ZIMMER BIOMET

BioCUE® BMA Bone Marrow Aspirate Concentration System

Surgical Technique

Introduction

Bone marrow aspiration has been shown to be a safe and effective means to harvest nucleated cells. Nucleated cells are only present in a low concentration in a bone marrow aspirate. The BioCUE BMA Concentration System was designed to address this by providing a rapid, efficient concentration of autologous bone marrow aspirate (BMA).

Bone marrow aspirate contains mesenchymal stem cells, which are able to proliferate and differentiate into a number of different soft and hard tissues. Utilizing BioCUE technology, these stem cells can be concentrated at the patient's point of care. Clinical evidence suggests cellular concentration positively affects the clinical outcome of bone grafting procedures.[1]

The features of the kit include:

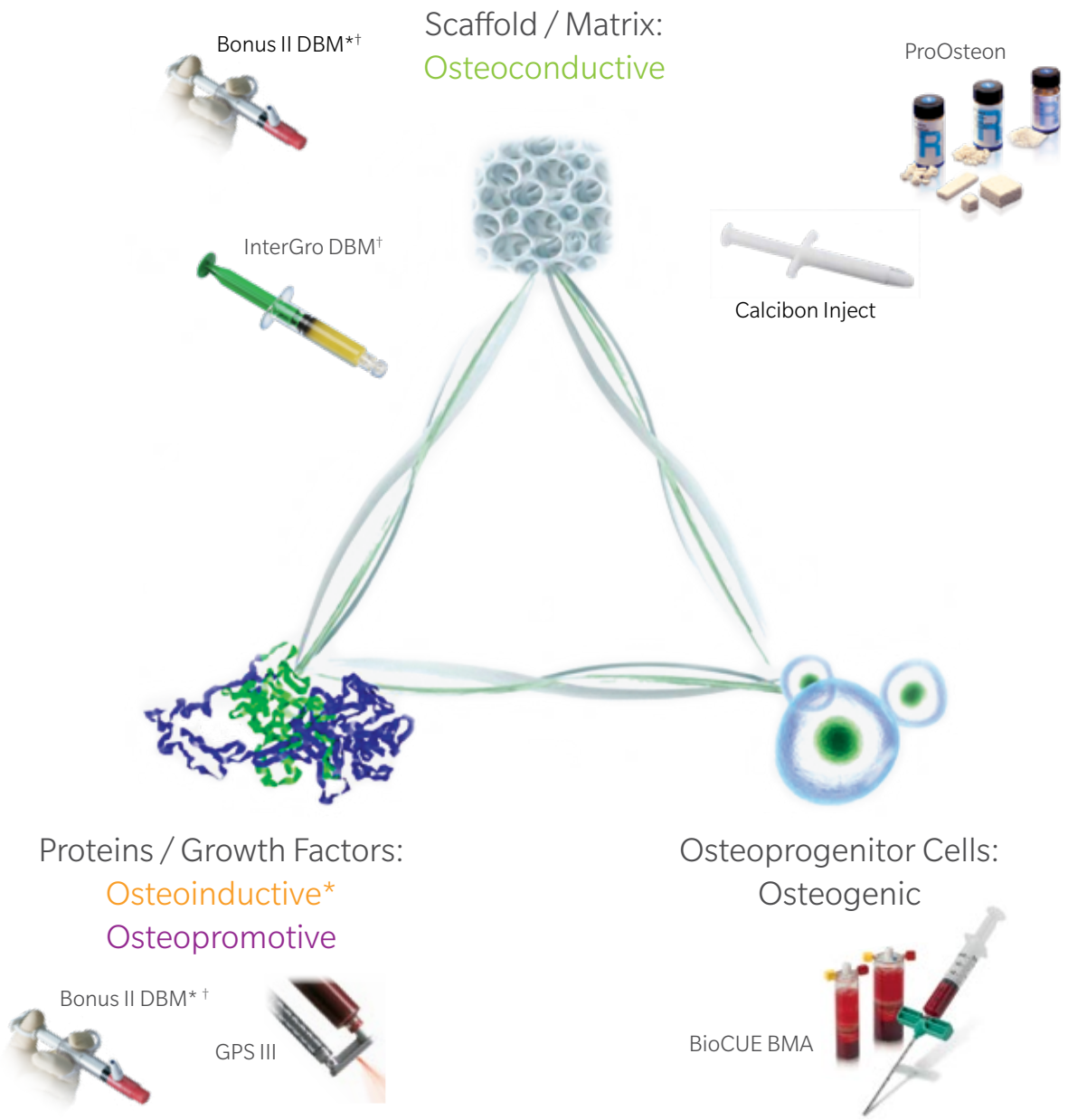
- All the components necessary to obtain and process autologous bone marrow aspirate at a patient's point-of-care
- Recovery of 80 percent of the nucleated cells from a bone marrow aspirate input[2]
- A processing time of 15 minutes
- Ability to process 30 or 60 ml of bone marrow aspirate per tube

Essentials of Bone Healing

The cBMA obtained with the BioCUE BMA concentration system can be used in different ways. It can be used in different orthopedic applications3-26, alone or in combination with Platelet Rich Plasma, Demineralized Bone Matrix or a Fibrin Sealant.

The Biomet portfolio encompasses everything to suit a variety of surgical needs. Biomet offers solutions that address the essential aspects of bone regeneration: osteoconduction, osteoinduction, osteopromotion and osteogenesis by offering a unique combination of autologous stem cells and growth factors (signals) with (porous) osteoconductive matrix, the three key elements to grow bone.

