KNEE MICROFRACTURE CLINICAL PRACTICE GUIDELINE

Disclaimer

The following rehabilitation guidelines are specific to patients who have undergone a knee microfracture surgical procedure. Please refer to the Ohio States Sports Medicine website for rehabilitation guidelines specific to other procedures and conditions, as appropriate.

Progression is criterion-based and dependent on soft tissue healing, patient demographics, and clinical evaluation. The time frames identified for each phase of rehabilitation are approximate times for the average patient and not recommended as guidelines for progression for the individual patient. It is recommended that progression is based upon the achievement of functional criteria demonstrating readiness for progression, noted at the end of each phase.

Background

Knee microfracture surgery is an arthroscopic surgical procedure to restore full thickness cartilage defects of the knee. During the procedure, multiple small holes, or “microfractures”, are made in the bone exposed by the cartilage defect. This releases stem cells which form a fibrous clot that covers the area of exposed bone. As this area matures and heals, it will turn into a smooth and durable repair tissue. The goal during the healing process is to avoid harmful forces to the site of cartilage repair. Improving tissue mechanical properties and protection of the tissue is done through early and controlled weight bearing, early and protected range of motion, and gradually progressing forces during different phases of rehabilitation.

Summary of Recommendations

General	• It is important to be aware of lesion size and location • ***Please refer to the "post-op plan" section of the operative note for clarification on post-operative precautions***
Weight Bearing Guidelines	Weight bearing status is largely dependent on lesion size. Please refer to operative note for post-operative weight bearing precautions.
Range of Motion Progression	• Symmetrical knee extension should be achieved by post-op week 4 • Full ROM should be achieved by post-op week 8
Outcome Tools	Collect the LEFS at each visit *You may choose to include IKDC, KOOS, ACL-RSI, Tegner or other questionnaires specific to your patient's needs*.
Strength Testing	• Isometric testing: 3 months • Isokinetic testing: 4, 6, 9 and 12 months • Functional hop testing: once 80% LSI is achieved on isokinetic testing
Criteria to Discharge Assistive Device	1. ROM: Full active knee extension; no pain on passive overpressure 2. Strength: Able to perform strong quad isometric with full tetany and superior patellar glide and able to perform 20 SLR without quad lag 3. Effusion: 1+ or less is preferred (2+ acceptable if all other criteria are met) 4. Weight Bearing: Demonstrates pain-free ambulation without visible gait deviation
Criteria to Discharge NMES	<20% quadriceps deficit on isometric or isokinetic testing (can use HHD for isometric testing) **OR- If testing equipment is not available:** 1. 20 SLR without quad lag 2. Normal gait 3. 10 heel taps to 60 degrees with good quality 4. 10 rep max on LP and similar effort bilaterally 5. Inability to break quad MMT
Criteria to Initiate Running and Jumping	1. ROM: full, pain-free knee ROM, symmetrical with the uninvolved limb 2. Strength: Isokinetic testing 80% or greater for hamstring and quad at 60º/sec and 300º/sec 3. Effusion: 1+ or less 4. Weight Bearing: normalized gait and jogging mechanics 5. Neuromuscular Control: Pain-free hopping in place without dynamic knee valgus
Criteria for Return to Sport	1. ROM: full, pain-free knee ROM, symmetrical with the uninvolved limb 2. Strength: Isokinetic testing 90% or greater for hamstring and quad at 60º/sec and 300º/sec 3. Effusion: No reactive effusion ≥ 1+ with sport-specific activity 4. Weight Bearing: normalized gait and jogging mechanics 5. Neuromuscular control: appropriate mechanics and force attenuation strategies with high level agility, plyometrics, and high impact movements 6. Functional Hop Testing: LSI 90% or greater for all tests 7. Physician Clearance
Return to Sport Expectation	6-12 months

