



**Lahey Hospital
& Medical Center**

**Rehabilitation Protocol:
Distal Femoral/Proximal Tibial Microfracture
and
Osteochondral Autograft Transplantation
(OATS)**

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◀ Overview

The Osteochondral Autograft Transplantation (OATS) procedure involves transplantation of plugs of bone from non weight bearing to weight bearing areas of the knee which have articular cartilage loss. The size of the harvest plug is sized to match that of the lesion and then press fit into holes created at the lesion. These plugs can be susceptible to getting pushed in further; therefore weight bearing is restricted for the first 6 weeks to ensure that the cartilage plug heals properly.

Microfracture is a surgical procedure performed to assist with cartilage regeneration. This procedure consists of the surgeon debriding any frayed tissue or flaps at the margin of the lesion. After this, the calcified chondral layer is debrided to expose the underlying subchondral bone. Removal of this layer allows the surgeon to pick holes into the bone with an awl called microfractures which will mature to form into fibrocartilage.

Post-operative rehabilitation will focus on regaining range of motion and protecting the healing plugs, grafts and allowing cartilage regeneration. As rehabilitation progresses the focus shifts to progressive weight bearing, regaining strength, flexibility and movement control. Developing muscle strength reduces the force and will help decrease stress to the articular cartilage. The progression of rehabilitation is based on size, depth and location of the lesion. Specific time frames, restriction and precautions are given to protect healing tissues and surgical repairs/reconstruction. General time frames for the average rehabilitation are given but individuals will progress at different rates depending on their age, associated injuries, pre-injury health status, rehabilitation compliance and injury severity.

◀ Phase I 0-2 Weeks

Goals

- Good patella mobility
- ROM minimum 0°-90°
- Regaining quadriceps control
- No soft tissue contracture
- Control inflammation and effusion
- Protection of healing tissue from load and shear forces
- Decrease pain and effusion
- Restoration of full passive knee extension
- Gradual improvement of knee flexion

Precautions

- Weight bearing as ordered per surgeon
- Weight bearing status varies based on lesion location and size
- Sleep in locked brace for 2-4 weeks
- Use caution with stair climbing
- No impact activities until 12 weeks after surgery
- No Resisted Closed Chain exercises x 6 weeks
- No Resisted Open Chain exercises x 6 weeks
- Avoid
 - post activity swelling, reduce activities if swelling occurs
 - Extended standing

Weeks 0–2

- ROM
 - Knee PROM 0°-90°
 - Initiate CPM day 1 for total of 8-12 hours per day (0°-60°)
 - Progress CPM ROM as tolerated 5°-10° per day
 - May continue CPM for total of 6-8 hours per day for up to 6 weeks
 - Patella mobilization (4-6 times per day)
- Therapeutic Exercise
 - Strengthening
 - Active quadriceps isometrics
 - 4 way straight leg raises (flexion, extension, abduction, adduction)
 - Assisted heel slides
 - Ankle pumps -> progress to plantar flexion with resistance band
 - Heel prop/ prone hangs
 - Stretches
 - Hamstring and gastroc-soleus
- Gait Training
 - Non weight bearing
 - Brace locked at 0°
 - Sleep in locked brace for 2-4 weeks
- Modalities
 - Electrical muscle stimulation

**◀ Phase II
Weeks 3 – 4**

Goals

- Good patella mobility
- ROM minimum 0°-90°
- Regaining quadriceps control
- No soft tissue contracture
- Control inflammation and effusion
- Protection of healing tissue from load and shear forces
- Decrease pain and effusion
- Restoration of full passive knee extension
- Gradual improvement of knee flexion

Precautions

- Weight bearing as ordered per surgeon
- Weight bearing status varies based on lesion location and size
- No Resisted Closed Chain exercises x 6 weeks
- No Resisted Open Chain exercises x 6 weeks
- Sleep in locked brace for 2-4 weeks
- Use caution with stair climbing
- No impact activities until 12 weeks after surgery
- Avoid
 - post activity swelling, reduce activities if swelling occurs
 - Extended standing

