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Dry Tap During Bone Marrow Aspiration for Musculoskeletal Treatments: Case Report and Proposed Management Algorithm

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Background: Bone marrow concentrate injections, orthobiologic treatments utilized for musculoskeletal diseases, are increasingly used by interventional pain management physicians, sports medicine physicians, and other musculoskeletal specialists. A rarely discussed yet clinically important is the "dry tap," in which no marrow is obtained during aspiration. Although well-documented in the hematology-oncology literature, its significance and management in otherwise healthy patients remain unclear.

Case Report: We present the case of a dry tap occurring during the in-office bone marrow aspiration of a patient with knee osteoarthritis who had no hematologic or oncologic history. This case prompted a multidisciplinary evaluation and highlighted the clinical uncertainty this issue presents for interventional pain management.

Conclusions: We reviewed the relevant literature. We propose a practical management algorithm developed in collaboration with hematology-oncology and sports medicine specialists. This approach may assist physicians to effectively deal with a dry tap during an orthobiologic procedure.

Key words: Dry tap, bone marrow aspiration, orthobiologics, orthopedics, osteoarthritis, case report

BACKGROUND

Bone marrow aspirations (BMAs) have been performed since 1908 (1), predominantly in hematology and oncology. More recently, bone marrow concentrate (BMC) use has grown in musculoskeletal specialties such as orthopedic surgery, physiatry, sports medicine, and interventional spine medicine (2-5).

Rich in growth factors, cytokines, and mesenchymal stem cells, BMC has shown great promise in both preclinical and clinical research for tendon, joint, ligament, bone, and intervertebral disc disorders (6-11). In comparison to platelet-rich plasma (PRP), an even more commonly used orthobiologic, BMC contains significantly greater interleukin-1 receptor antagonist protein—a potent anti-inflammatory cytokine that reduces chondrocyte apoptosis and matrix degradation and enhances collagen deposition; younger platelets with greater anti-inflammatory potential; and far higher concentrations of mesenchymal stem cells that create a more powerful paracrine effect (12).

BMC injections are used by interventional pain management physicians as a potential nonsurgical treatment option for osteoarthritis, tendinopathies, ligament injuries, and discogenic low back pain (6,11,13-16). They have also been used as a surgical augmentation in arthroscopic tendon repairs as well as ligament repairs and reconstructions (17-19). Recent advances

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in orthobiologics, combined with the desire to increase nonoperative options for patients, have led to the increased popularity of using BMAs and subsequent therapies for musculoskeletal diseases.

An unsuccessful BMC harvest is the failure to aspirate bone marrow, also known as a "dry tap." Relevant research on dry taps has only been published in the hematology and oncology literature. Historically, the procedure is performed for known or suspected pathology within the bone marrow, such as cancer. Due to the relatively new use of BMAs for orthopedic conditions, there is a paucity of guidelines regarding managing dry taps.

As the field of orthobiologics for nonhematologic applications advances, it is essential to review potential barriers and complications associated with these applications in order to enhance patient care and outcomes. In this manuscript, prepared in accordance with the CARE guidelines and checklist, we present a clinical example of an in-office bone marrow dry tap, review the relevant literature on this procedural barrier, and propose a practical workup algorithm to guide its management. The patient gave informed consent for publication of this case report.

CASE PRESENTATION

A 52-year-old woman presented to our sports medicine clinic. She reported 4 years of worsening right medial knee pain. The pain was worse with long walks, prolonged sitting, and lifting off that leg. She was referred by a total joint orthopedic surgeon for consideration of orthobiologics after she achieved unsatisfactory outcomes with conservative treatments including physical therapy, corticosteroid injections, and a voluntary 32-pound weight loss. She did not have hematologic or oncologic symptoms, and did not have a history of cancer.

Her physical exam revealed medial joint line tenderness, and pain with end-range flexion, which was consistent with right medial knee osteoarthritis. A knee radiograph showed severe medial joint space narrowing with osteophytes (Fig. 1). After a full discussion of treatment, the patient wished to proceed with an intra-articular BMC injection.

For the procedure the patient was prepped and draped while prone, the posterior superior iliac spine (PSIS) was visualized with ultrasound, and the periosteum was anesthetized with 10 mL of 1% lidocaine with epinephrine per side.

