Isolated ACL Rehabilitation Guide

Evidence-based physical therapy for the youth athlete

Texas Children's Hospital®

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Phase 1: Early Post-Operative

Phase Summary

Early physical therapy goals include protecting the healing graft, improving range of motion, decreasing swelling and regaining leg muscle control. It is especially important to regain full knee extension range of motion (ROM) as this prevents scar tissue from forming. Estimated timeline: 0-4 weeks post-op.

Appointments

Initial physical therapy evaluation should occur within 10 days of surgery with follow-up appointments 1-2 times a week until patient passes return to sport testing.

Objectives

- Gain full patellar mobility
- Decrease joint swelling
- Develop full knee extension ROM equal to contralateral side
- Address basic kinesthetic and proprioceptive awareness
- Begin ambulating with less assistance
- Fill out Pedi-IKDC at initial evaluation

Contraindications [1-3]

Hamstring graft

- Until 4 weeks post-op: no open-kinetic chain (OKC) knee extension
- Until 6 weeks post-op: No hamstring stretching/isometrics

Quad tendon graft

- Until 4 weeks post-op: No OKC knee extension
- Until 6 weeks post-op: No quad stretching

Bone-patellar tendon-bone graft

- Until 4 weeks post-op: No OKC knee extension

Physeal Sparing Technique (Modified MacIntosh Procedure)

- Until 4 weeks post-op: No OKC knee extension
- Until 6 weeks post-op: Toe-touch weight bearing unless otherwise instructed

Brace Use [4]

- When ambulating lock brace in extension, weight bearing as tolerated (WBAT)
- Unlock brace when:
  - > 2 weeks post-op
  - Able to complete active straight leg raises (ASLR) x 10 without quad lag
- After the first 2 weeks post-op, only use brace while walking in public/school
- Discontinue brace use if patient is not progressing as expected with knee extension ROM
- Discontinue brace when:
  - > 2 weeks post-op
  - Able to complete ASLR x 10 without quad lag
  - No increased pain with weight-bearing
  - Noticeable quad contraction during stance phase of ambulation

Crutch Use [4]

- Crutches should be used as needed to normalize gait and reduce knee effusion
- Discontinue crutches when:
  - Minimal effusion
  - Normal gait pattern with good active quad control
  - Able to complete ASLR x 10 without quad lag
  - Able to maintain single leg stance (SLS) at 20° of knee flexion and good alignment
- Monitor patient for effusion by using sweep test at follow-up appointments after discharging crutches

Clinical Recommendations [5-7]

- In the first 2 weeks post-op, emphasize achieving full knee extension ROM and avoid aggressively stretching into flexion ROM in order to protect the healing graft
- Neuromuscular Electrical Stimulation (NMES) aids in the recovery of quad strength after knee surgery
  - Frequency > 50 Hz, Pulse width 250 µs up to 1 ms, Duty cycle ratio 1:2 or 1 (on:off), Ramp time of 2 seconds for patient comfort
  - Treatment duration from 3-6+ weeks post-operatively or until patient has full quad activation
- Personalized Blood Flow Restriction Training (PBFR) reduces muscle atrophy following ACL reconstruction
  - Parameters: 80% limb occlusion pressure; Sets/Reps: 1 set x 30 reps, 3 sets x 15 reps; Rest: 30 seconds between each set

Phase 1 Progression Criteria

- Symmetrical knee extension ROM to contralateral limb
- Knee flexion ROM at least 90 - 110°
- Straight leg raise (SLR) with no quad lag
- Able to ambulate in PT clinic and at home with one crutch

Phase 2: Foundational Strength

Phase Summary

This phase of physical therapy focuses on transitioning from using crutches and brace to walking without any assistance. The goal is to develop knee strength and control with fundamental movement patterns such as walking, squatting, and balancing. Estimated timeline: 4-8 weeks post-op.

Objectives

- Increase work capacity, progressing from muscular endurance toward hypertrophy
  - See repetition continuum in **Appendix A**
- Normalize joint effusion and achieve full knee ROM
- Achieve independence with activities of daily living (ADLs)
- Full ambulation without crutches or brace

Contraindications [1-3]

Hamstring graft

- After 4 weeks post-op: Perform OKC knee extension without resistance from 90-45°
- After 8 weeks post-op: Perform OKC knee extension with moderate resistance from 90-0°

Quad tendon graft

- After 4 weeks post-op: Perform OKC knee extension without resistance from 90-45°
- After 8 weeks post-op: Perform OKC knee extension with moderate resistance from 90-0°

Bone-patellar tendon-bone graft

- After 4 weeks post-op: Perform OKC knee extension with resistance from 90-45°
- After 8 weeks post-op: Perform OKC knee extension with moderate resistance from 90-0°

Physeal Sparing Technique (Modified MacIntosh Procedure)

- After 4 weeks post-op: Perform OKC knee extension without resistance from 90-45°
- After 8 weeks post-op: Perform OKC knee extension with moderate resistance from 90-0°

Clinical Recommendations

- Rate of Perceived Exertion (RPE)
  - Moderate resistance = 5-6 on RPE scale
  - Heavy resistance = 7+ on RPE scale
- When prescribing exercise, consider chronological age and training experience
- Consider ordering knee dynamic splinting if ROM is not improving or approaching symmetry with uninvolved side
- See **Appendix A** for *Strengthening Exercises for each Muscle Group and Strength Training Principles and Autoregulatory Progressive Resistance Exercise (APRE) Description*
- See **Appendix B** for *Patient Reported Outcome Measures*

Foundational Strength Continued

Texas Children's Motion Analysis Laboratory

- Utilize Texas Children's Motion Analysis Laboratory to assess patient's ability to perform basic functional tasks such as walking and squatting. Motion analysis assessments during the foundational strength phase are focused on range of motion and loading asymmetries. This assessment typically occurs 2 months after surgery once the patient has been performing the above movements consistently in physical therapy.
- See **Appendix E** for *Motion Analysis Lab Assessments and Biofeedback Training*

Phase 2 Progression Criteria

- Symmetrical knee extension and flexion ROM compared to contralateral limb
- Appropriate form when performing functional movement patterns (squat, hinge, etc.)
- Ambulate without crutches or brace and with normal gait pattern

Phase 3: Progressive Strength

Phase Summary

As the athlete progresses back to normal daily activities, this phase focuses on increasing the intensity of exercise to build lower extremity and core strength. The goal of this phase is for the athlete to get strong enough to start a run:walk program. Estimated timeline: 8-16 weeks post-op.

