



OATS (Osteochondral Autologous Transfer System)/Mosaicplasty

1. Defined

- a. An open procedure in which the area of chondral lesion is cleaned and drilled for the donor cartilage. One recipient site only. The donor cartilage is then harvested in one plug the size of the deficit, and placed into the donor site, into alignment with the condyle.
- b. Designed as a one step approach for small to medium chondral lesions (1-4cm) It is used in a younger population 20-50 years of age who have clicking and locking with an osteochondral defect after ACL surgery with continued pain and swelling, failed conservative treatment, and failed fluid replacement therapy.
- c. Other similar surgical option is Mosaicplasty: Area of chondral lesion cleaned and drilled out for donor cartilage. Usually 3-4 sites. Donor cartilage harvested in multiple plugs to make up the size of the deficit, and placed into the recipient site in alignment with the condyle.
- d. Many surgeons use the terms interchangeably.

2. Goals

- a. Protect healing tissue
- b. Control post-operative pain and swelling
- c. Improve post-operative range of motion
- d. Improve functional strength, stability, and neuromuscular control

3. Rehabilitation Principles (specific to OATS)

- a. Based on the 4 biological phases of cartilage healing: Proliferation, Transitional, Remodeling, Maturation
- b. As knee flexion increases, compressive loads across the joint surface.
- c. The combination of weight-bearing and knee flexion causes a combination of compression and shear across the joint surface that may be detrimental to the repair.
- d. Location of the transplanted tissue is key determinants of progression of rehab after OATS. (too vigorous rehab can lead to failure).
- e. Limit muscular inhibition and atrophy from effusion.
- f. Initiate early activity of quads and hamstrings (isometric, isotonic, resistive), (e-stim and biofeedback).

- g. Incorporate comprehensive, lower extremity (hip and calf) muscle stabilization and strengthening activities, as well as core strengthening activities.
 - h. Address limb confidence issues with progression of unilateral activity.
 - i. Address limb velocity issues during gait with verbal and tactile cueing.
 - j. Identify motion complications early and begin low-load, long-duration stretching activity:
 - i. ROM expectations
 - ii. visit 2 - 0-60
 - iii. week 2 - 90 degrees flexion, full knee extension
 - iv. week 4 - AROM within 10 degrees of involved
 - v. week 6 - full knee flexion (heel to buttock)
 - k. Initiate early proprioceptive activity and progress by means of distraction techniques:
 - i. eyes open to eyes closed
 - ii. stable to unstable
 - l. bilateral to unilateral
 - m. Constantly monitor for signs and symptoms of patellofemoral irritation.
 - n. Encourage low impact cardiovascular activity and patellofemoral protection strategies. (especially those found to have CMP at surgery)
4. Clinical Restrictions
- a. No weight bearing for 4 weeks
 - b. No flexion under weight-bearing beyond 45 degrees for 8 weeks.
 - c. No flexion under weight-bearing beyond 90 degrees for 12 weeks.
5. Assistive Device Guidelines
- a. **Post-op brace:**
 - i. If used, locked at 0 degrees for first 4 weeks.
 - ii. Sleep in brace for 4 weeks. In first 4 weeks patient can be out of brace at night if full extension is achieved.
 - iii. Discontinue brace at 6 weeks.
 - iv. Assistive device (crutch, cane, walker)—modified weight bearing for 4-6 weeks post operatively, FWB at 6 weeks. This is dependant on size of lesion—progress more slowly with larger lesions.
 - b. **Crutch use:**
 - i. 2 crutches/walker for 4 weeks NWB unless script dictates otherwise, then progress to 1 crutch to normalize gait.
 - ii. FWB at 6 weeks.
 - iii. Dependant on size of lesion. May need to progress more slowly with larger lesions
6. Functional Activity Guidelines
- a. **Driving:**
 - i. 7-14 days
 - ii. Dependent upon:
 - iii. Adequate muscle control for braking and acceleration.
 - iv. Proprioceptive/reflex control.

