



---

# ORTHOPAEDICS

## ACL Reconstruction Rehab Protocol

---

### **Vonda J. Wright, MD**

6775 Chopra Terrace, Orlando, FL 32827

Ph: (407) 965-4114

Fax: (833) 408-2573

Anterior cruciate ligament (ACL) injuries occur more than 250,000 times per year in the United States. (Griffin 2006) The majority of these injuries are treated with surgical intervention to reconstruct the ACL. (Mall 2014). Northside Hospital Sports Medicine Network uses a criterion-based rehabilitation guideline to ensure the optimal level of success with return to sport. Each individual will be treated uniquely based upon the observations of the sports medicine team. It is vital that a multi-factorial approach is used during rehabilitation to decrease risk of re-injury. Safety of the patient is the number one priority.

	Jogging	Low-level agility	Cutting	Return to Sport
Autograft	4-5 months	5-6 months	6-7 months	9+ months
Allograft	5-6 months	6-7 months	7-8 months	10+ months

Timelines are estimated based upon current literature studying graft healing and patient progress in formal physical therapy. Concomitant procedures such as a meniscal repair may delay the timeframes listed above.

- Risk of knee reinjury was reduced by 58% for each month RTS was delayed until 9 months after surgery (Grindem BJSM 2016)
- Those who returned to level I sports had a 4.68 times higher risk of knee reinjury than those who did not (Grindem 2016)
  - Level 1 sport – Jumping, pivoting, hard cutting (basketball, football, soccer) (Daniel 1994)

### **Contact physician IF:**

- **Symmetrical knee extension not achieved by 4 weeks post-op**
- **> 2+ effusion on modified stroke test at 4 weeks post-op**
- **When athlete has passed functional return to sport testing and requires final clearance**

### **Do NOT progress at any point if patient experiences any of the following:**

- **Significant increase in joint effusion**
- **Obvious deviation in gait pattern**
- ***Increase in anterior knee pain!***

### **Pre-operative Instructions**

- Schedule post-op PT visit for 3-5 days after surgery.
- Flexion AROM limited to 60 degrees until 1 week post-op
- Complete home exercise program as outlined in handout
- Purchase NMES unit as recommended by surgeon and bring to initial PT evaluation

### **Initial Post-op Instructions**

- No bathing or submerging the incision in water until the sutures have been removed by the physician, the scabs have fallen off, and the skin is completely closed
- Showering is allowed after the surgical dressing is removed; a waterproof dressing is not needed as the incision can get wet. A shower seat may be used to decrease the risk of falls.
- Steri-strips will be used after suture removal by the physician to assist with incision closure. Allow steri-strips to fall off in their own time. No need to replace once they have fallen off.
- Weight-bearing as tolerated (WBAT) with the use of 2 crutches immediately after surgery unless instructed otherwise by the physician
- For R knee surgery, no driving for 4-6 weeks. Patients are medically liable if in a motor vehicle collision.
- For L knee surgery, patients may drive after 1 week as long as they have an automatic transmission vehicle and have discontinued use of narcotic

### **Brace Use Post-op (Manske)**

- Brace will be locked in full extension until initial PT evaluation. May be unlocked at that time
- Brace use can be discontinued using same criteria as discharging crutch use starting at 2-4 weeks
  - Brace use may be continued on individual basis per discussion with surgeon/PT

### **Crutch Use Post-op (Manske)**

- Patients will be WBAT with the use of 2 crutches immediately following surgery unless instructed otherwise by the physician.
  - Early WB beneficial to quadriceps activation and decreased anterior knee pain, with no increase in graft laxity (Manske)
- Patient will use 2 crutches for 2-4 weeks, at which point they will begin to wean off of crutch use.
- At no point will patient use only 1 crutch.
- Criteria to begin weaning off of crutches:
  - Symmetrical knee hyperextension with no pain on passive overpressure
  - Full active quadriceps contraction with superior patellar glide
  - No knee extension lag with 20 straight leg raises
  - Pain-free ambulation without obvious gait deviation
  - ≤2+ grade on stroke test for effusion
- Steps to wean off crutches. Progress to next step every 2 days
  - Discontinue use of crutches within home