Essentials of Bone Healing

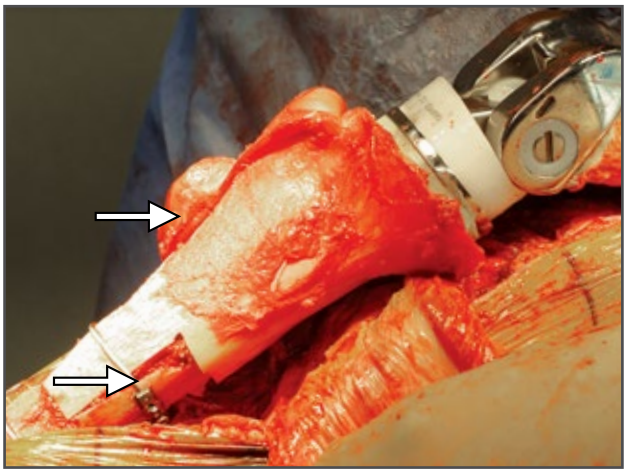


† Bonus II DBM and InterGro DBM are only available in certain countries

Applications of Concentrated Bone Marrow Aspirate

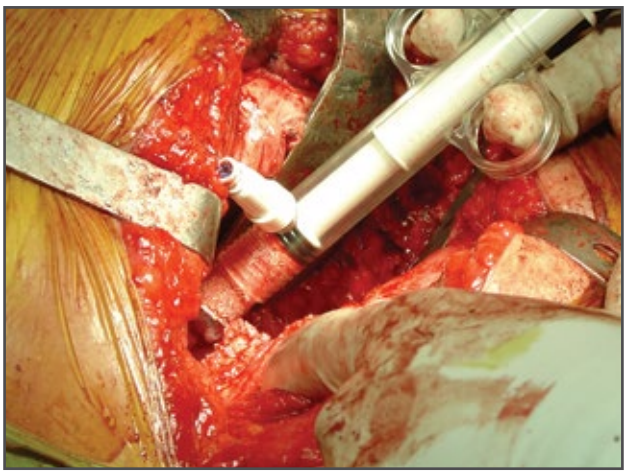
- Delayed union and nonunion[3-4]
- Avascular necrosis[5-7]
- Degenerative disc disease[8-9]
- Bone defects[10-17]
- Dental implant fixation[18-19]
- Bone cysts[20-21]

Concentrated bone marrow aspirate, platelet-rich plasma and Bonus II DBM applied to a fibula nonunion.



Concentrated bone marrow aspirate and Bonus II DBM applied to a knee revision.

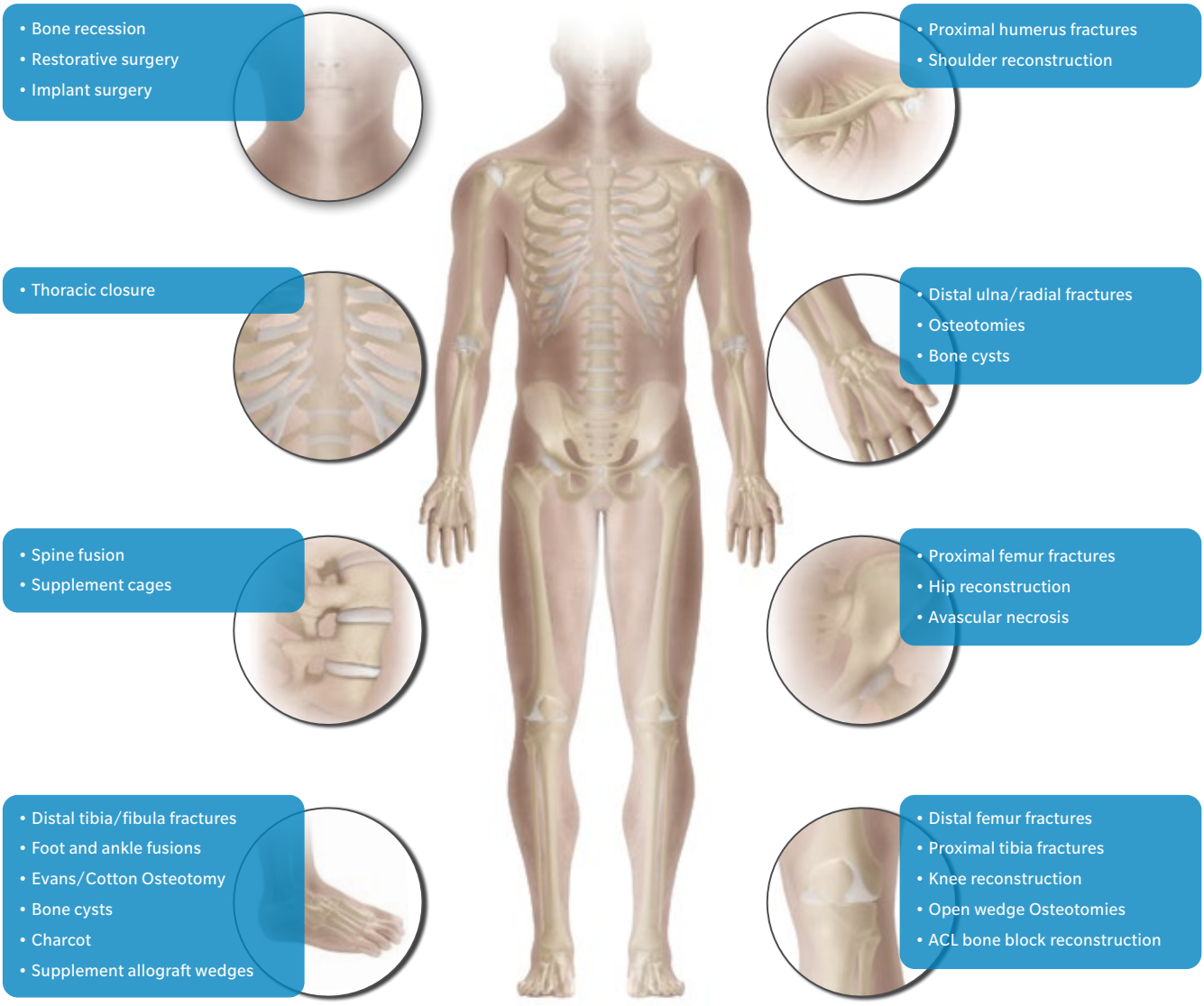
Concentrated bone marrow aspirate and Bonus II DBM in spine surgery.



