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ORIGINAL ARTICLE

Bone Marrow Biopsy Operator Experience and Impact on Aspirate, Biopsy, and Ancillary Testing Quality

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Abstract

Objective: To assess the relationship between bone marrow (BM) biopsy operator experience and both specimen quality and ancillary testing utilization.

Patients and Methods: We evaluated all referred and in-house (IH) BM biopsy specimens obtained over a contiguous 6-week period from April 3, 2017, to May 19, 2017. The BM specimens were assessed for the length of interpretable marrow, and aspirates were assessed for the presence of spicules. Subgroup comparisons included IH BM obtained by a trained team of nurses within our institution, patients clinically referred (CR) to our institution with outside-obtained BM specimens, and outside pathologist-referred (PR) consultation cases. Ancillary study usage was compared between the first 100 cases of each group.

Results: A total of 1191 BM specimens were analyzed, including 600 IH, 288 CR, and 303 PR cases with biopsies and/or aspirates. The average interpretable biopsy lengths of IH, CR, and PR cases were 16.0 mm, 10.0 mm, and 7.0 mm, respectively ($P<.001$). World Health Organization–recommended length of 15 mm or more was achieved in 61.4%, 26.6%, and 19.1%, respectively ($P<.001$). Of the aspirates analyzed among IH, CR, and PR cases, 93%, 71.3%, and 73.5% contained spicules, respectively ($P<.001$). Use of immunohistochemistry, flow cytometry, karyotype, and fluorescence in situ hybridization was higher in CR and PR cases than in IH cases (all $P<.05$). The IH, CR, and PR cases used on average 1.5, 2.8, and 4.8 immunohistochemistry stains per case ($P<.001$).

Conclusion: Having a dedicated team of BM biopsy operators is likely one factor contributing to improved BM biopsy quality and a reduced need for ancillary testing.

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Adequate bone marrow (BM) biopsy specimens and aspirates are essential to the diagnosis and management of many hematologic diseases. The World Health Organization (WHO) recommends that BM core biopsies include at least 15 mm of evaluable marrow and a 500-cell differential be counted "as close to the particle and as undiluted with blood as possible" in aspirates.[1] In addition, studies indicate that variations in biopsy quality have a negative effect on a pathologist's ability to make a definitive assessment. A considerable correlation has also been observed between length of interpretable BM and rate of a positive diagnosis in cohorts of diffuse large B-cell lymphoma, neuroblastoma, and other lymphomas and metastatic disease in BM.[2-4] Accurate assessment for myeloid malignancy, as well, relies heavily on having adequate aspirates and core biopsies to assess the architecture, cytology of the marrow, and differential count.[1,5,6]

Anecdotally, many factors may affect the quality of BM biopsies and aspirates including patient characteristics (age, body mass index [calculated as the weight in kilograms divided by the height in meters squared], disease state), operator experience, having a dedicated procedural site, use of sedation during the procedure, and needle gauge. However, results

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of published studies vary in terms of which of these factors show true association with sample quality. Operator experience, however, is one factor that has been repeatedly shown to impact BM specimen quality, and, as one recent study has shown, can be addressed with targeted education.[4,7,8]

At our institution, the vast majority of BM specimens are obtained by a trained team of nurses performing BM procedures daily; a small percentage of BM procedures are performed by resident and fellow trainees under the supervision and direction of the nurses. Approximately 75% of our BM procedures are performed under sedation in a dedicated outpatient procedural space, with the remaining performed at the bedside in hospital rooms. Laboratory technologists are present at the bedside to assess BM specimen quality in real time. Our institution averages approximately 4500 in-house (IH) BM procedures per year, divided among 4.5 full-time nurses, giving our operators an optimum level of experience. As a national tertiary referral center with a busy pathology consultation practice, we review BM specimens from a large number of other medical centers. This affords us a unique opportunity to compare specimen quality between BM biopsies and aspirates obtained under a consistent setting within our institution with those obtained at outside institutions, under heterogeneous circumstances. In doing so, we sought not only to assess the quality of our own BM biopsy practice but also to inform the hematology community atlarge about the state of clinical BM specimens today. This type of audit comparing the adequacy of BM biopsy specimens obtained in different clinical settings is lacking in the literature. Second, we compared the use of ancillary testing between case types to determine whether specimen quality (associated with operator experience) might impact the ordering of ancillary testing on BM specimens.

PATIENTS AND METHODS

Specimen Review

We evaluated all IH and referred BM biopsy specimens and aspirates seen in the Division of Hematopathology at Mayo Clinic over a contiguous 6-week period from April 3, 2017, to May 19, 2017. Cases were considered as 1 of 3 types: (1) IH: BM obtained within our institution; (2) clinically referred (CR): patients who were clinically being seen at our institution whose outside-obtained pathology case was sent for review in conjunction with their visit at Mayo Clinic; and (3) pathologist referred (PR): pathology consultations in which a patient's BM specimen was reviewed at our institution at the request of an outside physician (usually a pathologist).

Core biopsies were assessed for the length of interpretable BM on the hematoxylin and eosin–stained slide, excluding areas with crush or aspiration artifact when it completely obscured the marrow space. If multiple biopsies were obtained during the procedure, the lengths of each were added together. Cortical bone was excluded, but areas of subcortical marrow were included in measurements. We compared the median total length of evaluable marrow, percentage of biopsies with a length above the WHO-recommended minimum adequate length of 15 mm, percentage of biopsies below 5 mm, and aspirate quality among the 3 defined groups.[1] Aspirate smears were classified on the basis of an assessment of Wright-Giemsa (or similar)–stained slides as having spicules, marrow elements without spicules, or peripheral blood elements only. Because of logistic limitations, samples were not blinded to the reviewer with regard to origin (IH, PR, CR).

BM Aspirate and Biopsy Procedure

In-house BM procedures are performed primarily while the patient is under sedation and using standard technique with 15-gauge aspirate and 8-gauge Argon T-LOK manual core biopsy needles (Argon Medical Devices) (for further details on needle selection, see Supplemental Table 1, available online at http://mcpiqojournal.org/). After aspiration, the technologist evaluates a small sample on a slide for the presence of spicules, instructing the nurse to redirect up to 3 times to obtain an adequate sample. Once adequacy is verified, the technologist immediately prepares both unit preparation and direct smear slides, ensuring even distribution of units and correct length and thickness and decanting excess fluid. The technologist also provides real-time feedback in evaluation of biopsy core adequacy, redirecting the nurse when the core is less than 1 cm or contains predominantly fat

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