Minimally Invasive Intraosseous Bioplasty for Treating Subchondral Cysts: A Case Report

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CASE DESCRIPTION

We were presented with 47-year old male with subchondral cyst (SC) in lateral condyle of femur with a history of chronic pain and no previous trauma (Figure 1A and 1B). An Intraosseous Bioplasty (IOBP) was performed. First, diagnostic arthroscopy was performed to ensure no breach of femur articular surface (Figure 2). Bone-marrow was then harvested from the femur and processed in the Arthrex Angel system (Figure 3). The Arthrex Angel System separates platelet rich plasma (PRP) with nucleated cells, platelet poor plasma, and red blood cells (RBC's) into separate sterile compartments with customizable levels of each including white blood cells (WBC's). The bone marrow aspirate (BMA) is connected in the "whole blood in" compartment and spun for a total of 17min. The BMA is passed through three sensors to separate the blood components using the cell-specific wavelengths. The concentrated PRP that was obtained was mixed with demineralized bone matrix (DBM) (Figure 4A and 4B). The PRP concentration had roughly 105 x 10^3 platelets, greater than 1% WBC's, less than 1% RBC's and not externally stimulated, as classified using the PLRA classification. The cyst was decompressed, PRP and DBM mixture was inoculated, and allograft cancellous bone was impacted. Fluoroscopic assessment of the lesion was then performed (Figure 5A and 5B).

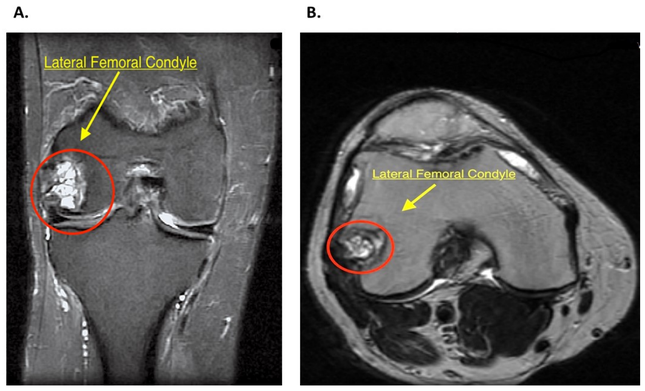

Figure 1. (A) Right Knee magnetic resonance image, fat-saturated FSE-IR. Coronal plane shows a multiloculated cystic area (red circle) in the lateral femoral condyle with proximal bone marrow edema. **(B)** Right Knee magnetic resonance image, non-fat-saturated T2 weighted. Axial plane image shows the cystic area (red circle) used for localization and planning of procedure.

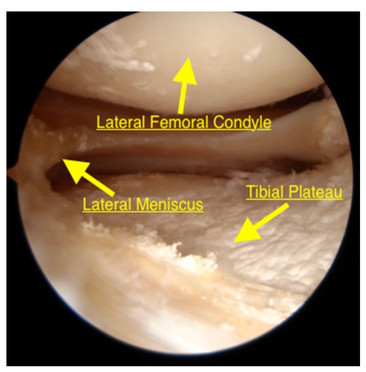

Figure 2. Arthroscopy appearance of the lateral compartment of the knee from the antero-lateral portal. The knee is in the figure-four position to allow adequate visualization of the lateral joint space. The lateral condyle was intact. Crystal deposits are evident in the articular cartilage.

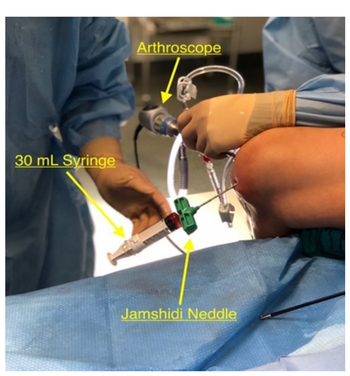

Figure 3. Harvest setup. The knee is flexed over the side of the table and the Jamshidi needle is impacted into the intercondylar notch of the femur with a pretreated 30 mL syringe. The arthroscope is in the anterior-lateral portal for visualization.

