Stanford HEALTH CARE

STANFORD HOSPITAL and CLINICS
STANFORD, CALIFORNIA 94305

CLINIC REHAB MEDICAL SCREENING QUESTIONNAIRE

Post-Operative Knee Rehabilitation

Orthopedics and
Sports Medicine Clinic
450 Broadway
Redwood City, CA

Physician Helpline:
1- 800-717-0012

**The MD Specific Protocol is designed to serve as a guide for the rehabilitation process. It is not intended to supersede clinical judgment and decision making. Progression through each phase is designed to allow for maximal tissue healing of repaired tissues and is based on scientific evidence and clinical experience.*

MD Comments:

For KNEE REHAB PROTOCOL
Scan QR Code or Visit
https://shorturl.at/E0TtW

Open Phone Camera & Scan

Knee Protocol, Pathways, and Precautions

Rehabilitation Protocol

- Scan QR code for Knee Rehabilitation Protocol

ALSO FOLLOW PATIENT SPECIFIC PATHWAYS AND PRECAUTIONS BELOW

☐ Pathway 1: Knee Repair/Reconstruction

Weightbearing Precautions

☐ Foot Flat (<10% WB) Protocol
- Foot Flat (<10%WB) for ___ week(s) then Weight Bearing As Tolerated (WBAT)
- Brace: (locked in -10 EXT) for ambulation/night, off for exercise
  Once WBAT with good quad control, OK to unlock brace
- Crutches at all times until progress to WBAT
- Discontinue brace NOT before ___ week(s), then transition to _____

☐ Weight Bearing As Tolerated (WBAT) Protocol
- Brace: (locked in -10 EXT) for ambulation/night, off for exercise
  - ☐ *Unlock w/ quad control as tolerated*
  - ☐ *Unlock no sooner than* ___ week(s)
- Crutches: at least until suture removal
- Discontinue brace NOT before ___ week(s), then transition to _____

Range of Motion/Strengthening Precautions

☐ PROM→AAROM→AROM Protocol
- ☐ Start Immediately | ☐ Start at ____week(s)
- Isometric Quad Sets at 0º →SLR as tolerated (no extensor lag)
- ☐ CPM Start at (-10) to (45°) ➔ ↑10°/day FLX & EXT(up to 8 hrs/day)

☐ PROM ONLY Protocol
- ☐ Start Immediately | ☐ Start at ____week(s)
- Advance to AAROM→AROM no sooner than _____week(s)
- Isometric Quad Sets at 0º ONLY until advance to AAROM
- ☐ CPM Start at (-10) to (45°) ➔ ↑10°/day FLX & EXT (up to 8 hrs/day)

Closed Kinetic Chain

☐ As tolerated once patient is WBAT
☐ Avoid Weight Bearing Knee Flexion ≥ 90° (i.e., squat, lunges, etc.) for ___ week(s)

Running and Plyometric Initiation

☐ Per Phase Progression Criteria (Scan QR Code for Specific Protocol)
☐ Additionally, MD Approval Required prior to initiation

☐ Pathway 2: Knee Scope

- Weightbearing as tolerated, ROM as tolerated
- Crutches until NOT limping, knee sleeve after suture removal

Running and Plyometric Initiation

☐ Per Phase Progression Criteria (Scan QR Code for Specific Protocol)
☐ Additionally, MD Approval Required prior to initiation

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POST-OPERATIVE KNEE PROTOCOL CHECKLIST

PHASE 1

Achieved		Criteria to Progress to Phase 2
☐	1.	Minimal Effusion (negative or trace stroke test)
☐	2.	Knee Extension: Full ≤ 0° (Goal: ±2° contralateral limb) | Flexion to ≥90° (unless otherwise specified MD precautions)
☐	3.	Near Normal Patellar Mobility (superior, inferior, medial)
☐	4.	Ability to complete 20 straight leg raises without extensor lag
☐	5.	Physician Clearance to WBAT & Clearance from brace and crutches
☐	6.	Near Normal Gait (minimal compensation; hip hiking, adequate EXT during midstance)

PHASE 2

Achieved	Criteria to Progress to Phase 3
☐	*Soreness lasting no longer than 24 hours after activity
☐	Knee Range of Motion: ≤ 0° – ≥135° (Goal: Extension ±2°, Flexion: ±5° contralateral limb)
☐	Symmetrical Single-Leg Balance-Eyes Closed 30 sec (OR within age & gender predicted norms: see Appendix E)
☐	Performs squat to 75° without pain and symmetrical weight-bearing
☐	Ability to reciprocally ascend/descend 1 flight of stairs without compensation
☐	Y Balance Test – Lower Quarter (YBT-LQ) 90% Composite

*Soreness: symptoms/pain of the involved structure (e.g., knee joint, not muscle(s))