- ROM
 - Knee PROM 0°-90°
 - Progress CPM ROM as tolerated 5°-10° per day
 - May continue CPM for total of 6-8 hours per day for up to 6 weeks
 - Patella mobilization (4-6 times per day)
- Therapeutic Exercise
 - Strengthening
 - 4 way- Straight leg raises (flexion, extension, abduction, adduction)
 - Isometric training: multi-angle (0°, 60°) with co contraction of quad and hamstrings
 - Heel slides
 - Weight shifting exercises with knee in extension
 - Ankle pumps -> progress to plantar flexion with resistance band
 - Stretching
 - Hamstring and gastroc-soleus
- Gait training
 - TTWB with crutches
 - Brace locked at 0°
 - Sleep in locked brace for 2-4 weeks
- Modalities
 - Electrical muscle stimulation
 - Cryotherapy

◀ Phase III Weeks 5-6

Goals

- Good patellar mobility
- ROM: 0°-120°
- Strength > 3/5
- Voluntary quad contraction achieved
- Gradual return to daily activities
- Control inflammation and effusion
- Protection of healing tissue from load and shear forces
- Decrease pain and effusion
- Restoration of full passive knee extension
- Gradual improvement of knee flexion

Precautions

- Weight bearing as ordered per surgeon
- Weight bearing status varies based on lesion location and size
- No impact activities until 12 weeks after surgery
- No Resisted Closed Chain exercises x 6 weeks
- No Resisted Open Chain exercises x 6 weeks
- Use caution with stair climbing
- Protect knee from overstress to allow healing
- Activity level should be modified if increased pain, catching or swelling occurs
- Avoid
 - post activity swelling, reduce activities if swelling occurs
 - Extended standing
 - Loading knee at deep flexion angles

- Cardiovascular
 - Stationary bicycle when ROM allows, low resistance
- ROM
 - Knee PROM 0°-120°
 - Continue patella mobilization
- Therapeutic Exercise
 - Strengthening
 - 4 way- Straight leg raises (flexion, extension, abduction, adduction) with addition of ankle weight, not to exceed 10% of body weight
 - Isometric training: multi-angle (0°, 60°, 90°) with co contraction of quad and hamstrings
 - Heel slides
 - Weight shifting exercises with knee in extension
 - Ankle pumps -> progress to plantar flexion with resistance band
 - Stretching
 - Hamstring and gastroc-soleus
- Gait training
 - Partial 50-75% weight bearing with crutches
 - D/C Brace at 6 weeks if muscle control throughout ROM
- Modalities
 - Electrical muscle stimulation

◀ Phase IV Weeks 7-8

Goals

- Mild pain
- Minimal effusion
- Good patellar mobility
- ROM: 0°-120°
- Strength > 4/5
- Voluntary quad contraction achieved
- Gradual return to daily activities

Precautions

- Weight bearing as ordered per surgeon
- Weight bearing status varies based on lesion location and size
- No impact activities until 12 weeks after surgery
- Use caution with stair climbing
- Protect knee from overstress to allow healing
- Activity level should be modified if increased pain, catching or swelling occurs
- Avoid
 - post activity swelling, reduce activities if swelling occurs
 - Extended standing
 - Loading knee at deep flexion angles

- Cardiovascular
 - Stationary bicycle when ROM allows, low resistance
 - Water walking
- ROM
 - Knee AROM 0°-120°
- Therapeutic Exercise
 - Strengthening
 - 4 way- Straight leg raises (flexion, extension, abduction, adduction) with addition of ankle weight
 - Standing: Straight leg raises x 4 with theraband bilaterally
 - Isometric training: multi-angle (0°, 60°, 90°) with co contraction of quad and hamstrings
 - Closed-chain
 - Initiate weight shifts
 - Wall sits (exclude in patellofemoral patients)
 - Mini-squats (rubber tubing, 0°-45°)
 - Balance training
 - Stretching
 - Hamstring and gastroc-soleus
- Gait training
 - Partial weight bearing 75% with crutches
- Modalities
 - Cryotherapy

