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Quality and Cost Comparison of Powered Versus Manual Bone Marrow Biopsy Devices in Patients with Myelofibrosis

Abhishek Maiti, MBBS¹, Nicholas J. Short, MD², Srdan Verstovsek, MD, PhD³, Cynthia A. Powers, DNP, RN⁴, Cheryl A. Fullmer, MBA, RN⁵, Steven R. Reyes⁶, and Carlos E. Bueso-Ramos, MD, PhD.⁶

¹Department of Internal Medicine, The University of Texas Health Sciences Center at Houston, TX

²Division of Cancer Medicine, The University of Texas MD Anderson Cancer Center, Houston, TX

³Department of Leukemia, The University of Texas MD Anderson Cancer Center, Houston, TX

⁴Executive Vice President and Physician-in-Chief's Office, The University of Texas MD Anderson Cancer Center, Houston, TX

⁵Clinical Center for Targeted Therapy, The University of Texas MD Anderson Cancer Center, Houston, TX

⁶Department of Hematopathology, The University of Texas MD Anderson Cancer Center, Houston, TX

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To the Editor:

Evaluation of bone marrow (BM) architecture with a high quality trephine biopsy is essential for diagnosis of many hematologic disorders.¹ For decades manual bone marrow biopsy devices (MBM) have been the primary method for this procedure; however, powered bone marrow biopsy devices (PBM) have become increasingly popular over the last several years. While studies have consistently shown that PBM produces longer BM core samples than MBM,^{2–5} the relative clinical utility of these two methods has not been established.⁶ We therefore sought to evaluate the quality and cost-effectiveness of PBM and MBM in patients

Correspondence: Dr. Carlos E. Bueso-Ramos, MD, PhD, Department of Hematopathology, The University of Texas MD Anderson Cancer Center, 1515 Holcombe Boulevard, Unit #0072, Houston, TX 77030. Phone: +1-713-563-1091; Fax: +1-713-794-1800
cbuesora@mdanderson.org.

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Authorship contribution

A.M. and N.J.S. designed the study, collected and analyzed the data, and wrote the manuscript; S.V. designed the study and treated patients; C.E.B.-R. designed the study, collected and analyzed the data and provided pathologic review; C.A.P., C.A.F., S.R.R. collected and analyzed the data and provided administrative support. All authors reviewed and approved the manuscript.

with myelofibrosis, a disorder in which a quality BM biopsy assessment is imperative for accurate diagnosis and treatment monitoring.

We retrospectively reviewed pathology reports from 569 BM biopsies obtained between September 2010 and May 2015 in 293 patients with myelofibrosis presenting to our institution in a study approved by the Institutional Review Board. This population contained patients with primary myelofibrosis and those who developed myelofibrosis after polycythemia vera or essential thrombocythemia. The OnControl® PBM system (Vidacare, Shavano Park, TX) utilized 11 gauge needles with a length of either 102 mm or 152 mm. The MBM used 11 gauge 101.6 mm core biopsy needles, and 15 gauge 68.6 mm aspiration needles (Argon Medical Devices, Plano, TX). The length and quality of BM biopsy specimens between these two modalities were compared utilizing pathologist reports. In fragmented biopsy specimens, the lengths of individual fragments of the biopsy were added to obtain the length of the biopsy sample for analysis. Inadequate biopsies were defined by qualitative assessment of the pathologist, with descriptions of “suboptimal”, “poor,” “inadequate,” or other similar terms. In a separate cohort of treatment-naïve patients (n=126), we evaluated aspirate samples for adequate yield of diagnostic information. Among these 126 samples, 104 BM specimens (MBM, n=92; PBM, n=12) were banked and available for retrospective pathologic review; these BM specimens were evaluated for length of evaluable marrow. Length of evaluable marrow elements was determined by multiplying the percentage of evaluable marrow elements (determined by visual estimation) and total length of the core biopsy specimen. Two authors (A.M. and N.J.S.) independently reviewed the banked samples for evaluable marrow in a blinded fashion, and differences were settled by consensus with a third author (C.E.B-R.). Samples from treated patients were excluded to remove the confounding effect of treatment on the assessment of quality. Cost to the institution for supplies for each bone marrow biopsy performed was also compared.

