KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

The following Osteochondral Autograft Guideline was developed by HSS Rehabilitation. **Progressions in this guideline are both criteria-based and can be modified for individual patient needs. Phases and time frames are designed to give the clinician a general sense of progression.** The rehabilitation program following an osteochondral autograft emphasizes early, controlled motion to prevent knee stiffness and to avoid disuse atrophy of the musculature. The program should be a balance of managing prior deficits, tissue healing and appropriate interventions to maximize flexibility, strength, and pain-free performance of functional activities. This model should not replace clinical judgment.

These types of patients may have additional alignment issues that may have caused their initial cartilage breakdown. Be aware if concomitant surgical procedures have been performed. Defer to surgeon for additional direction.

Monitor edema throughout the rehab process. If persistent edema occurs, monitor load volume and consult with referring physician.

FOLLOW SURGEON'S MODIFICATIONS AS PRESCRIBED

KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

Phase 1: Weeks 0-2

PRECAUTIONS

- Range of motion (ROM): progress as tolerated (DO NOT FORCE ROM)
  - 0-90˚ over first 2 weeks
- Adhere to weight bearing restrictions
  - 20% body weight foot flat weight bearing (FFWB) with bilateral axillary crutches for 3 weeks or as per surgeon preference
- Brace Guidelines
  - Ambulation with brace locked and bilateral axillary crutches for 3 weeks
  - **Sleep with brace locked in extension for 1 week**
- Avoid pillow under knee to prevent knee flexion contracture
- Control post- operative edema

ASSESSMENT

- Lower Extremity Functional Scale (LEFS) - Validated for ages 18+ years
- Pediatric International Knee Documentation Committee Subjective Knee Evaluation Form (Pedi-IKDC) validated for ages 10 -18 years
- Numeric pain rating scale (NPRS)
- Patellar mobility
- Neurovascular assessment
- Edema (girth and description)
- Inspection of incision
- Quality of quadriceps contraction
- Lower extremity (LE) flexibility
- LE active ROM (AROM) and passive ROM (PROM)
- Gait assessment

TREATMENT RECOMMENDATIONS

- Patient education
- ROM/Soft Tissue
    - Immediate ROM after surgery
        - **Do not force ROM**
    - Emphasize full knee extension immediately
        - Heel prop multiple times per day
        - LE stretching (hamstring/gastrocnemius/soleus)
    - Patellar mobilization as indicated (all planes)
- Strengthening
    - Quadriceps re-education
        - Quad sets, straight leg raises (SLR) with neuromuscular electrical stimulation (NMES)
    - SLRs (all planes)
        - Emphasize no extension lag during exercise
    - Initiate primary core stabilization/kinetic linking program
        - Abdominal sets
        - Pelvic bracing
        - Bent knee fallout (BKFO)
        - Clam shells
    - Ankle progressive resistive exercises (PRE)
    - Consider blood flow restriction (BFR) program with FDA approved device and qualified therapist if patient cleared by surgeon
- Independent with home exercise program (HEP) that addresses primary impairments
- Edema control (cryotherapy)

CRITERIA FOR ADVANCEMENT

- Maintain knee ROM: 0°-90°
- Control post-operative pain and edema
- SLR flexion without extensor lag
- Adherence to post-operative restrictions
- Independent with HEP

EMPHASIZE

- Ambulation with brace locked in extension and 20% FFWB
- Quadriceps activation
- Full knee extension
- Control of pain/edema
- Improvement in patellar mobility

KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

Phase 2: Weeks 2-6

PRECAUTIONS

- Progress ROM as tolerated or as per surgeon preference: **do not force motion**
- Adhere to weight bearing restrictions
    - Weeks 3-5: partial weight bearing (PWB) up to 50% with crutches or as per surgeon preference
    - Weeks 5-6: weight bearing as tolerated or as per surgeon preference
- Brace guidelines
    - Weeks 2-3: Locked in extension for ambulation
    - Weeks 3-5: Unlock brace when proper quad control is established
    - Discharge brace after week 5 (may use knee sleeve or unloader brace at this point if needed)
- Avoid pillow under knee to prevent knee flexion contracture
- Control post-operative edema

ASSESSMENT

- LEFS
- Pedi-IKDC
- NPRS
- Patellar mobility
- Edema (girth and description)
- Inspection of incision/scar mobility
- Quality of quadriceps contraction
- LE flexibility
- LE AROM and PROM
- Gait assessment