PHASE 3

	Achieved		Criteria to Initiate Jogging Progression[1-14,70]
Alter-G Initiation Criteria[8]	☐	1.	Met Criteria to Progress to Phase 3
	☐	2.	‡LE Strength Symmetry (LSI) ≥70% Quad:Quad | Hamstring:Hamstring[2]
	☐	3.	Walk: normal gait,15 min, >4.2 mph[5]
Linear Jogging Criteria	☐	1.	80 SL squats to 45° @ 40 RPM (2 min) w/ trunk, pelvis, femur & knee valgus <10° frontal plane deviation[5,9-11,70]
	☐	2.	‡LE LSI ≥80% Quad:Quad | Hamstring:Hamstring[6]
	☐	3.	30 split jumps w/o loss of balance[1,10,12-14]
	☐	4.	Completed Low-Level Plyometrics[5]

Note. ‡Strength Testing Options in order of preference: 1. isokinetic dynameter, 2. handheld dynamometer, 3. OKC Knee EXT/FLX machine

Achieved		Criteria to Progress to Phase 4
☐	1.	Minimal *Soreness <2/10 with WB exercises (lasting ≤ 24 hours after activity)
☐	2.	Cleared tissue timeline cleared for plyometrics/cutting: (Reconstruction/Repair: see Precautions | Arthroscopic: not <6 wks.)
☐	3.	Normal Jogging Gait Pattern
☐	4.	Timed Lateral Step Down: ≥90% Limb Symmetry Index (LSI)
☐	5.	Isokinetic testing: ≥80% Quad LSI | ≥80% Hamstring LSI (Goal: ≥ 90% Peak Torque to BW ratio)

Note. *Soreness: symptoms/pain of the involved structure (e.g., knee joint, not muscle(s))

PHASE 4

Achieved		High-Level Plyometric Initiation Criteria
☐	1.	Pass ALL Running 'Linear Jogging Criteria'
☐	2.	Squat or Leg Press >1.5 x Body Weight
☐	3.	Squat 60% Body Weight 5 reps / 5 seconds

Achieved		Criteria to Progress Return to Sport/Activity
☐	1.	<2/10 pain OR active effusion/trace (<20 cc/stroke test) with all activity
☐	2.	Knee ROM: FLX & EXT ±2° of contralateral limb
☐	3.	IKDC ≥ Gender Predicted Norm (see Appendix F)
☐	4.	ACL—RSI Questionnaire ≥65%
☐	5.	‡LE Strength Symmetry (LSI) >90% & HS:Q >75% ♀ |>65% ♂
☐	6.	FLEE Test - Composite score >90% LSI
☐	7.	Running T-test

Note. ‡Strength Testing Options in order of preference: 1. isokinetic dynameter, 2. handheld dynamometer, 3. OKC Knee EXT/FLX machine

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PHASE 1

Goals

1. Reduce pain and joint effusion
2. Minimize scar adhesion formation
3. Achieve full knee extension ROM
4. Facilitate quadriceps activation

Interventions

Range of Motion
- PROM/AAROM/AROM (*See MD Precautions on Face Sheet*)[15,16,17,18]
- Bike: Rocking for ROM[19] *(IF Knee FLX ≥115°, then full rotations)*

Exercises
- Quad Isometrics[20,21]
- Heel Slides
- Ankle Pumps
- Calf/Hamstring Stretches
- SLR – 3 way (flex/abd/ext)[17,20] (*NO extension lag*) (*See MD Precautions on Face Sheet*)
- Clamshells/Reverse Clamshells[17,22,23]
- Bridging/Hamstring Isometrics[17,22,23]
- Core Exercises: Supine Activation
- Upper Body Resistance Training[24]

Manual
- Patella Mobilizations[25,26,27,28,29]
- Extension with Overpressure[16,26]
- Scar mobilizations[26,29]

Modalities
- Functional Electrical Stimulation[30,31,32,33,34,35,36,37,38,39]
- EMG Biofeedback[40]
- Cryotherapy[41,42,43,44,45,46]
- Blood Flow Restriction Training (*IF available & NOT contraindicated*)

Achieved — Criteria to Progress to Phase 2

- ☐ 1. Minimal Effusion (negative or trace stroke test)
- ☐ 2. Knee Extension: Full ≤ 0° (Goal: ±2° contralateral limb) | Flexion to ≥90° (unless otherwise specified MD precautions)
- ☐ 3. Near Normal Patellar Mobility (superior, inferior, medial)
- ☐ 4. Ability to complete 20 straight leg raises without extensor lag
- ☐ 5. Physician Clearance to WBAT & Clearance from brace and crutches
- ☐ 6. Near Normal Gait (minimal compensation; hip hiking, adequate EXT during midstance)

PHASE 2

Goals

1. Control Pain and edema
2. Improve knee ROM
3. Muscle performance progression – develop functional quad control
4. Achieve full terminal knee extension with normalized gait

Interventions

Range of Motion:
- PROM/AAROM/AROM (0-MD prescribed limit)[47,48,49,50]
- Bike[51]

Gait Training:
- Cone Walking[52,53] & Retrowalking (Treadmill)[54,55]

