# Bone Marrow Aspirate Evaluation

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**KEYWORDS**

• Bone marrow • Cat • Cytology • Dog • Evaluation • Interpretation

**KEY POINTS**

- Bone marrow aspirate evaluation is a key diagnostic tool in small animal medicine that is used to answer specific questions that cannot be answered by routine diagnostics, such as complete blood cell count (CBC) and serum biochemistry.
- Bone marrow examination typically provides information concerning the likely pathogenesis of cytopenias and other abnormalities in blood.
- Once the pathogenesis of a disorder is determined, a short differential list of specific disorders can be provided, and, in some instances, a specific diagnosis can be made.
- Appropriate sampling and sample preparation techniques are the basis for obtaining high-quality bone marrow specimens. Knowledge of the morphology of bone marrow cells and a systematic approach to the evaluation of bone marrow cytology (in context of a current CBC) are the basis for complete and accurate interpretation of bone marrow cytologic findings.

## INTRODUCTION

Bone marrow tissue provides complex microenvironments for the structural and nutritional support essential for orderly differentiation, proliferation, maturation, and release of developing blood cells. The tissue is filled with a network of sinusoids lined by a single layer of endothelial cells. Hematopoietic cells and supporting structures, consisting of adipose tissue, reticular cells, and extracellular matrix, are located outside the vasculature.[1] The bone marrow is structured in distinct and functionally efficient ways. For example, megakaryocytes are located next to sinusoids and extend cytoplasmic processes (proplatelets) into the vasculature, where they bud off to produce platelets. In addition, precursors of the erythroid cell line surround macrophages

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(called erythroid islands) that provide growth factors needed for erythrocyte production. The main function of bone marrow is the production of all blood cell types from primitive stem cells in adult mammals. It responds sensitively to increased peripheral blood cell demands through hematopoietic growth factors and alterations in the bone marrow microenvironment.

Bone marrow aspirate smears provide the best morphologic assessment of hematopoietic cells and determination of cell proportions (**Fig. 1**), that is, the myeloid to erythroid (M:E) ratio and percentages of lymphocytes, plasma cells, macrophages, and mast cells. In contrast, histopathologic evaluation of core biopsies is the best means to evaluate structural and stromal changes and marrow cellularity (**Fig. 2**), for example, diagnosis of myelofibrosis, inflammation, osteolysis, and myelonecrosis, or confirmation of generalized bone marrow hypoplasia or aplasia, which may be difficult diagnoses when the sample quality of a bone marrow aspirate is questionable. Bone marrow aspirate biopsies are more frequently performed than core biopsies in small animal practice because the procedure is faster, easier to perform, and less expensive. Both complement each other, however, in complete evaluation of the bone marrow and the diagnosis of its disorders.

The goal of this article is to provide an overview of bone marrow aspirate evaluation and cytologic interpretation. Readers are referred to recommended references for additional reading.[2–4]

## INDICATIONS FOR BONE MARROW ASPIRATION

Bone marrow evaluation is indicated when peripheral blood cell abnormalities are present that cannot be explained in context of clinical history, physical examination, or other additional diagnostics (eg, diagnostic imaging, chemistry). **Box 1** provides an overview of indications for bone marrow aspirate sampling in small animal practice, based on Harvey[2] and Raskin.[3]

Contraindications for bone marrow aspirate and core biopsy sampling should be considered before performing these procedures on a patient. The main consideration is whether an aspirate and/or core biopsy is truly indicated. Procedural risks, including restraint, sedation, and anesthesia (when used), are generally minimal, unless a patient

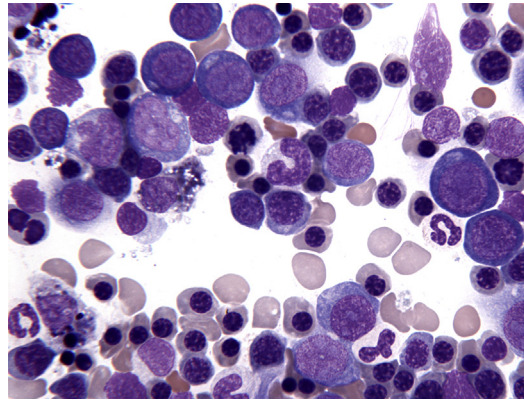

**Fig. 1.** Bone marrow aspirate from a dog with erythroid hyperplasia demonstrating the morphologic detail of hematopoietic cells, which can be visualized by cytologic evaluation (Wright-Giemsa stain, original magnification ×50).