Following adequate anesthesia, and under ultrasound guidance, a heparinized 11G Jamshidi needle (Arthrex, Inc.) was used to penetrate the cortex of the left PSIS using a twisting technique. The stylette was removed, and aspiration was attempted with a 10 mL syringe. Upon the inability to aspirate bone marrow, the stylette was replaced, the Jamshidi needle was advanced another 5 mm and another aspiration attempt failed. This process was repeated for 8 more attempts at this puncture site.

Due to the inability to aspirate through this site, 2 additional sites were attempted on the left and 3 on the right PSIS, all of which were unsuccessful. In order to rule out the possibility of equipment malfunction, 2 additional manual Jamshidi needles and one power-drill-driven Jamshidi needle (Arrow™ OnControl™, Teleflex, Inc.) all 11G, were used for the subsequent aspiration attempts. None of these yielded bone marrow, confirming a bone marrow aspiration dry tap.

After unsuccessful aspiration attempts, the procedure was aborted, and the case was discussed with a local hematologist. As advised by the hematologist, a complete blood count (CBC) with differential, a computed tomography (CT) scan of the pelvis without contrast medium, and a peripheral blood smear were ordered; they were all within normal range (Table 1).

Additionally, CBC values remained within normal limits at the patient's 6-month follow-up. The pelvis CT scan was negative for lymphadenopathies, hepatosplenomegaly or tumors, and only showed Jamshidi tracks (Fig. 2).

Two years after the bone marrow aspiration dry tap, the patient ultimately underwent knee hemiarthroplasty for managing her osteoarthritis.

DISCUSSION

Although BMA is increasingly performed in interventional pain management and sports medicine for musculoskeletal diseases, handling procedural failure—including dry taps—is rarely addressed. The literature on dry taps describes this phenomenon in patients with existing oncologic or hematologic pathology, including leukemias, lymphomas, metastatic carcinomas, multiple myeloma, myelodysplastic syndrome, and primary myelofibrosis, among others (20). In the reported cases, 7%–20% of dry taps occurred in patients who did not have an identifiable causative pathology (20-23). Faulty technique is believed to be a rare cause of failed BMA (20,21,23).

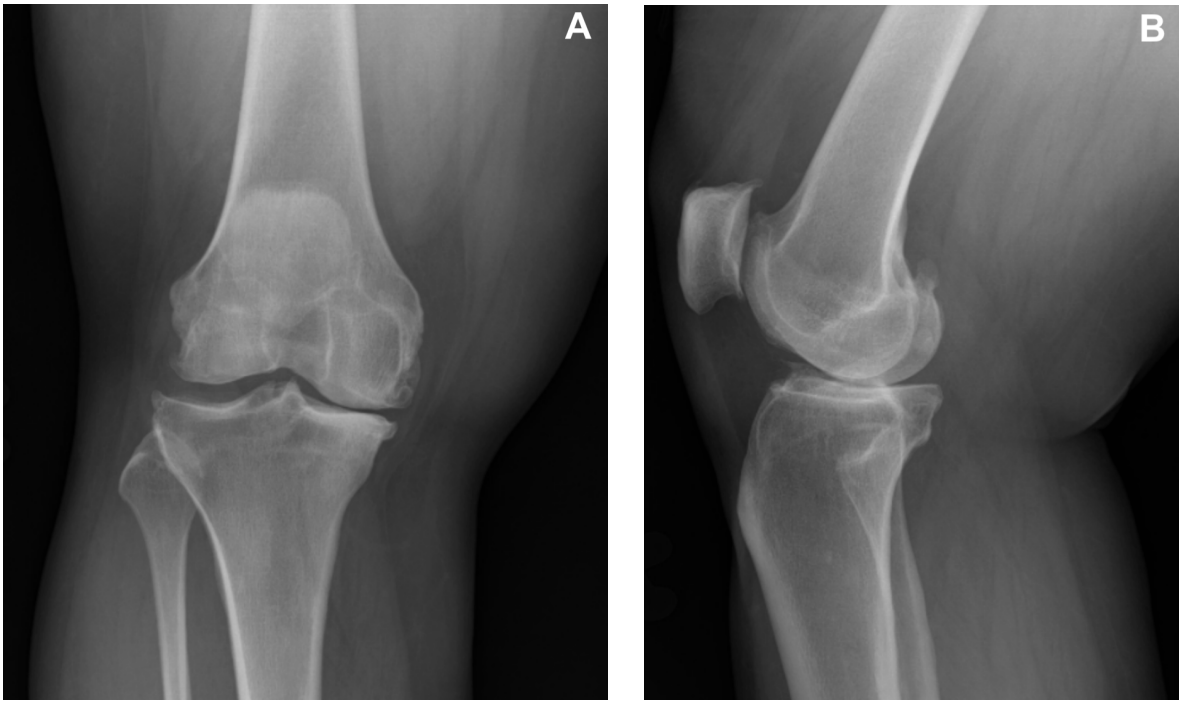

Fig. 1. Anteroposterior (A) and lateral (B) radiographs of the right knee demonstrate severe medial joint space narrowing with osteophytes and subchondral sclerosis, consistent with severe medial knee osteoarthritis.