Concentrated bone marrow aspirate and Bonus II DBM applied to a hip revision.

Examples of Autograft/ Allograft Bone Grafting Applications

The cBMA output from the BioCUE BMA Concentration System can be applied to a surgical site or can be mixed with graft material prior to application to a surgical site as deemed necessary by the clinical use requirements.



Characteristics for a single BioCUE BMA kit

Input	50 ml of Bone Marrow Aspirate
ACD-A	10 ml
Output	6 ml of cBMA
Plasma Output	25–35 ml
Nucleated Cell Recovery	78.7%[2]
Spin Time	15 minutes
Spin Speed	3200 RPM

Design Features for the Bone Marrow Aspiration Needle

- Six (6) holes placed at the distal tip, allowing for better aspiration
- Stylet, with its trocar point, makes it possible to easily penetrate the bone marrow cavity
- Ergonomically designed handle enables safe maneuverability, since the force needed to penetrate the bone marrow cavity is homogenously distributed over the entire palm of the hand rather than locally
- Extra stylet with blunt point. This stylet can be used once the trocar is inside the bone. The blunt nose prevents from pushing the trocar through the second cortex. This can more easily happen in patients with poor bone quality.

Six holes at the distal tip for better aspiration

Each needle comes with a trocar point and blunt tip for surgeon options

Bone Marrow Aspiration

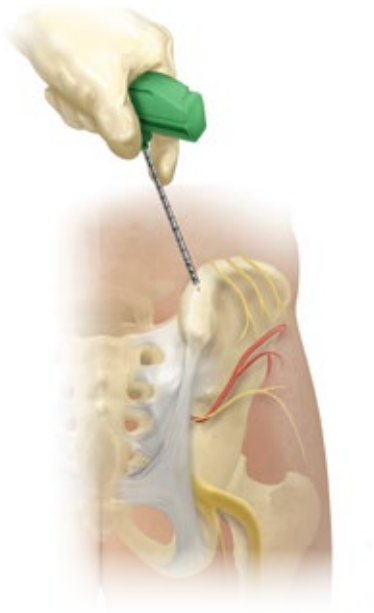


Figure 1

The BioCUE BMA procedure, as described below, is almost completely performed in a sterile area. Only the centrifugation steps are performed in a non-sterile area.

1. Prepare Patient

After suitable anesthesia is achieved, place the patient in, e.g., the lateral decubitus position. Using sterile technique, prepare the skin with antiseptic and drape.

2. Rinse and Prepare Syringes & Needle

Make sure to bring a sterile cup into the sterile field to spray the ACD-A in to.

The nurse outside the sterile field holds the ACD-A bottle in front of the nurse in the sterile field. The nurse in the sterile field takes one 30 ml syringe with a pink needle (found in the BioCUE kit) attached to it.

The nurse in the sterile field draws 5 ml of the ACD-A into the 30 ml syringe. Pull syringe plunger back completely, ensuring the ACD-A coats the entire inner surface of the syringe and set aside. This is followed by a draw of 10 ml ACD-A solution into a second 30 ml syringe. Pull syringe plunger back completely, ensuring the ACD-A coats the entire inner surface of the syringe.

Attach the second 30 ml syringe to the BMA needle and prime with ACD-A, ensuring 5 ml ACD-A remains in the 30 ml syringe. Remove BMA needle and replace the trocar.

Figure 2

Figure 3

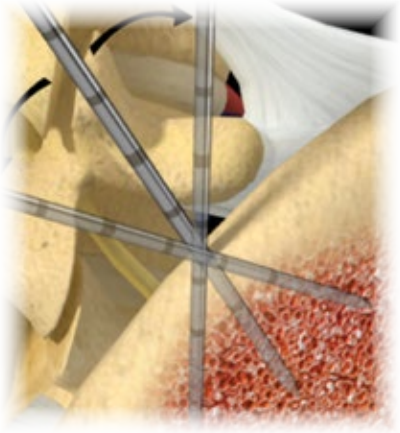


Figure 4

3. Position and Advance the Needle

The ASIS should be palpated on the anterior iliac crest. Approximately two centimeters posterior from the ASIS a small stab incision is made. The trocar assembly is used to probe the iliac crest through the incision (Figure 1). The medial and lateral edges of the iliac crest are identified and the trocar assembly is then docked in the middle of the superficial cortex of the iliac crest (Figure 2).