- Complete short community trip without crutches (grocery store, etc)
- Complete half day of activities without crutches
- Complete full day of activities without crutches
- Do NOT progress to next step if patient experiences any of the following:
  - Significant increase in joint effusion
  - Significant increase in pain level
  - Obvious deviation in gait pattern

### **Special Weightbearing Guidelines for Concomitant Procedures**

- Brace will be worn and locked in extension for combined ACL/MCL procedures, concomitant meniscal repairs, and microfracture procedures.
- MENISCUS REPAIR: Patients will be NWB for 4 weeks, 50% WB for 2 weeks, then WBAT at 6 weeks post-op.
- MICROFRACTURE or ARTICULAR CARTILAGE PROCEDURE: Patients will be NWB for 4 weeks, 50% WB for 2 weeks, then WBAT at 6 weeks post-op.
- At 6-8 weeks post-op patients will wean off crutches as outlined above.

### **Phase 1: Immediate Postoperative Phase (Week 1-4)**

- Initial visit 3-5 days post-operatively
- Visit frequency 1-2x/week
  - Consider # of insurance visits, progress towards goals, concomitant procedures
- GOALS:
  - ROM:
    - Symmetrical knee hyperextension ASAP following surgery. Contact surgeon at 4 weeks post-op if not achieved.
    - Symmetrical flexion at 4 weeks post-op for ACLR only. No flexion >90° for meniscal repair.
  - Strength:
    - Active quadriceps contraction with superior patellar glide
  - Effusion:
    - Effusion management through compression (sleeve, ACE wrap, donut, etc), cryotherapy, elevation (Manske)
    - ≤2+ on stroke test
- INTERVENTIONS:
  - Flexion ROM:
    - Heel slides, wall slides, seated knee flexion w/ opposite LE overpressure
    - Upright bike for flexion ROM
      - Start with high seat height to allow for attempted retro revolutions
        - If needed, start with “half moon” or bottom half of revolution to allow for progression to full revolutions
        - If needed, use heel of foot on pedal if unable to complete full revolutions
      - Progress to forward revolutions
      - Decrease seat height as needed to achieve ROM gains
  - Extension ROM
    - Long sitting bag hangs
      - 2x10 minutes per day
      - Use 5-7# (waterbottles, books, etc) in reusable grocery bag

- Continue until symmetrical AROM in hyperextension achieved
  - Prone hangs
    - Same guidelines as for bag hangs
- TKE:
  - Prone with heel prop
    - Add weight behind knee if needed
  - Standing versus band/cable resistance
- 4-way patellar mobilization
  - Medial, lateral, superior, inferior
- Quad sets
  - Supine, long sitting, seated
  - Eyes closed to increase neuromuscular activation
- 4-way SLR (flexion, abduction, extension, adduction)
  - Supine and/or long sitting for flexion SLR
  - 3x10 (2x/day)
  - Kuczynski Progression:
    - Eyes closed
    - Add 5 second hold each repetition
    - Patient in supine – PT completes continuous PROM SLR, patient completes reactive SLR hold to verbal commands
    - Add speed – 5 maximum speed repetitions, 5 second hold on last rep, repeat 4x per set for 20 reps total
- LAQ
  - Unweighted
- Stepups
- Heel Taps
  - Proper hip hinge and glute activation
- Double leg bridges
- Gait training
  - Emphasis upon full knee hyperextension with proper quadriceps activation, passive knee flexion during terminal stance phases, and great toe pushoff
  - Avoid flexed knee gait pattern
- Single leg balance
  - Without UE assist
  - Stable and unstable surfaces
  - Head turns
  - Eyes closed
  - With perturbations from PT
  - Rebounder toss
- Neuromuscular electrical stimulation (NMES) guidelines (adams)
  - Electrodes placed over proximal lateral quadriceps and distal medial quadriceps (modify distal electrode placement as needed to avoid covering superior medial arthroscopy portal until the stitches have been removed and the skin is healed.
  - Stimulation parameters: 2500 Hz, 75 bursts; 2-second ramp; 12 seconds on, 50 seconds rest
  - Intensity to maximum tolerable (at least 50% maximal volitional isometric contraction (MVIC); 15 minutes total
  - Continue until involved quadriceps strength MVIC is 80% of uninvolved limb.
  - Complete in long sitting with heel prop initially to help achieve hyperextension
  - Progress to seated with knee at 60° flexion and shank secured with strap at ankle