Given the high incidence of reported cancer in documented dry tap cases, further workup is clearly indicated in orthopedic cases when this occurs.

A patient's history may reveal symptoms of hematologic or oncologic pathology, such as easy bleeding or bruising, fatigue, frequent infections, bone pain, night sweats, weight loss, and fever (24-26). Since bone marrow produces billions of circulating blood cells daily—including red blood cells, white blood cells, and platelets (12,27)—most pathologies leading to BMA failure are associated with abnormalities in blood counts (28). In patients with pathologic causes of dry tap, the most commonly reported abnormal lab values were nucleated red blood cells (63%), thrombocytopenia (62%), elevation of the serum lactate dehydrogenase (69%), and elevation of alkaline phosphatase (35%) (20, 21). A leukoerythroblastic picture on blood smear (i.e., the presence of nucleated erythrocytes and immature cells of the myeloid lineage in the circulating blood) may also be suggestive of marrow infiltration and extramedullary hematopoiesis, and, although not specific for cancer, is associated with malignancies in most cases (29).

A dry tap usually indicates that marrow cellularity is severely reduced (e.g., aplastic anemia), that the marrow cavity is densely infiltrated (e.g., acute leukemia, metastatic cancer), or that a fibrotic process is occurring (e.g., primary myelofibrosis). In a study by Humphries (20), 2,235 bone marrow biopsies were performed, resulting in a dry tap rate of 3.9% (87 patients) . Of the dry taps, 6.9% (6 patients) showed normal bone marrow biopsies, while metastatic cancer was present in 17.2% (15 patients). The most common cancers were chronic

Table 1. The patient's complete blood count and differential at 2 weeks post dry tap.

Cell Type	Result	Normal Range
White Blood Cells	10.4 x 103/µL	3.4 - 10.8 x 103/µL
Red Blood Cells	5.00 x 106/µL	3.77 - 5.28 x 106/µL
Hemoglobin	14.9 g/dL	11.1 – 15.9 g/dL
Hematocrit	43.4%	34.0 – 46.6%
Platelets	267 x 103/µL	150 – 379 × 103/µL
Neutrophils (absolute)	6.7 x 103/µL	1.4 – 7.0 x 103/µL
Lymphocytes (absolute)	2.6 x 103/µL	0.7 – 3.1 x 103/µL
Monocytes (absolute)	0.7 x 103/µL	0.1 – 0.9 x 103/µL
Eosinophils (absolute)	0.3 x 103/µL	0.0 – 0.4 x 103/µL
Basophils (absolute)	0.1 x 103/µL	0.0 – 0.2 x 103/µL
Immature granulocytes (absolute)	0.1 x 103/µL	0.0 – 0.1 x 103/µL

myeloid leukemia (14.9%), idiopathic myelofibrosis (13.8%), and hairy cell leukemia (10.3%).

As in-office orthobiologic procedures such as BMAs become more common for musculoskeletal treatments, physicians should be aware that a dry tap could occur. Given the high rate of published reports of dry taps associated with cancer occurring, it is prudent to discuss and understand the appropriate workup for such patients.

Proposed Dry Tap Management Algorithm For Orthopedics

The following management algorithm was developed collaboratively by a multidisciplinary team, including specialists in physical medicine and rehabilitation and hematology-oncology, based on clinical experience and synthesis of relevant literature.

1. Attempt performing a BMA with a Jamshidi needle at multiple depths and multiple sites with different entry points and different angles.
2. If unsuccessful, attempt performing a BMA with another Jamshidi needle to rule out an equipment defect, clog, or clot.
3. Obtain a trephine (or solid core) biopsy via the Jamshidi needle and save it in a sterile specimen cup. Contact a hematology/oncology specialist to determine if a pathology analysis is needed and which analyses to order.