RED/YELLOW FLAGS

Red Flags
 	
Require immediate referral for re-evaluation
	• Signs of DVT→ *Refer directly to ED*
	  ○ Localized tenderness along the distribution of deep venous system
	  ○ Entire LE swelling
	  ○ Calf swelling >3cm compared to asymptomatic limb
	  ○ Pitting edema
	  ○ Collateral superficial veins
	• Lack of full knee extension by 4 weeks post-op→*Refer to surgeon for re-evaluation*
	• Mechanical block or clunk→*Refer to surgeon for re-evaluation*
	• Reported episode of instability→*Refer to surgeon for re-evaluation*

Yellow Flags *Require modifications to plan of care*	• Persistent reactive effusion or pain following therapy or ADLs ○ *Decrease intensity of rehab interventions, continue effusion management, educate patient regarding activity modifications until symptoms resolve*

Early Post-Operative Phase (0 – 6 weeks)

Appointments	Post-operative evaluation should be performed 3-5 days following surgery. Follow-up PT appointments 1-2x per week, depending on progression towards goals.
Pain and Effusion	Goal is ≤ 2+ (using Modified Stroke Test) Cryotherapy and compression
ROM	Extension: Emphasis on achieving full knee extension immediately following surgery. If full extension is not achieved by 4 weeks, contact surgeon regarding ROM concerns. Flexion: Progressive flexion ROM, with full flexion achieved by post-op week 8 ***Please refer to the "post-op plan" section of the operative note for clarification on post-operative precautions***
Weight Bearing	Refer to operative note for precautions

Suggested Interventions	• Extension PROM: bag hangs (Appendix A) or prone hangs
	• Flexion: wall slides, heel slides, upright bike
	• Patellar mobilization: superior, inferior, medial, lateral
	• Quad Isometrics; SLR 4-way
	• Prone TKE
	• Open Chain Knee Extension:
	  ○ Unresisted LAQ: week 4-6
	  ○ Modified range SL knee extension machine: week 6-8
	• Open chain hamstring exercise: prone hamstring curls, hamstring curl machine
	• Shuttle press
	  ○ Partial range: week 4
	  ○ Full range: week 6
	• SL balance (pending WBing status)
	• Heel raises (pending WBing status)
	• Begin Neuromuscular re-education using electrical stimulation (NMES) in long sitting with pads on proximal and distal quadriceps. Once 60º knee flexion is easily obtained, then perform NMES following instructions below.

NMES Parameters at 60º	• NMES pads are placed on the proximal and distal quadriceps • Patient: Seated in long sitting (knees extended) until able to achieve 90° knee flexion. Progress to seated at 60° knee flexion once they are able to easily obtain 90° • The patient is instructed to relax while the e-stim generates at least 50% of their max volitional contraction against a fixed resistance OR maximal tolerable amperage without knee joint pain • 10 seconds on/ 50 seconds off x 15 min
Criteria to Progress to Middle Phase of Rehab	ROM: Symmetrical knee extension and flexion > 125°. If full AROM knee extension is not achieved by 4 weeks, contact surgeon regarding ROM concerns. Strength: Quadriceps set with normal superior patellar translation, 20x SLR without extensor lag Effusion: 1+ or less with Modified stroke test

Middle Phase of Rehabilitation (6-16 weeks)

Appointments	Goal to increase lower extremity strength and regain flexion ROM. 1-2 visits per week with emphasis on patient compliance with resistance and ROM training as part of HEP
Weight Bearing	• Refer to operative note for WBing precautions. • Goal: all patients should be FWBing without assistive device by 8 weeks, unless otherwise outlined in operative note
Criteria to Discharge Assistive Device	• ROM: Full active knee extension; no pain on passive overpressure • Strength: Able to perform strong quad isometric with full tetany and superior patellar glide and able to perform 20 SLR without quad lag • Effusion: 1+ or less is preferred (2+ acceptable if all other criteria are met) • Weight Bearing: Demonstrates pain-free ambulation without visible gait deviation
Pain and Effusion	Cryotherapy/compression as needed for effusion – effusion should be 1+ or less
ROM	Symmetrical ROM by week 8