## CRITERIA TO PROGRESS TO PHASE 2

- Symmetrical knee hyperextension and no pain with overpressure
- Knee flexion AROM >120 degrees
- Symmetrical gait pattern
- ≤2+ effusion on stroke test – contact surgeon if >2+ effusion at 4 weeks
- Good neuromotor control during CKC exercises with no reactive effusion

## Phase 2: Intermediate Rehabilitation (4-12 weeks)

- Visit frequency 1-2x/week
  - Consider # of insurance visits, progress towards goals, concomitant procedures
  - HEP focused upon strength
- GOALS:
  - ROM:
    - Maintain symmetrical knee hyperextension
    - End range knee flexion AROM
  - Strength:
    - 1RM quadriceps and hamstring test ≥ 80% limb symmetry index (LSI) on knee extension and hamstring curl at 12 weeks
  - Effusion:
    - Effusion management through compression (sleeve, ACE wrap, donut, etc), cryotherapy, elevation (Manske)
    - ≤1+ on stroke test
    - Contact surgeon if consistently ≥2+ on stroke test
    - Discontinue vasopneumatic cryotherapy treatment in clinic once trace effusion achieved consistently
  - Neuromotor control
    - Can complete 10 repetitions of heel taps and single leg squat to surface without compensatory movement patterns
      - Avoid hip adduction, femoral internal rotation, knee valgus
- INTERVENTIONS:
  - Flexion AROM
    - Child's pose in weeks 8-12 to achieve symmetrical AROM
  - Extension AROM
    - Add manual overpressure at week 4 if symmetrical hyperextension not achieved
    - Moderate to heavy intensity for 15 seconds x 5 repetitions
  - Cardiovascular
    - Moderate intensity biking gradually increasing to 30 minutes
    - Introduce walking program, stairmaster, elliptical (6 weeks)
  - Mini squats
    - Starting 0°-30° knee flexion
      - Emphasize hip hinge and glute activation
      - Symmetrical LE loading
    - Progress to 0°-45° at 8 weeks
      - Add weight in goblet squat form to increase difficulty
      - Progress to single leg as able
  - Knee extension isometrics
    - 90°-30° knee flexion

- Maximal effort **without pain**
  - 30 second holds
- Open chain knee extension
  - 90°-30° at week 6
  - Single leg ONLY – do not strengthen the uninvolved limb at this time
  - Progress resistance to remain in strength/power focus
  - Full range starting at week 8
- Leg Press
  - Single leg ONLY – do not strengthen the uninvolved limb at this point
- Single leg wall sits
  - Maximal effort holds to fatigue
- Hamstring exercises (week 8 for HS autografts)
  - Single leg ONLY – do not strengthen the uninvolved limb at this point
  - Hamstring curls
  - Swiss ball curls
  - RDLs
- Progress SLS activities
- Progress glute strengthening
  - Marching bridges
  - Single leg bridges
  - Steamboats
  - Standing 4 way hip vs band
  - Monster walks
  - Side steps vs band
- PWB plyometrics on shuttle (week 8-10)
  - Double leg jumps
  - Alternating LE jumps
  - Single leg jumps
    - **Avoid valgus knee collapse**
    - **Symmetrical landing and good eccentric control**
    - **Watch for unilateral hip drop!**
- Prone/side planks
- Continue with NMES until 1RM quadriceps LSI >80%