Objectives

- Continue hypertrophy and progress to high intensity strengthening in preparation for power
- Begin heavy resistance OKC knee extension for all graft types from 90-0° at 12 weeks post-op
- Begin run:walk program once criteria are met
- Begin low impact plyometrics
- Fill out Pedi-IKDC at 3 months post-op

Contraindications [1-3]

- Effusion with increased activity levels
- Plateau in ROM - contact surgeon immediately
- No running before 12 weeks post-op

Criteria to Initiate Run:Walk Program (3 months at earliest) [7-10]

- No effusion and at least 12 weeks post-op
- Y-Balance anterior reach
  - ≤ 4 cm difference to non-operative limb or 90% limb symmetry index (LSI)
- 5 repetition maximum (RM) SL leg-press ≥ 80% of contralateral limb
- Able to perform 10 SL squats to 45° knee flexion without loss of balance or dynamic valgus
- No pain with 50 reps of low intensity DL to SL landing hold [11]
  - No dynamic valgus, knee flexion to 45°, maintain landing position for ≥ 3 seconds or greater
- Able to perform 20 reps of SL calf raise

Clinical Recommendations

- Screen for closed kinetic chain dorsiflexion (DF) with DF Lunge Test (at least 10 cm toe to wall or >35-40° tibial shaft angle) to limit biomechanical deficits with functional movement
- Improve cardiovascular endurance through circuit training, low impact exercise and run:walk program
- See **Appendix A** for *Strengthening Exercises for each Muscle Group and Strength Training Principles and Autoregulatory Progressive Resistance Exercise (APRE) Description*
- See **Appendix B** for *Patient Reported Outcome Measures*
- See **Appendix C** for *Sport Specific Testing*

Texas Children's Motion Analysis Laboratory

- Utilize Texas Children's Motion Analysis Laboratory to assess patient's progress in performing basic functional tasks such as walking and squatting. More challenging movements such as SL squats, vertical jumps, and running may be assessed. These assessments are focused on identifying asymmetries in loading patterns and the ability to move through full ROM. This assessment typically occurs 4 months after surgery once the patient has been performing the above movements consistently in physical therapy.
- See **Appendix E** for *Motion Analysis Lab Assessments and Biofeedback Training*

Phase 3 Progression Criteria

- Consistently performing run:walk program with normal gait and no adverse reaction

Phase 4: Speed and Power

Phase Summary

This phase of physical therapy focuses on the athlete developing more strength for jumping and other high-impact activities. Speed and power development are the primary goals of this phase so that the athlete can enter the last phase of rehabilitation when they will start a return to sport (RTS) progression. Estimated timeline: 4-6 months post-op

Objectives [12]

- Continue high intensity strengthening and progress to power
- Perform strength testing at 4 months as part of criteria to initiate Sportsmetrics jump program
- Begin Sportsmetrics Jump Program once criteria are met
- Advance proprioception training increasing sport specific and cognitive demands
- Physical performance testing at 6 months to prepare for RTS testing at 9+ months
    - 6 months tests include: Isokinetic Testing, ACL-RSI, Pedi IKDC12 to prepare for RTS testing at 9+ months

Criteria to Initiate Sportsmetrics Jump Program (4 Months at earliest) [11, 13-14]

- No increase in joint swelling/effusion
- No subjective reports of knee instability or giving way
- Isometric knee extension testing ≥ 70% LSI at 90° knee flexion
- Able to perform 10 SL squats to 60° knee flexion without loss of balance or dynamic valgus

Clinical Recommendations

- Begin RTS progression if applicable after completion of run:walk program
- Consider using slow motion video analysis apps to help with jump training (Coach's Eye, Dartfish, etc.)
- See **Appendix A** for *Strengthening Exercises for each Muscle Group and Strength Training Principles and Autoregulatory Progressive Resistance Exercise (APRE) Description* specific to phase 4
- See **Appendix C** for *Sport Specific Testing* at 4 and 6-months post-op
- See **Appendix D** for *Sport Specific Progression*

Texas Children's Motion Analysis Laboratory

- Utilize Texas Children's Motion Analysis Laboratory to assess patient's progress in squatting, jumping and running. More challenging movements such as drop jump and single leg jumps may be assessed at this time. During this phase, motion analysis assessments begin to include assessments of landing mechanics and athletic performance in addition to the asymmetries in range of motion and loading. This assessment typically occurs 6 months after surgery once the patient has been performing the above movements consistently in physical therapy.
- See **Appendix E** for *Motion Analysis Lab Assessments and Biofeedback Training*

Phase 4 Progression Criteria

- Consistently performing Sportsmetrics Jump Program with proper landing mechanics and no adverse reaction

Phase 5: Athletic Development

Phase Summary

In this phase, the athlete initiates cutting and pivoting activities in a controlled environment and progresses to an environment that more closely replicates their sport. The athlete continues to strength train and perform conditioning exercises to return to full sports participation.
Estimated timeline: 6 – 9 months post-op.

Objectives

- Complete return to sprinting program
- Continue high intensity power and strength
- Physical performance testing at 6 months to prepare for RTS testing at 9+ months.
  - 6 month tests include: Isokinetic Testing, ACL-RSI, Pedi-IKDC [12]
- Perform Hop Testing and LESS following successful completion of Sportsmetrics Jump Program
- Pass RTS testing at 9+ months

Clinical Recommendations

- Progress reactive proprioception training including perturbations
- Incorporate cognitive challenges when performing sport-specific activity
- The RTS phase should be individualized based on the athlete's sport
- Determine need for functional knee brace based on surgeon recommendation
- RTS Progression:
  - Foundational movement/power: sprinting, side shuffle, back-pedal, cutting
  - Planned movement practice: sport specific tasks, alone, in controlled environment
  - Non-contact partner drills: sport specific tasks, no hesitancy or compensation
  - Planned contact partner drills: progress to full speed and unplanned contact
  - Non-contact scrimmage: progress from partial to full time
  - Contact scrimmage: progress from partial to full time
  - Return to play progression: modify time and situation
  - Full return to play at athlete's pace
- Independent with Injury Prevention Program that includes a dynamic warm-up, strengthening, and jump training with proper landing mechanics
- See **Appendix A** for *Strengthening Exercises for each Muscle Group, Strength Training Principles and Autoregulatory Progressive Resistance Exercise (APRE) Description* specific to phase 5

Return to Sport Testing and Clearance (9+ Months) [11, 15-23]

- ACL-RSI ≥ 75%
- Pedi-IKDC ≥ 90%
- Isokinetic testing ≥ 90% knee extension LSI at 60°/s
- Knee Flexion Peak Torque / Knee Extension Peak Torque LSI ≥ 90% at 60°/s
- Hop Testing ≥ 90% LSI
  - 6 m Timed Hop
  - Single Hop
  - Triple Hop
  - Crossover Hop
  - Single Leg Vertical Hop
- LESS < 5 Errors

Texas Children's Motion Analysis Laboratory

- Utilize Texas Children's Motion Analysis Laboratory to assess patient's progress in performing more advanced athletic tasks such as single leg jumping/hopping, drop jumps, landing and cutting, and deceleration tasks. At this stage of the rehabilitation process, these assessments are focused on identifying asymmetries in loading patterns, high risk landing patterns, and the ability to control high velocity deceleration tasks. This assessment typically occurs 9+ months after surgery once the patient has been performing the above movements consistently in physical therapy.
- See **Appendix E** for *Motion Analysis Lab Assessments and Biofeedback Training*

Appendix A

Strength and Conditioning Principles

- Emphasize Building Endurance/Capacity → Hypertrophy → Strength → Power
  It is paramount that the athlete address endurance, hypertrophy, strength and power of necessary muscle groups to ensure full rehabilitation and return to sport.

  1. The athlete should set the foundation to build muscle mass and strength through muscular endurance training. While maintaining appropriate movement patterns, high repetitions with lower loads are performed.