TREATMENT RECOMMENDATIONS

- ROM/Soft Tissue
    - Knee ROM goals (USE AS A GUIDELINE)
        - Week 3- 0-105°
        - Week 4- 0-115/120°
        - Week 6- 0-130° (progressing to full ROM)
    - Continue exercises from phase 1
    - Heel slides against wall if there is difficulty gaining ROM

    - Step knee flexion stretch
    - Supine hip flexor stretch when tolerated
    - Maintain passive knee extension
    - Maintain patellar mobility
    - LE soft tissue treatment continuation as needed
    - LE stretching continuation per phase 1
- Strengthening
    - Quadriceps re-education with NMES continuation as needed
    - Blood flow restriction (BFR) program if patient cleared by surgeon
    - Bilateral Leg Press
        - 60° → 0° arc (week 2-4)
        - 90° → 0° arc (week 4-6) *depending on ROM gains*
    - Core stabilization/kinetic linking program progression
    - Standing bilateral heel raises-Week 2-3
    - Short crank bicycle progressing to upright bike with adequate ROM (110-115˚ of ROM)
    - Multiplanar gluteal/core/hip strengthening
        - Bridges with resistance band, side lying clamshells, standing clamshells
    - Hydrotherapy when incisions are healed for gait, proximal strengthening, functional movements, balance and edema control- week 4-6
    - Underwater treadmill/anti-gravity treadmill gait training if gait pattern continues to be abnormal
- Balance/Proprioception:
    - Weight shift exercises with upper extremity (UE) support
        - Bilateral weight bearing proprioception exercises
        - Single leg (SL) balance/proprioceptive activities after proper quad control obtained
- Edema control: cryotherapy

CRITERIA FOR ADVANCEMENT

- Full weight bearing with crutches, discharge brace
- Demonstrate a normal gait pattern without deviations
- Progressing toward full ROM
- Normal patellar mobility (all planes)
- Proximal strength > 4/5 manual muscle test (MMT)
- Minimal edema
- Pain well controlled
- Independent with HEP

EMPHASIZE

- Proper gait pattern
- Continued full knee extension
- Control of pain and edema

KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

Phase 3: Weeks 6-12

PRECAUTIONS

- Progress to full ROM
- Avoid pain with therapeutic exercises and functional activities
- Continue to control post-operative edema

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- Patellar mobility
- Edema (girth and description)
- Inspection of incision/scar mobility
- Quality of quadriceps contraction
- Proximal & distal strength: MMT or hand held dynamometer (HHD)
- LE flexibility
- LE AROM and PROM
- Gait assessment
- Movement assessment

TREATMENT RECOMMENDATIONS

- ROM/Soft Tissue
    - Gradual increase of ROM to full
        - Continue ROM exercises from Phase 2
        - Prone knee flexion stretch
    - Maintain full passive knee extension
    - Patellar mobilization continuation as needed
    - LE soft tissue program continuation as needed
    - LE stretching program continuation (hip, hamstring, gastrocnemius/soleus)
        - Add hip flexor and quad stretching
    - Initiate foam rolling program

- Strengthening
    - Single leg pawing → retrograde treadmill
    - Multiplanar gluteal/core/hip strengthening
        - Exercises from phase II continuation
        - Three point step/hip clocks
        - Lateral/monster walks
    - Romanian Dead Lift (RDL): double leg → single leg
    - Open kinetic chain (OKC) knee extension initiation(multiple angle isometrics, avoid lesion)
        - Progress to isotonics (PRE)
    - Eccentric leg press progression (2 up/1 down)
        - Emphasis on SLOW ECCENTRIC LOWERING and good alignment
    - Suspension training squats
    - Chair/Box Squats
        - Band around knees to promote gluteal activation and avoid valgus breakdown
        - Promote movement through hips and proper form.
        - Progressively lower seat height per strength gains
        - Progress to adding weights as appropriate (PREs)
    - Step-up progression initiation (week 6-8)
        - Start with 4" step → 6" step → 8" step
        - Emphasize proper movement pattern (no hip drop, no valgus breakdown)
        - Progress to adding weights as appropriate (PREs)
        - Emphasize good control
    - Front lunges → traveling lunges (DON'T PUSH ROM)
    - Gluteal/hip strengthening progressions
        - Exercises from phase II continuation
        - SL wall push
        - Windmills
        - Clamshells in modified side plank
        - Bridge progression
    - Core/kinetic linking progression
    - BFR program progression to more weight bearing activities (i.e. squats, leg press)
    - Eccentric step down program initiation (week 8-12)
        - Start with 4" step → 6" step → 8" step (assisted with railing if necessary)
        - Emphasize proper movement pattern (no hip drop, no valgus breakdown)
        - Emphasize good control
        - Progress to adding weights as appropriate (PREs)
- Balance/Proprioception progression
    - Rocker board
    - SL rebounder (Progress to foam pad/ ½ foam roller)
    - Sports specific balance