Exercises:
- OKC Ext 90-40°(LAQ)[56,20,20,57,58]
- OKC Flex 0-90° (stand/prone)
- Calf raises
- Weight Shifting
- Balance Board[61]
- Mini squats (0-70°)[20,58,62,63,64]
- Perturbation Training[65,66]
- (Shuttle) Leg Press(70-0°)[20,58,62,63,64]
- Step ups, Step Downs
- Lateral Step Downs[59,60]
- RDL/Deadlift
- Side Stepping
- Lunges (0-50°)
- Upper Body Resistance Training[67]

Manual: Continue from Phase 1 PRN

Modalities: Continue from Phase 1 PRN

CV Exercise: Bicycling, Elliptical, Deep Water Aqua-jogging[68,69]

Achieved — Criteria to Progress to Phase 3

- ☐ 1. Soreness (e.g., symptoms/pain of the knee joint, not muscle(s)) lasting no longer than 24 hours after activity
- ☐ 2. Knee Range of Motion: ≤ 0° – ≥135° (Goal: Extension ±2°, Flexion: ±5° contralateral limb)
- ☐ 3. Symmetrical Single-Leg Balance-Eyes Closed 30 sec (OR within age & gender predicted norms: see Appendix E)
- ☐ 4. Performs squat to 75° without pain and symmetrical weight-bearing

Note. ‡Strength Testing Options in order of preference: 1. isokinetic dynameter, 2. handheld dynamometer, 3. OKC Knee EXT/FLX machine

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PHASE 3

Goals

1. Full knee AROM
2. Improve eccentric quad control
3. Muscle performance progression
4. Begin linear jogging (*once 'Running Initiation Criteria' is met*)

Interventions

Exercises:

Quadriceps
- Split squat/lunge
- Lateral step down
- OKC Knee Extension

Hamstrings/Glutes
- Double & single leg RDL
- Post-lateral CKC strength

†Proprioception/Balance[71]
- Push/Pulling
- Controlled Rotational
- Uneven/unstable surfaces

†*see Appendix H for suggested progression*

Squat Variations
- Double-Leg Squat (0-100 °)[20,58,62,63,64]
- Single-Leg Squats[20]

Low velocity & impact agility drills
- Forward/backward skipping
- Side shuffle
- Skaters/carioca/crossovers[70]
- Forward/backward jog
- Shallow DL jump landings

Integrated Dual Task Activities
- Cognitive-Visual Training[72]

CV Exercise:

Deep water Aqua-jogging[73,74]
Elliptical
Swimming (all strokes, no pain)
Stationary biking with resistance
Treadmill/walking (incline/decline)
Stair stepper
Linear Jogging Progression (if cleared to jog see Appendix D)

Achieved		Criteria to Initiate Jogging Progression
Alter-G Initiation Criteria	☐	1. Met Criteria to Progress to Phase 3
	☐	2. ‡LE Strength Symmetry (LSI) ≥70% Quad:Quad | Hamstring:Hamstring
	☐	3. Walk: normal gait,15 min, >4.2 mph
Linear Jogging Criteria	☐	1. 80 SL squats to 45° @ 40 RPM (2 min) w/ trunk, pelvis, femur and knee valgus <10° deviation in frontal plane
	☐	2. ‡LE LSI ≥80% Quad:Quad | Hamstring:Hamstring
	☐	3. 30 split jumps w/o LOB
	☐	4. Performs squat to 75° without pain and symmetrical weight-bearing
	☐	5. Completed Low-Level Plyometrics

Achieved		Criteria to Progress to Phase 4
☐	1.	*Soreness <2/10 Soreness (e.g., symptoms/pain of the knee joint, not muscle(s)) with or lasting ≤ 24 hrs after activity
☐	2.	Cleared tissue timeline cleared for plyometrics/cutting: (Reconstruction/Repair: see Precautions | Arthroscopic: not <6 wks)
☐	3.	Normal Jogging Gait Pattern
☐	4.	Timed Lateral Step Down: ≥90% Limb Symmetry Index
☐	5.	Isokinetic testing: ≥80% Quad:Quad strength | ≥80% Hamstring:Hamstring strength (Goal: ≥ 90% Peak Torque to BW ratio)
☐	6.	Y Balance Test – Lower Quarter (YBT-LQ) 90% Composite

Note. *Soreness: symptoms/pain of the involved structure (e.g., knee joint, not muscle(s))

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PHASE 4

Goals

1. Begin sport specific drills
2. Normalize neuromuscular control
3. Normalize jumping/landing mechanics if indicated
4. Prepare for return to sport

Interventions

Exercises: Strength/Endurance
- Quadriceps (Phase 3 cont.)
- HS/Glutes (Phase 3 cont.)
- Squat (0-100 °)[20,58,62,63,64]
- Single Leg Squats[20]

†Neuromuscular Training[75,76,77,78,79,80,81]
- Balance/proprioceptive drills
- Core stabilization progression
- Reactive motor control drills