Suggested Interventions and timelines	• Continue phase 1 interventions
	• Multi-angle knee isometrics
	• Open chain knee extension:
	  ○ Modified range SL knee extension machine: week 6-8
	  ○ Full range SL knee extension machine: week 8
	• Leg press machine: week 8
	• Single leg dead lifts
	• Squats:
	  ○ 0-45°: week 6
	  ○ 0-90°: week 8
	• Heel taps: week 6
	• Step ups: week 6
	• Lunges: week 10
	• Elliptical: week 10
	• Progress gluteal and lumbopelvic strength and stability
	• Progress single leg balance and proprioceptive exercises
	• NMES: progress to seated with 60˚ of knee flexion (Appendix B)
	• Continue effusion management strategies

Strength Testing	Isometric testing: 12 weeks Isokinetic testing: 16 weeks
Criteria to Discharge NMES	• <20% quadriceps deficit on isometric testing (can use HHD for isometric testing) **OR- If testing equipment is not available:** 1. 20 SLR without quad lag 2. Normal gait 3. 10 heel taps to 60 degrees with good quality 4. 10 rep max on LP and similar effort bilaterally 5. Inability to break quad MMT
Criteria to Progress to Late Phase of Rehab	1. ROM: Maintain full, pain-free AROM including patellofemoral mobility 2. Effusion: 1+ or less with Modified Stroke Test and no reactive effusion with progressions 3. Strength: Isometric quadriceps and hamstrings strength >/= 80% 4. Weight Bearing: Able to tolerate therapeutic exercise program, including PWB plyometrics, without increased pain or >1+ effusion 5. Neuromuscular Control: Demonstrates proper lower extremity mechanics with all therapeutic exercises (bilaterally)

Late Phase of Rehabilitation (weeks 16 - RTS)

Appointments	Increased frequency from previous stage to 1-2x per week when appropriate to initiate plyometric training and return to running program.
Criteria to initiate Running and Jumping	1. ROM: full, pain-free knee ROM, symmetrical with the uninvolved limb 2. Strength: Isokinetic testing 80% or greater for hamstring and quad at 60º/sec and 300º/sec 3. Effusion: 1+ or less 4. Weight Bearing: normalized gait and jogging mechanics 5. Neuromuscular Control: Pain-free hopping in place
Pain and Effusion	Effusion may increase with increased activity, ensure ≤1+ and/or non-reactive effusion for progression of plyometrics
ROM	Full, symmetrical to contralateral limb, and pain-free with overpressure

Strength Testing	• Isokinetic testing: 4, 6, 9 and 12 months
	• Hop testing (Appropriate after 80% symmetry achieved on isokinetic testing)
	  ○ SL hop for distance
	  ○ Triple hop
	  ○ Cross over hop
	  ○ Timed 6m hop
	
	Functional strength testing and hop testing should be reserved for patients returning to high level activity

Therapeutic Exercise	• Performance of the quadriceps, hamstrings and trunk dynamic stability • Initiate walk-jog program once 80% LSI is achieved on isokinetic testing • Muscle power generation and absorption via plyometrics • Sport- and position-specific activities • Begin agility exercises between 50-75% effort (utilize visual feedback to improve mechanics as needed) • Advance plyometrics: Bilateral to single leg, progress by altering surfaces, adding ball toss, 3D rotations, etc.
Suggested Interventions	Therapeutic Exercise/Neuromuscular Re-education

	• Squats, leg extension, leg curl, leg press, deadlifts, lunges (multi-direction), rotational trunk exercises on static and dynamic surfaces, resisted side steps, monster walks, PWB to FWB jumping • Single-leg squats on BOSU, Single-leg BOSU balance with manual perturbation to trunk or ball, single-leg BOSU Romanian deadlift Agility • Side shuffling, carioca, figure 8, zig-zags, resisted jogging (Sport Cord) in straight planes, backpedaling, ladder drills Plyometrics • Single-leg hop downs from increasing height (up to 12" box), Single-leg hop-holds, Double and single-leg hopping onto unstable surface, Double and single-leg jump-turns, Repeated tuck jumps
Criteria for Return to Sport	1. ROM: full, pain free knee ROM, symmetrical with the uninvolved limb 2. Strength: Isokinetic testing 90% or greater for hamstring and quad at 60º/sec and 300º/sec 3. Effusion: No reactive effusion and ≤ 1+ with sport-specific activity 4. Weight Bearing: normalized gait and jogging mechanics 5. Neuromuscular control: appropriate mechanics and force attenuation strategies with high level agility, plyometrics, and high impact movements 6. Functional Hop Testing: LSI 90% or greater for all tests 7. Physician Clearance