- Cardiovascular Training
    - Progress stationary bicycle time
        - Initiate interval bicycle program between weeks 10-12 to help with fitness training
    - Progress to elliptical

MINIMUM CRITERIA FOR ADVANCEMENT

- Full pain-free ROM
- Chair/box squats with proper form and without pain
- SL stance > 30 sec with proper form and control
- Demonstrate ability to ascend 8” step with proper form, no pain
- Descend 6” step with good eccentric control, no pain
- 70% limb symmetry (quadriceps and hamstring) with hand-held dynamometry or isokinetic system
- Independent with HEP

EMPHASIZE

- Minimal edema
- Control volume and load with functional activities
- Emphasis on proper movement strategy/quality of movement
- Activity modification that is age-appropriate

KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

Phase 4: Weeks 12-20

PRECAUTIONS

- Avoid pain with therapeutic exercises and functional activities
- Control post-operative edema
- Monitor overall load and volume

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- Patellar mobility
- Edema (girth and description)
- Quality of quadriceps contraction
- LE flexibility
- Strength assessment: isokinetic testing, hand-held dynamometry
- Movement assessment

TREATMENT RECOMMENDATIONS

- ROM/Soft Tissue
    - Patient should demonstrate full ROM without limitations
    - LE soft tissue treatment continuation as needed
- Strengthening ****EMPHASIZE ECCENTRIC STRENGTH AND CONTROL****
    - Squat program progression continued (PREs)
    - Eccentric leg press progression
    - Suspension system squat progression
        - Eccentric double leg squats
        - Single leg squats focusing on control and technique
    - Step-ups/down progressions by increasing height and adding weights (intrinsic load)
    - Aquatic program progression if available
    - Stair machine/stair climber
    - Core/kinetic linking progression continuation
    - LE stretching continuation
    - Isotonic knee extension OKC progression:
        - progress to isokinetics at high to moderate speeds

- Balance/Proprioception
    - advanced proprioception training (perturbations)
- Running progression initiation with anti-gravity treadmill or pool running - weeks 18-20
        - Demonstrate good eccentric control with 8” step down prior to initiating running
        - Monitor for edema

CRITERIA FOR ADVANCEMENT

- 80% limb symmetry (quadriceps and hamstring) with hand-held dynamometry and functional testing
- No pain/inflammation after activity
- Movement without asymmetrical deviations and a hip dominant strategy
- Independent with HEP

EMPHASIZE

- Minimal edema
- Control volume and load with functional activities
- Eccentric control with activity
- Emphasis on proper movement strategy/quality of movement

KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

Phase 5 (Return to Sport): Weeks 20+

PRECAUTIONS

- Avoid pain with advanced strengthening, and plyometric activity
- Avoid pain with progression of return to running program
- Be cautious of patellofemoral overload with increased activity level
- Continue to control post-operative edema
- Monitor overall load and volume

ASSESSMENT

- LEFS
- Pedi-IKDC (if applicable)
- NPRS
- LE flexibility
- Strength assessment: hand-held dynamometry, isokinetic testing
- Return to sport testing, e.g., hop testing
- Movement assessment
- Apprehension with sports specific movement

TREATMENT RECOMMENDATIONS

- Advanced strength and cardiovascular program 3-4 times/week
    - Cardiovascular endurance training with continued low load methods
        - Bicycle/elliptical/stair machine/rower
    - Gluteal activation exercises
    - Chair/box squats
    - Leg press (DL/SL)
    - Multiplanar hip strengthening
    - Front/side/back lunges
    - RDL (DL/SL)
    - Advanced kinetic linking progression
        - Chops/lifts
    - LE stretching/foam rolling program
- Plyometric program (DL → SL)
    - Individualized per sport and patient need
- Strength and flexibility progression through entire kinetic chain (hips, knees, ankle)

- Agility and balance drills
- Sport specific program progressions
- Return to running program after week 20
    - DEMONSTRATE GOOD ECCENTRIC CONTROL WITH 8” STEP DOWN
    - Progress with interval treadmill program (be cautious of overloading the knee)
    - Progress to treadmill running based on no symptom reproduction (pain or edema) after tolerating 95% weight bearing in Alter-G
- Collaborate with ATC, performance coach/strength and conditioning coach, skills coach and/or personal trainer to monitor load and volume with return to sport participation