Holding the trochar assembly in the palm and using gentle but firm pressure the needle is clockwise/ counter clockwise motion until it advances between the cortices of the iliac crest. Ensure all aspiration holes in the cannula are below the cortical surface.

4. Remove Stylet

The inner trochar is then removed and the syringe containing ACD-A is locked onto the trocar handle (Figure 3).

5. Aspirate Bone Marrow

Follow the BMA needle manufacturer package insert to obtain a total of 60 ml anticoagulated BMA (5 ml ACD-A mixed with 25 ml BMA per 30 ml syringe), using the two syringes prepared in the previous step.

In case of the BioCUE Mini System, only one 30 ml syringe is pre-filled with 5 ml of ACD-A for a total of 30 ml anticoagulated BMA.

After 3-5 ml bone marrow is aspirated disconnect the syringe, replace the inner trochar, redirect the assembly by 15-20 degrees and advance the assembly (Figure 4). With the syringe disconnected invert the syringe to mix the bone marrow with ACD-A.

Preparation of Concentrated Bone Marrow Aspirate (cBMA)

Figure 1

Figure 2

Figure 3

1. Load Bone Marrow Aspirate

Unscrew cap on center port No. 1 and remove cap and green packaging post (Figure 1).

Slowly load aspirate from both 30 ml syringes into center port No. 1 (Figure 2).

BioCUE BMA Mini System: Slowly load aspirate from one 30 ml syringe into center port No.1

Remove protective cover on white tethered cap. Screw white cap onto center port No. 1 (Figure 3). Now the tube is ready to transfer to the non-sterile area to proceed with the centrifugation step.

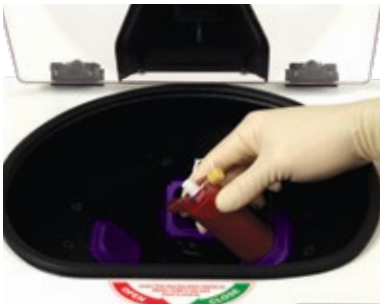


Figure 4

Figure 5

Figure 6

2. Balance Centrifuge

Press red button to release lid of centrifuge. Open and place the device into the centrifuge (Figure 4).

BioCUE BMA Mini System: If using the mini kit, the purple mini buckets must be inserted into the centrifuge.

Fill Biomet Biologics counterbalance with 60 ml of sterile saline and place into opposite side of centrifuge (Figure 5).

BioCUE BMA Mini System: Fill the Biomet Biologics Mini counterbalance with 30 ml of sterile saline and place into opposite side of centrifuge.

3. Spin BioCUE BMA disposable

Close lid. Set speed at 3200 RPM and time to 15 minutes. Press green button to start spin. Once cycle is completed, the lid can be opened for 60 seconds (Figure 6).

Once spin is completed the centrifuge is automatically locked after for 60 seconds. Press red button to release lid and open.

Figure 7

Figure 8

Figure 9

4. Extract Concentrated Bone Marrow Aspirate (cBMA)

Remove BioCUE BMA device from centrifuge and ensure bone marow aspirate has separated in three distinct layers.

The instrumentation nurse in the sterile area collects the plasma. The nurse outside the sterile field removes the yellow cap, tilts the tube and the nurse in the sterile field attaches the sterile 30 ml. syringe on side port No. 2. The plasma is withdrawn carefully.

The nurse in the non-sterile field reattaches the yellow cap on side port 2.

5. Suspend cBMA

While holding the tube in upright position, the nurse in the non-sterile field taps the tube horizontally against the palm of her/his hand for 30 seconds to resuspend the cBMA cells (Figure 8).

6. Extract cBMA

The nurse in the non-sterile field transfers the sterile 10 ml syringe into the sterile area. She/he also removes the red cap from side port No. 3. The nurse in the sterile field attaches the 10 ml syringe and carefully extracts the cBMA from the tube, held by the nurse in the non-sterile field (Figure 9).

BioCUE BMA Concentration System and Bonus II DBM

DBM is an ideal balance between allograft and autograft. It promotes bone growth by providing osteoinductive growth factors and an osteoconductive scaffold. The BioCUE BMA Concentration System provides concentrated stem cells, which have been advocated as a means to provide an osteogenic cell source, with osteopromotive capacities in a variety of procedures. This powerful combination of Bonus II DBM and the BioCUE BMA Concentration System provides the surgeon with the scaffold, concentrated cells and concentrated signals necessary for successful bone healing. (Table 1)

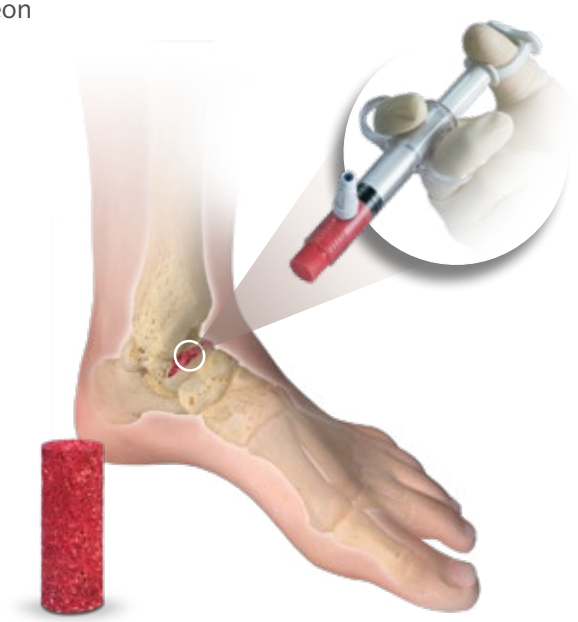


Table 1

	Bonus II DBM (with cBMA)	Traditional DBM
Scaffold	Yes	Yes
Signals	Yes	Yes
Cells	Yes	No

