

Maximizing Cell Counts—Reducing Time & Cost

How Bone Marrow Aspiration Technique Affects Stem Cell Counts

Introduction

Obtaining as many mesenchymal stem cells (MSCs) as possible while minimizing morbidity at the donor site and dilution with peripheral blood is the goal of a bone marrow aspiration procedure. Multiple factors can affect stem cell counts in the bone marrow aspirate (BMA), including the aspiration site, aspiration technique, and, if conducted, the post-harvest processing of the marrow aspirate.¹

Despite advances in the field, many surgeons continue to use time-consuming bone marrow aspiration methods that are highly dependent on technique resulting in variable stem cell levels or require expensive equipment and complicated disposable systems that yield fewer high-quality cells. Clinical teams that excel at choosing and using the right bone marrow aspiration technology will likely have better patient outcomes than those who don't—and they might even reduce costs.

Best Practices for Bone Marrow Aspiration

In order to understand the effects of bone marrow puncture techniques on cell counts, it is important to understand some rules of thumb that surgeons use during the process. Best practices for proper aspiration include:

- Changing needle position to maximize stem cell collection
- Avoiding disrupting the microvasculature with aggressive motions
- Avoiding aspiration of peripheral blood
- Avoiding harvesting too much fluid from any single location
- Minimizing marrow handling time following aspiration

Depending on the tools at a surgeon's disposal, following these guidelines can yield vastly different results.

Common Bone Marrow Aspiration Techniques

Bone marrow aspiration equipment varies considerably in terms of cost, ease of use, and performance characteristics.

Jamshidi Needles

Jamshidi needles are ubiquitous, inexpensive, and relatively easy to use. Originally designed for biopsying bone marrow rather than harvesting a large volume, traditional Jamshidi needles have an open and tapered tip and a small capacity. Because they only have one opening at the tip, these needles can only harvest

marrow from one level of depth at a time, requiring the surgeon to manually reposition the needle several times to obtain the desired volume.

Jamshidi needles are suitable for aspirating up to 2ml of marrow. Depending on the patient and the surgeon's aspiration technique, this amount can yield a cell count of around 356 CFU-f (colony forming units) per ml.²

However, peripheral blood contamination of the Jamshidi aspirate is common, especially as the 2ml maximum is approached. This becomes especially problematic when a high volume of BMA is needed, as it may take quite a few different harvest sites to gather enough marrow volume for the graft.³



Picture 1: Jamshidi Trocar with tapered open tip

Bone Marrow Aspirate Concentrators (Centrifuge Systems)

Bone marrow aspirate concentrators (BMACs), commonly referred to as “centrifuge systems”, are kits that enable clinical staff to isolate concentrated stem cells from the collected bone marrow aspirate. Generally, these kits utilize disposable components to be used with specialized centrifuges.⁴

Clinicians first extract a large volume of marrow, up to 100ml or more, using a compatible needle system, then use the kit and centrifuge to concentrate the sample in preparation for grafting.

Although BMACs typically yield more stem cells than Jamshidi needle aspirations, with a typical cell count being 1270 CFU-fs per ml, a significant number of cells are discarded with the separated peripheral blood.⁵

BMACs are costly and require a substantial amount of OR time and dedicated, trained personnel due to the complicated set-up and processing method.⁶ In addition, these systems require moving the sample off the sterile field for processing, which introduces the risk of contamination.

Marrow Cellution™ (multi-level harvesting)

In recent years, newer and more innovative methods of harvesting BMA have become available on the market. The main innovation has been the introduction of the Marrow Cellution™ Bone Marrow Aspiration System—a multi-level, multi-directional harvesting system.

Due to the patented design, this system can obtain pure bone marrow from numerous locations within the marrow space from just one single insertion. What is most attractive is that there is no need to perform time-consuming manipulation outside of the sterile field (e.g. centrifugation).

So how are newer systems different?

Unlike traditional Jamshidi needles which contain only one opening (at the distal tip), newer needle designs feature multiple lateral holes to help aspirate bone marrow in multiple, simultaneous directions. Some newer, improved Jamshidi needles contain lateral holes as well; however, the distal hole at the end of the improved Jamshidi remains the main aspiration path and can still pull in peripheral blood that dilutes the BMA.