CASE DESCRIPTION continued

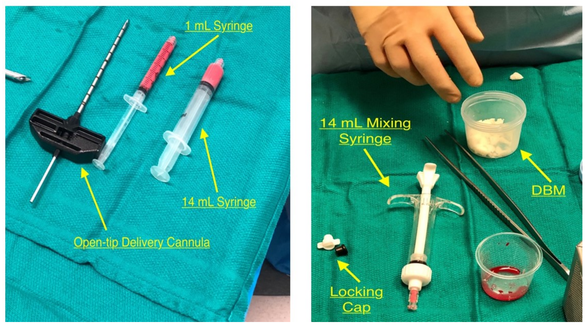

Figure 4. (A) The open-tip cannula is used for the direct approach of IOBP. Removal of the stylet will show the circular open end, rather than the 3-pin side end delivery used in the indirect approach. 1 mL syringe and 14 mL syringe filled with 50:50 Isovue dye, DBM and PRP. **(B)** The DBM in the plastic container will be mixed with the PRP from the Angle system in the container and will be inserted into the 1 mL or 14 mL syringes seen in Figure 4A.

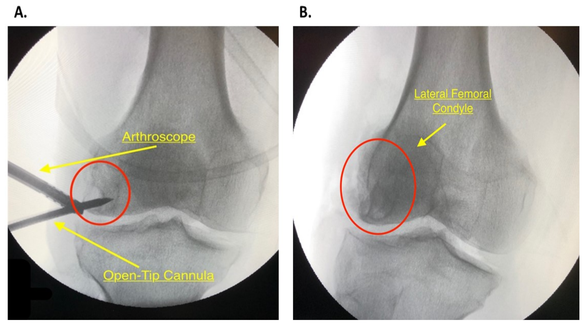

Figure 5. (A) Fluoroscopic image of the open-tip delivery cannula injecting the biologic mixture into the decompressed SC (red circle) with arthroscopic guidance. **(B)** Final fluoroscopic image of the right knee after injection of the biologic mixture into the SC (red circle).

RESULTS

Radiographs at 3 and 6 months indicated successful filling of defect (Figure 6). The patient increased range of motion to flex knee to 0-120^0, minimal or no pain most of the day with 50% activity.

