Technical Note

Arthroscopic Technique for Treating Patella and Femoral Condyle Lesions With DeNovo Natural Tissue Allograft

Jeremy Truntzer, M.D., Blake Schultz, M.D., and Jason Dragoo, M.D.

Abstract: Use of juvenile particulate cartilage allograft has been previously described for the treatment of full-thickness chondral lesions of the knee. Although this procedure has traditionally been performed with an open approach, it can be performed using arthroscopic techniques with the potential for less morbidity and accelerated rehabilitation. This article describes an all-arthroscopic technique for treating patella and femoral condyle lesions with DeNovo Natural Tissue allograft, including clinical indications and a rehabilitation protocol.

Pain and loss of function caused by chondral lesions of the knee continues to remain a challenging problem. Full-thickness lesions rarely heal and can accelerate osteoarthritis.[1] Numerous options for treating chondral lesions have been proposed depending on location and severity.[2] Methods include arthroscopic debridement, marrow-stimulating techniques, autograft and allograft osteochondral transplantation, as well as cell-based therapies. Whereas each technique has advantages and disadvantages, no single option has proven superior for all lesion types and locations.

From the Department of Orthopaedic Surgery, Stanford, Palo Alto, CA, U.S.A.

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Address correspondence to Jason Dragoo, M.D., Department of Orthopaedic Surgery, 300 Pasteur Dr, R144, Stanford, Palo Alto, CA, U.S.A. E-mail: jdragoo@stanford.edu

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DeNovo Natural Tissue allograft (Zimmer, Warsaw, IN) consists of minced hyaline cartilage from donors younger than or equal to the age of 13. Juvenile chondrocytes have shown favorable attributes for cartilage repair with upregulation of genes that promote direct cartilage growth and expansion, as well as increased collagen and proteoglycan production, rates of proliferation, and cell density.[3] Taylor et al.[4] showed that juvenile cells were different than adult cells and secreted extracellular matrix factors chordin-like 1 and microfibrillar-associated protein 4. Cartilage development pathways, epithelial-mesenchymal transition, and innate immunity pathways were also found to be overrepresented in juvenile-enriched genes.

Favorable results have been demonstrated within most compartments of the knee.[5,6] The technique is performed by placing the juvenile particulate cartilage into a chondral defect and securing it with a fibrin coating.[7] The procedure has been well described using arthrotomy-based techniques with excellent results[6]; however, recent reports also support the application using all-arthroscopic methods for trochlear lesions.[8] We describe our method for the treatment of patella and femoral condyle lesions, as well as our preferred indications and rehabilitation protocol.

Surgical Technique

Preoperative Assessment and Patient Positioning

Preoperative magnetic resonance imaging is important for identification of lesion size and location. Preoperative history and physical examination of the knee are important to localize symptomatic lesions. The

Table 1. Indications and Contraindications for All-Arthroscopic Implantation of DeNovo to the Femoral Condyle

Indications
Lesion size >1 cm^2, <5 cm^2
Achievable stable rim/Contained lesion
ICRS grade 3 or 4a chondral lesions
Symptomatic lesion that corresponds to MRI findings
Contraindications
BMI >35 kg/m^2
Uncorrected ligamentous instability
Extensive subchondral bone edema
Recent or active infection
Diffuse chondral wear with multiple symptomatic compartments
Radiographic mechanical axis malalignment >5°
History of rheumatoid arthritis, psoriatic arthritis, gout or avascular necrosis
Bipolar lesions (relative)

BMI, body mass index; ICRS, International Cartilage Repair Society; MRI, magnetic resonance imaging.

summary of indications and contraindications of the proposed procedure are shown in Table 1.

This technique consists of standard knee arthroscopic technique with the use of a lateral post with the patient in the supine position. A DeMayo leg holder can be helpful for positioning the leg in fixed flexion, especially for more posterior condylar lesions (Fig 1).

A tourniquet is applied at least 5 fingerbreadths above the patella and preferably as high as possible on the thigh. The tourniquet is not inflated until the DeNovo component of the procedure.