Agility drills
- Progress velocity & intensity of Phase 3 exercises

Power (Speed and rate of force development)
- Higher amplitude double leg & single leg landing drills
- Uni-planar to multi-planar

Progress running/sport-specific training

†*see Appendix I for suggested progression*

CV Exercise: Progress volume, velocity, & intensity of Phase 3 exercises

High-Level Plyometric Initiation Criteria

Achieved	
☐	1. Pass ALL Running 'Linear Jogging Criteria'
☐	2. Squat or Leg Press >1.5 x Body Weight
☐	3. Squat 60% Body Weight 5 reps / 5 seconds

Criteria to Progress Return to Sport/Activity

Achieved	
☐	1. <2/10 pain OR active effusion/trace (<20 cc/stroke test) with all activity
☐	2. Knee ROM: FLX & EXT ±2° of contralateral limb
☐	3. IKDC > Gender Predicted Norm (see Appendix F)
☐	4. ACL—RSI Questionnaire >65%
☐	5. ‡LE Strength Symmetry (LSI) >90% & HS:Q >75% ♀|>65% ♂
☐	6. FLEE Test - Composite score >90% LSI
☐	7. Running T-test

Note. ‡Strength Testing Options in order of preference: 1. isokinetic dynameter, 2. handheld dynamometer, 3. OKC Knee EXT/FLX machine

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Appendix A: Tegner Activity Scale

ACTIVITY LEVEL	TEGNER LEVEL	DISCRIPTION
Competitive Athlete	10	Competitive sports- soccer, football, rugby (national elite)
	9	Competitive sports- soccer, football, rugby (lower divisions), ice hockey, wrestling, gymnastics, basketball
	8	Competitive sports- racquetball or bandy, squash or badminton, track and field athletics (jumping, etc.), down-hill skiing
	7	Competitive sports- tennis, running, motorcars speedway, handball, Recreational sports- soccer, football, rugby, bandy, ice hockey, basketball, squash, racquetball, running
Recreational Athlete	6	Recreational sports- tennis and badminton, handball, racquetball, down-hill skiing, jogging at least 5 times per week
	5	Work- heavy labor (construction, etc.) Competitive sports- cycling, cross-country skiing, Recreational sports- jogging on uneven ground at least twice weekly
	4	Work- moderately heavy labor (e.g. truck driving, etc.)
General Orthopedic Population	3	Work- light labor (nursing, etc.)
	2	Work- light labor Walking on uneven ground possible, but impossible to back pack or hike
	1	Work- sedentary (secretarial, etc.)
	0	Sick leave or disability pension because of knee problems

Activity Level Classification[82,83,84]

Activity Level	Sport Activity	Occupational Activity
1	Jumping, Cutting, Pivoting (i.e., basketball, soccer, football, skiing)	Activity comparable to level I sports
2	Lateral movements: less jumping & pivoting compared to level I (i.e., baseball, racket sports)	Heavy Manual labor, working on uneven surfaces
3	Straight-ahead activities: no jumping or pivoting (i.e., running, weight lifting)	Light Manual Work
4	Sedentary	Activities of daily living

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Appendix B: Alter G Running Progression[85,86]

ALTER – G TREADMILL RETURN TO RUNNING PROGRESSION

Week	BW	Walk Pace	Time	Jog Pace	Time	Total Time	Goal
1a	60%	Walk 3.0-3.3mph	1 min	Jog 5.0–7.0mph	1 min	5 bouts or 1 mile	Find comfortable jog pace
1b	60 – 65%	Walk 3.0-3.5mph	1 min	Jog 5.0–7.0mph	1-2 mins	5 bouts or 1 mile	Increase jog time
2a	70%	Walk 3.0-3.5mph	1 min	Jog 5.0–7.0mph	1-2 mins	5 bouts or 1 mile	Increase body weight
2b	70 - 75%	Walk 3.0-3.5mph	1 min	Jog 5.0–7.0mph	1-3 mins	5-8 bouts or 1.5 miles	Progress distance
3a	80%	Walk 3.0-3.5mph	1 min	Jog 5.0–7.0mph	1-2 mins	5 bouts or 1 mile	Increase body weight
3b	80 - 85%	Walk 3.0-3.5mph	1 min	Jog 5.0–8.0mph	1-3 mins	5-8 bouts or 1.5 miles	Increase jog speed
4a	90%	Walk 3.0-3.5mph	1 min	Jog 5.0–8.0mph	1-3 mins	1-2 miles	Normal running gait pattern
4b	90%	Walk 3.0-3.5mph	1 min	Jog 5.0-8.0mph	2-5 mins	1-2 miles	Increase jog time during bouts

** Running not to be done on back to back days **

** A treadmill incline of 3 – 5 degrees is recommended if it improves running mechanics in the athlete **

Graduated Running Criteria-ACLR

In order to begin Alter G running progression the following must be met by ALL participants in entirety.