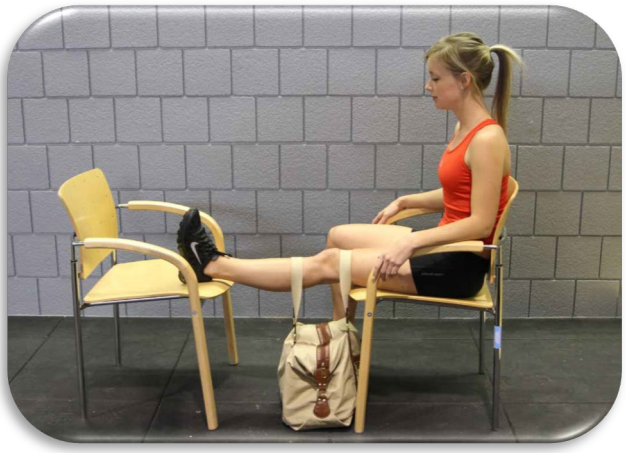
Activities that generate high compression, shear and rotational loads are to be avoided until 4-6 months, or as directed by orthopaedic surgeon

Full RTS expected between 6-12 months postoperatively depending on location and size of lesion

Appendix A: Bag Hang

Emphasis on low load, long duration stretching

- *Goal: 60 minutes of bag hang time total per day.*
- *Ideally: 4x15 minutes (or greater) per day*