### CRITERIA TO PROGRESS TO PHASE 3

- Symmetrical knee AROM (flexion/extension)
- ≤1+ effusion on stroke test
- 1RM quadriceps and hamstring test ≥ 80% LSI on knee extension and hamstring curl
- Good neuromotor control on all LE exercises

### Phase 3: Late Stage Rehabilitation (12-24 weeks)

- Visit frequency 1-2x/week
  - Consider # of insurance visits, progress towards goals, concomitant procedures
  - HEP focused upon strength/power/plyometrics
- GOALS:
  - Strength:
    - Focus upon quadriceps and hamstring power/strength/speed
    - Focus upon trunk stability with rotation and dynamic activities
  - Effusion:

- Zero to trace effusion on stroke test
  - Neuromotor control
    - Proper neuromotor control during double/single leg plyometrics, agility exercises, and running
  - **Avoid valgus knee collapse**
  - **Symmetrical landing and good eccentric control**
  - **Watch for unilateral hip drop!**
- INTERVENTIONS:
  - Plyometrics progression
    - Double leg
      - Emphasis upon symmetrical takeoff/landing, hip hinge/glute incorporation (no knees over toes), soft landing, avoid dynamic knee valgus
      - In place, forward, 90° rotation and 180° rotation
      - Tuck jumps
    - Single Leg
      - Contralateral step and hold (L→R, R→L)
      - Contralateral hop and hold (L→R, R→L)
      - **Bounding** (incorporate into dynamic warmup)
      - With visual feedback, without visual feedback
      - Progress to triple hop (L→R→L→R)
    - Boxes
      - Forward onto box(height, speed, power)
      - With 90° rotation
      - Drop downs
  - Return to Jogging Program
    - Criteria to initiate:
      - 20 single leg hop and holds with proper neuromotor control (trunk, hip, knee)
      - No pain/reactive effusion with plyometrics
    - Complete walk:jog progression as outlined in appendix A
      - Completed with minimum 1 rest day between steps
  - Strength
    - Continue with leg extension, hamstring curls, leg press, deadlifts, double/single leg squats, glute strengthening
    - Add split squats, lunges, rotational/dynamic trunk stability, resisted retro walking vs bungee/cable,
  - Neuromotor Re-education
    - BOSU
      - Step and hold, hop and hold, RDLs, split squats, SLS, ball toss
  - Agility
    - Start at 50% effort and increase as able
    - Ladder Drills
      - Two feet in, One foot in, Lateral two feet in, Icky Shuffle, 1 foot in down the outside, Hopscotch, Single leg hop through (fwd/lateral)
    - Carioca, Side shuffle, Backpedaling
    - Skipping
      - Regular, speed, height, distance

#### CRITERIA TO PROGRESS TO PHASE 4

- Zero to trace effusion on stroke test
- 1RM quadriceps and hamstring test  $\geq 85\%$  LSI on knee extension and hamstring curl
- Completion of walk:jog progression with no compensatory movement patterns
- Good neuromotor control with no increased pain/effusion with plyometrics, agility

#### **Phase 4: Late Stage Rehabilitation (24 weeks to Return to Sport)**

- Visit frequency 1x/week or every other week
  - Consider # of insurance visits, progress towards goals, concomitant procedures, sporting demands
  - HEP focused upon strength/power/plyometrics/agility/sport specific
- **GOALS:**
  - Strength:
    - 1RM quadriceps and hamstring test  $\geq 90\%$  LSI on knee extension and hamstring curl
  - Effusion:
    - Zero to trace effusion on stroke test
  - Neuromotor control
    - Proper neuromotor control during hop testing and sport specific activities
  - Power
    - LSI  $\geq 90\%$  on all 4 functional hop tests
  - Physician clearance to return to full sport activities
- **INTERVENTIONS:**
  - Strength
    - Power/speed as needed
    - Olympic weightlifting if appropriate
  - Plyometrics
    - Functional hop testing
    - Single hop, Triple hop, Crossover hop, 6m hop test
    - Outlined in Appendix B
    - Proper neuromotor control – no dynamic knee valgus, loud landings
  - Sport specific activities
    - Individual basis
    - Coordinate with ATC, S&C coach, position coach if appropriate

