

IntraOsseous BioPlasty® (IOBP®) Scientific Update

A review of the design rationale, techniques, and outcomes

Persistent bone marrow lesions (BMLs) are the result of both acute and chronic injuries, including insufficiency fractures, osteoarthritis, persistent bone bruises, avascular necrosis, and osteonecrosis.

Patients with BML who fail to respond to conservative treatment may benefit from the IOBP® technique. The procedure includes decompression of the lesion and delivery of a concentrated dose of platelet-rich plasma (cPRP) from bone marrow aspirate (BMA) using the Angel® cPRP and bone marrow processing system mixed with a flowable demineralized bone matrix, such as AlloSync™ Pure demineralized bone matrix. The biologic material delivered to the BML contains all of the necessary components needed to aid bone repair: an osteoconductive scaffold, osteoinductive factors, and an osteogenic source of stem cells.¹

The literature below relates to the principles of the IOBP technique and highlights positive clinical outcomes.

Aaron RK,
Dyke JP,
Ciombor DM,
et al

Scope of the Problem

[Perfusion abnormalities in subchondral bone associated with marrow edema, osteoarthritis, and avascular necrosis.](#) *Ann N Y Acad Sci.* 2007;1117:124-137. doi:10.1196/annals.1402.069

- Measured the differences in blood flow between bone with or without BMLs.
- The result of increased pressure led to reduced venous outflow, hypoperfusion (not enough blood flow for proper metabolism), and hypoxia (decreased oxygen in blood).
- The associated results of these blood flow concentrations were focal avascular necrosis (AVN), trabecular remodeling, sclerosis, and thickening of the subchondral plate.

Takeaway

Bone marrow lesions negatively affect pressure and blood flow within the subchondral bone, presenting a biologic problem that needs a biologic solution.

Felson DT,
Chaisson CE,
Hill CL,
et al

[The association of bone marrow lesions with pain in knee osteoarthritis.](#) *Ann Intern Med.* 2001;134(7):541-549. doi:10.7326/0003-4819-134-7-200104030-00007

- Lesions seen on MRI are strongly associated with knee pain.
- The identification of BMLs is the strongest predictor of the presence of pain associated with knee osteoarthritis (OA).

Takeaway

An x-ray, while showing joint space narrowing and alignment, won't be effective in diagnosing one potential source of pain. MRI can be used to localize BMLs.



Hunter DJ,
Gerstenfeld L,
Bishop G,
et al

[Bone marrow lesions from osteoarthritis knees are characterized by sclerotic bone that is less well mineralized.](#) *Arthritis Res Ther.* 2009;11(1):R11. doi:10.1186/ar2601

- Histology of BMLs shows micro-cracks/fractures, fibrosis, bone necrosis, and limited bone remodeling.
- MicroCT analysis of BMLs shows gaps and fractures in bone.

Takeaway

These histologic and radiologic findings in BMLs associated with OA are similar to those present in bone nonunions.

Uchio Y,
Ochi M,
Adachi N,
Nishikori T,
Kawasaki K

[Intraosseous hypertension and venous congestion in osteonecrosis of the knee.](#) *Clin Orthop Relat Res.* 2001;(384):217-223. doi:10.1097/00003086-200103000-00025

- Compared intraosseous pressure and venogram in osteonecrotic knees versus knees with OA.
- Intraosseous pressure was significantly higher in the medial femoral condyle of osteonecrotic knees than in those with OA.
- Average drainage time of the venous injection medium was longer in the osteonecrosis group than the OA group.

Takeaway

BMLs, especially those resulting from osteonecrosis, are often associated with increased pressure and decreased blood flow, limiting healing potential.

Scher C,
Craig J,
Nelson F

[Bone marrow edema in the knee in osteoarthrosis and association with total knee arthroplasty within a three-year follow-up.](#) *Skeletal Radiol.* 2008;37(7):609-617. doi:10.1007/s00256-008-0504-x

- Objective was to determine whether there is a correlation between MRI findings of bone marrow edema (BME) in patients with knee OA and the clinical need for total knee arthroplasty (TKA) within a 3-year follow-up period.
- Subjects with any pattern type of BME were 8.95x as likely to progress rapidly to TKA compared to those with no BME ($p=0.016$).

Takeaway

Improving bone health may alter the course of progression and resulting symptoms in patients with OA.

Hunter DJ,
Niu J,
Zhang Y,
et al

[Increased perfusion and venous hypertension is present in regions of bone affected by BMLs in knee OA.](#) *Osteoarthr Cartil.* 2007;15(suppl C):171-172. doi:10.1016/S1063-4584(07)61940-2

- Evaluated whether BMLs show venous hypertension compared to surrounding normal tissue.
- BMLs in knees with OA are associated with “altered perfusion and intraosseous venous hypertension” in the tibial plateau and femur.

Takeaway

These changes in venous and perfusion rates may be responsible for the inhibition of bone remodeling and osteonecrosis in patients with knee OA.



Hernigou P,
Poignard A,
Beaujean F,
Rouard H

Clinical Treatment

[Percutaneous autologous bone-marrow grafting for nonunions. Influence of the number and concentration of progenitor cells.](#) *J Bone Joint Surg Am.* 2005;87(7):1430-1437. doi:10.2106/JBJS.D.02215

- Study included 60 patients with established tibial nonunion; bone marrow concentrate was percutaneously delivered to the nonunion site.
- Bone union (healing) observed in 88% of patients.

Takeaway

Percutaneous use of a biologic solution has a role in treating nonunion and, by correlation, BMLs with similar histologic findings (such as BMLs associated with OA).

