INTRODUCTION

A dry tap in the process of obtaining an aspiration of bone marrow typically means a failure to obtain any sample of hematopoietic tissue. Cytomorphological evaluation of a bone marrow aspirate sample is essential to make an accurate diagnosis in cases such as leukemia, lymphoma, or multiple myeloma. A dry tap can therefore interfere with the diagnostic evaluation of a hematopoietic condition or status. We report a case where smears prepared from the small amount of material left within the aspiration needle following a dry tap helped make an accurate diagnosis which might have been otherwise missed if only simultaneously obtained hematoxylin and eosin-stained sections of the bone marrow biopsy were examined.

Bone marrow aspirations from the sternum or the posterior ilium and the cytological smears produced from them are widely used in the diagnosis and management of patients with various hematological disorders.\(^1,2\) However, a definitive cytological diagnosis becomes difficult when the bone marrow aspiration is a dry tap. The latter is not uncommon when the marrow is packed with malignant hematopoietic cells, carcinoma, or is associated with myelofibrosis.\(^3,6\) In such circumstances smears produced from the small amount of material that may be present in the needle following a dry tap can be very useful and may provide valuable information either to complement or even make an accurate diagnosis.

PATIENT AND METHODS

A 67-year-old white female patient was referred to our hospital for the evaluation and management of transfusion-dependent anemia and high WBC count. She did not have any major complaints except tiredness and generalized weakness particularly in her legs. Her physical examination was unremarkable except for pallor and slight splenomegaly as evidenced by CT scanning. Her laboratory values were:

- WBC: 25.4 × 10\(^9\)/L
- Hemoglobin: 7.2 g/dL
- Elevated MCV at 122.4 fl
- Raised MCH at 39.3 pg
- Normal platelet count: 254 × 10\(^9\)/L
- Normal iron studies except for the serum iron level which was modestly raised at 168 μg/dL (n = 20-135).
- Normal folate level at 5.2 ng/mL but her B12 level was raised at >2000 pg/mL (although she was not taking any vitamin B12).
- Elevated LDH at 283 unit/L (n = 95-265).
- Normal complete metabolic profile.
- Elevated erythropoietin level to about 79.4 milliunit/mL (n = 2.6-18.5).
- Normal reticulocyte count at 3.6%.
- Normal serum intrinsic factor antibody was normal at 1.0 Au/mL (n = 0.0-1.1) and...
parietal cell antibody was negative (<1:20). Her stool occult blood test was negative X3 and a colonoscopy and esophagogastrduodenoscopy did not reveal any source of bleeding. She was positive for the JAK-2 mutation, but negative for the BCR–ABL translocation. A solid core bone marrow biopsy revealed a highly cellular marrow (cellularity of 95%-100%) with a markedly increased amount of granulopoietic cells (Figure 1), occasional atypical megakaryocytes (Figure 1 arrows), and a few scattered erythroid precursors. The bone marrow aspirate was a dry tap. However, smears prepared from the small amount of material left within the aspiration needle following the dry tap clearly revealed marked myeloid hyperplasia with rare blast cells (<1%). Red cell maturation was megaloblastoid and showed dysplastic features (Figure 2A). Myeloid maturation was progressive and dysplastic (Figure 2B). Megakaryocytic atypia was clearly evident (Figure 2C,D). Ring sideroblasts were not observed. These bone marrow aspirate findings lead to a diagnosis of myelodysplastic/myeloproliferative neoplasm (MDS/MPN). The patient’s high vitamin B12 level was consistent with her myeloproliferative disorders.7

3 | DISCUSSION

In 2008, the WHO introduced a new disease entity termed the myelodysplastic syndrome/myeloproliferative neoplasm (MDS/MPN).8 It is considered to be a rare de novo myeloid neoplasm that exhibits hybrid dysplastic and proliferative features at presentation.9 The dysplastic features of the maturing hematopoietic cells are an important criterion for the diagnosis of MDS/MPN. Unlike H & E-stained sections of BM biopsy specimens, dysplastic features in developing hematopoietic elements are best visualized in the May–Grunwald or Wright–Giemsa-stained smears of aspirated marrow. When no marrow is obtained as in the case of a dry tap, such a diagnosis can be difficult to establish and may be easily missed if only H & E-stained sections of BM biopsy specimens are available.