  2. When the athlete demonstrates the appropriate movement patterns and muscular endurance, it is important to address muscle size and capacity for strength via hypertrophy training. The athlete progresses to moderate loads and less repetitions with a longer rest period.

  3. An emphasis should then be placed on force production and strength of the required muscle groups. At this point, the athlete is transitioning to strength training with lower repetitions and higher loads.

  4. The athlete may progress to power training when the required foundational muscular strength and endurance are present. The focus will be velocity of movements specific to the athlete's sport.

- To ensure the appropriate intensity of exercise, the therapist can use:
  - % 1 RM – which can be calculated using the APRE scale
  - RPE - Modified scale from 0-10 (rest-max effort)
  - OMNI-RES scale - 0-10 (extremely easy-extremely hard)
  - Reps in Reserve (RIR): Utilized to help determine proximity to failure by athlete reporting how many more repetitions could have been performed. An RIR of 0 would be the athlete's perceived RM. This tool is helpful to determine effort. However, it is important to note that individuals tend to underestimate RIR.

Repetition Continuum

Parameters	Training Experience	Load (%1 RM)	Sets x Reps	Rest Time	Frequency
Endurance	Novice	<50%	2 x 10-15	<90 sec	2-3 days/week
	Advanced	40-60%	2 x 10-25	1-2 min	2-3 days/week
Hypertrophy	Novice	60-70%	1-3 x 8-12	1-2 min	2-3 days/week
	Advanced	70-100%	3-6 x 6-12	2-3 min	4-6 days/week
Strength	Novice	60-70%	2-4 x 8-12	3-5 min	2-3 days/week
	Advanced	>80-85%	2-6 x 1-12		4-6 days/week
Power	Novice	>80%	1-3 x 1-12	3-5+ min	2-3 days/week
	Advanced	>85-93%	3-6 x 1-6		3 days/week

*Recently there has been more evidence challenging the current standard of repetition continuum. See references for more details on a new paradigm for muscular adaptations. [24-25]

Training the Youth Athlete

- When a child is ready to play sports, they are ready to perform resistance training
- Children and adolescents should not be treated the same as adults
- It is important to consider adequate supervision, safety protocols and progression with resistance training
- **NSCA Position Statement Recommendations:**
  - **Training**: 2-3 x week on non-consecutive days
  - **Strength**: 1-3 sets x 6-15 reps; 1-2 min rest
  - **Power**: 1-3 sets x 3-6 reps; 2-3 min rest
  - Trial resistance with light load for prescribed range - children must demonstrate good technique prior to increasing resistance
  - Increase resistance 5-10% as strength improves
  - **Training Age** (experience): Novice ≤ 3 months; Intermediate 3-12 months; Advanced > 12 months

Autoregulatory Progressive Resistance Exercise

What is Autoregulatory Progressive Resistance Exercise (APRE)? [26-27]

APRE is an auto-regulation resistance program consisting of 3 training cycles and can be used to determine adequate loading according to your rehabilitation goals. This program has been shown to be an effective training strategy to improve strength and motor performance.

How does the APRE program work?

The APRE is a 10-week resistance program divided into 3 training cycles:

Cycle 1: Hypertrophy Cycle (Weeks 1-4)

- The focus of this cycle is to increase the muscular size of a targeted muscle group by determining the individual's 10 RM
- **Week 1**
  - The 1st week of APRE will require clinical judgment to determine 50% of the individual's 10 RM as the starting point
  - Following the 3rd set, adjust the weight based on the number of reps performed (see 10 RM adjustment table)
  - Obtain an RPE rating (see RPE scale below) following the 4th set to ensure the individual is working in the proper zone of 8-10 RPE. Any weight adjustments required after the 4th set will be made during Week 2
- **Weeks 2 & 3**
  - Continue with same sets/reps as Week 1, adjust weight as needed based on the previous week's progress
- **Week 4**
  - The 4th week is considered a "De-Load Week" to facilitate muscle recovery and growth prior to beginning the strengthening cycle. This should be 75% of current training load

Cycle 2: Strength Cycle (Weeks 5-8)

- The focus of this cycle is to improve muscular strength of a targeted muscle group by determining the individual's 6 RM
- **Week 5**
  - The 5th week of APRE will require clinical judgment to determine 50% of the individual's 6 RM as the starting point
  - Following the 3rd set, adjust the weight based on the number of reps performed (see 6 RM adjustment table)
  - Obtain an RPE rating (see RPE scale below) following the 4th set to ensure the individual is working in the proper zone of 8-10 RPE. Any weight adjustments required after the 4th set will be made during Week 6
- **Weeks 6 & 7**
  - Continue with same sets/reps as Week 5, adjust weight as needed
- **Week 8**
  - The 8th week is considered a "De-Load Week" to facilitate muscle recovery and growth prior to beginning the power cycle. This should be 75% of current training load

Cycle 3: Power Cycle (Weeks 9-10)

- The focus of this cycle is to improve muscular power determining the individual's 3 RM
- **Week 9**
  - The 9th week of APRE will require clinical judgment to determine 50% of the individual's 3 RM as the starting point
  - Following the 3rd set, adjust the weight based on the number of reps performed (see 3 RM adjustment table)
  - Obtain an RPE rating (see RPE scale below) following the 4th set to ensure the individual is working in the proper zone of 8-10 RPE. Any weight adjustments required after the 4th set will be made during Week 10
- **Week 10**
  - Continue with same sets/reps as Week 9, adjust weight as needed

RPE Scale Based On Repetitions In Reserve	
10	Could not do more reps or load
9.5	Could not do more reps, could do slightly more load
9	Could do 1 more repetition
8.5	Could definitely do 1 more repetition, chance at 2
8	Could do 2 more repetitions
7.5	Could definitely do 2 more repetitions, chance at 3
7	Could do 3 more repetitions
5-6	Could do 4 to 6 more repetitions
1-4	Very light to light effort

Autoregulatory Progressive Resistance Exercise (APRE)

		Set 1	Set 2	Set 3	Set 4	*Adjustments for 10 RM	
Hypertrophy Cycle	Week 1	12 reps (50% of 10 RM)	10 reps (75% of 10 RM)	Reps to Failure*	Adjusted Reps to Failure	**Repetitions**	**Set 4**
						4-6	↓ 10-15 lbs.
	Week 2	12 reps (50% of 10 RM)	10 reps (75% of 10 RM)	Reps to Failure*	Adjusted Reps to Failure	7-8	↓ 5-10 lbs.
						9-11	Same
	Week 3	12 reps (50% of 10 RM)	10 reps (75% of 10 RM)	Reps to Failure*	Adjusted Reps to Failure	12-16	↑ 5-10 lbs.
						17+	↑ 10-15 lbs.
	Week 4	De-load Week: Perform 3 sets of 10 repetitions at 75% of last estimated 10 RM					