Gangji V,
De Maertelaer V,
Hauzeur JP

[Autologous bone marrow cell implantation in the treatment of non-traumatic osteonecrosis of the femoral head: Five year follow-up of a prospective controlled study.](#) *Bone.* 2011;49(5):1005-1009. doi:10.1016/j.bone.2011.07.032

- Prospective study comparing core decompression (CD) alone versus core decompression with bone marrow mononuclear cells (BMCs).
- Success with CD alone: 27% at 5-year follow-up.
- Success with CD + BMCs: 77% at 5-year follow-up.
- Patients treated with both core decompression and BMC in their affected hip experienced a decrease in their pain levels and the volume of the necrotic lesion as compared to those who received only decompression.

Takeaway

Core decompression alone was not as effective in treating osteonecrosis as decompression augmented with a biologic solution.

Hernigou P,
Beaujean F

[Treatment of osteonecrosis with autologous bone marrow grafting.](#) *Clin Orthop Relat Res.* 2002;(405):14-23. doi:10.1097/00003086-200212000-00003

- Prospective study comparing early- and late-stage AVN and treatment with core decompression plus BMC.
- Success in stage I and II AVN: 94% at 10-year follow-up.
- Success in stage III and IV AVN: 43% at 10-year follow-up.

Takeaway

Treating AVN in the early stages is the best course of action when considering treatment options for BMLs.



Pawar N,
Vaish A,
Vaishya R

Clinical Treatment

Core decompression and bone marrow aspirate concentrate injection for Avascular Necrosis (AVN) of the femoral head: a scoping review. *J Clin Orthop Trauma*. 2021;24:101691. doi:10.1016/j.jcot.2021.101691

- Analyzed 612 hips from 11 studies to evaluate the role of core decompression and concentrated bone marrow aspirate (BMA) and their various stages of effectiveness in disease progression.
- Functional scores (HHS, WOMAC, VAS) improved in the majority of cases.
- Researchers concluded that core decompression with concentrated BMA in pre-collapse stages of AVN improves function scores and reduces radiological progression of the disease, which can lead to total hip arthroplasty.

Takeaway

Biologic treatment in early AVN stages can lead to improved functional scores and delay disease progression into total joint replacement.

Ankem HK,
Diulus SC,
Maldonado DR,
et al

Arthroscopic-assisted intraosseous bioplasty of the acetabulum. *Arthrosc Tech*. 2020;9(10):e1531-e1539. doi:10.1016/j.eats.2020.06.015

- Technical note reporting key tips and pearls for arthroscopic-assisted completion of the IOBP® technique in the acetabulum.
- Performing an IOBP procedure for the hip—particularly the acetabulum—can be beneficial in treating young patients with early hip arthritis and helps to achieve successful outcomes while delaying more invasive procedures.

Takeaway

This minimally invasive joint preservation technique can help delay more invasive procedures, such as total joint arthroplasty.

Hernigou P,
Delambre J,
Quiennec S,
Poignard A

Human bone marrow mesenchymal stem cell injection in subchondral lesions of knee osteoarthritis: a prospective randomized study versus contralateral arthroplasty at a mean fifteen year follow-up. *Int Orthop*. 2021;45(2):365-373. doi:10.1007/s00264-020-04571-4

- Study involved 140 patients with bilateral OA. Patients received TKA on one knee and a subchondral injection of mesenchymal stem cells (MSC) on the other.
- Incidence of knee arthroplasty was 1.19% per person per year, which is equivalent to the risk of a primary TKA revision.
- Study found that subchondral bone marrow concentrate had a sufficient effect on pain as to allow patients with bilateral OA to postpone or avoid TKA in the contralateral joint.

Takeaway

Using a biologic solution for patients with severe joint degeneration can help delay or avoid total joint arthroplasty.



Kasik CS,
Martinkovich S,
Mosier B,
Akhavan S

Short-term outcomes for the biologic treatment of bone marrow edema of the knee using bone marrow aspirate concentrate and injectable demineralized bone matrix. *Arthrosc Sports Med Rehabil.* 2019;1(1):e7-e14. doi:10.1016/j.asmr.2019.07.001

- Evaluated short-term outcomes of using a biologic solution of concentrated BMA and DBM in patients with bone marrow lesions of the knee.
- Of 20 cases reviewed, 19 patients (95%) reported improvement in their VAS pain scores compared to their preoperative baseline.
- Based on postoperative MRI, 75% of the BMLs (3 of 4) demonstrated complete healing.
- Study found that intraosseous pressures in the medial and lateral femoral condyles of patients with BMLs were 97% greater than pressures in patients without BMLs (63 mm Hg vs 32 mm Hg).

Takeaway

Short-term results show that the IntraOsseous BioPlasty® technique is associated with clinically significant improvements in knee pain and function.

Current Subchondroplasty® Literature

Subchondral bone marrow lesions associated with knee osteoarthritis. *Am J Orthop (Belle Mead NJ).* 2012;41(9):413-417.

- 30% revision to TKA within 2 years.
- Mean age of arthroplasty conversion was 58.2 years.
- Authors conclude that this procedure “...will become more refined and delivery of cytokines and other cell signaling agents that create some combination of osteogenesis, chondrogenesis, and angiogenesis may further enhance the results.”

Reference

1. Malinin TI, Carpenter EM, Temple HT. Particulate bone allograft incorporation in regeneration of osseous defects; importance of particle sizes. *Open Orthop J.* 2007;1:19-24.

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Cohen SB,
Leinberry CF,
Parvizi J

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