**◀ Phase V
Weeks 9-12**

Goals

- Minimal pain
- Minimal swelling
- Good patellar mobility
- No crepitus
- Symmetrical gait
- ROM 0°-135°
- Strength 4/5
- Muscle control throughout ROM
- Hamstrings within 20% of contralateral extremity
- Quadriceps within 30% of contralateral extremity
- Balance testing within 30% of contralateral extremity

Precautions

- No impact activities until 12 weeks after surgery
- Use caution with stair climbing
- Protect knee from overstress to allow healing
- Activity level should be modified if increased pain, catching or swelling occurs
- Avoid
 - post activity swelling, reduce activities if swelling occurs
 - Extended standing

- Cardiovascular
 - Stationary bicycle
 - Water walking
 - Swimming (straight leg kicking)
 - Walking
- ROM
 - Full Knee AROM 0°-135°
- Therapeutic Exercise
 - Strengthening
 - 4 way- Straight leg raises (flexion, extension, abduction, adduction) with addition of ankle weight
 - Standing: Straight leg raises x 4 with theraband bilaterally
 - Hamstring curls (active, 0°-90°)
 - Knee extension quads (active, 0°-30° progressing to 90°)
 - Multi-hip machine (flexion, extension, abduction, adduction)
 - Closed-chain
 - Wall sits
 - Mini-squats (rubber tubing, 0°-40°)
 - Forward, lateral and retro step-ups (2-4" step)
 - Balance training
 - Balance board/2-legged
 - Single leg stance
 - Stretching
 - Hamstring and gastroc-soleus
- Gait training
 - Full weight bearing when:

- Pain, effusion controlled
- Muscle control throughout ROM
- Modalities
 - Cryotherapy

◀ Phase VI Weeks 13-26

Goals

- Minimal pain
- Minimal swelling
- Good patella mobility
- No crepitus
- Symmetrical gait
- Increase functional activities
- Full painfree ROM
- Strength >4/5
- Strength within 80%-90% of contralateral extremity
- Balance and/or stability within 75%-80% of contralateral extremity

Precautions

- Avoid post activity swelling, reduce activities if swelling occurs
- Activity level should be modified if increased pain, catching or swelling occurs

- Cardiovascular
 - Stationary bicycle
 - Water walking
 - Swimming (straight leg kicking and kicking)
 - Walking
 - Stair machine (low resistance, low stroke)
 - Ski machine (short stride, level, low resistance)
- ROM
 - Full Knee AROM 0°-135°
- Therapeutic Exercise
 - Strengthening
 - 4 way Straight leg raises, rubber tubing (high speed)
 - Hamstring curls (active, 0°-90°)
 - Knee extension with resistance
 - Leg press (0°-90°)
 - Multi-hip machine (flexion, extension, abduction, adduction)
 - Forward lunge < 60 degrees of knee flexion with slow pain free progression
 - Forward, lateral and retro step ups (2-8" step)
 - Closed-chain
 - Wall squats
 - Mini-squats (rubber tubing, 0°-40°)
 - Balance training
 - Balance board/2 legged
 - Single leg stance
 - Stretching
 - Hamstring and gastroc-soleus
- Gait training
 - Full weight bearing with symmetrical gait
- Modalities

◀ Phase VII Weeks 27-52

Goals

- Symmetrical gait
- Gradual return to full unrestricted functional activities
- No effusion, painless ROM, joint stability
- ROM 0°-135°
- Performs ADL, can walk 20 minutes without pain

Precautions

- Post activity soreness should resolve within 24 hours
- Avoid post activity swelling
- Avoid knee pain with impact
- Higher-impact sports such as jogging, running, and aerobics may be performed at 8-10 months
- High-impact sports such as tennis, basketball, and baseball, are allowed at 12-18 months