Operative Technique

Standard anteromedial and anterolateral portals are created adjacent to the patella tendon followed by routine diagnostic arthroscopy using a 30° arthroscope (Video 1). Concurrent pathology is initially addressed as indicated including meniscal or ligamentous procedures.

The DeNovo procedure is generally performed last to avoid disrupting the implant with the use of additional instrumentation. The back table is routinely organized to minimize tourniquet time and operative duration (Fig 2). It is also essential to initially evaluate optimal visualization and lesion access using both the anteromedial and anterolateral portals to determine location of the flexible cannula (working portal) and arthroscopic (visualization portal) portal because the individual variation of knee architecture prohibits a uniform approach. There should be a low threshold to create an accessory working portal if required for best access to the lesion.

The chondral defect is debrided using a combination of full radius shaver, curved curettes, or both. An arthroscopic biter can also be helpful to trim unstable edges. A curette is then used to remove the calcified cartilage layer at the base of the lesion and to stabilize the vertical edges (Fig 3). Careful attention is given to avoid violation of the subchondral bone. The lesion is measured to ensure compliance with indications and to plan the amount of DeNovo material that will be required.

A 10-cm × 4-cm Passport cannula (Arthrex, Naples, FL) is then placed into the working portal depending on the location of the lesion using a hemostat (Fig 4). If needed, the original portal site is extended to allow easier passage of the cannula.

Next, if improved visualization is required, the tourniquet can be inflated, and the saline solution is drained from the knee. Two suction lines are required. The first is attached to the arthroscopic outflow cannula, and the other is attached to an 8F Frazier suction tip for use via the working portal (Fig 5). Generally, we recommend titrating outflow through the cannula first before inserting the Frazier suction tip. Pledglets may also be helpful to dry the base of the lesion. This is a critical step

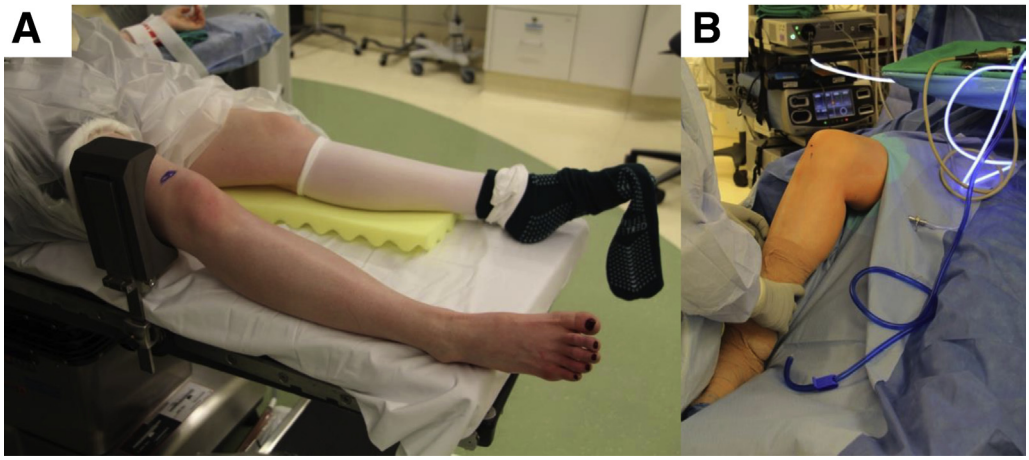

Fig 1. (A) Arthroscopic setup for right knee using lateral post with the patient supine. (B) Portals are created at 90 degrees of flexion. When accessing the lateral compartment, the post is lowered to allow for figure-of-4 positioning. A DeMayo leg holder can be added to aid with leg positioning without the use of an assistant.