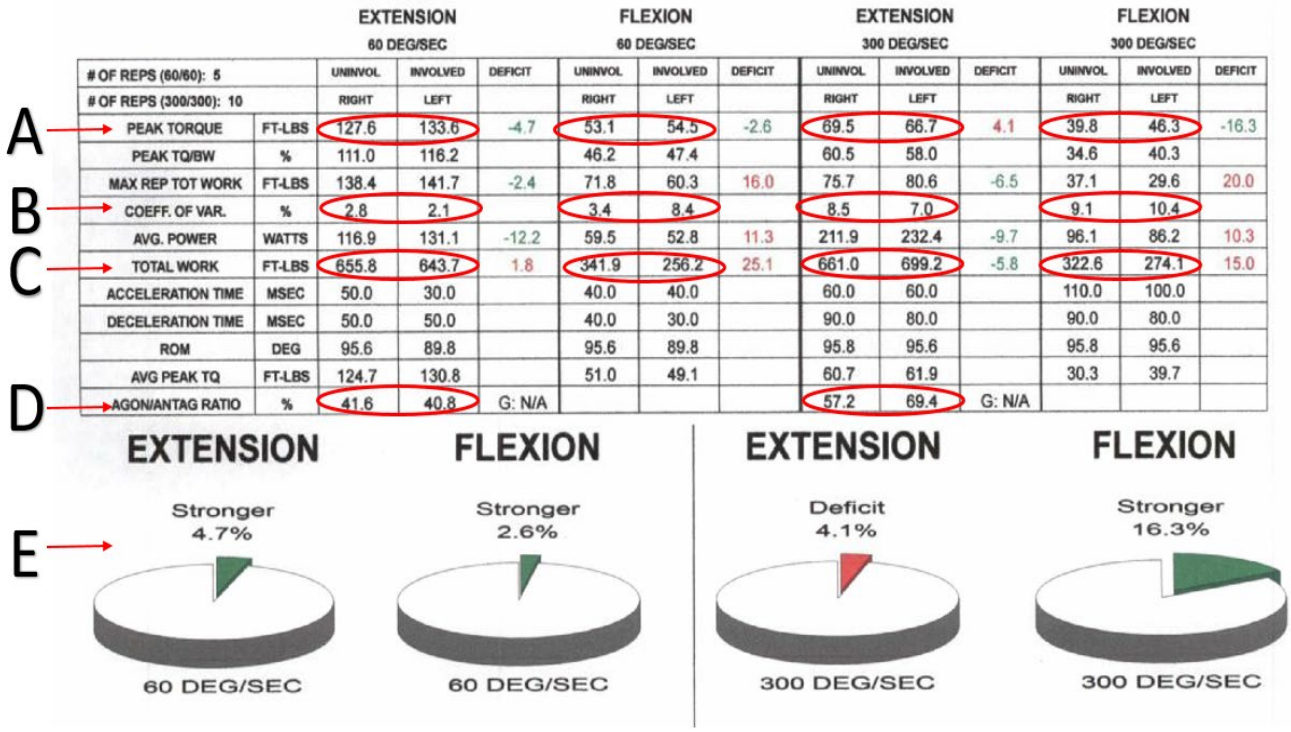


Appendix B: NMES Set Up

2 or 4 pad set-up is appropriate

- NMES pads are placed on the proximal and distal quadriceps
- Patient: Seated with the knee in at least 60º flexion, shank secured with strap and back support with thigh strap preferred. The ankle pad/belt should be two finger widths superior to the lateral malleoli
- The patient is instructed to relax while the e-stim generates at least 50% of their max volitional contraction against a fixed resistance OR maximal tolerable amperage without knee joint pain
- 10-20 seconds on/ 50 seconds off x 15 min

Appendix C: Isokinetic Data Interpretation



		EXTENSION 60 DEG/SEC			FLEXION 60 DEG/SEC			EXTENSION 300 DEG/SEC			FLEXION 300 DEG/SEC		
# OF REPS (60/60): 5		UNINVOL	INVOLVED	DEFICIT	UNINVOL	INVOLVED	DEFICIT	UNINVOL	INVOLVED	DEFICIT	UNINVOL	INVOLVED	DEFICIT
# OF REPS (300/300): 10		RIGHT	LEFT		RIGHT	LEFT		RIGHT	LEFT		RIGHT	LEFT	
A → PEAK TORQUE	FT-LBS	127.6	133.6	-4.7	53.1	54.5	-2.6	69.5	66.7	4.1	39.8	46.3	-16.3
PEAK TQ/BW	%	111.0	116.2		46.2	47.4		60.5	58.0		34.6	40.3	
MAX REP TOT WORK	FT-LBS	138.4	141.7	-2.4	71.8	60.3	16.0	75.7	80.6	-6.5	37.1	29.6	20.0
B → COEFF. OF VAR.	%	2.8	2.1		3.4	8.4		8.5	7.0		9.1	10.4	
AVG. POWER	WATTS	116.9	131.1	-12.2	59.5	52.8	11.3	211.9	232.4	-9.7	96.1	86.2	10.3
C → TOTAL WORK	FT-LBS	655.8	643.7	1.8	341.9	256.2	25.1	661.0	699.2	-5.8	322.6	274.1	15.0
ACCELERATION TIME	MSEC	50.0	30.0		40.0	40.0		60.0	60.0		110.0	100.0	
DECELERATION TIME	MSEC	50.0	50.0		40.0	30.0		90.0	80.0		90.0	80.0	
ROM	DEG	95.6	89.8		95.6	89.8		95.8	95.6		95.8	95.6	
AVG PEAK TQ	FT-LBS	124.7	130.8		51.0	49.1		60.7	61.9		30.3	39.7	
D → AGON/ANTAG RATIO	%	41.6	40.8	G: N/A				57.2	69.4	G: N/A			