- Therapeutic Exercise
 - Continue maintenance program progression 3-4 times per week
 - Progress resistance as tolerated
 - Emphasis on entire lower extremity strength and flexibility
 - Progress agility and balance drills
 - Impact loading program should be individualized to the patient's needs
 - Progress sport programs depending on patient variables
- Functional activities
 - Patient may return to various sport activities as progression in rehabilitation and cartilage healing allows.
 - Generally, low-impact sports, such as skating, rollerblading, and cycling, are permitted at about 6-8 months
 - Higher-impact sports such as jogging, running, and aerobics may be performed at 8-10 months
 - High-impact sports such as tennis, basketball, and baseball, are allowed at 12-18 months

AAROM = active-assisted range of motion, AROM = active range of motion, PROM = passive range of motion, ROM = range of motion

Rehabilitation Protocol for OATS and ACI

Rehabilitation Guidelines: Summary Table

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase I 0 - 2 weeks after surgery</p> <p>Goals: Good patella mobility ROM minimum 0°-90° Regaining quadriceps control No soft tissue contracture Control inflammation and effusion Protection of healing tissue from load and shear forces Decrease pain and effusion Restoration of full passive knee extension Gradual improvement of knee flexion</p>	<p>Weeks 0-2</p> <ul style="list-style-type: none"> • Knee PROM 0°-90° • Initiate CPM day 1 for total of 8-12 hours per day (0°-60°) • Progress CPM ROM as tolerated 5°-10° per day • May continue CPM for total of 6-8 hours per day for up to 6 weeks • Patella mobilization (4-6 times per day) 	<p>Therapeutic Exercise</p> <ul style="list-style-type: none"> • Active quadriceps isometrics • 4 way- Straight leg raises (flexion, extension, abduction, adduction) • Assisted heel slides • Ankle pumps -> progress to plantar flexion with resistance band • Heel prop/ prone hangs • Stretches-Hamstring and gastroc-soleus <p>Gait Training</p> <ul style="list-style-type: none"> • Non weight bearing with crutches • Brace locked at 0° • Sleep in locked brace for 2-4 weeks <p>Modalities</p> <ul style="list-style-type: none"> • Electrical muscle stimulation • Cryotherapy 	<p>Weight bearing as ordered per surgeon Weight bearing status varies based on lesion location and size Use caution with stair climbing No impact activities until 12 weeks after surgery No Resisted Closed Chain exercises x 6 weeks No Resisted Open Chain exercises x 6 weeks Sleep in locked brace for 2-4 weeks</p> <p>Avoid: post activity swelling, reduce activities if swelling occurs Extended standing</p>

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase II 3-4 Weeks</p> <p>Goals: Good patella mobility ROM minimum 0°-90° Regaining quadriceps control No soft tissue contracture Control inflammation and effusion Protection of healing tissue from load and shear forces Decrease pain and effusion Restoration of full passive knee extension Gradual improvement of knee flexion</p>	<p>Weeks 3-4</p> <ul style="list-style-type: none"> • Knee PROM 0°-90° • Progress CPM ROM as tolerated 5°-10° per day • May continue CPM for total of 6-8 hours per day for up to 6 weeks • Patella mobilization (4-6 times per day) 	<p>Therapeutic Exercise</p> <ul style="list-style-type: none"> • 4 way- Straight leg raises (flexion, extension, abduction, adduction) • Isometric training: multi-angle (0°, 60°) with co contraction of quad and hamstrings • Heel slides • Ankle pumps -> progress to plantar flexion with resistance band • Stretching-Hamstring and gastroc-soleus <p>Gait Training</p> <ul style="list-style-type: none"> • TTWB with crutches • Brace locked at 0° <p>Modalities</p> <ul style="list-style-type: none"> • Electrical muscle stimulation • Cryotherapy 	<p>Weight bearing as ordered per surgeon Weight bearing status varies based on lesion location and size Use caution with stair climbing No impact activities until 12 weeks after surgery No Resisted Closed Chain exercises x 6 weeks No Resisted Open Chain exercises x 6 weeks Sleep in locked brace for 2-4 weeks</p> <p>Avoid: Post activity swelling, reduce activities if swelling occurs Extended standing</p>

