COMPARATIVE ANALYSIS OF MARROW CELLUTIONS AND THE BMAC® HARVEST®/TERUMO® SYSTEM

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INTRODUCTION

Research has demonstrated that the number of fibroblast-like colony forming units (CFU-f) in a graft is positively correlated with clinical outcomes. [2,3]. Cells capable of forming a CFU-f are found in marrow but not in blood and therefore are an indication of the number of early stage stem and progenitor cells present in a biologic. Several systems are available for harvesting autologous bone marrow aspirate and optionally centrifuging it to further concentrate cells, via volume reduction, to treat local bone defects [1,2,3].

OBJECTIVE

Previous published research demonstrated that Harvest SmartPrep® (Terumo) Bone Marrow Aspirate Concentrate system (BMAC®) was superior to the Biomet GPS and the Arteriocyte Magellan marrow concentration systems. [4]. This study was designed to compare the Marrow Cellution™ system to the Harvest® SmartPrep® (Terumo) BMAC® system.

MATERIALS AND METHODS

Five sets of bone marrow aspirate samples were collected during spine surgery from bilateral iliac crest draw with the BMAC system and the Marrow Cellution™ System, each being randomly assigned to one iliac crest. All bone marrow aspirates (BMA) were processed in operating room during surgery and samples arrived at the lab within 24 hrs of collection. The BMA was processed according to the manufacturer's most recent instructions, including published and unpublished protocols. For each sample, a total nucleated cell (TNC) count and CFU-f count was conducted at two separate laboratories, (Franciscan University, Steubenville, OH and BSR Laboratories, Cambridge, MA) with the higher value from each laboratory used in the analysis. Redundant testing was performed to ensure bias due to shipping or handling of the samples was minimized.

RESULTS

Processing Time

The Marrow Cellution™ System requires approximately 1.5 minutes to obtain 8 to 10 mL of bone marrow aspirate from a single entry. The biologic never leaves the sterile field, the entire sample is used, no manipulation (e.g., filtering) is required, and no extra anti-coagulation is needed.

In this case series, the Harvest/Terumo SmartPrep System for bone marrow aspirate concentrate (BMAC®) required approximately 3 minutes per patient to aspirate. To obtain the required volume, the needle was removed from the body after the initial insertion and aspiration of 20 mL, the stylet was put back into the needle which was then re-directed in the body to aspirate an additional 20 mL from two additional locations, for a total aspirate volume of 60 mL. The Harvest/Terumo SmartPrep System for bone marrow aspiration concentrate (BMAC®) requires 2-3 minutes of technician setup time, and 14 minutes of centrifugation time that is conducted outside the sterile field, for a total processing time, including aspiration, of approximately 20 minutes.

Analysis of BMA and BMAC

Table 1. Five donors with bilateral bone marrow aspiration. Each system was evaluated on each donor and samples of the bone marrow were sent to two laboratories for analysis. The mean fibroblast-like colony forming unit (CFU-f) was 1,607.8/mL (Marrow Cellution™ System); 216.75/mL (Harvest/Terumo BMA), and 835/mL (Harvest Terumo BMAC). The mean total nucleated cell count (TNC) was 32.72 x 10^6/mL (Marrow Cellution™ System), 20.06 x 10^6/mL (Harvest/Terumo BMA), and 67.5 x 10^6/mL (Harvest/Terumo BMAC).

The percent of cells alive upon arrival at the lab for both the Marrow Cellution™ and Harvest aspirates was approximately 99% after 24 hours. This compares to the centrifuged product (BMAC) where the percent of cells alive dropped to approximately 94%. This increased rate of cell apoptosis raises the concern that the additional stress from the centrifugation steps (BMAC) may lead to increased rate of cell apoptosis and may have damaged the remaining 94% of viable cells.

Table 1

Sample #	Description	TNC (millions)	CFU-f
1	Marrow Cellution	31.2	1,278
1	Harvest Aspirate	14.9	200
1	Harvest Concentrate	57.2	1,312
2	Marrow Cellution	55	2,915
2	Harvest Aspirate	29.1	**
2	Harvest Concentrate	96	1,248
3	Marrow Cellution	16.6	600
3	Harvest Aspirate	8.8	100
3	Harvest Concentrate	40.3	232
4	Marrow Cellution	30	1,496
4	Harvest Aspirate	23.8	167
4	Harvest Concentrate	72.5	883
5	Marrow Cellution	30.8	2,200
5	Harvest Aspirate	23.7	400
5	Harvest Concentrate	71.5	500
Average	**Marrow Cellution**	**32.72**	**1,697.8**
Average	**Harvest Aspirate**	**20.06**	**216.75**
Average	**Harvest Concentrate**	**67.5**	**835**

** Neither lab performed a CFU-f count on the Harvest Aspirate for Sample 2

CONCLUSIONS

- The Marrow Cellution aspiration system had over two times as many CFU-f per mL as compared to the Harvest/Terumo bone marrow concentrate (BMAC).
- The Marrow Cellution System had significantly less contaminating peripheral blood compared to the Harvest/Terumo bone marrow concentrate system as indicated by the higher ratio of CFU-f to nucleated cells. The Marrow Cellution™ aspiration system had over twice as many CFU-f and only approximately half as many nucleated cells as compared to the Harvest/Terumo bone marrow concentrate.
- The Marrow Cellution System required significantly less preparation time compared to the Harvest/Terumo bone marrow concentrate (BMAC) system.
- The Marrow Cellution System required significantly less aspirate (8mL compared to 60mL) compared to the Harvest/Terumo System bone marrow concentrate (BMAC).
- The Marrow Cellution System did not require additional manipulative steps outside the sterile field compared to the Harvest/Terumo System bone marrow concentrate (BMAC) system.

	Marrow Cellution™	**Harvest BMAC®**
Aspiration Volume	≈7-10mL	≈60mL
Final Volume	≈7-10mL (no change)	≈7 mL
Aspiration Sites	1	3
Aspiration time	1-2 Minutes	3-5 Minutes
Manipulated off sterile field	NO	YES
Processing Time	0 Minutes	17 Minutes
CFU-f/million TNC	51.89	12.37
Avg. CFU-f Concentration	1,697.8 per mL	835 per mL

REFERENCES

1. Connolly J. et al. JBJS 1989;71: 684-91.
2. Hernigou P. et al. JBJS 2006; 88 Suppl 1: 322-27.
3. Hernigou P. et al. JBJS 2005; 87: 1430-7.
4. Hedge V. et al. Journal of Orthopedic Trauma 2014; vol 28; issue 10; p 591-598