		Set 1	Set 2	Set 3	Set 4	*Adjustments for 6 RM	
Strength Cycle	Week 5	10 reps (50% of 6 RM)	6 reps (75% of 6 RM)	Reps to Failure*	Adjusted Reps to Failure	**Repetitions**	**Set 4**
						0-2	↓ 10-15 lbs.
	Week 6	10 reps (50% of 6 RM)	6 reps (75% of 6 RM)	Reps to Failure*	Adjusted Reps to Failure	3-4	↓ 5-10 lbs.
						5-7	Same
	Week 7	10 reps (50% of 6 RM)	6 reps (75% of 6 RM)	Reps to Failure*	Adjusted Reps to Failure	8-12	↑ 5-10 lbs.
						13+	↑ 10-15 lbs.
	Week 8	De-load Week: Perform 3 sets of 5 repetitions at 75% of last estimated 6 RM					

		Set 1	Set 2	Set 3	Set 4	*Adjustments for 3 RM	
Power Cycle	Week 9	6 reps (50% of 3 RM)	3 reps (75% of 3 RM)	Reps to Failure*	Adjusted Reps to Failure	**Repetitions**	**Set 4**
						1-2	↓ 5-10 lbs.
						3-4	Same
	Week 10	6 reps (50% of 3 RM)	3 reps (75% of 3 RM)	Reps to Failure*	Adjusted Reps to Failure	5-6	↑ 5-10 lbs.
						7+	↑ 10-15 lbs.

**After set 3, refer to adjustments column to determine reps in set 4*

Strengthening Exercises for Specific Muscle Groups

This is a list of recommended exercises derived from evidence-based clinical electromyography studies. These exercises should be prescribed during the appropriate phase of ACL rehabilitation in order to safely progress strengthening.

Gluteus Medius: [28]

- SL Bridge
- Lateral Step-Up
- Resisted Side-Step
- Hip Hitch / Pelvic Drop
- Isometric Standing Hip Abduction
- Side-lying Hip Abduction (with hip internal rotation)
- Standing Hip Abduction (on stance or swing leg) with added resistance

Gluteus Maximus: [29]

- Step Up Variations:
  - Step-Up
  - Lateral Step-Up
  - Diagonal Step-Up
  - Crossover Step-Up
- Hex Bar Deadlift
- Hip Thrust Variations:
  - Rotation Barbell Hip Thrust
  - Traditional Barbell Hip Thrust
- Belt Squat
- Split Squat

Quad: [30]

- Seated Leg Extension Machine
- Leg Press Machine
- Jumps Squats
- Back Squats
- SL Decline Squat

Hamstrings: [31-32]

- Nordic Hamstring Curl
- Supine Leg Curl
- Kettle Bell Swings
- Seated Leg Curl
- Hip Extension + Barbell

Appendix B

Patient Reported Outcome Measures

Patient reported outcome measures to be completed throughout rehabilitation.

Outcome Measure	Description	When To Administer	Passing Criteria
ACL-RSI [17]	ACL-RSI is a tool used to quantify the psychological readiness for a patient to return to sport after ACL reconstruction.	6 and 9 months post-op	9+ months ≥ 75%
PEDI-IKDC [18]	Pedi-IKDC is a subjective score of overall knee function.	0, 3, 6 and 9 months post-op	9+ month Pedi-IKDC ≥ 90%

ACL-RSI

Instructions: Place a mark, which best describes you in relation to each descriptor

Scoring: Total/1200 = _____%

1. Are you confident that you can perform at your previous level of sport participation?

	0	10	20	30	40	50	60	70	80	90	100	
Not at all confident	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Fully Confident

2. Do you think you are likely to re-injure your knee by participating in your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Extremely likely	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Not likely at all

3. Are you nervous about playing your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Extremely nervous	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Not nervous at all

4. Are you confident that your knee will not give way by playing your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Not at all confident	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Fully Confident

5. Are you confident that you could play your sport without concern for your knee?

	0	10	20	30	40	50	60	70	80	90	100	
Not at all confident	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Fully Confident

6. Do you find it frustrating to have to consider your knee with respect to your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Extremely frustrating	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Not at all frustrating

7. Are you fearful of re-injuring your knee by playing your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Extremely fearful	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	No fear at all

8. Are you confident about your knee holding up under pressure?

	0	10	20	30	40	50	60	70	80	90	100	
Not at all confident	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Fully Confident

9. Are you afraid of accidentally injuring your knee by playing your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Extremely afraid	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Not at all afraid

10. Do thoughts of having to go through surgery and rehabilitation prevent you from playing your sport?

	0	10	20	30	40	50	60	70	80	90	100	
All the time	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	None of the time

11. Are you confident about your ability to perform well at your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Not at all confident	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Fully Confident

12. Do you feel relaxed about playing your sport?

	0	10	20	30	40	50	60	70	80	90	100	
Not at all relaxed	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Fully Relaxed

Pedi-IKDC Subjective Knee Evaluation Form

Section A: General Information

1. Study ID: _____ _____ _____

2. Age of patient/subject: _____

3. Date distributed: _____ / _____ / _____ **(MM/DD/YYYY)**

Section B: Symptoms & Sports Activities

Date you injured your knee: _____ / _____ / _____ **(MM/DD/YYYY)**

We would like to learn more about your injured knee. Each of the questions asks you a different question about your injured knee. Please answer each question below.

Symptoms

1. If you were asked to do the activities below, what is the most you could do today without making your injured knee hurt a lot?

- 4 ☐ Very hard activities like jumping or turning fast to change direction, like in basketball or soccer
- 3 ☐ Hard activities like heavy lifting, skiing or tennis
- 2 ☐ Sort of hard activities like walking fast or jogging
- 1 ☐ Light activities like walking at a normal speed
- 0 ☐ I can't do any of the activities listed above because my knee hurts too much now.

2. During the past 4 weeks, or since your injury, how much of the time did your injured knee hurt?

	0	1	2	3	4	5	6	7	8	9	10	
Never	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	All of the time

3. How badly does your injured knee hurt today?

	0	1	2	3	4	5	6	7	8	9	10	
Does not hurt at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Hurts so much I can't stand it

4. During the past 4 weeks, or since your injury, how hard has it been to move or bend your injured knee?

- 4 ☐ Not at all hard
- 3 ☐ A little hard
- 2 ☐ Somewhat hard
- 1 ☐ Very hard
- 0 ☐ Extremely hard

Pedi-IKDC

5. During the past 4 weeks, or since your injury, how puffy (or swollen) was your injured knee?

- 4 ☐ Not at all puffy
- 3 ☐ A little puffy
- 2 ☐ Somewhat puffy
- 1 ☐ Very puffy
- 0 ☐ Extremely puffy

6. If you were asked to do the activities below, what is the most you could do today without making your injured knee puffy (or swollen)?

- 4 ☐ Very hard activities like jumping or turning fast to change direction, like in basketball or soccer
- 3 ☐ Hard activities like heavy lifting, skiing or tennis
- 2 ☐ Sort of hard activities like walking fast or jogging
- 1 ☐ Light activities like walking at a normal speed
- 0 ☐ I can't do any of the activities listed above because my injured knee is puffy even when I rest.

7. During the past 4 weeks, or since your injury, did your injured knee ever get stuck in place (lock) so that you could not move it?

0 ☐ **Yes** 1 ☐ **No**

8. During the past 4 weeks, or since your injury, did your injured knee ever feel like it was getting stuck (catching) but you could still move it?