#### **CRITERIA TO PROGRESS TO Return to Sport (Kryitsis)**

- Zero to trace effusion on stroke test
- 1RM quadriceps and hamstring test  $\geq 90\%$  LSI on knee extension and hamstring curl
- Good neuromotor control with no increased pain/effusion with sport specific activities
- Functional hop testing  $\geq 90\%$  LSI for all 4 tests with good neuromotor control (Appendix B)
- Running t test <11 seconds (Appendix C)
- Physician clearance

***4x greater risk of re-injury if athlete does not pass ALL of the above return to sport criteria (Kyritsis)***

**Only 5.6% of athletes who passed RTS criteria before returning to level I sports suffered reinjuries compared to 37.5% of those who didn't pass (Grindem 2016)**



**Once athlete has been cleared to return to sport through criteria outlined above it is imperative that the athlete completes a sport specific build up with their team. Education must occur with the team ATC or coaching staff to ensure a safe gradual return to full activity level**

**If not fully confident on specifics of how to gradually return athlete to full sport activity, contact author below to discuss.**

## **References**

- Adams D, Logerstedt D, Hunter-Giordano A, Axe M, Snyder-Mackler L. Current concepts for anterior cruciate ligament reconstruction: a criterion-based rehabilitation program. *J Ortho Sports Phys Ther.* 2012;42(7): 601-14.
- Daniel DM, Stone ML, Dobson BE, Fithian DC, Rossman DJ, Kaufman KR. Fate of the ACL-injured patient. A prospective outcome study. *Am J Sports Med.* 1994 Sep-Oct;22(5): 632-44.
- Grindem H, Snyder-Mackler L, Moksnes H, Engebretsen L, Risberg MA. Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study. *Br J Sports Med.* 2016 Jul;50(13): 804-8.
- Kyritsis P, Bahr R, Landreau P, Miladi R, Witvrouw E. Likelihood of ACL graft rupture: not meeting six clinical discharge criteria before return to sport is associate with a four times greater risk of rupture. *Br J Sports Med.* 2016 Aug;50(15): 946-51.
- Manske RC, Prohaska D, Lucas B. Recent advances following anterior cruciate ligament reconstruction: rehabilitation perspectives. *Curr Rev Musculoskelet Med.* 2012 Mar;5(1): 59-71.
- Mayr HO, Stueken P, Munch EO, Wolter M, Bernstein A, Suedkamp NP, Stoehr A. Brace or no-brace after ACL graft? Four-year results of a prospective clinical trial. *Knee Surg Traumatol Arthrosc.* 2014 May;22(5): 1156-62.
- Ramirez-Campillo R, Sanchez-Sanchez J, Gonzalo-Skok O, Rodriguez-Fernandez A, Carretero M, Nakamura F. Specific changes in player's fitness after traditional bilateral vs. unilateral combined strength and plyometric training. *Front Physiol.* 2018 Mar;9(265): 1-10.
- Sturgill LP, Snyder-Mackler L, Manal TJ, Axe MJ. Interrater reliability of a clinical scale to assess knee joint effusion. *J Orthop Sports Phys Ther.* 2009 Dec;39(12): 845-9.