The PBM and MBM groups were similar in terms of age and proportion of post-treatment samples (Table 1). PBM yielded longer BM samples compared to MBM (1.65 vs. 1.40 cm, $p<0.001$). Comparison of the longest biopsy fragment length also favored PBM over MBM (1.45 vs. 1.24 cm, $p<0.001$). However, no differences were observed in the pathologists’ global assessment of BM biopsy adequacy or the ability to assess cellularity or special staining (i.e. reticulin or trichrome). In the subset of treatment-naïve patients, a longer mean length of evaluable marrow elements was observed in the PBM group (0.96 vs. 0.80 cm, $p=0.05$), but no differences were seen in the adequacy of aspirates for cytogenetic assessment or cell differential.

To our knowledge, this study is the largest to compare the MBM and PBM methods in a homogenous population. We corroborated findings in prior studies regarding yield of longer trephine biopsy specimens and more evaluable marrow elements with PBM compared to MBM.²⁻⁵ However, this did not translate into meaningful difference in overall quality of the BM aspiration and biopsy in terms of diagnostic performance. The number of inadequate biopsies or samples inevaluable for various morphologic other diagnostic assessments were similar between the two groups. This study is strengthened by the use of a homogeneous population of patients with myelofibrosis, which decreased the risk of confounding results, as has been present with many previous studies of these two BM biopsy modalities.

These findings have important implications for quality and cost-effective care of patients with hematologic disorders. We perform ~17,000 BM biopsies annually at our institution. Accounting for necessary supplies for each procedure, the cost to our institution for the PBM system was \$130 per BM biopsy versus \$56 per BM biopsy for MBM, yielding an average excess cost of approximately \$74 per BM biopsy performed with PBM. Therefore, the projected cost for universal adoption of PBM at our institution was estimated at \$1,258,000 more than that for MBM (annual cost of materials: \$2,210,000 vs. \$952,000 respectively). Given similar results and substantially increased cost, our findings do not support universal adoption of PBM.

Despite the lack of a clear quality difference between the MBM and PBM, we did not compare procedural time or the patient/operator satisfaction of these two modalities, which may also be relevant factors in deciding on the optimal BM biopsy modality. One meta-analysis suggested that operator ease-of-use and rate of adverse events were similar between these two BM biopsy methods. This same meta-analysis showed a relative reduction in patient-perceived pain by 17–25% with PBM compared to MBM.⁷ However, some individual studies have shown no difference in patient-perceived pain.^{5,8} Given the retrospective nature of our study, we could not assess how operator experience contributed to the adequacy of biopsy samples. To our knowledge no studies have evaluated whether an experienced operator can consistently acquire higher quality samples using PBM, compared to those with lesser experience. However, at least one study suggests that personnel who usually do not perform BM biopsies can be trained to acquire excellent biopsy samples with PBM.⁹

While we studied the relative utility of MBM and PBM in patients with myelofibrosis, there are other hematological diseases where the trephine biopsy is critically important, as the diagnosis may be missed due to focal and uneven distribution of pathological lesions (e.g., lymphoma or multiple myeloma). PBM may have incremental utility in those cases owing to the longer biopsy samples obtained through this method, and future studies are needed to assess whether use of PBM may result in higher diagnostic yield in these diseases. However, until contrary data is available, our results suggest that, despite its ability to yield longer BM biopsy lengths, PBM is costlier than MBM and does not result in a discernable improvement in the quality of BM specimens.