0 ☐ **Yes** 1 ☐ **No**

9. If you were asked to do the activities below, what is the most you could do today without your injured knee feeling like it can't hold you up?

- 4 ☐ Very hard activities like jumping or turning fast to change direction, like in basketball or soccer
- 3 ☐ Hard activities like heavy lifting, skiing or tennis
- 2 ☐ Sort of hard activities like walking fast or jogging
- 1 ☐ Light activities like walking at a normal speed
- 0 ☐ I can't do any of the activities listed above because my injured knee feels like it can't hold me up.

Sports Activities

10. What is the most you can do on your injured knee most of the time?

- 4 ☐ Very hard activities like jumping or turning fast to change direction, like in basketball or soccer
- 3 ☐ Hard activities like heavy lifting, skiing or tennis
- 2 ☐ Sort of hard activities like walking fast or jogging
- 1 ☐ Light activities like walking at a normal speed
- 0 ☐ I can't do any of the activities listed above because my injured knee feels like it can't hold me up.

Pedi-IKDC

11. Does your injured knee affect your ability to:

	No, not at all	Yes, a little	Yes, somewhat	Yes, a lot	I can't do this
A. Go up stairs?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
B. Go down stairs?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
C. Kneel on your injured knee?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
D. Squat down like a baseball catcher?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
E. Sit in a chair with your knees bent, feet flat on the floor?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
F. Get up from a chair?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
G. Run?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
H. Jump and land on your injured knee?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐
I. Start and stop moving quickly?	4 ☐	3 ☐	2 ☐	1 ☐	0 ☐

12. How well did your knee work before you injured it?

	0	1	2	3	4	5	6	7	8	9	10	
I could not do anything at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	I could do anything I wanted to

13. How well does your knee work now?

	0	1	2	3	4	5	6	7	8	9	10	
I am not able to do anything at all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	I am able to do anything I want to do

14. Who completed the questionnaire?

1 ☐ Child Alone

2 ☐ Child with help from parent/adult

15. Date questionnaire completed: _____ / _____ / _____ (MM/DD/YYYY)

Thank you very much!

Scoring Instructions for the Pedi-IKDC Subjective Knee Evaluation Form

The Pedi-IKDC Subjective Knee Evaluation Form is scored by summing the scores for the individual items and then transforming the score to a scale that ranges from 0 to 100. The responses to each item are scored using an ordinal method such that a score of 0 is given to responses that represent the lowest level of function or highest level of symptoms. For example, item 1, which is related to the highest level of activity without significant knee pain is scored by assigning a score of 0 to the response "I can't do any of the activities..." and a score of 4 to the response "Very hard activities like jumping or turning fast...". For item 2, which is related to the frequency of pain over the past 4 weeks, the responses are reverse-scored such that "All of the time" is assigned a score of 0 and "Never" is assigned a score of 10. Item 3 is also reverse-scored such that "Hurts so much I can't stand it" is assigned a score of 0 and "Does not hurt at all" is assigned a score of 10. Note: The responses to item 12 "How well did your knee work before you injured it" do not have numerical equivalents, and thus this question does not factor into the overall score.

Scoring Process:

1. Assign the appropriate numerical scores to the individual's response for each item, such that the lowest score of zero represents the lowest level of function or highest level of symptoms.
2. Calculate the raw score by summing the numerical equivalents to each item's response, with the exception of the response to item 12.
3. Transform the raw score to a 0 to 100 scale as follows:

$$\text{Pedi - IKDC Score} = \left[\frac{\text{Raw Score}}{\text{Maximum Possible Score}} \right] \text{x100}$$

The Maximum Possible Score is 92. Thus, if the sum of the numerical equivalents for all items is 60, the Pedi-IKDC score would be calculated as follows:

$$\text{Pedi - IKDC Score} = \left[\frac{60}{92} \right] \text{x100}$$

$$\text{Pedi - IKDC Score} = 65.2$$

The calculated Pedi-IKDC Score should be interpreted as a measure of function, such that higher scores represent higher levels of function and lower levels of symptoms. A score of 100 is interpreted to mean no limitation with sporting activities or daily living and a complete absence of symptoms.

The Pedi-IKDC Subjective Knee Score can still be calculated if there is missing data, so long as there are responses to at least 90% of the items. To calculate the raw IKDC score when there is missing data, the Pedi-IKDC Subjective Knee Form Score is calculated as (sum of the completed items) / (maximum possible sum of the completed items) * 100.

Appendix C

Sport-Specific Testing [8, 11, 15-16, 19-23]

Test	Description	When to Administer	Passing Criteria
SL Squat Testing	A patient's ability to perform repetitive SL squats without compensation indicates adequate SL stability to initiate the Run:Walk or jumping programs.	Phase 3 (3 months)	10 reps to 45° knee flexion without loss of balance or dynamic valgus
		Phase 4 (4 months)	10 reps to 60° knee flexion without loss of balance or dynamic valgus
SL Leg Press 5 RM	SL leg press 5 RM measures maximal closed-kinetic chain strength. A 1 RM measurement can also be calculated from 5 RM effort.	Phase 3 (3 months)	≥ 80% of contralateral quad
Anterior Reach Y-Balance	Anterior reach Y-Balance is one criterion used to initiate the Run:Walk program.	Phase 3 (3 months)	≤ 4 cm difference to non-operative limb or 90% LSI
Isometric Knee Extension	Isometric testing is used to measure maximal open-chain muscle strength in the quad and hamstrings while adhering to graft loading precautions dependent on the ACL procedure performed.	Phase 4 (4 months)	≥ 70% of contralateral quad
Isokinetic Testing	Isokinetic testing is used to measure maximal open-chain muscle strength and peak torque at 60°/s in the quad and hamstrings (HS).	6- & 9-months post op	≥ 90% knee extension LSI at 60°/s
			Knee Flexion Peak Torque / Knee Extension Peak Torque LSI ≥ 90% at 60°/s
LESS	Use slow motion video to assess. The LESS test is used to provide a qualitative assessment of landing ability at the trunk, hip, knee, and ankle. Perform after completing Sportsmetrics.	6- & 9-months post op	< 5 errors
Hop Testing	Hop testing consists of single leg hopping movements to compare strength, power, and dynamic balance in involved and uninvolved limbs. Perform after completing Sportsmetrics.	6- & 9-months post op	≥ 90% LSI

*Do not perform LESS or Hop Testing if the patient has not completed the Sportsmetrics Jump Program

Y Balance Test

Name: _____

Date: _____ / _____ / _____ **(MM/DD/YYYY)**

Involved Lower Extremity: ☐ **Left** ☐ **Right**

Lower Quarter: Right LE Limb Length _____cm (Distal ASIS to Distal Medial Malleolus)

Direction	Greatest Right	Greatest Left
Anterior		
Posteromedial		
Posterolateral		

Composite Right Score: Lower _____

Composite Left Score: Lower _____

Composite Reach Distance:

Composite score = ((sum of the greatest reach in each direction) / (3 x Limb Length)) x 100.
Calculate the composite scores for left and right separately.