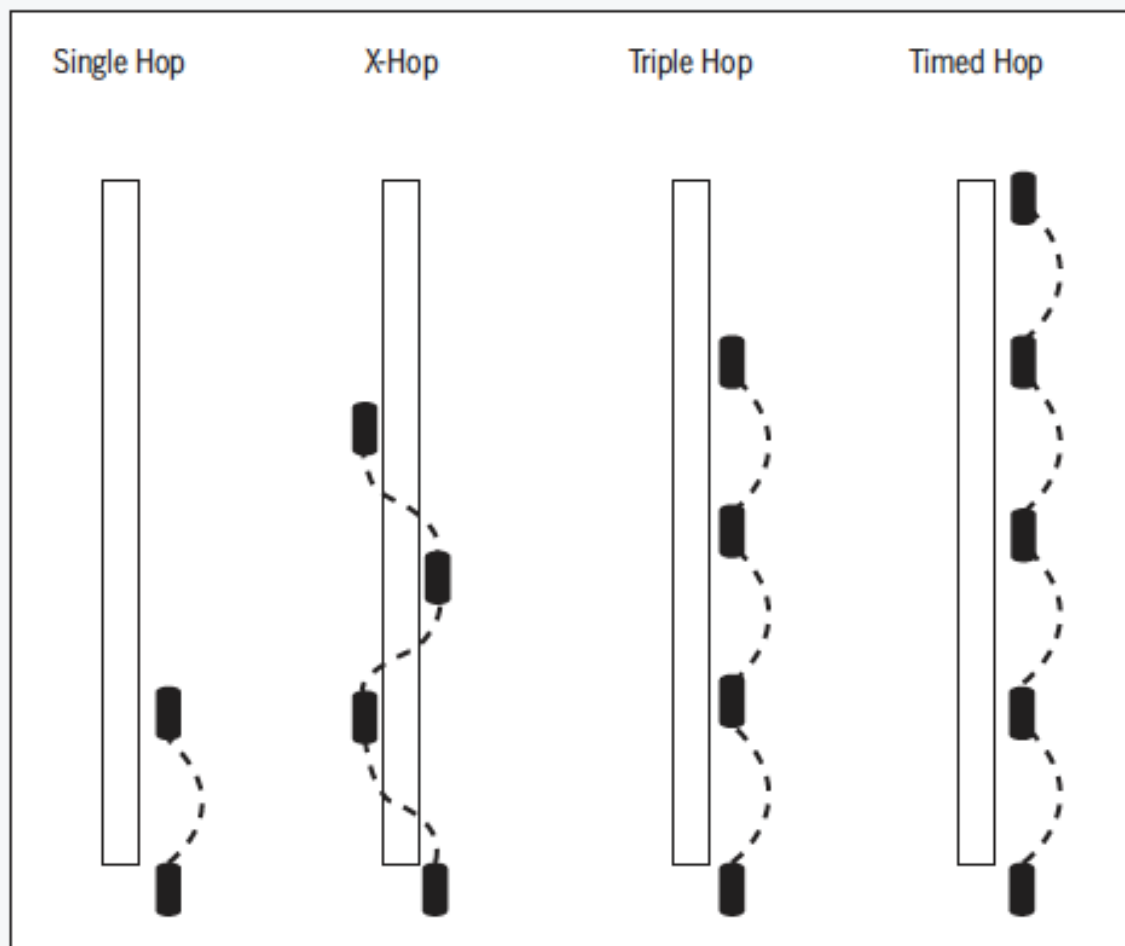
## APPENDIX A: Return to Running Progression

- Minimum of 1 rest day between each step
- Patient must be pain-free and no reactive effusion in order to progress
- If patient experiences pain/effusion during progression they must rest for 2 days and complete previous step in progression. Return to typical progression if pain/effusion does not return at that time.

