging w/ sports cord 5)Pool running	- Functional training 1)More challenging and emphasize correct movement patterns 2) Progress to sport specific plyometric training drills →hop variations, skipping and bounding variations →return to throwing program in overhead throwers, etc	
8. Plyometrics					- Low level plyometrics 1) step and land 2) bilateral low level box drops	- Plyometric training : box hops (double-leg)	- continue plyometric training
9. Agility and Sports specific exercises					- Initiate sport-specific exercise 1) cone drills 2) side shuffles 3) cariocas - Walking-based agility exercises - Low impact aerobic training - Ergometer, elliptical, treadmill	- Basic agility exercises	- Gradual return to practice, starting with unopposed drills, progressing to opposed drills followed by return to competition - ‡ Sports-specific drills
10. Prevention of recurrent injury							- Encourage maintenance program for strength/endurance
11. Milestones for progression to the next phase	A. Adequate wound healing	A. Minimal pain and swelling	A. Normal gait	A.Performs activities of daily living	A. Adequate progression in neuromuscular balance training exercises	A. Ability to run for up to 1km without any pain or swelling or gait asymmetries	A. [§] Criteria for return to sport
	B. Controlled pain, swelling, effusion	B. Full active extension w/o lag	B. Isometric quadriceps strength at least 65% of contralateral knee (90, 60, 30)	B.Increase strength and endurance	B. Tolerance for low impact aerobic activities	B. No subjective sense of instability	B. Clinical scoring
	C. Full passive extension 90 passive flexion	C. Walking with full wt bearing, w/o crutches	C.Knee flexor/extensor strength ratio > 70-75 %		C. Single leg perturbation equivalent to contralateral leg	C. Isometric quadriceps strength (90, 60, 30), Single-leg function tests hop distance, timed hop : >80% of contralateral	
	D. Good patellar mobility	D. Single stance on affected leg with upper extremity assisted	D. Hamstring strength equal		D. Isometric quadriceps strength (90, 60, 30) : >70% of contralateral knee	D. Isokinetic test (isometric + torque 300degree /sec, % difference) : 20~25%	
		E. Isometric quadriceps strength at least 60% of contralateral knee (60,30)			E. Hamstring strength : > 70% contralateral extremity	E. Hamstrings/quadriceps ratio : > 70%	
		E. [§] Clinical scoring			F. Single-leg function tests, hop distance, timed hop, : >70% of contralateral knee	F. Joint arthrometer : <3mm	
					G. Clinical scoring	G. Clinical scoring	

* Crutches Cease Criteria : 1) minimal pain and swelling, 2) full passive extension, 3) at least 100° to 120° flexion, 4) SLR without extension lag, 5) normal gait pattern without crutches

** Instability (+) : If a hard endpoint was not palpable on the Lachman test or pivot-shift test was positive of more than grade 2

† Aerobic conditioning : 1) Water walking 2) Stationary bicycling 3) Swimming 4) Ski machine

‡ Sports-specific drills : 1) Cone drills, 2) Side shuffles, 3) Grapevine drill, 4) Cariocas, 5) Sudden start/stops, 6) Agility drills combination, 7) Sport- and position- specific skill training

§ Clinical scoring : 1) SMC patellofemoral, 2) Tegner activity, 3) Lysholm, 4) Knee injury and osteoarthritis outcome score (KOOS)

§§ Criteria for return to sport: 1) Passive and active extension symmetrical to the noninvolved knee, 2) Flexion within 5 degrees of the noninvolved knee, 3) Minimal pain, no increase swelling with exercise, 4) Quadriceps index and Hop test greater than or equal to 90% of the contralateral knee, 5) Tolerating full effort agility, jumping, hopping, cutting, and sprinting activities without asymmetries or symptoms, 6) Full participation in practice

AAROM; active assistive range of motion, CKC; closed kinetic chain, OKC; open kinetic chain, PROM; passive range of motion, Q set; quadriceps setting exercise, ROM; range of motion, SLR; straight leg raise exercise, Wt; weight,
