



Osteochondral Autograft Procedures: Rehabilitation Protocol*

This rehabilitation protocol was developed for patients who have had either an osteochondral autograft transfer (OAT) procedure or autologous chondrocyte implantation (ACI or Carticel). It is especially important to protect these patients against high weight bearing forces in the early postoperative period as these could dislodge graft tissues. Early knee motion is highly beneficial to enhance cartilage remodeling.

The protocol is divided into 7 phases according to postoperative weeks (for instance, Phase I = Postoperative Weeks 1-2). Each phase has several categories including:

- v *General observation* of the patient's condition (weight bearing, pain, hemarthrosis, muscle control)
- v *Evaluation* of specific variables with *goals* identified for each
- v Treatment and exercise program, according to *frequency* and *duration*
- v *Rehabilitation goals* which must be achieved to enter into the next phase

The **overall goals** of the reconstruction and rehabilitation are to:

- v Control joint pain, swelling, hemarthrosis (minimal or none)
- v Regain normal knee flexion and extension
- v Regain a normal gait pattern and neuromuscular stability for ambulation
- v Regain normal quadriceps, hamstring lower extremity muscle strength
- v Regain normal proprioception, balance, and coordination for desired activities
- v Achieve optimal functional outcome based on orthopaedic and patient goals

The supervised rehabilitation program is supplemented with a *home self-management program* which the patient performs on a daily basis. The therapist must evaluate the patient thoroughly to implement the enclosed protocol and should see the patient in the clinic for therapeutic procedures and modality treatments which are required for rehabilitation. The majority of this protocol can be accomplished at home provided patient cooperation and follow through are present. The approximate number of rehabilitation visits required for each phase are provided. Additional supervision may be required if a complication develops.

Important postoperative signs to monitor include:

- v Swelling of the knee joint or soft tissues
- v Abnormal pain response
- v Abnormal gait pattern with or without assistive device
- v Insufficient flexion or extension
- v Weakness (strength/control) of the lower extremity, especially the quads/hamstrings
- v Insufficient lower extremity flexibility
- v Return of pain to the compartment of the implant/transfer

The patient is placed into one of four **sports activity** and **occupational activity categories** based on the following scales. It is expected that patients who follow this protocol desire to return to sports activity levels I or II, or very heavy/heavy occupations.

1. Cincinnati Knee Rating System Sports Activity Scale

(check one)

0 Level I - jumping, hard pivoting, cutting sports (basketball, volleyball, football, gymnastics, soccer)

0 Level II - running, twisting, turning (tennis, racquetball, handball, ice/field hockey, skiing, wrestling)

0 Level III - light recreational sports (bicycling, swimming - no running, twisting, jumping)

0 Level IV - no sports, activities of daily living only

2. Cincinnati Knee Rating System Occupational Rating Scale

Factor 1 sitting	Factor 2 standing/ walking	Factor 3 walking on uneven ground	Factor 4 squatting	Factor 5 climbing	Factor 6 lifting/ carrying	Factor 7 pounds carried
0 0 8-10 hrs/day	0 0 0 hrs/day	0 0 0 hrs/day	0 0 0 times/day	0 0 0 times/day	0 0 0 times/day	0 0 0-5 lbs
1 0 6-7 hrs/day	2 0 1 hrs/day	2 0 1 hrs/day	1 0 1-5 times/day	2 0 1 flight 2 times/day	1 0 1-5 times/day	1 0 6-10 lbs
2 0 4-5 hrs/day	4 0 2-3 hrs/day	4 0 2-3 hrs/day	2 0 6-10 times/day	4 0 3 flights 2 times/day	2 0 6-10 times/day	2 0 11-20 lbs
3 0 2-3 hrs/day	6 0 4-5 hrs/day	6 0 4-5 hrs/day	3 0 11-15 times/day	6 0 10 flights/ ladders	3 0 11-15 times/day	3 0 21-25 lbs
4 0 1 hrs/day	8 0 6-7 hrs/day	8 0 6-7 hrs/day	4 0 16-20 times/day	8 0 ladders with weight 2-3 days/week	4 0 16-20 times/day	4 0 26-30 lbs
5 0 0 hrs/day	10 0 8-10 hrs/day	10 0 8-10 hrs/day	5 0 > 20 times/day	8 0 ladders daily with weight	5 0 > 20 times/day	5 0 > 20 lbs

_____ points x 2 = _____ total points

Occupation Rating

Total Points

0 Disabled	0
0 Very light	1-20
0 Light	21-40
0 Moderate	41-60
0 Heavy	61-80
0 Very heavy	> 80

Physical Therapy Visit Timeline*

Phase	Weeks Postoperative	Minimum # Visits	Maximum # Visits
1	1-2	2	4
2	3-4	2	4
3	5-6	1	2
4	7-8	1	2
5	9-12	1	2
6	13-26	2	3
7	27-52	2	4
Total		11	21

*Physician Notification

The physician will be notified if the patient (1) fails to meet the expected goals for each phase of the protocol, (2) has a persistent joint effusion, (3) develops a chronic pain syndrome, (4) has difficulty with ambulation, (5) has a limitation of knee motion or patellar mobility, or (6) develops other complications associated with surgery.