- v. Adequate ROM to get into driver's side.
- vi. Confidence level
- vii. car insurance restrictions on driving after surgery
- viii. no requirement of pain medication
- b. **Golf**
 - i. 6 months
 - ii. Dependent upon:
 - iii. symptoms (swelling and pain)
 - iv. range of motion
 - v. quad control
 - vi. proprioceptive/reflex control of limb
 - vii. no limb-velocity asymmetry with gait
 - viii. encourage the following
 - 1. backwards golf
 - 2. putting, chipping, short irons, 50% swing, 75% swing, 100% swing
 - 3. avoid bunkers, uneven surfaces and severe slopes
 - 4. warm up properly with stretching
- c. **Jogging on treadmill**
 - i. 12 weeks
 - ii. observe and minimize limb velocity asymmetry
 - iii. encourage lower impact activity
- d. **Cutting and Rotational activity**
 - i. 4-6 months
- e. **Return to sport**
 - i. 6 months for low impact, non contact
 - ii. 8-12 months for high impact, contact sports
 - iii. Dependent upon:
 - 1. Full ROM
 - 2. good quad control
 - 3. 80% score on hop testing
 - 4. 80% isokinetic score (when ordered and appropriate)

7. Modalities

- a. **Electrical Stimulation (VMS, biphasic or Russian):**
 - i. intensity to observed contraction
 - ii. appropriate until symmetrical intensity contraction
 - iii. Proximal, lateral quad and distal, medial quad pad placement
 - iv. Variety of positions: quad set, SLR, multi-angle isometrics, mini squats, step-ups.
 - v. Pre-modulated, high-volt., bi-phasic, with ice for pain and swelling as needed.

8. Rehabilitation Guidelines

- a. **Week 1-3**
 - i. Clinical Guidelines:
 - 1. Control post-op swelling and effusion
 - 2. Maintain patellar mobility

3. Restore active and passive ROM in open-chain
 4. Inhibit post-op muscle shut down and quad atrophy (e-stim, biofeedback, verbal/tactile cueing)
 5. Progress comprehensive lower extremity stretching program in open-chain positions
 6. Progress hip, calf and core strengthening activities in open-chain positions.
 7. Cue for proper gait with assistive device appropriately
 8. No closed chain exercises including bike for 3 weeks
- ii. Clinical Expectations
1. Full knee extension
 2. AROM knee flexion to 90 degrees
 3. Fair+ to Good – quad contraction
 4. SLR without quad lag
 5. Mod to min effusion
 6. Ambulating in brace NWB with 2 crutches

b. Week 3-6

- i. Clinical Guidelines
1. Initiate closed chain exercises
 2. Control post-op swelling and effusion
 3. Maintain patellar mobility
 4. Restore active and passive ROM in open-chain
 5. Inhibit post-op muscle shut down and quad atrophy (e-stim, biofeedback, verbal/tactile cueing)
 6. Progress comprehensive lower extremity stretching program in open-chain positions
 7. Progress hip, calf and core strengthening activities in open-chain positions.
 8. Cue for proper gait with assistive device appropriately
- ii. Clinical Expectations
1. Full knee extension
 2. PROM to 120 degrees or greater
 3. Minimal effusion
 4. Good – quad control
 5. Full patellar mobility
 6. Ambulation with 2 crutches NWB

c. Weeks 6-7

- i. Clinical Guidelines
1. Control post-op swelling and effusion
 2. Restore ROM
 3. Inhibit post-op muscle shut down and quad atrophy (e-stim, biofeedback, verbal/tactile cueing)
 4. Progress comprehensive lower extremity stretching program

5. Progress bilateral and unilateral, closed-chain activity to improve limb confidence with knee flexion less than 45 degrees
 6. Progress bilateral and unilateral, proprioceptive activity and reactive neuromuscular training (RNT)
 7. Progress hip, calf and core strengthening activities
 8. Cue for proper gait with and without assistive device appropriately.
 9. Progress unilateral flexion under weight-bearing activity (ie. step ups) with knee flexion less than 45 degrees.
 10. Progress no-impact endurance activity.
- ii. Clinical Expectations
1. Symmetrical extension, full knee flexion with asymmetry to end feel
 2. Visible and strong quad contraction (Good- to Good)
 3. Ambulating FWB without deviations
 4. Minimal to no effusion
 5. Able to stand on involved extremity for 30"
 6. Able to perform unilateral squat to 45 degrees symmetrically

d. Weeks 8

- i. Clinical guidelines
1. Continue activities from weeks 1-8
 2. Initiate bilateral, low-amplitude plyometric activities with emphasis on deliberate, quality movement.
- ii. Clinical Expectations
1. Symmetrical extension, full, pain-free knee flexion (heel to buttock)
 2. Visible, strong, but asymmetrical quad contraction (Good – to Good)
 3. Ambulating without deviation and without limb velocity asymmetry.
 4. Able to land but with asymmetry to landing pattern during bilateral, low-amplitude plyometrics.