		Definition	Clinical Impact	What to do
A	Peak Torque (ft-lbs)	Peak torque during repetitions	Symmetry criteria (see 'E'- this is the data represented in pie charts)	If <80%; continue unilateral, high resistance strength training
B	Coefficient of Variance (%)	Between repetition variability	Goal: < 15%	If >15%, consider retest
C	Total Work (ft-lbs)	Torque over all repetitions	Possible indicator of fatigue	If >10%; consider high volume training
D	Agonist/Antagonist Ratio (%)	Hamstring/Quadriceps Ratio	Goal: >60%	<60%; ensure 1:1 quadriceps:hamstring exercise ratio
E	Limb Symmetry Pie Charts	Strength relative to involved limb	Goal: <10% asymmetry (either direction- deficit OR stronger on involved limb)	If <80%, continue NMES in addition to strength training If <90%, continue unilateral > bilateral strength training emphasis

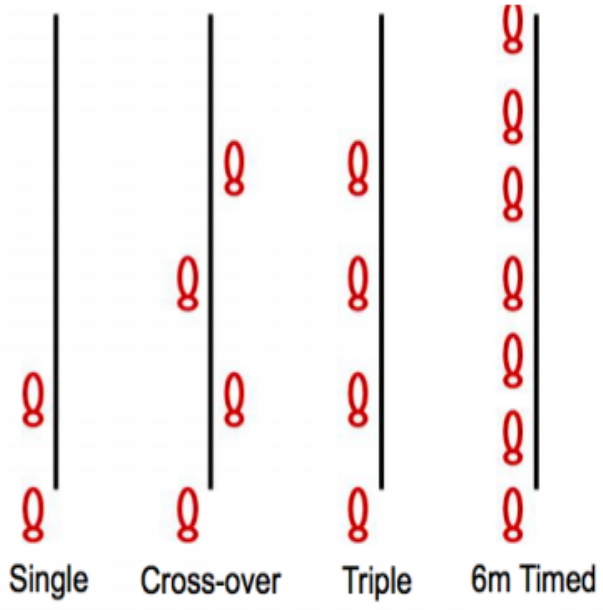
Appendix D: Isokinetic Testing and Appropriate Alternatives

Sinacore, J. A., Evans, A. M., Lynch, B. N., Joreitz, R. E., Irrgang, J. J., & Lynch, A. D. (2017). Diagnostic accuracy of handheld dynamometry and 1-repetition-maximum tests for identifying meaningful quadriceps strength asymmetries. *Journal of orthopaedic & sports physical therapy*, *47*(2), 97-107.

Isokinetic Dynamometry		• Considered the "gold standard" • 60°/sec for strength and power assessment • 300°/second for speed and endurance assessment
Hand Held Dynamometry with Static Fixation at 90°		• Appropriate alternative • Results may overestimate quadriceps strength symmetry: be cautious with data interpretation
SL 1RM Knee Extension Machine: 90°- 45°		• Appropriate alternative • Recommended to decrease stress on PF joint and limit strain on reconstructed ACL for up to 6 months • Results may overestimate quadriceps strength symmetry: be cautious with data interpretation
SL 1RM Leg Press		• Fair alternative • Results in significant overestimation of quadriceps strength symmetry due to compensation from other LE muscle groups
SL 1RM Knee Extension Machine: 90°- 0°		• Fair alternative • May be uncomfortable and/or inappropriate due to PF stress

Appendix E: Single Leg Hop Series

1) **Single hop for distance:** Have the subject line their heel up with the zero mark of the tape measure, wearing athletic shoes. The subject then hops as far as he/she can, landing on the same push off leg, for at least 3 seconds. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.
2) **Cross-over hop for distance:** The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot, crossing fully over the center line each time. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.
3) **Triple hop for distance:** The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.
4) **Timed 6-meter hop:** The subject lines their heel up at the zero mark of the tape measure and hops, on cue with the tester, as fast as they can the length of the 6-meter tape. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb time/Uninvolved limb time X 100%.



Author: Tiffany Marulli, PT, DPT, OCS and Sarah Depp, PT, DPT, OCS
Reviewer: Caroline Brunst, PT, DPT; Victoria Otto, PT, DPT; Robert Duerr, MD; Robert Magnussen, MD; David Flanigan, MD; Christopher Kaeding, MD
Completion Date: April 2020

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