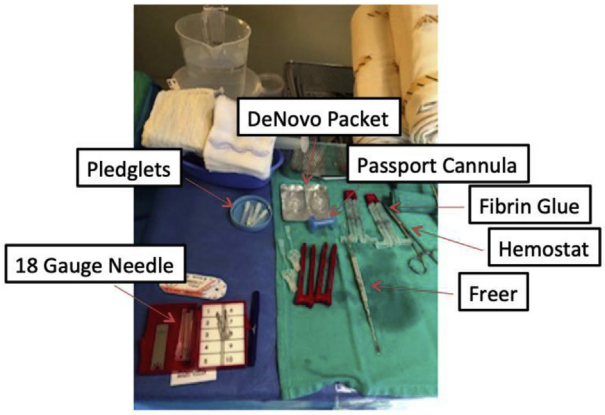

Fig 2. Typical back table setup for DeNovo technique. Routine setup can help minimize operative time and shorten tourniquet time.

for preparation of the defect bed before application of the material.

A layer of fibrin glue is then placed over the subchondral bed using an 18-gauge needle through the cannula (Fig 6A). Often, multiple needles are required to ensure uniform distribution because the fibrin glue frequently clogs the needle. Using the manufacturer's recommendation of 1 Denovo package for every 2.5 cm^2 of lesion area, the appropriate DeNovo material is prepared.

For improved allograft handling, we recommend removing the fluid within the cartridge using an 18-gauge needle attached to a controlled syringe before opening the package. Placing the needle at the top of the solution prevents aspiration of cartilage fragments. Afterward, the cartridge is cut a few millimeters from the beveled end into a straight line to help with loading of the Craig biopsy needed. After opening the cartridge, the allograft material is moved toward the cut-edge and loaded into a Craig biopsy needle using a freer and delivered into the lesion bed through the cannula (Fig 6B). Ensuring that all material settles at the distal end of the Craig biopsy needle before delivery can help with transfer to the lesion.

Alternatively, a freer can be used to transport the DeNovo material into the lesion via the cannula. We strongly recommend this technique for patella lesions to navigate the curved trajectory required to access the patella with the knee in extension (Fig 7). Coating the freer with a small amount of fibrin glue can help with transport and retention while passing through the Passport cannula.

Next, a freer elevator is used to press the material flat into the fibrin glue and manipulate it until the lesion is completely filled to the level of the surrounding articular surface. Ideally the allograft is placed as a 1- to 2-mm monolayer within the defect (Fig 6C). A second fibrin glue coating is applied to the monolayer with an 18-gauge needle, and the implanted material is allowed to dry for 7 to 10 minutes (Fig 6D). During this time the allograft is carefully monitored for any signs of displacement and the excess moisture is removed.

The working cannula is then removed, and the skin incisions are closed. Steri-Strips are placed over the incisions, and the wound is dressed. Local anesthetic injection is generally limited to the skin and subcutaneous tissue to avoid disruption or loss of viability of the allograft.

Postoperative Management and Rehabilitation

A knee brace is applied before the patient awakens to ensure controlled knee motion. The patient is usually discharged from the post-anesthesia care unit on the same day. Rehabilitation is based on procedures