Research validated composite score cut points for age, gender, and sport/activity are available through the Move2Perform software
www.move2perform.com

Involved Lower Extremity: ☐ Left ☐ Right

Isometric Knee Testing

This test can be performed on an isokinetic machine on an isometric setting or with a crane scale with the knee in 90° of flexion. Perform this test at 4 months post ACL reconstruction. [11]

This test can be performed on an isokinetic machine (isometric setting), hand held dynamometer, or crane scale in 90° of knee flexion.

Testing Procedure						
Direction	**Trials**	**Trial Time**	**Rest Time**	**Knee Position**	**Highest Peak Force**	
					Left	**Right**
Knee Extension	3	5 sec	30 sec	90°	Trial 1 =	Trial 1 =
					Trial 2 =	Trial 2 =
					Trial 3 =	Trial 3 =
Knee Flexion	3	5 sec	30 sec	90°	**Left**	**Right**
					Trial 1 =	Trial 1 =
					Trial 2 =	Trial 2 =
					Trial 3 =	Trial 3 =

Isokinetic Knee Testing

This test can be performed on an isokinetic machine and must be performed at 6 months post ACL reconstruction unless otherwise instructed by the referring physician.

Testing Procedure			Isokinetic Peak Torque / Body Weight				Limb Symmetry Index (%) Involved/Uninvolved	
Speed	**Reps**	**Rest Time**	**Left**		**Right**		**Left**	**Right**
			Quad	**HS**	**Quad**	**HS**		
60°/sec	5	2 min						
180°/sec	10	2 min						
300°/sec	15	2 min						

Landing Error Scoring System (LESS)

Test Instructions

1. Stand on a 30-cm-high box placed at a distance of half the body height away from a landing area, marked by a line on the ground
2. Jump forward so that both limbs leave the box simultaneously, to land just past the line, and jump for maximum height immediately after landing
3. Perform warm-up jumps until comfortable with the movement, and then perform 3 scored trials
4. Video of jumps is recorded in frontal and sagittal views for assessment via slow or stop-motion
5. All 17 items are scored (0, 1 or 2) for all 3 jumps, and the 3 trials are then averaged for a final score
6. A score of <5 is considered good (i.e. at low risk)

View	Item	Definition of Error	Score Absent=0 Present=1
Sagittal	Ankle plantar flexion at initial contact	Heel-to-toe or flat foot landing	0 or 1
	Knee flexion at initial contact	Knee flexion <30°	0 or 1
	Hip flexion at initial contact	Thigh is in line with the trunk (hips not flexed)	0 or 1
	Trunk flexion at initial contact	Trunk is vertical or extended at the hips (i.e., not flexed)	0 or 1
	Knee flexion displacement	Knee flexes less than 45° between initial contact and maximum knee flexion	0 or 1
	Hip flexion displacement	Thigh does not flex more on the trunk between initial contact and maximum knee flexion	0 or 1
	Trunk flexion displacement	Trunk does not flex more between initial contact and maximum knee flexion	0 or 1
	Symmetric foot contact at initial contact	1 foot lands before the other foot or 1 foot lands heel-to-toe and the other foot lands toe-to-heel	0 or 1
Frontal	Stance width (wide) at initial contact	Feet are positioned > shoulder width apart (acromion processes)	0 or 1
	Stance width (narrow) at initial contact	Feet are positioned < shoulder width apart (acromion processes)	0 or 1
	Knee valgus at initial contact	Center of patella is medial to the midfoot	0 or 1
	Lateral trunk flexion at initial contact	Midline of the trunk is flexed to the left or the right side of the body	0 or 1
	Foot position (external rotation)	Foot is externally rotated >30° between initial contact and maximum knee flexion	0 or 1
	Foot position (internal rotation)	Foot is internally rotated >30° between initial contact and maximum knee flexion	0 or 1
	Knee valgus displacement	At the point of maximum medial knee position, the center of the patella is medial to the midfoot	0 or 1
Overall	Joint displacement	Soft (0), Average (1), Stiff (2)	0, 1, or 2
	Overall impression	Excellent (0), Average (1), Poor (2)	0, 1, or 2

LESS Scoresheet

Sagittal View		Scoring: Error Absent=0 Error Present=1		
		Jump 1:	Jump 2:	Jump 3:
1.	Ankle plantar flexion at initial contact			
2.	Knee flexion at initial contact			
3.	Hip flexion at initial contact			
4.	Trunk flexion at initial contact			
5.	Knee flexion displacement			
6.	Hip flexion displacement			
7.	Trunk flexion displacement			
Frontal View				
8.	Symmetric foot contact at initial contact			
9.	Stance width (wide) at initial contact			
10.	Stance width (narrow) at initial contact			
11.	Knee valgus at initial contact			
12.	Lateral trunk flexion at initial contact			
13.	Foot position (external rotation)			
14.	Foot position (internal rotation)			
15.	Knee valgus displacement			
Overall				
16.	Joint displacement: Soft (0 errors), Average (1 error), Stiff (2 errors)			
17.	Overall impression: Excellent (0 errors), Average (1 error), Poor (2 errors)			
Total				
Average				

Hop Test Instructions

- The recommended order of single leg hop testing is:

SL 6m Timed Hop → SL Hop → SL Triple Hop → SL Triple Crossover Hop → SL Vertical Hop

- The uninvolved limb is tested first, with self-selected recovery (or 30 seconds) between trials
- A successful attempt is defined as stable landing maintained for 2 seconds
- The distance is measured from the starting line to the heel
- Scoring is an average of 3 trials unless the patient continues to improve (with a maximum of 5 trials)
- When possible, hop testing should not be performed on the same day as isokinetic testing
- Optional hop testing standards based on height vs LSI can be found in the literature [33-34]

Hop Test Descriptions	
Single Leg 6m Timed Hop	Jump as fast as possible on a single leg, without losing balance and landing firmly. The goal is to have ≤ 10%-time difference in the time taken to hop between the involved limb and uninvolved limb.
Single Leg Hop	Jump as far as possible on a single leg, without losing balance and landing firmly. The distance is measured from the start line to the heel of the landing leg. The goal is to have ≤ 10% difference in hop distance between the involved limb and uninvolved limb. Other advanced hop testing standards for single hop include single leg hop distance of ≥80% of body height for females and ≥90% of body height for males.
Single Leg Triple Hop	Jump as far as possible on a single leg 3 consecutive times, without losing balance and landing firmly. The distance is measured from the start line to the heel of the landing leg. The goal is to have ≤ 10% difference in hop distance between the involved limb and uninvolved limb. Other advanced hop testing standards for triple hop include distance >1.9x body height.
Single Leg Triple Crossover Hop	Jump medially across a midline that is 15cm wide, followed by a lateral and then medial jump again for a total of 3 consecutive jumps. The distance is measured from the start line to the heel of the landing leg. The goal is to have ≤ 10% difference in hop distance between the involved limb and uninvolved limb.
Single Leg Vertical Hop	The vertical hop test can be administered via Vertec, jump mat or any available wall space in the clinic. Jump as high as possible on a single leg without taking a step-to approach. The goal is to have ≤ 10% difference in score between the involved limb and uninvolved limb.