CRITERIA FOR DISCHARGE

- 90% limb symmetry (quadriceps and hamstring) with hand-held dynamometry and functional testing
- Isokinetic test $\geq$ 90% limb symmetry (if available)
- Independent with gym strengthening and maintenance program
- Movement without asymmetrical deviations and a hip dominant strategy
- Lack of apprehension with sports specific movement (e.g. acceleration/deceleration, cutting)

EMPHASIZE

- Monitor volume in sports related activities
- Collaboration with Sports Performance experts

KNEE ARTICULAR CARTILAGE OSTEOCHONDRAL AUTOGRAFT (OATS) POST-OPERATIVE GUIDELINE

References

1. Balazs GC, Wang D, Burge AJ, Sinatro AL, Wong AC, & Williams RJ. Return to play among elite basketball players after osteochondral allograft transplantation of full-thickness cartilage lesions. *Orthop J Sports Med.* 2018; 6(7).

2. Cotter EJ, Frank RM, Wang KC, & Cole BJ. Rehabilitation and return to play following osteochondral allograft transplantation in the knee. *Oper Tech Sports Med*. 2017: 25(3), 208–213.

3. Demange M. & Gomoll AH. The use of osteochondral allografts in the management of cartilage defects. *Curr Rev Musculoskelet Med*. 2012; 5(3):229–235.

4. Kane MS, Lau K, & Crawford DC. Rehabilitation and postoperative management practices after osteochondral allograft transplants to the distal femur: a report from the metrics of osteochondral allografts (MOCA) study group 2016 survey. *Sports Health*. 2017; 9(6): 555–563.

5. Kocher MS, Smith JT, Iversen MD, et al. Reliability, validity, and responsiveness of a modified International Knee Documentation Committee Subjective Knee Form (Pedi-IKDC) in children with knee disorders. *Am J Sports Med*. 2011;39(5):933-939. doi:10.1177/0363546510383002.

6. Krych, AJ, Robertson, CM, & Williams RJ. Return to athletic activity after osteochondral allograft transplantation in the knee. *Am J Sports Med*. 2012; 40(5): 1053–1059.

7. Krych, AJ, Pareek A, King AH, Johnson NR, Stuart MJ, & Williams RJ. Return to sport after the surgical management of articular cartilage lesions in the knee: a meta-analysis. *Knee Surg Sports Traumatol Arthrosc*. 2017; 25(10): 3186-3196. doi: 10/1007/s00167-4262-3.

8. Lai WC, Bohlen HL, Fackler NP, Wang D. Osteochondral allografts in knee surgery: narrative review of evidence to date. *Orthop Res Rev*. 2022; 14:263-274. doi:10.2147/orr.s253761.

9. Lorentz SG, Hurley ET, Danilkowicz RM, Ayeni OR, Dragoo JL, Lau BC, et al. Rehabilitation and return-to-play following knee cartilage injuries–an international Delphi consensus statement. *J Cartil Jt Preserv*. 2024; 4(3). doi.org/10.1016/j.jcjp.2024/100193.

10. Marom N, Wang D, Patel S, & Williams RJ. Return to play after bipolar patellofemoral osteochondral allograft transplantation for a professional basketball player: a case report. 2019. *JBJS Case Connector*. 2019; 9(3):e0291.

11. McCarthy MA, Meyer MA, Weber AE, Levy DM, Tilton AK, Yanke AB, & Cole BJ. Can competitive athletes return to high-level play after osteochondral allograft transplantation of the knee? *Arthroscopy*. 2017; 33(9):1712–1717.

12. Patel S, Amirhekmat A, Le R, Williams III RJ, Wang D. Osteochondral allograft transplantation in professional athletes: rehabilitation and return to play. *Int J Sports Phys Ther*. 2021; 16(3): 941-958. doi:10.26603/001c.22085.

13. Patel S, Marrone W. The evolution of rehabilitation and return to sport following cartilage surgery. *Int J Sports Phys Ther.* 2023; 18(3): 551-557.

14. Shaha JS, Cook JB, Rowles DJ, Bottoni CR, Shaha SH, Tokish JM. Return to an athletic lifestyle after osteochondral allograft transplantation of the knee. *Am J Sports Med*. 2013; 41(9): 2083–2089.

15. Tyler TF, Lung JY. Rehabilitation following osteochondral injury to the knee. *Curr Rev Musculoskelet Med.* 2012; 5(1): 72-81. doi: 10.1007/s12178-011-9108-5.

16. Wang T, Bugbee WD. Osteochondral allograft transplantation in the football player (knee and ankle). *J Cartil Jt Preserv*. 2022;2(2):100052. doi:10.1016/j.jcjp.2022.100052.

Created: 10/2020
Revised: 9/2022; 11/2024