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Harvest and Application of Bone Marrow Aspirate Concentrate to Address Acetabular Chondral Damage During Hip Arthroscopy

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Abstract

Background: During hip arthroscopy, managing concomitant cartilage damage and chondrolabral junction breakdown remains an ongoing challenge for orthopaedic surgeons, as previous studies have associated such lesions with inferior postoperative outcomes[1-7]. Although higher-level studies are needed to fully elucidate the benefits, recent literature has provided supporting preliminary evidence for the utilization of bone marrow aspirate concentrate (BMAC) in patients with moderate cartilage damage and full-thickness chondral flaps undergoing acetabular labral repair[7,8]. Thus, as the incorporation of orthobiologics continues to advance, there is a clinical demand for an efficient and reliable BMAC-harvesting technique that utilizes an anatomical location with a substantial concentration of connective tissue progenitor (CTP) cells, while avoiding donor-site morbidity and minimizing additional operative time. Thus, we present a safe and technically feasible approach for harvesting bone marrow aspirate from the body of the ilium, followed by centrifugation and application during hip arthroscopy.

Description: After induction of anesthesia and appropriate patient positioning, a quadrilateral arrangement of arthroscopic portals is established to perform puncture capsulotomy[9]. Upon arthroscopic visualization of cartilage/chondrolabral junction injury, 52 mL of whole venous blood is promptly obtained from an intravenous access site and combined with 8 mL of anticoagulant citrate dextrose solution A (ACD-A). The mixture is centrifuged to yield approximately 2 to 3 mL of platelet-rich plasma (PRP) and 17 to 18 mL of platelet-poor plasma (PPP). Then, approaching along the coronal plane and aiming toward the anterior-superior iliac spine under fluoroscopic guidance, a heparin-rinsed Jamshidi bone marrow biopsy needle is driven through the lateral cortex of the ilium just proximal to the sourcil. Under a relative negative-

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pressure vacuum, bone marrow is aspirated into 3 separate heparin-rinsed 50 mL syringes, each containing 5 mL of ACD-A. Slow and steady negative pressure should be used to pull back on the syringe plunger to aspirate a total volume of 40 mL into each syringe. To avoid pelvic cavity compromise and minimize the risk of mobilizing marrow-space contents, care should be taken to ensure that no forward force or positive pressure is applied during the aspiration process. A total combined bone marrow aspirate/ACD-A mixture of approximately 120 mL is consistently harvested and subsequently centrifuged to yield roughly 4 to 6 mL of BMAC. The final mixture containing BMAC, PRP, and PPP is combined with thrombin to generate a megaclot, which is then applied to the central compartment of the hip.

Alternatives: Currently, strategies to address acetabular cartilage lesions may include microfracture, autologous chondrocyte implantation, matrix-induced autologous chondrocyte implantation, autologous matrix-induced chondrogenesis, osteochondral allografts, and orthobiologics[10]. Orthobiologics have shown mixed yet promising results for addressing musculoskeletal injuries and may include bone-marrow-derived mesenchymal stromal cells, adipose tissue derivatives, and PRP[7,8,11,12]. Specifically, bone marrow aspirate can be harvested from numerous locations, such as the iliac crest, the proximal aspect of the humerus, the vertebral body, and the distal aspect of the femur. Moreover, alternative approaches have utilized multiple-site and/or needle-redirection techniques to optimize cellular yield[16,17], while also appreciating the potentially variable cellular characteristics of aspirated and/or processed samples[18]. However, previous literature has demonstrated that the body of the ilium contains a CTP cell concentration that is similar to or greater than other harvest locations when utilizing this outlined single-site and unidirectional aspirating technique[13,14].

Rationale: This versatile and updated technique is a safe and reproducible method for BMAC harvesting, processing, and application that avoids donor-site morbidity, obtains a substantial concentration of CTP cells, minimizes additional operative time, and limits the hip arthroscopy and aspiration to a single procedure[15]. Specifically, this technique details an evidence-supported approach to addressing chondral injury in patients undergoing acetabular labral repairs[7,8].

Expected Outcomes: Patients with moderate cartilage damage treated with BMAC at the time of labral repair experienced significantly greater improvements in functional outcomes at 12 and 24 months postoperatively compared with similar patients without BMAC augmentation[7]. Furthermore, patients with full-thickness chondral flaps treated with BMAC at the time of arthroscopic labral repair demonstrated significantly greater improvements in functional outcomes at 12 months compared with microfracture. Moreover, 77.6% of the BMAC cohort reached the minimal clinically important difference threshold for the International Hip Outcome Tool-33 (iHOT-33) compared with 50.0% in the microfracture group[8].

Important Tips:

- Utilize the previously established Dienst arthroscopic portal for the bone marrow aspiration in order to avoid secondary donor site morbidity.
- Under fluoroscopic guidance, approach the ilium along the coronal plane, aiming toward the anterior superior iliac spine.
- With a heparin-rinsed Jamshidi bone marrow biopsy needle, penetrate the lateral cortex of the ilium just proximal to the sourcil in order to consistently harvest a total combined bone marrow aspirate/ACD-A volume of approximately 120 mL.
- Simultaneously perform the bone marrow aspirate and whole venous blood centrifugation during the hip arthroscopy procedure in order to minimize additional operative time.
- Bone marrow aspiration should be performed without applied traction in order to minimize the risk of neurovascular complications associated with extended traction time.

Acronyms and Abbreviations:

- ACD-A = anticoagulant citrate dextrose solution A
- ADSCs = adipose-derived stem cells

- ASIS = anterior superior iliac spine
- BMAC = bone marrow aspirate concentrate
- CI = confidence interval
- CTP = connective tissue progenitor
- DVT = deep vein thrombosis
- HOS-ADL = Hip Outcome Score, Activities of Daily Living
- iHOT-33 = International Hip Outcome Tool-33
- MCID = minimal clinically important difference
- MRA = magnetic resonance arthrogram
- MSCs = mesenchymal stromal cells
- PPP = platelet-poor plasma
- PRP = platelet-rich plasma
- RBCs = red blood cells
- SD = standard deviation
- T1 = longitudinal relaxation time
- T2 = transverse relaxation time
- WBCs = white blood cells

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