e. Week 9

- i. Clinical Guidelines
1. Continue activities from weeks 1-9
 2. Continue bilateral, low-amplitude plyometric activities with emphasis on deliberate, quality, movement.
 3. Initiate unilateral, low-amplitude plyometric activities
 4. Initiate and progress bilateral, moderate-amplitude plyometric activity (includes jogging)
 - a. – (moderate amplitude = 0-6 inches high and 25-50% max distance.)
- ii. Clinical expectations

1. Symmetrical extension, full, pain-free knee flexion (heel to buttock)
2. Visible, strong, but asymmetrical quad contraction (Good – to Good)
3. Ambulating without deviation and without limb velocity asymmetry.
4. Able to land but with asymmetry to landing pattern during bilateral, low-amplitude and bilateral, moderate-amplitude plyometrics.

f. Week 10

i. Clinical guidelines

1. Continue activities from weeks 1-10
2. Continue bilateral, low-amplitude plyometric activities with emphasis on deliberate, quality movement.
3. Continue unilateral, low amplitude plyometrics
4. Progress bilateral, moderate-amplitude plyometric activity (includes jogging)
5. Initiate unilateral, moderate-amplitude hopping activity
 - a. – (moderate amplitude = 0-6 inches high and 25-50% of max distance.)

ii. Clinical Expectations

1. Symmetrical extension, full, pain-free knee flexion (heel to buttock)
2. Visible, strong, but asymmetrical quad contraction (Good – to Good)
3. Ambulating without deviation and without limb velocity asymmetry.
4. Able to land but with asymmetry to landing pattern during unilateral, moderate-amplitude hopping

g. Week 11

i. Clinical Guidelines

1. Continue activities from weeks 1-10
2. Continue bilateral and unilateral, low-amplitude hopping
3. Progress unilateral and bilateral, moderate-amplitude hopping (includes jogging)
4. Initiate bilateral, high amplitude hopping
 - a. –(high amplitude = 6-12 inches high, 50-75% max distance)
5. Progress higher level agility activities (forward, retro and lateral only – no cutting activities). Ladders, cones, lateral shuffling etc.

ii. Clinical Expectations

1. Symmetrical extension, full, pain-free knee flexion (heel to buttock)
2. Visible, strong, but asymmetrical quad contraction (Good – to Good)

3. Ambulating without deviation and without limb velocity asymmetry.
4. Able to land but with asymmetry to landing pattern during unilateral, moderate-amplitude hopping and bilateral, high amplitude hopping.

h. Weeks 12-16

i. Clinical Guidelines

1. Continue activity from weeks 1-12
2. Continue bilateral and unilateral, low-amplitude hopping
3. Continue bilateral and unilateral, moderate amplitude hopping
4. Continue bilateral, high-amplitude hopping
5. Initiate unilateral, high amplitude hopping
6. – (high amplitude = 6-12 inches high, 50-75% max distance)
7. Progress higher level agility activities
8. Initiate sports-specific cutting and agility activity.

ii. Clinical expectations

1. Symmetrical extension, full knee flexion (heel to buttock)
2. Visible, strong, symmetrical quad contraction (Good)
3. Ambulating without deviation and without limb velocity asymmetry
4. No effusion
5. Able to demonstrate good landing with all hopping activity
 - a. Good athletic posture (spine erect and shoulders back)
 - b. No valgus with landing
 - c. Soft landing
 - d. Able to “stick the landing”
6. Demonstrate 80-100% score on single leg hop test.
7. Proper coordination with sport-specific, agility activity.

9. References

- a. Reinold M., Wilk K., Macrina L., Dugas J., Cain E. Current Concepts in the Rehabilitation Following Articular Cartilage Repair Procedures in the Knee. *J Orthop Sports Phys Ther* 2006;36(10):774-794.
- b. Wilk K., Briem K., Reinold M., Devine K., Dugas J., Andrews J. Rehabilitation of Articular Lesions in the Athlete’s Knee. *J Orthop Sports Phys Ther* 2006;(10):815-827.
- c. Bartha L., Vajada A., Duska Z., Rahmeh H., Hangody L. Autologous Osteochondral Mosaicplasty Grafting. *J Orthop Sports Phys Ther* 2006;(10):739-750.