To solve this problem, the Marrow Cellution™ next-generation BMA device, includes an aspiration cannula that blocks the distal tip and forces aspiration to occur through the lateral holes only. Additionally,

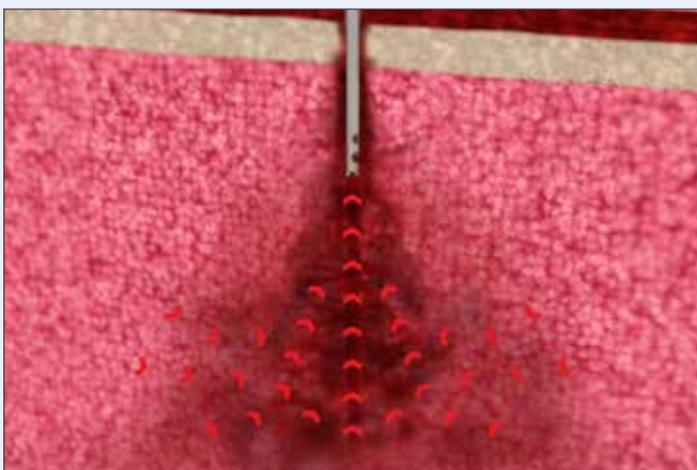
the Marrow Cellution™ was specially designed with a screw mechanism that allows the user to easily adjust the depth of the device in the marrow space in order to precisely relocate the aspiration holes to a fresh harvest site. This design ensures that proper harvesting technique is maintained during the complete aspiration process. Simply rotating the handle after every 1-2ml aspiration allows marrow to be harvested from multiple depths while minimizing infiltration with peripheral blood. The final aspirate contains a high proportion of high-quality stem and progenitor cells.

In a typical harvest with the Marrow Cellution™ aspiration system, cell counts of approximately 2885 CFU-f per ml can be obtained.⁷ This is significantly higher than with standard Jamshidi needles (356 CFU-f/ml) and bone marrow aspirate concentrator systems (1270 CFU-f/ml). Importantly, attaining these stem cell counts with Marrow Cellution™ does not require additional handling or manipulation steps like centrifugation—the system remains in the sterile field during the whole procedure.

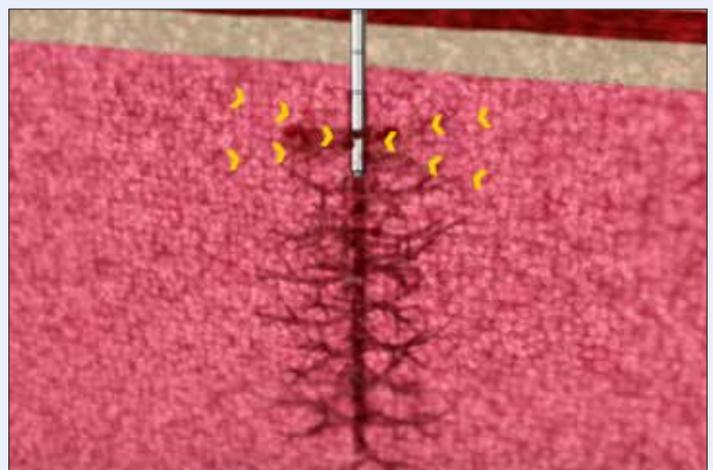


Picture 2: Marrow Cellution™ bone marrow aspiration system with closed needle tip and repositioning mechanism

Traditional Trocars (with or without side holes) collect additional excess peripheral blood, diminishing cellular yield; thereby requiring additional manipulation steps to achieve the cellular demand necessary for most clinical indications.



Marrow Cellution™ is a multi-level and multi-directional harvesting system with blocked distal tip to limit peripheral blood infiltration. Marrow is collected via lateral collection ports only. The system never leaves the sterile field; further BMA manipulation is not required.



Picture 3+4: Open vs. Closed Tip marrow aspiration

Using the Right Bone Marrow Aspiration Technique and Technology to Maximize Stem Cell Counts

In addition to aspiration technique and ease of use, stem cell count is one of the most critical variables for successfully harvesting BMA. It is no surprise that more clinicians are evolving their technique and using

newer technologies that save time and are backed by strong supporting data.

For added convenience, Marrow Cellution™ is also available as an “all-in-one” system for bone autograft procedures. The included bone core harvesting device allows the surgeon to combine high quality BMA and percutaneous harvested cancellous bone cores to deliver a combination autograft without the associated morbidity.

The Marrow Cellution™ system is a novel bone marrow aspiration device that is proven to harvest more mesenchymal stem cells than common alternatives like Jamshidi needles and BMACs. With its innovative multi-level, multi-directional needle design, and distal tip blocking, Marrow Cellution™ allows the clinical staff to minimize OR time while maximizing the possibility for a successful outcome.

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