Hop Test Scoring

Involved Lower Extremity: ☐ Left ☐ Right

SL 6m Timed Hop					
	Trial 1	Trial 2	Trial 3	Average	LSI
Left					
Right					

SL Hop for Distance					
	Trial 1	Trial 2	Trial 3	Average	LSI
Left					
Right					

SL Triple Hop for Distance					
	Trial 1	Trial 2	Trial 3	Average	LSI
Left					
Right					

SL Triple Crossover Hop for Distance					
	Trial 1	Trial 2	Trial 3	Average	LSI
Left					
Right					

SL Vertical Hop for Height					
	Trial 1	Trial 2	Trial 3	Average	LSI
Left					
Right					

Appendix D

Return to Sport Programs [8-11, 13, 14, 35]

Progression	Description	When to Administer
Run: Walk Program	The run:walk program is a graded progression of running distance and/or time with guidelines for frequency, rest days and soreness rules.	Begin run:walk program at minimum 3 months and once criteria are met.
Sportsmetrics Jump Program	The Sportsmetrics jump program is a 6-week progression from DL to SL jumping with consideration of number of jump contacts per day.	Begin Sportsmetrics at 4 months if criteria are met.
Sprint Progression	The sprint progression is a 3-stage progression of sprinting intensity with considerations for anaerobic conditioning, speed development and maximal effort training.	Begin sprint progression after completion of the Run:Walk Program.

Return to Run Program

Dynamic Warm-Up

Complete prior to each session of the running program. Examples include:

- Walking Knee Hug
- Walking Quad Stretch
- RDL Walk
- Soldier Walk
- World's Greatest Stretch
- High Knees
- Butt Kicks
- A-Skips
- B-Skips

Run:Walk

	Time	Treadmill
Level 1	1 min run / 1 min walk (5 reps/ 10 min total)	0.1 mile run/ 0.1 mile walk (1 mile total)
Level 2	2 min run / 1 min walk (5 reps/ 15 min total)	0.2 mile run/ 0.1 mile walk (1.5 miles total)
Level 3	3 min run / 1 min walk (5 reps/ 20 min total)	0.3 mile run/ 0.1 mile walk (2 miles total)
Level 4	4 min run / 1 min walk (5 reps/ 25 min total)	0.4 mile run/ 0.1 mile walk (2.5 miles total)
Level 5	8 min run / 2 min walk (3 reps/ 30 min total)	0.8 mile run/ 0.2 mile walk (3 miles total)
Level 6	15 min run / 2 min walk (2 reps/ 34 min total)	1.5 mile run/ 0.2 mile walk (3.4 miles total)
Level 7	30 min run	3 mile run

Guidelines:

- 2-day rest period required between runs for Levels 1-3
- 1-day rest period required between runs for Levels 4-7
- Do not advance more than 2 levels per week
- Runs should be performed on a flat surface ONLY
- Pace - able to maintain conversation throughout

Considerations:

- Endurance vs. Non-endurance athletes: Modifications to the running program should be decided by the clinician and individualized to the athlete depending on specific sport demands
- Strength Statement: Successful completion of a return to running program does not negate the need for foundational muscle strengthening to safely return to sport. Return to running should happen in conjunction with loaded resistance training.

Soreness Rules

Criterion	Action
Soreness during warm-up that continues into the activity/training session	2 days off, drop down intensity level
Soreness during warm-up that goes away during the activity/training session	Stay at intensity level that led to soreness
Soreness during warm-up that goes away but redevelops during activity/training session	2 days off, drop down 1 intensity level
Soreness the day after the activity/training session (not muscle soreness)	1 day off, do not advance program to next intensity level
No soreness	Advance 1 intensity level/week or as instructed by health care professional

Sportsmetrics Jump Program

Dynamic Warm-Up

- Walking Knee Hugs
- Walking Quad Stretch
- Soldier Walks
- Lunges Forward
- Lunges Backward
- World's Greatest Stretch
- Sidesteps
- High Knees
- Butt Kicks
- A-Skips

Phase 1: Technique Development

		Week 1 # of Contacts				Week 2 # of Contacts		
Type of Jump	Time	Mon	Wed	Fri	Time	Mon	Wed	Fri
Wall Jumps	20 sec				25 sec			
Tuck Jumps	20 sec				25 sec			
Broad Jumps - Stick Landing	5 reps				10 reps			
Squat Jumps	10 sec				15 sec			
Line Jumps: side-to-side	20 sec				25 sec			
Line Jumps: back-to-front	20 sec				25 sec			
180 Jumps	20 sec				25 sec			
Bounding in Place	20 sec				25 sec			
Total Contacts								
		Maximum goal per day total contacts = 160				Maximum goal per day total contacts = 190		

Phase 2: Fundamentals

		Week 3 # of Contacts				Week 4 # of Contacts		
Type of Jump	Time	Mon	Wed	Fri	Time	Mon	Wed	Fri
Wall Jumps	30 sec				30 sec			
Tuck Jumps	30 sec				30 sec			
Jump, jump, jump, vertical jump	5 reps				8 reps			
Squat Jumps	20 sec				20 sec			
Bounding for Distance	60 ft				2 x 60 ft			
Cone Jumps: side-to-side	30 sec				30 sec			
Cone Jumps: back-to-front	30 sec				30 sec			
Scissor Jumps	30 sec				30 sec			
Hop, hop, stick (double)	5 reps				5 reps			
Total Contacts								
		Maximum goal per day total contacts = 160				Maximum goal per day total contacts = 190		

Phase 3: Performance

		Week 5 # of Contacts				Week 6 # of Contacts		
Type of Jump	Time	Mon	Wed	Fri	Time	Mon	Wed	Fri
Wall Jumps	30 sec				30 sec			
Step, jump up, down, vertical	5 reps				5 reps			
Scissor Jumps	30 sec				30 sec			
Single leg jump distance	5 reps				5 reps			
Squat Jumps	25 sec				25 sec			
Jump into bounding	2 x 60 ft				3 x 60 ft			
Single leg hop, hop, stick	5 reps				5 reps			
Total Contacts								
		Maximum goal per day total contacts = 220				Maximum goal per day total contacts = 250		

Jump Descriptions	
Wall Jumps	With knees slightly bent and arms raised overhead, jump up and down touching the wall above you.
Tuck Jumps	Bend your knees and jump, bringing both knees up to your chest quickly.
Broad Jumps	Two-footed jump as far as possible. Hold landing (knees bent) for 3 seconds.
Squat Jumps	Lower quickly into a squat position - touching hands to the floor, and jump up raising arms overhead. Land in a squat position and immediately jump again.
Cone Jumps Side-to-Side / Back-to-Front	With feet together, jump side-to-side over cone quickly. Then perform jumps back to front.
180 Jumps	Stand with feet shoulder width apart and jump rotating 180° in mid-air. Hold each landing for 2 seconds and repeat in the reverse direction.
Bounding in Place	While leaning forward over the toes, jump from one leg to the other straight up and down, progressively increasing rhythm and knee height.
Jump, Jump, Jump, Vertical Jump	Three broad jumps with vertical jump immediately after landing the 3rd broad jump. Raise arms overhead with vertical jump.
Step, Jump Up, Down, Vertical	Two-footed jump on an 6-12 inch box. Jump off box with 2 feet. After landing, quickly jump straight up with arms raised overhead.
Scissors Jump	Start in lunge position with 1 foot well in front of the other. Jump up, alternating foot positions in mid-air.
Single Leg Jump Distance	One-legged hop for distance. Hold landing for 3 seconds with knee slightly bent.
Jump into Bounding	Two-footed broad jump. Land on single leg, then progress into bounding for distance.
Single Leg Hop, Hop, Stick	Perform 3 single leg hops, holding the 3rd landing for 5 seconds with knee slightly bent. Increase distance of hop as technique improves. Alternate legs.
Bounding for Distance	Start bounding in place and slowly increase distance with each step, keeping knees high.
Hop, Hop, Stick (Double), Bounding for Distance	Perform 2 single leg hops, landing from the 2nd hop with both feet. Increase distance of hop as technique improves. Alternate legs.