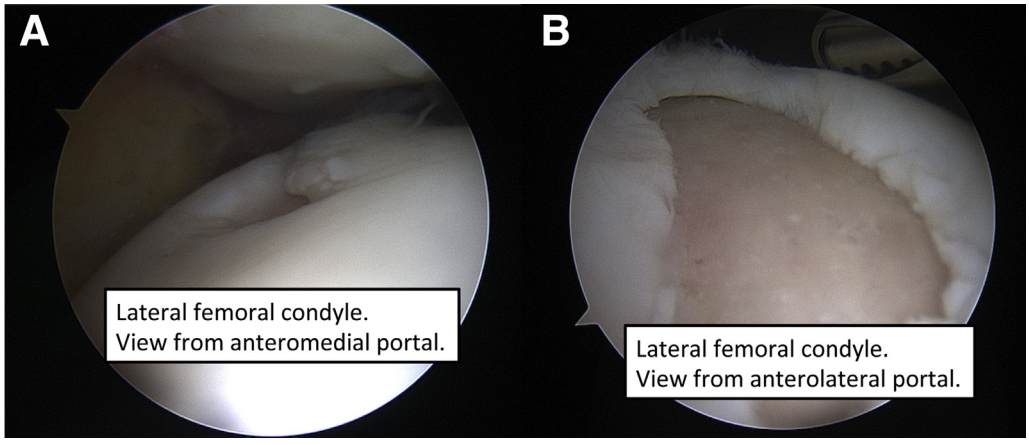

Fig 3. (A) Initial presentation of a lateral femoral condyle lesion viewed from anteromedial portal in a right knee. Traditional anterolateral portal failed to yield optimal visualization. Grade III/IV changes are observed. (B) Prepared lesion following curettage and debridement viewed from the anterolateral portal. Stable edges have been created and the calcified cartilage layer has been removed.

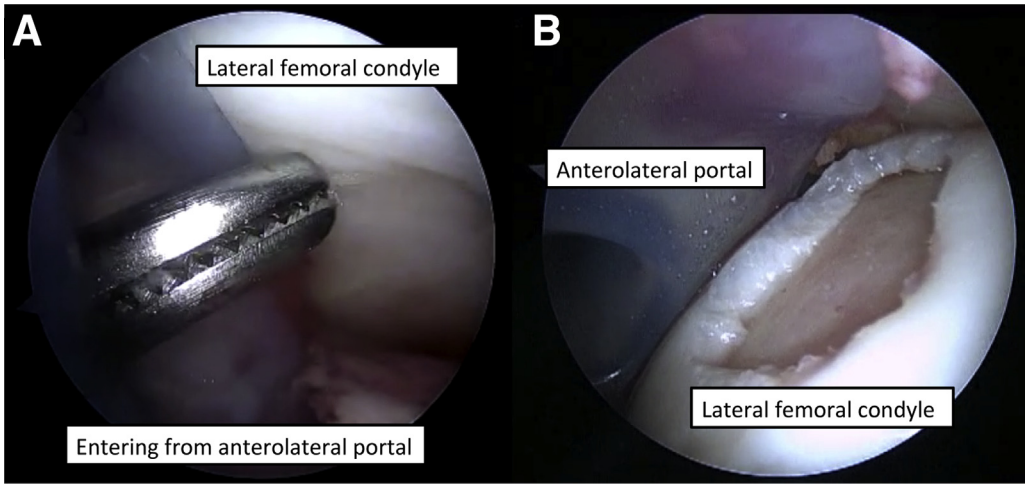

Fig 4. (A) Use of a hemostat to guide entry of a flexible cannula from the anterolateral portal in a right knee. (B) Ideal position of the Passport cannula for direct access to the lesion without interference of soft tissue or osseous structures.

performed. In cases of isolated femoral condyle DeNovo treatment, rehabilitation is carried out as indicated in Table 2. The summary of pearls and pitfalls of the proposed procedure is shown in Table 3.

Discussion

Previously published techniques to treat full-thickness chondral lesions of the patella and femoral condyle using juvenile particulate cartilage allograft advocate the use of arthrotomy to access patella and femoral condyle lesions, which may add inherent morbidity. The use of an all-arthroscopic technique also affords the benefit of accelerated rehabilitation without the need for soft tissue rest (Table 2). Moreover, we introduce a method with little variation in terms of setup and arthroscopic technique from traditional procedures, in turn theoretically improving reproducibility and outcomes.