Patient-specific demands require options

Surgery is not an assembly line. Each patient has specific needs. The powerful mesenchymal stem cells obtained with and concentrated by the BioCUE BMA Concentration System can be easily transferred to hydrate synthetic, allograft and autograft bone in a variety of methods. This allows the surgeon to customize according to the application. For use with the Bonus II DBM, the following ratios should be useful, depending on the desired handling characteristics. (Table 2)

Table 2

Liquid to Bonus II DBM Ratio	Application	Delivery	Handling Consistency
10 ml: 10 ml 5 ml: 5 ml 1 ml: 1 ml	Percutaneous injections, Contained defects	Fine bead nozzle	Flowable
6 ml: 10 ml 3 ml: 5 ml 0.6 ml: 1 ml	Standard packing, Molding	Fine bead nozzle, Log	Putty
4 ml: 10 ml 2 ml: 5 ml 0.4 ml: 1 ml	Very bloody environments with heavy irrigation	Log only	Crunchy

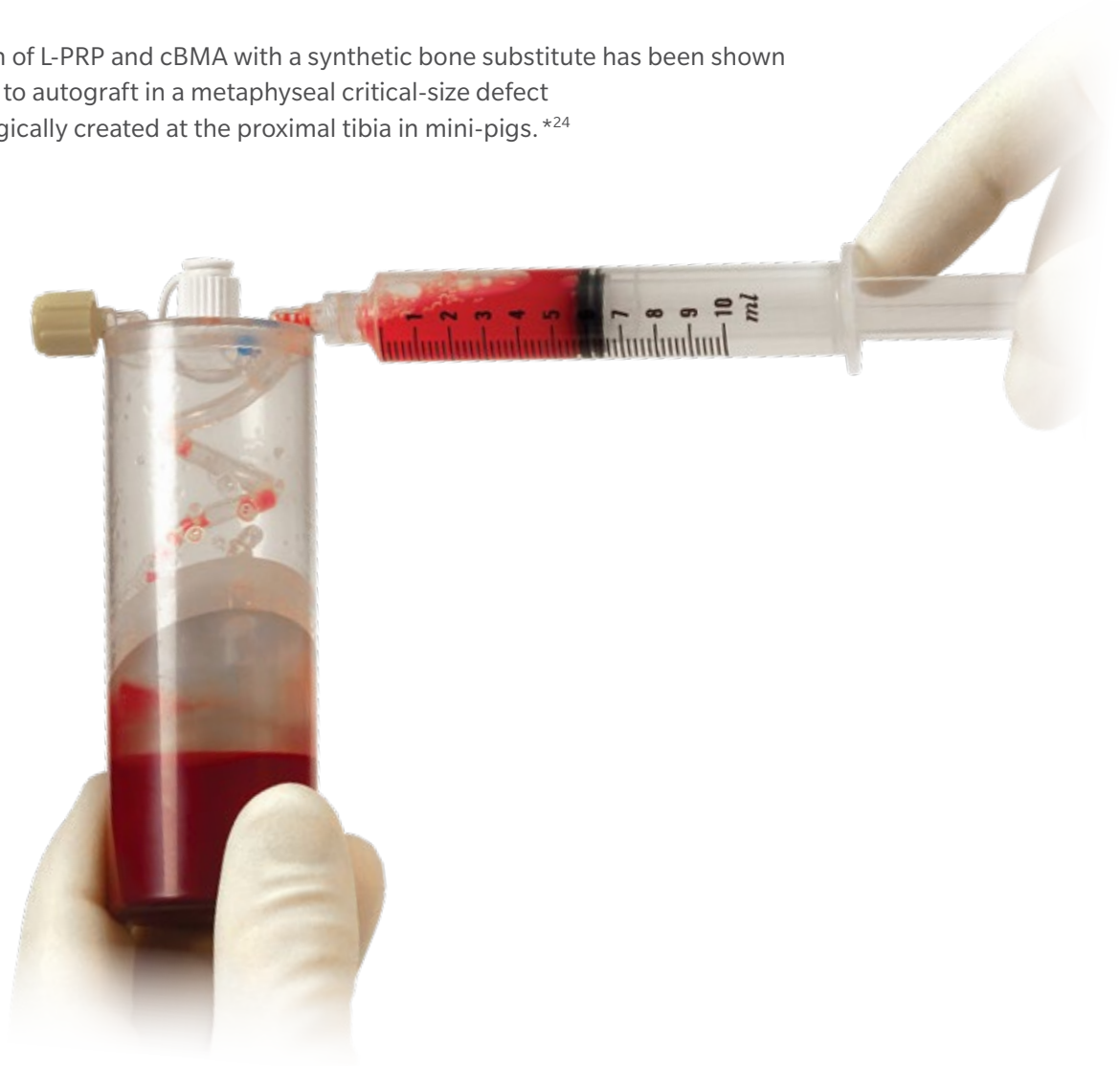
BioCUE BMA Concentration System and GPS III Platelet Concentrate Separation System