Criteria	Range	Definition
ROM	Full Knee Ext Knee Flex within 10	ROM must be documented within ranges prior to onset of Alter G running. Pt must meet all criteria within 5 min of stretching. ROM measurements goals are compared to contralateral side, and are patient specific. If pt contralateral side has marked genu recurvatum work to equalize. Can initiate running once hyperextension greater than 10 degrees is achieved.
Girth	Minimal Effusion	Effusion will be assessed via Stroke Test with a maximum of a trace score to initiate progression. If patient has greater than 1+ DO NOT run and drop down 1 level at next treatment session.
Gait Pattern	Normal gait pattern	Pt must be able to demonstrate normal step through gait pattern with full knee ext on initial contact no limping or pain, and reciprocal step climbing 5 days prior to starting Alter G running progression.
Strength	Quad strength greater than 70%	Pt must demonstrate at least 70% quad strength on affected side compared to contralateral leg via max rep to fatigue or significant loss of technique/pain with eccentric quad dominant step down minimum of 4-inch block. Or 3-rep single leg balance reach test in anterior direction touching with heel. Measure distance from contralateral toe to heel if mat is not present, and take the average of reps with balance reach. Remember to test uninvolved limb first.

*Please consult surgeon if ACL revision or has concomitant injuries such as MCL, PCL, or posterior lateral corner.

Alter G Protocol Soreness Rules:

- If MAJOR pain/soreness/edema after the prior run, or during warm-up, DO NOT run that day and drop down 1 level at the next therapy session.
- If pain/soreness during workout, drop down 1 level for the run that day.
- If minor pain/soreness after the prior workout, stay at the same level for the run that session.
- If NO pain/soreness/edema during or after the prior run, progress per protocol.

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Appendix C – Pre-Running Progression: Low Level Plyometric Routine[87]

Exercise	Sets	Foot contacts per set	Total foot contacts
Two-leg hops: in place	3	30	90
Two-leg hops: forward/backward	3	30	90
Two-leg hops: side to side	3	30	90
One-leg hops: in place	3	20	60
One-leg hops: forward/backward	3	20	60
One-leg hops: side to side	3	20	60
One-leg leg broad hop	4	5	20
Total	22		470

Rest Intervals: Between Sets 90 seconds | Between Exercises: 3 minutes

Criteria to Complete Low-Level Plyometric Routine:

- Patient able to perform 3 sessions of low level plyometrics within 7-day time without any increase in baseline lower extremity joint pain, swelling or symptoms (see Soreness Rules*).

*Soreness Rules:

Criterion	Action
Soreness during warm-up that continues with double leg exercises	2 days off, restart plyometric routine
Soreness during warm-up that goes away but redevelops during session	
Soreness the day after running (not muscle soreness)	
Soreness during warm-up that goes away	1 days off, proceed with plyometric routine
No soreness	

Appendix D – Phased Return to Running Progression[88]

Return to Running Progression

Level	Treadmill	Track
0	30 min walking (Pace: ≥3.5 mph, 1% grade)	Walk 8 laps (Pace: <4.5 min/lap)
1	0.1 miles walk and 0.1 miles jog: repeat 10 times	Jog straights and walk curves: 2 miles total
2	Alternate 0.1 miles walk and 0.2 miles jog: 2 miles total	Jog straights and jog 1 curve every other lap: 2 miles total
3	Alternate 0.1 miles walk and 0.3 miles jog: 2 miles total	Jog straights and jog 1 curve every lap: 2 miles total
4	Alternate 0.1 miles walk and 0.4 miles jog: 2 miles total	Jog 1.75 laps and walk curves: 2 miles total
5	Jog 2 full miles	Jog 2 miles
6	Increase workout to 2.5 miles	Increase workout to 2.5 miles
7	Increase workout to 3 miles	Increase workout to 3 miles
8	Alternate between running and jogging every 0.25 miles	Increase speed on straights and jog curves

Instructions:

1. 2 days rest mandatory between levels 1, 2, and 3 workout
2. 1 day rest mandatory between levels 4 to 8 workouts
3. Do not advance more than 2 levels per week
4. *Follow soreness rules*

Criterion	Action
Soreness during warm-up that continues	2 days off drop down 1 level
Soreness during warm-up that goes away but redevelops during session	2 days off drop down 1 level
Soreness the day after running (not muscle soreness)	1 day off, do not advance to the next
Soreness during warm-up that goes away	Stay at level that led to soreness
No soreness	Advance 1 Level per week

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Appendix E – Normative Data for Single Leg Stance Eyes Open and Closed[89]

Table 1. Unipedal Stance Test Time by Age Group and Gender for Eyes Open and Closed