DeNovo implantation has shown benefit for the treatment of full-thickness chondral lesions in the knee, wrist, and ankle in multiple studies with the advantage of a single-stage procedure that doesn't require cell culture, allograft matching, or donor site morbidity.[5,6,9,10] Moreover, specifically for the knee successful results have been reported for the patella, trochlea and condyle with and without concurrent surgeries.[5] Treatment of talar lesions using arthroscopic techniques have also been described with comparable results to open methods.[11,12] Size of the lesion is important for preoperative planning with less reliable results in lesions >3 cm.[2,13]

Complications do exist after DeNovo implantation, most commonly in the form of joint effusion and stiffness.[13] Graft hypertrophy and delamination are the most frequent reasons for reoperation.[6,9,14] Intraoperative difficulties include graft migration during fibrin glue application, defect overfilling, or, alternatively, failure to completely fill the defect, often caused by difficulty with accessing the lesion. It should be noted that use of an all-arthroscopic technique is unlikely to address many of the above complications and could increase intraoperative effort, especially during early adoption. Moreover, general risks associated with the procedure not unique to an arthroscopic technique include infection, scarring, pain, prolonged recovery, and failure to return to the same level of activity.

Arthroscopic techniques are limited compared with open techniques in some situations. Certain lesion locations may not be amenable to arthroscopic techniques and may require an arthrotomy for appropriate visualization and access with instrumentation. Additionally, in some cases when treating multiple lesions, open techniques may offer a single-incision solution

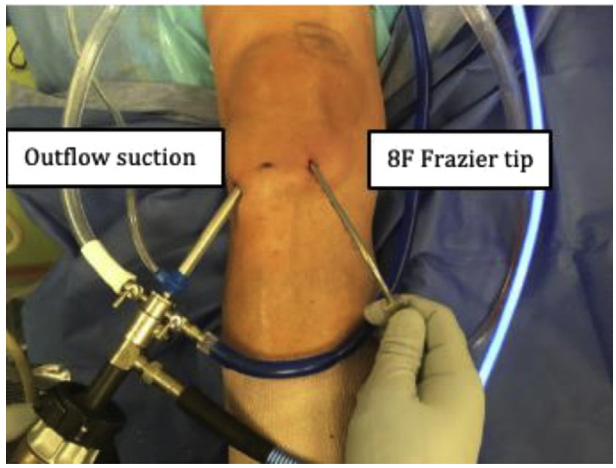

Fig 5. Setup used to dry the knee and prepare the lesion bed for application of material through the anteromedial and anterolateral portals in a right knee. Note that two suction lines are required.