Utilizing the GPS III Platelet Concentrate Separation System the patient's own platelets can be collected into a highly concentrated formula (Leucocyte- and Platelet-Rich Plasma (L-PRP)). It is well known that when platelets become activated, growth factors are released. Growth factors are important for several processes like:

- Cell replication
- Angiogenesis
- Epithelialisation
- Tissue formation
- Extracellular matrix formation
- Cell differentiation

The addition of platelet-rich plasma (PRP) to bone marrow aspirate has been shown to stimulate proliferation of mesenchymal stem cells in vitro.[22-23] In vivo, PRP addition to bone marrow stem cells and allograft has contributed to better allograft integration and increased bone formation.[15]

Combination of L-PRP and cBMA with a synthetic bone substitute has been shown to be similar to autograft in a metaphyseal critical-size defect that was surgically created at the proximal tibia in mini-pigs. *[24]



*Animal data not necessarily indicative of clinical results.

Bonus II demineralized bone matrix (DBM) hydration with concentrated BMA

Figure 1

Figure 2

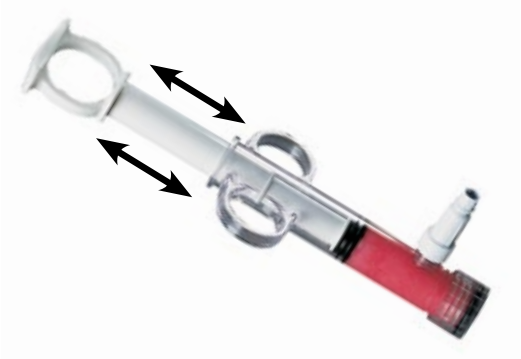


Figure 3

Figure 4

Step 1

Attach the 30 ml vacuum syringe to the valve fitting on the side of the Graft Preparation System containing Bonus II DBM. Attach the 30 ml vacuum syringe to the valve fitting on the Bonus II DBM syringe. Pull on the vacuum syringe plunger until fully out. Lock plunger and release vacuum syringe. Repeat procedure one more time (Figure 1).

Step 2

Twist off the 30 ml vacuum syringe. Attach a dispensing unit containing the cBMA onto the valve of the Graft Preparation System with or without the addition of PRP. Pushing in additional fluid will cause a more flowable material (Figure 2).

Step 3

Detach the syringe. Piston the plunger for ten seconds. This assists with hydration. Immediately, prior to removing from chamber, gently pump the plunger two times (Figure 3).

Step 4

Remove the cap from the end of the graft preparation system and push the graft out of the system using the plunger (Figure 4). Alternatively the supplemental nozzle can be attached to the hydrated Bonus II DBM syringe and with a needle attached to this nozzle, the DBM can be injected in a fine bead.

BioCUE BMA Concentration System

Product	Description	Part Number
	**BioCUE BMA Mini Kit**	**800-0610A**
	**BioCUE BMA Standard Kit**	**800-0611A**
	**BOS Bone Marrow Aspirate Kit**	**800-0705**