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase III 5-6 Weeks</p> <p>Goals: Good patellar mobility ROM: 0°-120° Strength > 3/5 Voluntary quad contraction achieved Gradual return to daily activities Control inflammation and effusion Protection of healing tissue from load and shear forces Decrease pain and effusion Restoration of full passive knee extension Gradual improvement of knee flexion</p>	<p>Weeks 5-6 Knee PROM 0°-120° Continue patella mobilization</p>	<p>Stationary bicycle when ROM allows, low resistance</p> <p>Therapeutic Exercise 4 way- Straight leg raises (flexion, extension, abduction, adduction) with addition of ankle weight, not to exceed 10% of body weight Isometric training: multi-angle (0°, 60°, 90°) with co contraction of quad and hamstrings Heel slides Weight shifting exercises with knee in extension Ankle pumps -> progress to plantar flexion with resistance band Stretching-Hamstring and gastroc-soleus Gait Training Partial 50-75% weight bearing with crutches D/C Brace at 6 weeks if muscle control throughout ROM</p> <p>Modalities Electrical muscle stimulation Cryotherpay</p>	<p>Weight bearing as ordered per surgeon Weight bearing status varies based on lesion location and size No Resisted Closed Chain exercises x 6 weeks No Resisted Open Chain exercises x 6 weeks No impact activities until 12 weeks after surgery Use caution with stair climbing Protect knee from overstress to allow healing Activity level should be modified if increased pain, catching or swelling occurs</p> <p>Avoid: Post activity swelling, reduce activities if swelling occurs Extended standing Loading knee at deep flexion angles</p>

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase IV Week 7-8 Goals: Mild pain Minimal effusion Good patellar mobility ROM: 0°-120° Strength > 4/5 Voluntary quad contraction achieved Gradual return to daily activities</p>	<p>Weeks 7-8 Knee AROM 0°-120°</p>	<p>Stationary bicycle when ROM allows, low resistance Water walking</p> <p>Therapeutic Exercise 4 way- Straight leg raises (flexion, extension, abduction, adduction) with addition of ankle weight Standing: Straight leg raises x 4 with theraband bilaterally Isometric training: multi-angle (0°, 60°, 90°) with co contraction of quad and hamstrings Closed-chain Initiate weight shifts Wall sits (exclude in patellofemoral patients) Mini-squats (rubber tubing, 0°-45°) Balance training Stretching-Hamstring and gastroc-soleus</p> <p>Gait Training Partial Weight Bearing 75% with crutches Modalities Cryotherapy</p>	<p>Weight bearing as ordered per surgeon Weight bearing status varies based on lesion location and size No impact activities until 12 weeks after surgery Use caution with stair climbing Protect knee from overstress to allow healing Activity level should be modified if increased pain, catching or swelling occurs</p> <p>Avoid: Post activity swelling, reduce activities if swelling occurs Extended standing Loading knee at deep flexion angles</p>