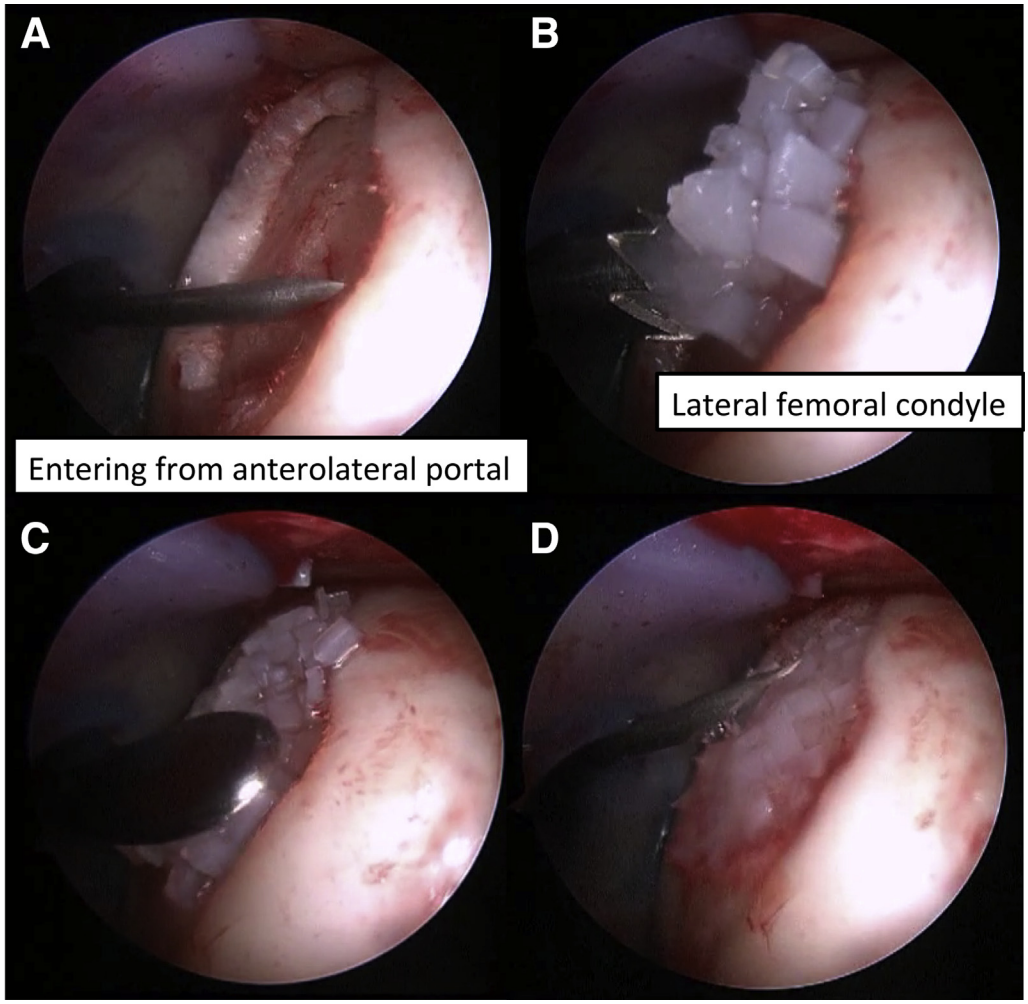

Fig 6. (A) 18-gauge needle is used to apply a fibrin glue foundation over a lateral femoral condyle lesion base from the anterolateral portal in a right knee. (B) Distribution of DeNovo allograft to lesion using needle biopsy cannula. (C) Manipulation of DeNovo allograft using freer throughout lesion to achieve optimal spacing (1-2 mm spacing) and depth (equal to or 1 mm below cartilage rim). (D) Application of fibrin glue to superficial layer with 18-gauge needle. If needed, fine adjustments can be made to the implanted material using a freer following application of fibrin glue. The material should be allowed to set for 7 to 10 minutes and monitored for any displacement.

compared with multiple accessory portals with arthroscopy.

The use of DeNovo implantation has become an important tool in the treatment of full-thickness chondral lesions in the knee. An all-arthroscopic technique to address chondral lesions of the knee may eliminate some of the potential morbidity of arthrotomy-based techniques. However, future studies

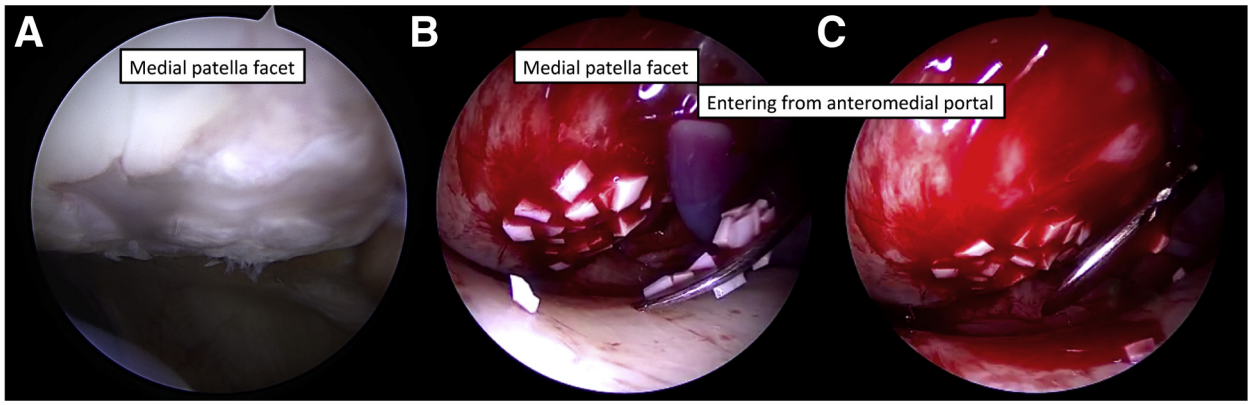

Fig 7. (A) Full-thickness lesion of the medial patella facet viewed from the anterolateral portal of a right knee. (B) A freer elevator prepped with fibrin glue is used to apply the allograft material to patella lesion through a Passport cannula with the knee in extension from the anteromedial portal. (C) The freer elevator is used to adjust spacing of the DeNovo allograft before fibrin glue application.