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References

1. Merzianu M, Cheney R, Groman A, et al. Bone Marrow Core Biopsy Adequacy and Variability in the United States and Canada: A Multicenter Retrospective Study. *Blood*. 2014; 124(21):1316–1316.
2. Swords RT, Anguita J, Higgins RA, et al. A prospective randomised study of a rotary powered device (OnControl) for bone marrow aspiration and biopsy. *J Clin Pathol*. 2011; 64(9):809–13. [PubMed: 21606230]

3. Reed LJ, Raghupathy R, Strakhan M, et al. The OnControl bone marrow biopsy technique is superior to the standard manual technique for hematologists-in-training: a prospective, randomized comparison. *Hematol Rep* [Internet]. 2011; 3(3) [cited 2015 Jun 22]. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3269796/>.
4. Miller LJ, Philbeck TE, Montez DF, et al. Powered bone marrow biopsy procedures produce larger core specimens, with less pain, in less time than with standard manual devices. *Hematol Rep*. 2011; 3(1):8.
5. Berenson JR, Yellin O, Blumenstein B, et al. Using a Powered Bone Marrow Biopsy System Results in Shorter Procedures, Causes Less Residual Pain to Adult Patients, and Yields Larger Specimens. *Diagn Pathol*. 2011; 6:23. [PubMed: 21429220]
6. Lynch DW, Stauffer SL, Rosenthal NS. Adequacy of Powered vs Manual Bone Marrow Biopsy Specimens. *Am J Clin Pathol*. 2015; 143(4):535–9. [PubMed: 25780005]
7. Voigt J, Mosier M. A powered bone marrow biopsy system versus manual methods: a systematic review and meta-analysis of randomised trials. *J Clin Pathol*. 2013 jclinpath-2013-201605.
8. Bucher CM, Lehmann T, Tichelli A, et al. Comparison of a powered bone marrow biopsy device with a manual system: results of a prospective randomised controlled trial. *J Clin Pathol*. 2013; 66(1):24–8. [PubMed: 23105124]
9. Cherington C, Robetorye R, Anderson EM, et al. High Quality Bone Marrow Core Biopsy and Aspiration (BMBX) Procedures Can Be Performed by a Nurse Led Team Using the OnControl Battery Powered Bone Marrow Biopsy System. *Blood*. 2011; 118(21):4743–4743.

Table 1

Baseline characteristics and biopsy quality analyses

	PBM	MBM	<i>p</i>
Baseline characteristics			
Number of patients, n	44	249	
Number of biopsies, n	73	496	
Post-treatment biopsies, ^a n(%)	60 (82)	383 (77)	0.33
Age (years), mean ± SD	66 ± 12	66 ± 12	0.77
Fibrosis grade, n (%)			
Not assessed	8 (10)	75 (15)	0.36
MF-0	0 (0)	10 (2)	
MF-1	7 (10)	69 (14)	
MF-2	29 (40)	178 (36)	
MF-3	29 (40)	164 (33)	
Biopsy quality analyses			
Biopsy length (cm), mean ± SD	1.65 ± 0.48	1.40 ± 0.41	<0.001
Longest fragment (cm), mean ± SD	1.45 ± 0.47	1.24 ± 0.40	<0.001
Length of evaluable marrow (cm) ^b , mean ± SD	0.96 ± 0.34 (n=12)	0.80 ± 0.41 (n=92)	0.05
Inadequate biopsy, n (%)	12 (16)	105 (21)	0.35
Not evaluable for cellularity assessment, n (%)	5 (7)	17 (3)	0.29
Not evaluable for special staining, n (%)	2 (3)	15 (3)	0.89
Inadequate cytogenetic assessment, n/N (%) ^b	1/10 (10)	16/108 (15)	0.68
Inadequate for cell differential, n/N (%) ^b	8/13 (62)	70/113 (62)	0.98

MF = myelofibrosis

^aPrior treatment included hydroxyurea, interferon, azacytidine, anagrelide, steroids, chemotherapeutic agents, and stem-cell transplantation.^bTreatment-naïve patients only.