These problems could result in a modification of this protocol and necessitate further visits to the physical therapist.

Discharge Criteria (If goals for sports and occupation place patient into different categories, use category with highest functional demand criteria. For symptoms, use Symptom Rating Form found on next page.)

*Sports Activity Level I or Heavy/Very Heavy Occupational Rating**

No pain, swelling, giving-way with level 10 on Symptom Rating Form

KT-2000 < 3 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength \geq 85% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 85%

*Sports Activity Level II or Moderate Occupational Rating**

No pain, swelling, giving-way with level 8 on Symptom Rating Form

KT-2000 < 3 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength \geq 80% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 85%

Sports Activity Level III or Light Occupational Rating

No pain, swelling, giving-way with level 6 on Symptom Rating Form

KT-2000 3-5 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength \geq 70% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 75%

Sports Activity Level IV (ADL) or Very light Occupational Rating

No pain, swelling, giving-way with level 4 on Symptom Rating Form

KT-2000 3-5 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength < 70% of opposite limb

Function testing: 2 hop tests, limb symmetry < 75%

*patients desiring to return to sports or strenuous work activities may require 4-6 more physical therapy visits during postoperative weeks 25-52 for advanced neuromuscular, strength, and activity-specific training to prevent reinjury.

Cincinnati Knee Rating System Symptom Rating Form

Scale	Description
10	Normal knee, able to do strenuous work/sports with jumping, hard pivoting
8	Able to do moderate work/sports with running, turning and twisting; symptoms with strenuous work/sports
6	Able to do light work/sports with no running, twisting or jumping; symptoms with moderate work/sports
4	Able to do activities of daily living alone; symptoms with light work/sports
2	Moderate symptoms (frequent, limiting) with activities of daily living
0	Severe symptoms (constant, not relieved) with activities of daily living

1. PAIN (circle one)

10 — 8 — 6 — 4 — 2 — 0

2. SWELLING (circle one)

10 — 8 — 6 — 4 — 2 — 0

3. PARTIAL GIVING-WAY (circle one) (partial knee collapse, no fall to the ground)

10 — 8 — 6 — 4 — 2 — 0

4. FULL GIVING-WAY (circle one) (knee collapse occurs with actual falling to the ground)

10 — 8 — 6 — 4 — 2 — 0

Return to Activities Warning

Return to strenuous activities after major knee surgery carries the definite risk of a repeat injury or the potential of compounding the original injury. These risks cannot always be scientifically assessed. Patients are warned to return to athletic activities carefully and to avoid any activity in which symptoms of pain, swelling, or a feeling of instability are present.

References

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Cincinnati Sportsmedicine and Orthopaedic Center
Rehabilitation Protocol Summary for
OAT, ACI

	Postoperative Weeks					Postop Months			
	1-2	3-4	5-6	7-8	9-12	4	5	6	7-12
Brace: Bledsoe OA unloader	X	X	X	X	X			X	X
Range of motion minimum goals: 0°-110° 0°-135°	X	X							
Weight bearing: None Toe touch - 1/4 body weight 1/4 to 1/2 body weight Full	X	X	X	X					
Patella mobilization	X	X	X	X					
Modalities: Electrical muscle stimulation (EMS) Pain/edema management (cryotherapy)	X X	X X	X X	X X	X	X	X	X	X
Stretching: Hamstring, gastroc-soleus, iliotibial band, quadriceps	X	X	X	X	X	X	X	X	X
Strengthening: Quad isometrics, straight leg raises Active knee extension Closed-chain: gait retraining, toe raises, wall sits, mini-squats Knee flexion hamstring curls (90°) Knee extension quads (90°-30°) Hip abduction-adduction, multi-hip Leg press (70°-10°)	X	X	X	X	X	X	X	X	X
Balance/proprioceptive training: Weight-shifting, mini-trampoline, BAPS, BBS, plyometrics					X	X	X	X	X
Conditioning: UBC Bike (stationary) Aquatic program Swimming (kicking) Walking Stair climbing machine Ski machine		X	X	X	X	X	X	X	X
Running: straight									X
Cutting: lateral carioca, figure 8's									X
Full sports									X

BAPS = Biomechanical Ankle Platform System (Camp, Jackson, MI), BBS = Biodex Balance System (Biodex Medical Systems, Inc, Shirley, NY), UBC = upper body cycle (Biodex Medical Systems, Inc, Shirley, NY).