	Warm-up (Walk)	Jog	Walk	Repetitions	Cool Down (Walk)	Total Time
Step 1	5 mins	1 min	3 mins	5	5 mins	30 mins
Step 2	5 mins	1 min	2 mins	7	5 mins	31 mins
Step 3	5 mins	2 mins	1 min	7	5 mins	31 mins
Step 4	5 mins	3 mins	1 min	5	5 mins	30 mins
Step 5	5 mins	5 mins	1 min	4	5 mins	34 mins
Step 6	5 mins	Jog 20 minutes. Gradually increase the pace every 5 minutes			5 mins	30 mins
Step 7	Jog for 30 consecutive minutes every other day. Start and finish with a 5 minute brisk walk					

Adapted from The Ohio State University Walk:Jog Program

## APPENDIX B: Functional Hop Testing (Adams)



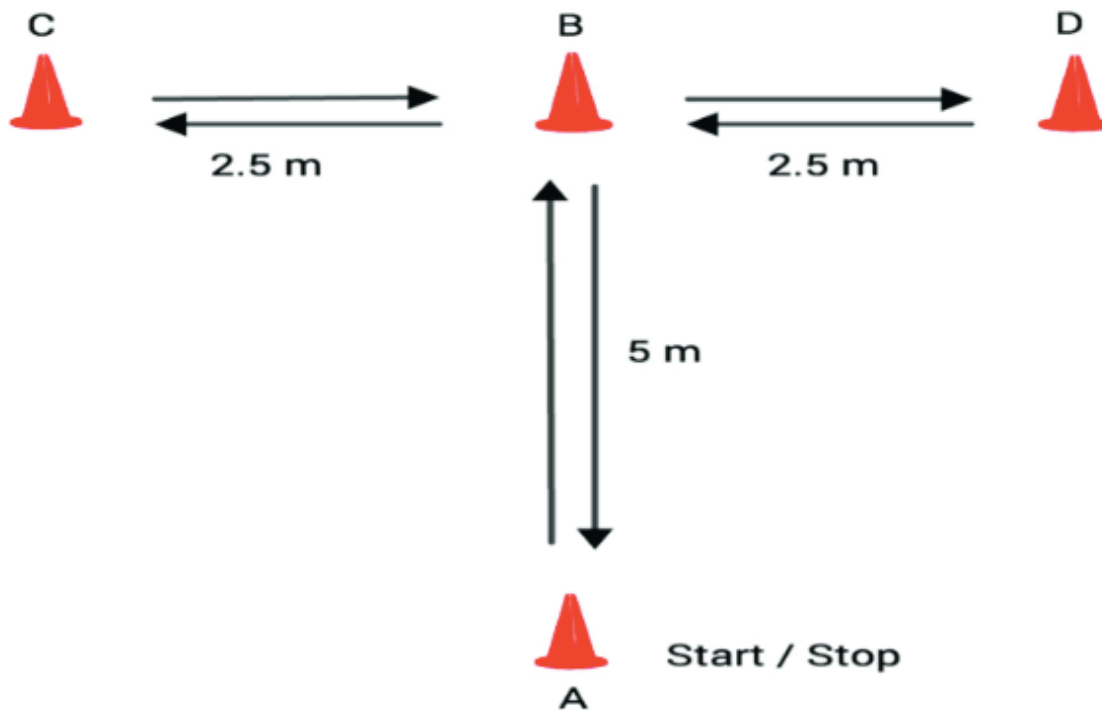
## Testing

- Patient performs 2 practice trials on each leg for each hop sequence
- Patient performs 2 timed or measured trials on each leg for each hop sequence
- Measured trials are averaged and compared (involved to uninvolved) for single, triple, and crossover hop
- Measured trials are averaged and compared (uninvolved to involved) for timed hop

## Passing criteria for return to sport

- Greater than or equal to 90% on quadriceps MVIC, hop testing, KOS-ADL score, and global rating of knee function score

### APPENDIX C: Modified Agility T-Test (Ramirez-Campillo)



1. Athlete sprints forward from A to B
2. Athlete side shuffles from B to C
3. Athlete side shuffles from C to D
4. Athlete side shuffles from D to B
5. Athlete backpedals from B to A