Age & Gender Groups	Eyes Open Best of 3 trials (sec) Mean (SE)	Eyes Open Mean of 3 trials (sec) Mean (SE)	Eyes Closed Best of 3 trials (sec) Mean (SE)	Eyes Closed Mean of 3 trials (sec) Mean (SE)
18-39				
Female (n = 44)	45.1 (0.1)	43.5 (3.8)	13.1 (12.3)	8.5 (9.1)
Male (n = 54)	44.4 (4.1)	43.2 (6.0)	16.9 (13.9)	10.2 (9.6)
Total (n = 98)	44.7 (3.1)	43.3 (5.1)	15.2 (13.3)	9.4 (9.4)
40-49				
Female (n = 47)	42.1 (9.5)	40.4 (10.1)	13.5 (12.4)	7.4 (6.7)
Male (n = 51)	41.6 (10.2)	40.1 (11.5)	12.0 (13.5)	7.3 (7.4)
Total (n = 98)	41.9 (9.9)	40.3 (10.8)	12.7 (12.9)	7.3 (7.0)
50-59				
Female (n = 50)	40.9 (10.0)	36.0 (12.8)	7.9 (8.0)	5.0 (5.6)
Male (n = 48)	41.5 (10.5)	38.1 (12.4)	8.6 (8.8)	4.5 (3.8)
Total (n = 98)	41.2 (10.2)	37.0 (12.6)	8.3 (8.4)	4.8 (4.8)
60-69				
Female (n = 50)	30.4 (16.4)	25.1 (16.5)	3.6 (2.3)	2.5 (1.5)
Male (n = 51)	33.8 (16.0)	28.7 (16.7)	5.1 (6.8)	3.1 (2.7)
Total (n = 101)	32.1 (16.2)	26.9 (16.6)	4.4 (5.1)	2.8 (2.2)
70-79				
Female (n = 45)	16.7 (15.0)	11.3 (11.2)	3.7 (6.2)	2.2 (2.1)
Male (n = 50)	25.9 (18.1)	18.3 (15.3)	2.6 (1.7)	1.9 (0.9)
Total (n = 95)	21.5 (17.3)	15.0 (13.9)	3.1 (4.5)	2.0 (1.6)
80-99				
Female (n = 22)	10.6 (13.2)	7.4 (10.7)	2.1 (1.1)	1.4 (0.6)
Male (n = 37)	8.7 (12.6)	5.6 (8.4)	1.8 (0.9)	1.3 (0.6)
Total (n = 59)	9.4 (12.8)	6.2 (9.3)	1.9 (1.0)	1.3 (0.6)
Total (all ages)				
Female (n=258)	33.0 (16.8)	29.2 (17.4)	7.7 (9.6)	4.7 (6.0)
Male (n = 291)	33.8 (17.1)	30.2 (17.7)	8.2 (10.8)	4.9 (6.4)
Total (n = 549)	33.4 (16.9)	29.8 (17.5)	8.0 (10.3)	4.9 (6.2)

Appendix F – Functional Testing Algorithm

Lower Extremity Functional Testing Algorithm[90]

Desired Level of Function	Test	Reference Value
1. General Orthopedic Patient (Activity Level 4)	- Pain Visual analog scale - Region Specific Validated Outcome Measure (i.e. Knee: IKDC or LEFS) - Clinical Measurements: o PROM/AROM o Circumference o KT 1000/2000 (*if available*) - Sensorimotor System Testing: o YBT-LQ o BESS o Biodex Balance System (BBS) (*if available*) - Muscle Performance o MMT, HHD, Isokinetic o CKC Testing (i.e. squat/SL Squat/lunge leap & catch)	- PAIN: No Pain - IKDC: M: 89.7; F: 83.9 (MCID 6.3 @ 6 mo|16.7 @ 12 mo)[91,92Error! Bookmark not defined.] - LEFS: ≥77/80[93] - PROM/AROM: ±5° of uninvolved - KT1000: <3 mm - YBT-LQ: LSI: </= 10% OR Composite Score ≥90% - BESS: LSI: </= 10% - BBS Single Leg Center of Pressure: ± SD of norm - BBS Single Leg Dynamic Center of Pressure: ± SD of norm - MMT: 5/5 | MMT: 5/5 | HHD or Isokinetic: LSI <10% - CKC Testing Options: o Force Plate (LSI</=10%) o SL Leg Press 'X'RM: LSI</=10% o Video Movement Analysis (quantitative joint angle cut offs)
2. Recreational Athlete (Activity Level 3)	- OKC Isokinetic Testing: Knee Extension and Flexion - Functional Jump Tests - Functional Noyes Hop Tests	- OKC: LSI </= 10% - Jump: <15%/Height &/or Normative Data - Video Movement Analysis (quantitative joint angle cut offs) - Hop Testing: LSI </=10%
3. Competitive Athlete (Activity Level 1-2)	- Lower Extremity Functional Tests (LEFT) OR - Functional Lower Extremity Evaluation (FLEE)[70] - Running T-Test - Sports Specific Tests o *Dependent on: Sport, position* - Note: *Consider Sports Science Literature/Resources*	- LEFT: M: 109.4 sec | F: 117.2 sec - FLEE: *test provides pass/fail cutoff for all test batteries* - Running T-test: < 11 seconds - Sports Specific Reference Values: *dependent on variables age, gender, level of sport*