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 1. Weeks 1-2 (Visits: 2-4)

General Observation	<ul style="list-style-type: none"> v Non weight bearing v Brace locked at 0° 	
Evaluation	<ul style="list-style-type: none"> v Pain v Hemarthrosis v Patellar mobility v ROM minimum v Quadriceps contraction & patella migration v Soft tissue contracture 	<p align="center">Goals</p> Controlled Mild Good 0°-60° Good None
Frequency 3-4 x/day 10 minutes 3 x/day 15 minutes As required	<p>Range of motion</p> ROM (passive, 0°-60°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches	<p align="center">Duration</p> 5 reps x 30 secs 3 sets x 10 reps 1 set x 10 reps 20 minutes 20 minutes
Goals	<ul style="list-style-type: none"> v ROM 0°-60° v Adequate quadriceps contraction v Control inflammation, effusion 	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 2. Weeks 3-4 (Visits: 2-4)

General Observation	<ul style="list-style-type: none"> v Non weight bearing v Brace locked at 0° 	
Evaluation	<ul style="list-style-type: none"> v Pain v Effusion v Patellar mobility v ROM minimum v Quadriceps contraction & patella migration v Soft tissue contracture 	<p align="center">Goals</p> Controlled Mild Good 0°-90° Good None
Frequency 3-4 x/day 10 minutes 2-3 x/day 20 minutes 2 x/day 10 minutes As required	<p>Range of motion</p> ROM (passive, 0°-90°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches	<p align="center">Duration</p> 5 reps x 30 secs 3 sets x 10 reps 1 set x 10 reps 20 minutes 20 minutes
	<p>Strengthening</p> Straight leg raises (flexion, extension, abduction, adduction) Isometric training: multi-angle (0°, 60°)	
	<p>Aerobic conditioning</p> UBC	
	<p>Modalities</p> Electrical muscle stimulation Cryotherapy	
Goals	<ul style="list-style-type: none"> v ROM 0°-90° v Control inflammation, effusion v Muscle control 	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 3. Weeks 5-6 (Visits: 1-2)

General Observation	<ul style="list-style-type: none"> v Partial (25%) weight bearing when: <ul style="list-style-type: none"> - Pain controlled without narcotics - ROM 0°-90° - Hemarthrosis controlled - Muscle control throughout ROM 	
Evaluation	<ul style="list-style-type: none"> v Pain v Effusion v Patellar mobility v ROM v Muscle control v Inflammatory response 	<p align="center">Goals</p> <p>Mild/No RSD Minimal Good 0°-110° 3/5 None</p>
<p>Frequency</p> <p>3 x/day 10 minutes</p> <p>2 x/day 20 minutes</p> <p>2 x/day 10 minutes</p> <p>As required</p>	<p>Range of motion</p> <p>ROM (passive, 0°-110°) Patella mobilization Hamstring, gastroc-soleus stretches</p> <p>Strengthening</p> <p>Straight leg raises (ankle weight, not to exceed 10% of body weight) Isometric training: multi-angle (90°, 60°, 30°)</p> <p>Aerobic conditioning (patellofemoral precautions) UBC</p> <p>Modalities</p> <p>Electrical muscle stimulation Cryotherapy</p>	<p align="center">Duration</p> <p>5 reps x 30 secs</p> <p>3 sets x 10 reps 2 sets x 10 reps</p> <p>20 minutes 20 minutes</p>
Goals	<ul style="list-style-type: none"> v ROM 0°-110° v Control inflammation, effusion v Muscle control v Early recognition complications (motion, RSD, patellofemoral) v 25% weight bearing 	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 4. Weeks 7-8 (Visits: 1-2)

General Observation	<ul style="list-style-type: none"> v Partial (25-50%) weight bearing when: - Pain controlled - Hemarthrosis controlled - ROM 0°-110° - Voluntary quad contraction achieved 	
Evaluation	<ul style="list-style-type: none"> v Pain v Effusion v Patellar mobility v ROM v Muscle control v Inflammatory response 	<p align="center">Goals</p> Mild/No RSD Minimal Good 0°-120° 4/5 None
Frequency		Duration
2 x/day 10 minutes	<p>Range of motion ROM (0°-120°) Hamstring, gastroc-soleus stretches</p>	5 reps x 30 secs
2 x/day 20 minutes	<p>Strengthening Straight leg raises (flexion, extension, abduction, adduction) Straight leg raises, rubber tubing Isometric training – multi-angle (90°, 60°, 30°) Closed-chain - Wall sits (exclude in patellofemoral patients) - Mini-squats (rubber tubing, 0°-30°)</p>	3 sets x 10 reps 3 sets x 30 reps 3 sets x 10 reps to fatigue x 3 3 sets x 20 reps
3 x/day 5 minutes	<p>Balance training Cup walking</p>	
1-2 x/day 15 minutes	<p>Aerobic conditioning UBC Water walking</p>	
As required	<p>Modalities Cryotherapy</p>	20 minutes
Goals	<ul style="list-style-type: none"> v 50-75% weight bearing v Muscle control v Control inflammation, effusion v ROM 0°-120° 	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 5. Weeks 9-12 (Visits: 1-2)