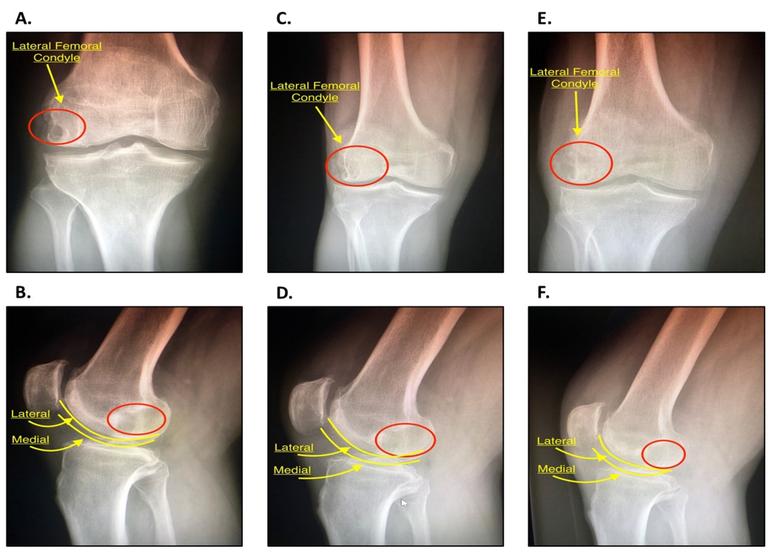

Figure 6. (A) AP radiograph of the right knee, pre-operative. The lateral femoral condyle can be visualized with the area of decreased opacity representing the SC (red circle). The joint space is well preserved with mild patellofemoral OA with osteophytes. **(B)** Lateral radiograph of the right knee, pre-operative. The red circle depicts the same SC. The lateral and medial femoral condyles are outlined in yellow. Both 6A and 6B will be used as a baseline for comparison. **(C)** AP radiograph of the right knee 3 months following IOBP. The lateral femoral condyle can be visualized with signs that the area of the previous SC is filling (red circle). **(D)** Lateral radiograph of right knee 3 months following operation. The red circle depicts the area of the SC. **(E)** AP radiograph of the right knee 6 months following IOBP. The area of the previous SC (red circle) has increased in opacity in comparison to the previous image at 3 months. **(F)** Lateral radiograph of the right knee six months following IOBP. The area of the previous SC (red circle) is more opaque, an indication that there is progressing filling of the previous lesion. This suggest that the IOBP has been successful.

DISCUSSION

IOBP is a viable option to manage SC in selected patients avoiding an open approach. Calcium phosphate and cement have been used, but they are brittle, and their use is usually limited to non-load-bearing areas. In IOBP, the combination of decompression and autologous bone marrow grafting allows achievement of a long-lasting solution as well as naturally promoting regrowth of the affected bone. In this way, the structural integrity of the joint space is maintained, the tissue where the cyst has developed can be restored, as shown in the postoperative imaging and improved postoperative symptoms. Ultimately, this procedure allows to spare the joint and delay the need for major procedures and is particularly indicated in younger individuals. IOBP carries minimal risks for adverse events, as it employs autologous bone marrow graft (Table 1).

Careful assessment of the cyst and joint cavity should be performed both pre- and intra-operatively, as communication between the two would lead to extravasation of the graft material, and it is a definite contraindication to IOBP.

It is imperative to ensure adequate pin placement through fluoroscopy prior to decompressing the cyst. Delivery of the biologic material should be performed under direct visualization under fluoroscopy, as a radio-opaque dye is added to the biologic mixture to ensure proper location of the injection and direct delivery of the PRP-DBM into the lesion.

The cancellous bone graft impacted into the defect contains high concentrations of osteoblasts and osteocytes, conferring a high osteogenic capacity. Its large trabecular surface area confers stability and encourages revascularization (Table 2). A local hematoma forms: it is rich in inflammatory cells and chemotactic mitogens that recruit mesenchymal stem cells to the defect, leading to neovascularization, osteoid deposition, and ultimately mineralization leading to new bone.

Table 1. Advantages and Disadvantages of IOBP.

ADVANTAGES	DISADVANTAGES
• Minimally Invasive • Joint preservation, avoiding arthroplasty • Wide choice of revision options • Biological solution: physiological remodeling used for stabilization	• Intraoperative time needed prepare PRP-DBM solution • Bone marrow harvest is needed, thus might need to have an extra incision site • Unable to perform if overlying bone is breached

Table 2. Pearls and Pitfalls of IOBP.

PEARLS	PITFALLS
• Directly visualize the articular surface via arthroscopy to assess articular surface • Harvest bone marrow without making an additional incision • Perform the core decompression during centrifugation • Use a guide pin during the decompression process • Perform a tunnel scope for direct visualization • Impact allograft cancellous bone into the decompressed lesion to add structural stability & increase revascularization • Use a 1 ml syringe or utilize the inner stylet during PRP inoculation	• Failing to do serial fluoroscopy & arthroscopy • Breach in the opposite cortex or articular surface during decompression

CONCLUSION

IOBP is a minimally invasive procedure which provides a permanent and biologic solution for SC. IOBP gives clinicians a versatile way of utilizing the physiological principles involved in bone remodeling to not only stabilize the lesion but to heal it. With successful treatment, the pain can be addressed while ensuring that the joint integrity is preserved.

REFERENCE

Potty, A.G.; Gupta, A.; Rodriguez, H.C.; Stone, I.W.; Maffulli, N. Intraosseous Bioplasty for a Subchondral Cyst in the Lateral Condyle of Femur. *J. Clin. Med.* 2020, *9*, 1358.