BioCUE BMA Standard Kit 800-0611A

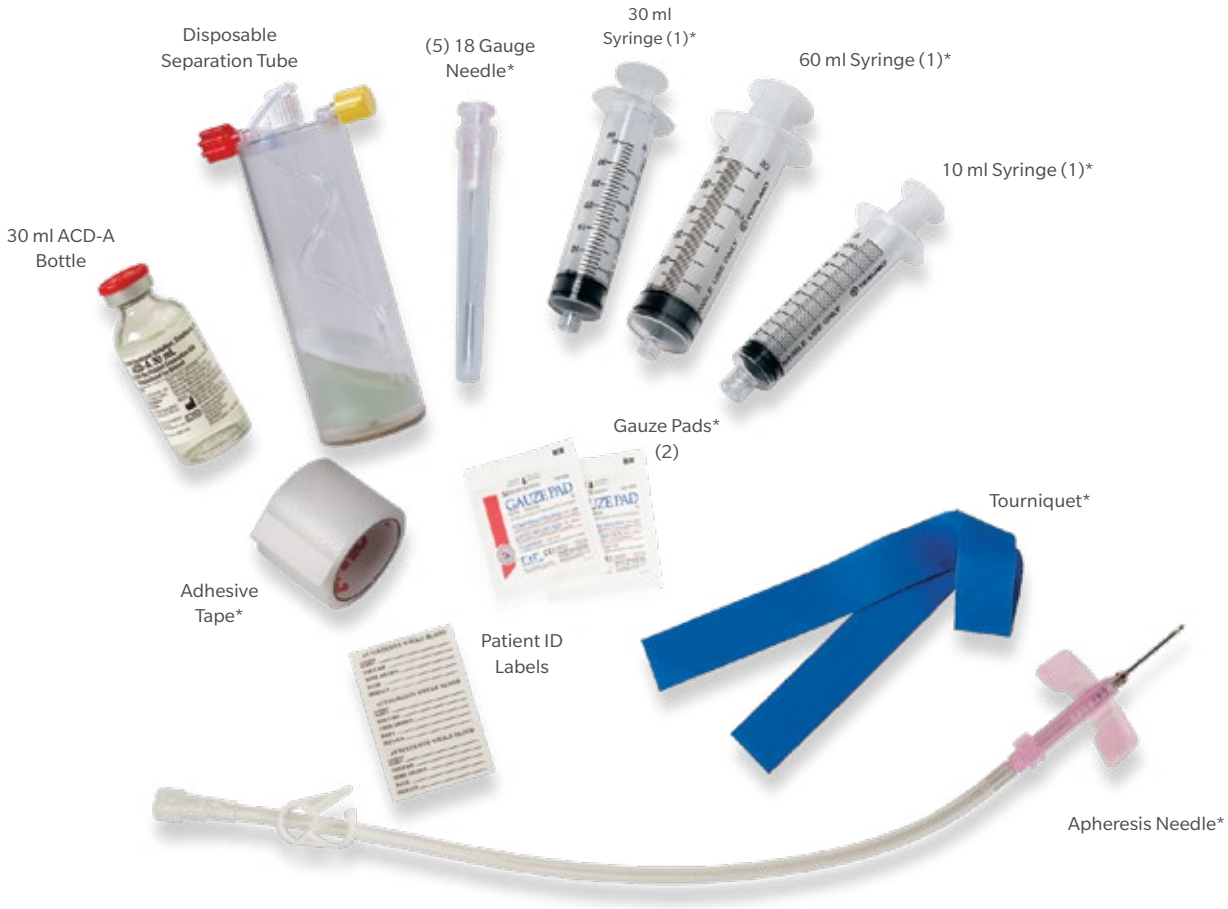
Bonus II DBM

Product	Description	Part Number
	**Bonus CC Matrix 5cc**	**48-1805**
	**Bonus CC Matrix 10cc**	**48-1810**

GPS III Platelet Concentrate Separation System

Product	Description	Part Number
	**GPS III Mini Kit w/ACD-A & BD**	**800-0505A**
	**GPS III Single Kit w/Blood Draw**	**800-1003A**
	**GPS III Double Kit w/BD & ACD-A**	**800-1004A**