Table 2. Rehabilitation Protocol Following Arthroscopic DeNovo of Patella and Condyle Lesions

- Patella Lesion
  - Phase 1 (0-8 wks)
    - Weight-bearing
      - TDWD × 2 weeks w/brace locked in extension for ambulation
      - WBAT × 6 weeks w/brace locked in extension for ambulation
    - Range of motion
      - 0-30° × 2 weeks
      - 0-60° × 2 weeks
      - 0-90° × 2 weeks
      - 0-110° × 2 weeks
    - Exercise
      - Quad isometrics
      - Straight leg raise − 4 ways
      - Clamshells
      - Hamstring isometrics
  - Phase 2 (9-12 wks)
    - Weight-bearing
      - As tolerated
    - Range of motion
      - Full PROM/AAROM/AROM
      - Bike for ROM
    - Exercise
      - Gait retraining/Cone Walking
      - Squats/Leg Press (60-0°)
      - Closed chain terminal extension (30-0°)
      - Calf raises
      - Weight shifting/Balance/Perturbation training
      - Bridging progressions
      - Step ups, Step downs, Lateral step downs
  - Phase 3 (>12 wks)
    - Weight-bearing
      - As tolerated
    - Range of motion
      - As tolerated
    - Exercise
      - Strength/Proprioception/Balance
      - Full squat to 100°
      - Single leg squat
      - Begin low impact activity progression
- Condyle Lesion
  - Phase 1 (0-8 wks)
    - Weight-bearing
      - TDWD × 8 weeks with brace unlocked for ambulation
    - Range of motion
      - Locked in extension for 24 hours
      - Full ROM after 24 hours
      - Bike: Rocking to full revolution as ROM allows
    - Exercise
      - Quad isometrics
      - Straight leg raise − 4 ways
      - Clamshells
      - Hamstring isometrics
  - Phase 2 (9-12 wks)
    - Weight-bearing
      - As tolerated
    - Range of motion
      - Full PROM/AAROM/AROM
      - Bike for ROM
    - Exercise
      - Gait retraining/Cone Walking
      - Squats/Leg Press (60-0°)
      - Closed chain terminal extension (30-0°)
      - Calf raises
      - Weight shifting/Balance/Perturbation training
      - Bridging progressions
      - Step ups, Step downs, Lateral step downs
  - Phase 3 (>12 wks)
    - Weight-bearing
      - As tolerated
    - Range of motion
      - As tolerated
    - Exercise
      - Strength/Proprioception/Balance
      - Full squat to 90°
      - Initiate jogging progression

AAROM, active-assisted range of motion; AROM, active range of motion; PROM, passive range of motion; ROM, range of motion; TDWD, Touch-down weight bearing; WBAT, weight bearing as tolerated.

Table 3. Pearls and Pitfall for All-Arthroscopic Implantation of DeNovo to the Femoral Condyle

- Pearls
  - Proper patient selection (lesion location, size, associated pathology)
  - Correct patient positioning, especially for posterior condyle lesions
  - Remove moisture from knee with suture attached cannula and Frazer suction
  - Ensure lesion accessible via flexible cannula prior to implantation
  - Filling to a depth 1 mm short of rim
  - Adequate removal of moisture using pledglet before DeNovo implantation
  - 7 full minutes of drying after application of fibrin coating
- Pitfalls
  - Difficult access to lesion either secondary to positioning or portal location
  - Overfilling of lesion with graft material
  - Violation of subchondral bone during lesion debridement
  - Difficult visualization due to soft tissue or bloody environment

are required to better understand results after the use of this technique because currently no comparable data are available.

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