General Observation	v Full weight bearing when: - Pain, effusion controlled - Muscle control throughout ROM	v ROM 0°-135°
Evaluation	v Pain v Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors v Swelling v Patellar mobility v Crepitus v Gait	Goals Minimal/No RSD 4/5 Minimal Good None/slight Symmetrical
Frequency 2 x/day 10 minutes 2 x/day 20 minutes 3 x/day 5 minutes 1 x/day 15-20 minutes As required	Range of motion Hamstring, gastroc-soleus, quad, ITB stretches Strengthening Straight leg raises Straight leg raises, rubber tubing Hamstring curls (active, 0°-90°) Knee extension quads (active, 90°-30°) Leg press (70°-10°) Closed-chain - Wall sits - Mini-squats (rubber tubing, 0°-40°) - Lateral step-ups (2-4" block) Multi-hip machine (flexion, extension, abduction, adduction) Balance training Cup walking Balance board/2-legged Single leg stance Aerobic conditioning (patellofemoral precautions) Water walking Swimming (straight leg kicking) Stationary bicycling Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)	Duration 5 reps x 30 secs 3 sets x 10 reps 3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps to fatigue x 3 3 sets x 20 reps 3 sets x 10 reps 3 sets x 10 reps
	Modalities Cryotherapy	20 minutes
Goals	v Increase strength and endurance v ROM 0°-135°	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 6. Weeks 13-26 (Visits: 2-3)

General Observation	<ul style="list-style-type: none"> v No effusion, painless ROM, joint stability v Performs activities of daily living, can walk 20 minutes without pain v ROM 0°-135° 	
Evaluation	<ul style="list-style-type: none"> v Pain v Manual muscle test v Swelling v Patellar mobility v Crepitus v Gait 	<p align="center">Goals</p> Minimal/No RSD 4/5 Minimal Good None/slight Symmetrical
<p>Frequency</p> 2 x/day 10 minutes	<p>Range of motion</p> Hamstring, gastroc-soleus, quad, ITB stretches	<p align="center">Duration</p> 5 reps x 30 secs
2 x/day 20 minutes	<p>Strengthening</p> Straight leg raises, rubber tubing (high speed) Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain: Mini-squats (rubber tubing, 0°-40°)	3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 20 reps
1-3 x/day 5 minutes	<p>Balance training</p> Balance board/2 legged Single leg stance	
3 x/week 20 minutes	<p>Aerobic conditioning (patellofemoral precautions)</p> Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)	
As required	<p>Modalities</p> Cryotherapy	20 minutes
Goals	v Increase strength and endurance	

Cincinnati Sportsmedicine and Orthopaedic Center Rehab Protocol: OAT, ACI
Phase 7. Weeks 27-52 (Visits: 2-3)

General Observation	v No effusion, painless ROM, joint stability v Performs ADL, can walk 20 minutes without pain	v ROM 0°-135°
Evaluation	v Pain v Manual muscle test v Swelling v Patellar mobility v Crepitus v Gait v Isometric test (peripheral, % difference quads & hams)	Goals Minima/No RSD 4/5 Minimal Good None/slight Symmetrical 20-30
Frequency 2 x/day 10 minutes	Range of motion Hamstring, gastroc-soleus, quad, ITB stretches	Duration 5 reps x 30 secs
1 x/day 20-30 minutes	Strengthening Straight leg raises, rubber tubing (high speed) Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain: Mini-squats (rubber tubing, 0°-40°)	3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 20 reps
1-3 x/day 5 minutes	Balance training Balance board/2 legged Single leg stance	
3 x/week 20-30 minutes	Aerobic conditioning (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Stair machine (low resistance, low stroke) Ski machine (short stride, level, low resistance)	
3 x/week 15-20 minutes	Running program (in unloader brace, 6 mos., straight) Jog Walk Backward run	1/4 mile 1/8 mile 20 yards
As required	Modalities Cryotherapy	20 minutes
Goals	v Increase function v Maintain strength, endurance	