GPS III Single Kit w/ Blood Draw 800-1003A



*Denotes Blood Draw Kit Items

References

1. Hernigou, P., Poignard, A, Beaujean, F., Rouard, H. Percutaneous autologous bone-marrow grafting for nonunions. Influence of the number and concentration of progenitor cells. Journal of Bone and Joint Surgery (American). 87(7): 1430–7, 2005.
2. Welch, Z.R., McKale, J.M., Woodell-May, J. Citrate-based Anticoagulant Does Not Hinder Stem Cell Viability and Concentration from Bone Marrow Aspirate. Submitted at 54th Annual Meeting of the Orthopaedic Research Society. March 2–5, 2008.
3. Hernigou, P., Mathieu, G., Poignard, A., Manicom, O., Beaujean, F., Rouard, H. Percutaneous autologous bone-marrow grafting for nonunions. Surgical technique. Journal of Bone and Joint Surgery (American). 88 (Suppl 1 Pt 2): 322–7, 2006.
4. Siwach, R.C., Sangwan, S.S., Singh, R., Goel, A. Role of percutaneous bone marrow grafting in delayed unions, non-unions and poor regenerates. Indian Journal of Medical Sciences. 55(6): 326–36, 2001.
5. Aarvold, A., Smith, J.O., Tayton, E.R., Jones, A.M.H., Dawson, J.I., Lanham, S., Briscoe, A., Dunlop, D.G., and Oreffo, R.O.C. "A Tissue Engineering Strategy for the Treatment of Avascular Necrosis of the Femoral Head." The Surgeon 11.6 (2013): 319-25.
6. Martin, John R., Matthew T. Houdek, and Rafael J. Sierra. "Use of Concentrated Bone Marrow Aspirate and Platelet Rich Plasma during Minimally Invasive Decompression of the Femoral Head in the Treatment of Osteonecrosis." Croatian Medical Journal 54.3 (2013): 219-24.
7. Hernigou, P., Poignard, A., Zilber, S. and Rouard, H. "Cell Therapy of Hip Osteonecrosis with Autologous Bone Marrow Grafting." Indian Journal of Orthopaedics 43.1 (2009): 40.
8. Muschler, G.F., Matsukura, Y., Nitto, H., Boehm, C.A., Valdevit, A.D., Kambic, H.E., Davros, W.J., Easley, K.A., Powell, K.A. Selective retention of bone marrow-derived cells to enhance spinal fusion. Clinical Orthopaedics and Related Research. 432: 242–51, 2005.
9. Muschler, G.F., Nitto, H., Matsukura, Y., Boehm, C., Valdevit, A., Kambic, H., Davros, W., Powell, K., Easley K. Spine fusion using cell matrix composites enriched in bone marrow-derived cells. Clinical Orthopaedics and Related Research. 407: 102–18, 2003.
10. Jia, X., Peters, P. G. and Schon, L. "The Use of Platelet-Rich Plasma in the Management of Foot and Ankle Conditions." Operative Techniques in Sports Medicine 19.3 (2011): 177-84.
11. Adams, S. B., Lewis, J. S., Gupta, A. K., Parekh, S. G., Miller, S. D. and Schon, L. C. "Cannulated Screw Delivery of Bone Marrow Aspirate Concentrate to a Stress Fracture Nonunion: Technique Tip." Foot & Ankle International 34.5 (2013): 740-44.
12. Torres, J., Gutierres, M., Lopes, M. A., Santos, J. D., Cabral, A. T., Pinto, R. and Van Eck, C. "Bone Marrow Stem Cells Added to a Hydroxyapatite Scaffold Result in Better Outcomes after Surgical Treatment of Intertrochanteric Hip Fractures." BioMed Research International (2014): 1-7. Bone Marrow Stem Cells Added to a Hydroxyapatite Scaffold Result in Better Outcomes after Surgical Treatment of Intertrochanteric Hip Fractures. Hindawi Publishing Corporation. Web. 06 Nov. 2014.
13. Tiedeman, J.J., Garvin, K.L., Kile, T.A., Connolly, J.F.. The role of a composite, demineralized bone matrix and bone marrow in the treatment of osseous defects. Orthopedics. 18(12):1153–58, 1995.
14. Yamada, Y., Ueda, M., Naiki, T., Takahashi, M., Hata, K., Nagasaka, T. Autogenous injectable bone for regeneration with mesenchymal stem cells and platelet-rich plasma: tissue-engineered bone regeneration. Tissue Engineering. 10(5–6): 955–64, 2004.
15. Lucarelli, E., Fini, M., Beccheroni, A., Giavaresi, G., Di, B.C., Aldini, N.N. et al. Stromal stem cells and platelet-rich plasma improve bone allograft integration. Clinical Orthopaedics and Related Research. 435: 62–8, 2005.
16. Yamada, Y., Boo, J.S., Ozawa, R., Nagasaka, T., Okazaki, Y., Hata, K. et al. Bone regeneration following injection of mesenchymal stem cells and fibrin glue with a biodegradable scaffold. Journal of Craniomaxiiofacial Surgery. 31(1): 27–33, 2003.
17. Yamada, Y., Ueda, M., Hibi, H., Baba, S. A novel approach to periodontal tissue regeneration with mesenchymal stem cells and platelet- rich plasma using tissue engineering technology: a clinical case report. International Journal of Periodontics and Restorative Denistry. 26(4): 363–9, 2006.
18. Oyama, T., Nishimoto, S., Takeda, M. Alveolar bone regeneration utilizing b-TCP and platelet-rich plasma (PRP) derived from bone marrow aspirate. Annals of Plastic Surgery. 54(2): 222–3, 2005.
19. Yamada, Y., Ueda, M., Naiki, T., Nagasaka, T. Tissue-engineered injectable bone regeneration for osseointegrated dental implants. Clinical Orthopaedics and Related Research. 15(5): 589–97, 2004.
20. Docquier, P.L., Delloye, C. Treatment of aneurysmal bone cysts by introduction of demineralized bone and autogenous bone marrow. Journal of Bone and Joint Surgery (American). 87(10): 2253–8, 2005.
21. Rougraff, B.T., Kling, T.J. Treatment of active unicameral bone cysts with percutaneous injection of demineralized bone matrix and autogenous bone marrow. Journal of Bone and Joint Surgery (American). 84–A(6): 921–9, 2002.
22. Haynesworth, S.E., Kadiyala, S., Liang, L., Bruder, S.P. Mitogenic Stimulation of human mesenchymal stem cells by platelet releasate suggest a mechanism for enhancement of bone repair by platelet concentrates. Transactions of the 48th Annual Meeting of the Orthopaedic Research Society. 42: 0462, 2002.
23. Lucarelli, E., Beccheroni, A., Donati, D., Sangiorgi, L., Cenacchi, A., Del Vento A.M. et al. Platelet-derived growth factors enhance proliferation of human stromal stem cells. Biomaterials. 24(18): 3095–100, 2003.
24. Hakimi, M., Grassmann, J. P., Betsch, M., Schneppendahl, J., Gehrmann, S., Hakimi, A. R., Kropil, P., Sager, M., Herten, M., Wild, M., Windolf, J. and Jungbluth, P. "The Composite of Bone Marrow Concentrate and PRP as an Alternative to Autologous Bone Grafting." PLOS ONE E100143 9.6 (2014): 1-18. PLOS ONE:. June 2014. Web. 06 Nov. 2014.

Notes

This material is intended for healthcare professionals and the Zimmer Biomet sales force. Distribution to any other recipient is prohibited. For indications, contraindications, warnings, precautions, potential adverse effects and patient counseling information, see the package insert or contact your local representative; visit www.zimmerbiomet.com for additional product information. All content herein is protected by copyright, trademarks and other intellectual property rights, as applicable, owned by or licensed to Zimmer Biomet or its affiliates unless otherwise indicated, and must not be redistributed, duplicated or disclosed, in whole or in part, without the express written consent of Zimmer Biomet.

For indications, contraindications, warnings, precautions, potential adverse effects and patient counseling information, see the package insert or contact your local representative; visit www.zimmerbiomet.com for additional product information. Check for country product clearances and reference product specific instructions for use. Zimmer Biomet does not practice medicine. This technique was developed in conjunction with health care professional. This document is intended for surgeons and is not intended for laypersons. Each surgeon should exercise his or her own independent judgment in the diagnosis and treatment of an individual patient, and this information does not purport to replace the comprehensive training surgeons have received. As with all surgical procedures, the technique used in each case will depend on the surgeon's medical judgment as the best treatment for each patient. Results will vary based on health, weight, activity and other variables. Not all patients are candidates for this product and/or procedure. Caution: Federal (USA) law restricts this device to sale by or on the order of a surgeon. Rx only.

©2017, 2021 Zimmer Biomet

ZIMMER BIOMET

Legal Manufacturer
Biomet, Inc.
P.O. Box 587
56 E. Bell Drive
Warsaw, Indiana 46581-0587
USA

CE 2797

1715.2-US-en Issue Date 2021-12-15

www.zimmerbiomet.com