AROM: active range of motion; CKC: closed kinetic chain; HHD: hand held dynamometer; IKDC: international knee documentation committee subjective evaluation form; LEFS: lower extremity functional scale; LSI: limb symmetry index = involved limb/non-involved limb; MMT: manual muscle testing;, PROM: passive range of motion; OKC: open kinetic chain; SD: standard deviation; SL: single limb; YBT-LQ: Y Balance Test Lower Quarter

Appendix G – Return to Sport Testing Protocol[70]

Orthopedic and Sports Physical Therapy FLEE Scoring Sheet

Gender:		Age:		Involved Side:		Date		Assessement	Result
IKDC 2000 score:								IKDC 2000	N/A

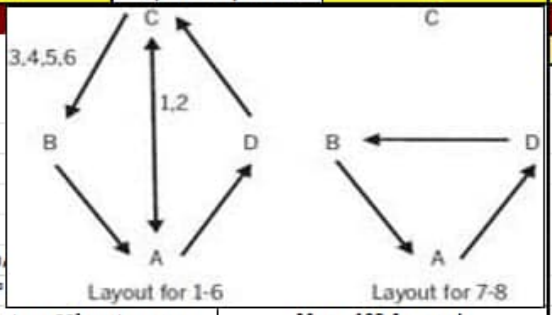
Age	18-24	25-34	35-50	51-65	18-24	25-34	35-50	51-65
Male	89.7	86.2	85.1	74.7	N/A	N/A	N/A	N/A
Female	83.9	82.8	78.5	69	N/A	N/A	N/A	N/A

Timed Lateral Step Down	LE	# of faults	Time (sec)	% of Other L	
60° +/- 5; 80 bpm;3 mi	Uninvolved			0%	Lat Step Down N/A
3 faults = stop test	Involved				

Timed leap and catch	# lines missed:		Total Missed		
60% height used	Uninvolved		0		Leap & Catch N/A
40 bpm for 60 seconds	Involved				

hop for distance (c	Uninvolved side				Involved side				% of Other L	
1 inch = 2.54 cm	1	2	3	Avg	1	2	3	Avg	0%	SL Hop for Distance N/A
				0.0				0.0		
SL timed hop (sec)	1	2	3	Avg	1	2	3	Avg	0%	SL Timed Hop N/A
6 meters = 19.7 feet				0.00				0.00		
Triple hop (cm)	1	2	3	Avg	1	2	3	Avg	0%	Triple Hop N/A
1 inch = 2.54 cm				0.0				0.0		
Crossover hop (cm)	1	2	3	Avg	1	2	3	Avg	0%	Crossover hop N/A
2 lines; 15cm (5. in) apart				0.0				0.0		

uare Hop Test (30 s	# of revolutions		# of revolutions		0%	Square Hop N/A
	# of additional lines		# of additional lines			
	# of missed lines		# of missed lines			
	Square Hop Score	0	Square Hop Score	0		

LEFT test		Score vs Avg	LEFT Test N/A
cones A to C = 30 feet		0	
cones B to D = 10 feet			Clinical Decision:
1. Forward run: ACA			N/A
2. Backward run: ACA			
3. Side shuffle: right then left (face center)			
4. Carioca: right then left			
5. Figure 8: A, D, circle C, B, circle A, B, circle C, D, A			
6. 45° cuts: ADCBA, plant outside foot then repeat ABCD			
7. 90° cuts: ADBA – ABDA, plant outside foot and cut 90°			
8. 90° crossover cuts: ADBA-ABDA, plant outside foot and cut 90° to the target	Men = 109.4 seconds		
9. Forward run: ACA	Women = 117.2 seconds		
10. Backward run: ACA	Time:		

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Appendix H – Neuromuscular Exercise Progression[94,95,96]

Neuromuscular Exercise Progression

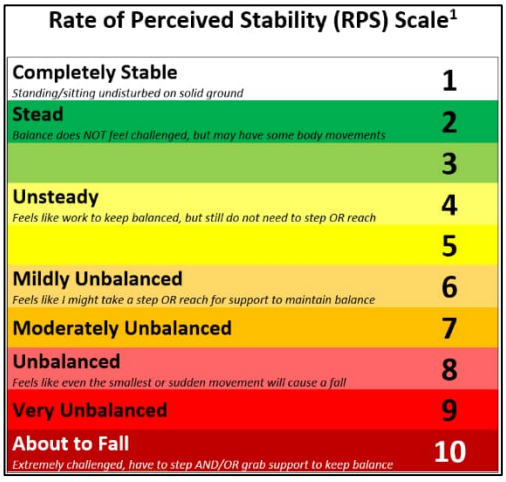
Criteria for Phase Progression:

1. ❑ No increase in baseline pain, soreness, or swelling
2. ❑ Ability to maintain balance of the position (static balance) prior to movements being imposed
3. ❑ Subjective Rating of Perceived Stability (RPS)[97] score of ≤ 6/10 on ALL current exercises (see scale below)
4. ❑ Limb symmetry index (LSI) of the number of faults per given exercise ≤10%
   a. LSI = (# of faults of involved limb / # of faults of uninvolved limb)
   b. Qualification of types of fault:
      1. 1. Hands lifted off iliac crest
      2. 2. Opening eyes
      3. 3. Step, stumble, or fall
      4. Moving hip into > 30 degrees abduction
      5. Lifting forefoot or heel
      6. Remaining out of test position >5 sec
5. ❑ Clinician's Quality Assessment ≤10° deviation of trunk/hip/knee in the frontal and transverse plane[98,99,70,71]

Phase	Exercises[94,95]	Sets/Limb[100]	Time/Set[100]	Frequency[100]	Duration[95,100]
1	Single leg stance, eyes closed Single leg standing on balance mat, appropriate knee & hip position Wobble board, 2 legs Balance reach leg involved leg Balance reach arm involved leg Step-up, both legs	2-3	20-40 sec	3x/week	~1 week
2	Wobble board, 2 legs with weights Wobble board, 2 legs, throwing ball Wobble board, 1 leg Step-down, uninvolved leg	2-3	20-40 sec	3x/week	~1 week
3	Single leg stance, trampoline, throwing ball Step-up and step-down, involved leg, different direction Balance reach leg, balance reach arm, balance mat, and wobble board	2-3	20-40 sec	3x/week	~1 week
4	Lunge exercise with bars/weights Single leg stance, trampoline, throwing ball, different directions (front, back, and sideways) Single leg stance, balance mat, throwing ball Step-up, wobble board	2-3	20-40 sec	3x/week	~1 week
5	• Slide board exercises • Single leg stance with weights, eyes closed • Wobble board single leg, eyes closed • Squatting exercises, wobble board	2-3	20-40 sec	3x/week	2-3 weeks

Intensity of exercises within a phase can be progressively increased by:

1. Altering Visual, somatosensory, or vestibular systems with given exercise(s)
2. Adding a dual physical or cognitive task (i.e. holding glass of water, motion guidance, or math or linguistic puzzles)
3. Increasing or setting tempo of dynamic movements to specific frequency or tempo (i.e., metronome)
4. Increasing the extent of internal and external perturbations through increased resistance
5. Altering the height of the center of mass (i.e., arms overhead, upright stance, partial squat, full squat)



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Appendix I – Advanced Neuromuscular Exercise Progression[76,77,78,79,80,81]

Five Phases of the Core Stability Portion of Neuromuscular Training Program

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Lateral jump and hold	Lateral jumps	Lateral hop and hold	Lateral hops	X-hops
Step-hold	Jump single-leg hold	Hop-hold	Hop-hop-hold	Crossover-hop-hop-hold
BOSU (round) toe touch swimmers*	BOSU (round) swimmers with partner perturbations*	Prone bridge (elbows and knees) hip extension opposite shoulder flexion*	Prone bridge (elbows and toes) hip extension*	Prone bridge (elbows and toes) hip extension opposite shoulder flexion*
BOSU (round) double-knee hold	BOSU (round) single-knee hold	Swiss ball bilateral kneel (**FIGURE 4**)	Swiss ball bilateral kneel with partner pertubations	Swiss ball bilateral kneel with lateral ball catch
Single-leg lateral Airex hop-hold	Single-leg lateral BOSU (round) hop-hold	Single-leg lateral BOSU (round) hop-hold with ball catch	Single leg 4-way BOSU (round) hop-hold	Single-leg 4-way BOSU (round) hop-hold with ball catch
Single-tuck jump soft landing	Double-tuck jump	Repeated-tuck jump	Side-to-side barrier tuck jumps	Side-to-side reaction barrier tuck jumps
Front lunges	Walking lunges	Walking lunges unilaterally weighted	Walking lunges with plate crossover	Walking lunges with unilateral shoulder press
Lunge jumps*	Scissor jumps*	Lunge jumps unilaterally weighted*	Scissor jumps unilaterally weighted*	Scissor jumps with ball swivel*
BOSU (flat) double-leg pelvic bridges*	BOSU (flat) single-leg pelvic bridges*	BOSU (round) single-leg pelvic bridges with weight*	Supine Swiss ball hamstring curl*	Russian hamstring curl with lateral touch*
Single-leg 90° hop-hold	Single-leg 90° Airex hop-hold (**FIGURE 3**)	Single-leg 90° Airex hop-hold reaction ball catch	Single-leg 180° Airex hop-hold	Single-leg 180° Airex hop-hold reaction ball catch
BOSU (round) lateral crunch	Box lateral crunch	BOSU (round) lateral crunch with ball catch	Swiss ball lateral crunch	Swiss ball lateral crunch with ball catch
Box double-crunch	Box swivel double-crunch	BOSU (round) swivel ball touches (feet up)	BOSU (round) double-crunch	BOSU (round) swivel double-crunch
Swiss ball back hyperextension*	Swiss ball back hyperextension with ball reach*	Swiss ball hyperextensions with back fly*	Swiss ball hyperextensions with ball reach lateral*	Swiss ball hyperextensions with lateral ball catch*

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