Following a dry tap, the following steps should be considered at a minimum for immediate workup:

4. Obtain a history of hematologic and oncologic symptoms, and a review of systems. Obtain relevant previous medical history including a history of cancer, radiotherapy, or antineoplastic/immunosuppressive agents. Perform a full-body physical examination to check for signs of hematologic cancers such as lymphadenopathy and splenomegaly, and any signs of solid tumors.
5. Order a CBC with differential; alkaline phosphatase, creatinine, full electrolytes (the latter 3 are part of the complete metabolic panel); peripheral blood smear; lactate dehydrogenase; serum protein electrophoresis, and free light chains.

If any one of steps 3, 4, or 5 are abnormal:

6. Refer to hematology/oncology for a formal consultation.

The above algorithm does not follow the stepwise convention in hematology-oncology practice of beginning a workup with blood tests because their patients have a known or suspected hematologic or oncologic disease before a BMA is performed. In a patient with a musculoskeletal disease, such as the patient in this case report, the first suspicion of a bone marrow disorder occurs at the time of a failed BMA attempt; obtaining a solid core biopsy requires no extra risk or effort since the Jamshidi needle can be simply withdrawn without the stylette. This eliminates any procedural morbidity, risk, and cost of a possible repeat bone marrow biopsy or aspiration attempt.

Pelvic imaging is not included in this algorithm since a pelvic CT scan, magnetic resonance imaging, or F-fluoro-2-deoxy-D-glucose positron emission tomography might not be as sensitive as a trephine biopsy to screen for bone marrow diseases that do not involve discrete bone lesions or indolent pathologies (30-32).

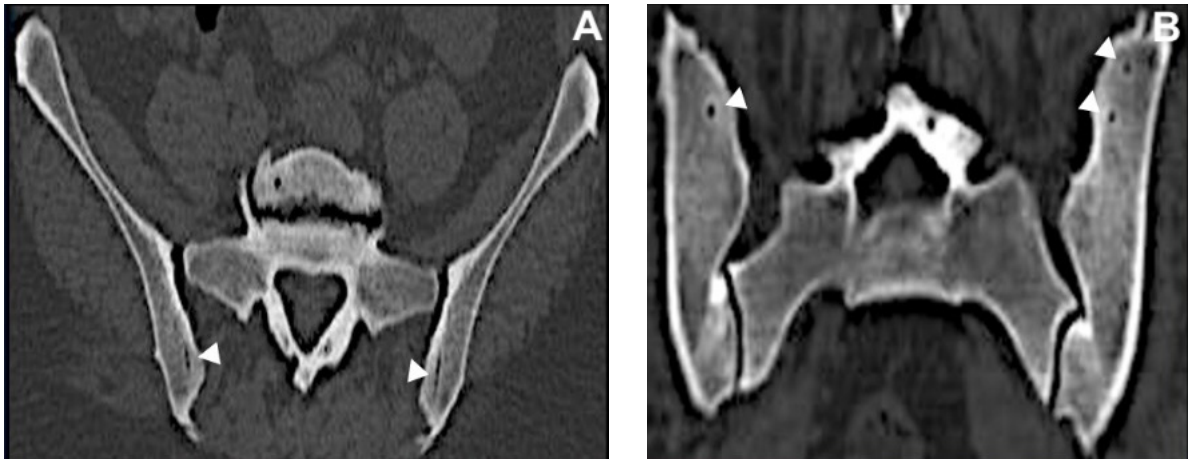

Fig. 2. Axial (A) and coronal (B) computed tomography images of the pelvis showing Jamshidi needle puncture sites (white arrows) without evidence of underlying bone pathology.

To our knowledge, this is the first report to address a BMA dry tap in the context of an orthobiologic procedure for a musculoskeletal disease. Our proposed management algorithm offers a structured approach to evaluating and managing this barrie, including strategies to assess for potential underlying malignancy that may be associated with a dry tap.

Limitations

The main limitation of this study is its single-patient design, which affects the generalizability of our findings. In addition, while the proposed management algorithm was developed through multidisciplinary collaboration and grounded in the hematology-oncology literature, validation via large clinical cohorts or a formal expert consensus is needed.

CONCLUSION

This case highlights the importance of reporting dry taps and developing systematic management strategies through multidisciplinary collaboration, especially as BMAs become more common in interventional pain management and musculoskeletal care. The proposed algorithm offers a practical approach to evaluating dry taps, with specific steps to help rule out underlying malignancy. Clear protocols may support clinical decision-making and help guide referral to a hematology-oncology specialist when further investigation is needed.

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