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase V Weeks 9-12 Goals:</p> <p>Minimal pain Minimal swelling Good patellar mobility No crepitus Symmetrical gait ROM 0°-135° Strength 4/5 Muscle control throughout ROM Hamstrings within 20% of contralateral extremity Quadriceps within 30% of contralateral extremity Balance testing within 30% of contralateral extremity</p>	<p>Weeks 9-12 Full Knee AROM 0°-135°</p>	<ul style="list-style-type: none"> • Stationary bicycle • Water walking • Swimming (straight leg kicking) • Walking <p>Therapeutic Exercise</p> <ul style="list-style-type: none"> • 4 way- Straight leg raises (flexion, extension, abduction, adduction) with addition of ankle weight • Standing: Straight leg raises x 4 with theraband bilaterally • Hamstring curls (active, 0°-90°) • Knee extension quads (active, 90°-30° progressing to 90°) • Multi-hip machine (flexion, extension, abduction, adduction) • Closed-chain <ul style="list-style-type: none"> • Wall sits • Mini-squats (rubber tubing, 0°-40°) • Forward, lateral and retro step-ups (2-4” block) • Balance training • Balance board/2-legged • Single leg stance • Stretching-Hamstring and gastroc-soleus <p>Gait Training</p> <ul style="list-style-type: none"> • Full weight bearing when: <ul style="list-style-type: none"> • Pain, effusion controlled • Muscle control throughout ROM <p>Modalities</p> <ul style="list-style-type: none"> • Cryotherapy 	<p>No impact activities until 12 weeks after surgery Use caution with stair climbing Protect knee from overstress to allow healing Activity level should be modified if increased pain, catching or swelling occurs</p> <p>Avoid: Post activity swelling, reduce activities if swelling occurs Extended standing Loading knee at deep flexion angles</p>

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase VI Week 13-26 Goals:</p> <ul style="list-style-type: none"> • Minimal pain • Minimal swelling • Good patella mobility • No crepitus • Symmetrical gait • Increase functional activities • Full painfree ROM • Strength >4/5 • Strength within 80%-90% of contralateral extremity • Balance and/or stability within 75%-80% of contralateral extremity 	<p>Weeks 13-26 Full Knee AROM 0°-135°</p>	<ul style="list-style-type: none"> • Stationary bicycle • Water walking • Swimming (straight leg kicking and kicking) • Walking • Stair machine (low resistance, low stroke) • Ski machine (short stride, level, low resistance) <p>Therapeutic Exercise</p> <ul style="list-style-type: none"> • 4 way Straight leg raises, rubber tubing (high speed) • Hamstring curls (active, 0°-90°) • Knee extension with resistance • Leg press (0°-90°) • Multi-hip machine (flexion, extension, abduction, adduction) • Forward lunge < 60 degrees of knee flexion with slow pain free progression • Forward, lateral and retro step ups (2-8” step) • Closed-chain <ul style="list-style-type: none"> • Wall sits • Mini-squats (rubber tubing, 0°-40°) • Balance training • Balance board/2 legged • Single leg stance • Stretching-Hamstring and gastroc-soleus <p>Gait Training</p> <ul style="list-style-type: none"> • Full weight bearing with symmetrical gait <p>Modalities</p> <ul style="list-style-type: none"> • Cryotherapy 	<p>Avoid post activity swelling, reduce activities if swelling occurs Activity level should be modified if increased pain, catching or swelling occurs</p>

Post –op Phase/Goals	Range of Motion	Interventions/Activities	Precautions
<p>Phase VII Week 27-52 Goals: Symmetrical gait Gradual return to full unrestricted functional activities No effusion, painless ROM, joint stability ROM 0°-135° Performs ADL, can walk 20 minutes without pain</p>	<p>Full AROM</p>	<p>Therapeutic Exercise</p> <ul style="list-style-type: none"> • Continue maintenance program progression 3-4 times per week • Progress resistance as tolerated • Emphasis on entire lower extremity strength and flexibility • Progress agility and balance drills • Impact loading program should be individualized to the patient’s needs • Progress sport programs depending on patient variables <p>Functional activities</p> <ul style="list-style-type: none"> • Patient may return to various sport activities as progression in rehabilitation and cartilage healing allows. • Generally, low-impact sports, such as skating, rollerblading, and cycling, are permitted at about 6-8 months • Higher-impact sports such as jogging, running, and aerobics may be performed at 8-10 months • High-impact sports such as tennis, basketball, and baseball, are allowed at 12-18 months 	<p>Post activity soreness should resolve within 24 hours Avoid post activity swelling Avoid knee pain with impact Higher-impact sports such as jogging, running, and aerobics may be performed at 8-10 months High-impact sports such as tennis, basketball, and baseball, are allowed at 12-18 months</p>