Return to Sprint Progression [35]

Progress 1 step every other day if athlete achieves run volume in recommended work:rest ratio without symptoms

Stage 1. 50% Intensity (1:3 work to rest ratio)

Objective: Build work capacity for anaerobic conditioning/endurance

Step 1	Step 2	Step 3	Step 4
20 yd x 3 untimed	20 yd x 4 untimed	20 yd x 3	20 yd x 3
40 yd x 2 untimed	40 yd x 3 untimed	40 yd x 4	40 yd x 4
60 yd x 2 untimed	60 yd x 2 untimed	60 yd x 2	60 yd x 2
80 yd x 2 untimed	80 yd x 2 untimed	80 yd x 2	80 yd x 2
100 yd x 1 untimed	100 yd x 1 untimed	100 yd x 1	100 yd x 2
80 yd x 2 untimed	80 yd x 2 untimed	80 yd x 2	80 yd x 1
60 yd x 2 untimed	60 yd x 2 untimed	60 yd x 2	60 yd x 2
40 yd x 2 untimed	40 yd x 3 untimed	40 yd x 4	40 yd x 4
20 yd x 3 untimed	20 yd x 4 untimed	20 yd x 3	20 yd x 3
Total: 19 runs @ 940 yds	Total: 23 runs @ 1060 yds	Total: 23 runs @ 1100 yds	Total: 23 runs @ 1120 yds

Stage 2. 75% Intensity (1:5 work to rest ratio)

Objective: Speed development, improve technique and build repeated sprint ability

Step 1	Step 2	Step 3	Step 4
20 yd x 3	20 yd x 3	20 yd x 2	20 yd x 2
40 yd x 2	40 yd x 2	40 yd x 2	40 yd x 2
60 yd x 2	60 yd x 1	60 yd x 1	60 yd x 2
80 yd x 1	80 yd x 1	80 yd x 1	80 yd x 1
100 yd x 1	100 yd x 1	100 yd x 1	60 yd x 2
80 yd x 1	80 yd x 1	80 yd x 1	40 yd x 2
60 yd x 2	60 yd x 1	60 yd x 1	20 yd x 2
40 yd x 2	40 yd x 2	40 yd x 2	
20 yd x 3	20 yd x 3	20 yd x 2	
Total: 17 runs @ 780 yds	Total: 15 runs @ 660 yds	Total: 13 runs @ 620 yds	Total: 13 runs @ 560 yds

Stage 3. 100% Intensity (1:7 work to rest ratio)

Objective: Achieve maximum effort. Work:rest ratio should replicate sport demands in step 3 and 4

Step 1	Step 2	Step 3	Step 4
20 yd x 6	10 yd x 3	10 yd x 3	10 yd x 2
40 yd x 2	20 yd x 4	20 yd x 3	20 yd x 3
60 yd x 1	40 yd x 2	30 yd x 2	30 yd x 2
40 yd x 2	60 yd x 1	40 yd x 2	40 yd x 1
20 yd x 6	40 yd x 2	60 yd x 1	60 yd x 1
10 yd x 3	30 yd x 1	30 yd x 2	40 yd x 1
	20 yd x 4	20 yd x 3	30 yd x 2
	10 yd x 2	10 yd x 3	20 yd x 3
**Full subjective recovery	**Full subjective recovery		10 yd x 2
Total: 20 runs @ 490 yds	Total: 19 runs @ 460 yds	Total: 19 runs @ 440 yds	Total: 17 runs @ 4200 yds

**Ensure full subjective recovery between runs so that the athlete can "train fast to be fast"*

Appendix E

Motion Analysis Laboratory

Motion Analysis Laboratory Assessment [36-40]

The 3D Motion Analysis is composed of two parts. The first is a thorough physical evaluation by a physical therapist. The second is movement assessment using three-dimensional motional analysis to assess the patient's mechanics during a variety of tasks.

We use state-of-the-art motion analysis technology to provide the health care team with kinetic and kinematic information about joint movements, movement patterns and asymmetries that are not visible to the naked eye.

The health care team will use this information to gain a better understanding of how the patient moves so that their physician and physical therapist can determine the best treatment plan.

Internal (TCH) providers can use the following form in REDCap© to schedule a patient in the Motion Analysis Lab using this link (redcap.link/MAL_Patient_Intake). A scheduler will call the patient to schedule an appointment and a PT from the motion analysis laboratory will email the referring PT if more information is needed to complete the desired assessment.

External providers can call 936-267-6686 to schedule a patient in the Motion Analysis Lab.

The motion analysis laboratory PT will interpret the results of the motion analysis assessments and provide a summary report along with the data to the referring PT. These data will be used to track their patient's progress and adjust treatment sessions as needed to help improve patient care and decrease re-injury risk.

Motion Analysis Laboratory Biofeedback Treatment Tools

Surface EMG Biofeedback

Surface EMG Biofeedback training can be used with patients to improve mind-muscle connection and increase body awareness, improve accuracy and quality of performance of exercises, improve strength of targeted muscle(s), and assist in finding the right cues that work best for that patient. Indications for use of this tool include a patient unable to demonstrate ability to activate specific muscles during exercise, generalized poor body awareness, or poor quality of movement during exercise with compensatory strategies observed.

After prepping the skin and sticking the EMG sensor onto the desired muscle(s), the patient can observe on the screen how hard they are contracting the muscle relative to their Maximum Voluntary Isometric Contraction (MVIC) and can practice using the muscle in a variety of different positions or exercises. The biofeedback can be visual and auditory to teach the patient how to fire the desired muscle(s).

One example of use for this tool in the ACL population is working to improve quad activation both pre and post ACL-R.

Jump Training

Achieving safe and symmetrical jump landing mechanics is a goal of ACL rehab. This technology allows the PT to quickly work on jumping with their patients with the help of real time video and force data feedback.

During the PT visit, the patient can perform multiple types of jumps on the force plates and immediately get valuable information on their performance such as jump height, ground reaction force data and kinetic asymmetry indexes. The patient can see themselves jumping in slow motion with force vector overlay. This allows the PT the opportunity to highlight important phases of jump landing in order to improve performance and symmetry. The patient can then repeat the jumps to immediately practice what they just observed and learned.

A simple, one page report is generated from the session that includes the data and pictures of each phase of all the jumps performed.

Contact Information

To schedule a visit that includes either of these treatment tools, please call us.
Motion Analysis Lab: 936-267-6686

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Notes


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