![Figure 1](image1.png)

**Figure 1** H & E-stained section of a bone marrow biopsy specimen demonstrating a markedly hypercellular marrow with massive infiltration by myeloid precursor cells. Note occasional atypical megakaryocytes (arrows)

![Figure 2](image2.png)

**Figure 2** Wright–Giemsa-stained smear of the material obtained from the needle following a dry tap demonstrating dysplastic features in the erythroid precursors (biloced nuclei and nuclear budding—arrows) (A), granuloid cells (nuclear hypolobation and pseudo-Pelger Huet cells—arrows) (B), and megakaryocytic cells [bi and multinuclear (separate nuclear lobes) megakaryocytes] (C,D)
If the dry tap is genuine and not due to technical reasons (see below) it usually indicates significant marrow pathology which is usually associated either with marrow fibrosis or hypercellularity (packed marrow), or both. The predominant conditions associated with a dry tap usually include leukemias, particularly chronic myelogenous leukemia and hairy cell leukemia; metastatic solid tumors, and idiopathic myelofibrosis. The topic of dry taps has received very little attention in recent years and the diagnostic value of making smears from the material left in the needle has largely been ignored. It has been reported that in about 80% of the dry taps there is retained material inside the lumen of the bone marrow aspiration needle. When this material is expelled on to a slide and smears are made and stained, the resulting microscopic image can reveal not only useful information complimentary to a simultaneously obtained bone marrow core biopsy specimen but may provide the only material available to yield correct diagnostic information.

In the present case a solid core bone marrow biopsy revealed an extremely hypercellular marrow (cellularity over 90%) with predominant myeloid hyperplasia (Figure 1), occasional erythroid precursors, and a few megakaryocytes. When considered in conjunction with the CBC findings and the JAK-2 mutation a diagnosis of myeloproliferative disorder was not in question. On the other hand, with only an examination of the H & E-stained section of the bone marrow biopsy it was not possible to appreciate the dysplastic features of the hematopoietic cells which were clearly evident in the smears produced from the material left within the aspiration needle following the dry tap. As a result a diagnosis of MDS/MPN could be accurately established.

During bone marrow aspiration occasionally no material enters into the syringe causing a dry tap. The frequency of dry tap is about 5%, although it has been reported to vary from 1.6% to 6.8%. It also varies with the type of disease as well as faulty technique and operator experience. While attempting a bone marrow aspiration from the posterior ilium if the aspiration needle is introduced tangentially the tip of the needle may remain completely buried in the solid cortical bone and may never reach the hemopoietic spongy bone (Figure 3, needle 1). Alternatively, the tip of the needle may traverse cortical bone, pass through spongy bone and re-enter cortical bone of the contralateral wall of the ilium. As a result the procedure will obviously be a dry tap (Figure 3 needle 2).

When a bone marrow aspiration procedure is performed and no marrow is obtained on the first attempt one should withdraw the needle a few millimeters with the stilette in place and reintroduce the needle into the bone at a different angle (Figure 4). Hopefully this step will reach a site of spongy bone with aspiratable marrow. On the other hand, if this second attempt fails to yield an aspirate and the operator is confident that the tip of the needle is in spongy bone, this
status can be considered a verified dry tap. At this point the
needle is withdrawn from the patient and its potential con-
tents should be expelled from the needle with the use of a tro-
car/stilette on to a glass slide. Dry film smears are prepared
and stained.

We have presented a case where this procedure/technique
provided us with material of diagnostic value and recom-
mand that in case of a dry tap one should routinely try to
make smears from the material left within the lumen of the
needle.

CONFLICT OF INTEREST
None declared.

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