ORIGINAL ARTICLE

DRY TAP: A DIAGNOSTIC ALERT FOR UNDERLYING BONE MARROW PATHOLOGY

Saqib Qayyum Ahmad, Rizwan Yusuf*, Nadeem Zafar, Nadir Ali*****

Clinical Laboratory, Pakistan Air Force (PAF) Hospital, Mianwali, *Department of Medicine, PAF Hospital, Sargodha, ** Department of Pathology, Combined Military Hospital, Multan, ***Department of Haematology, Armed Forces Institute of Pathology, Rawalpindi-Pakistan

Background: Dry tap is an annoying experience in bone marrow (BM) findings, especially in cases where the diagnosis may hinge on BM findings. This study was conducted to determine, on the basis of bone marrow (BM) trephine biopsy, the frequency of various underlying conditions causing a dry tap, among different age groups. **Methods:** It was a descriptive study carried out at PAF hospital Mianwali, Pakistan from 1st Jan 2009 to 31 Dec 2012. Record of all BM aspirations and trephine biopsies performed during 4 years was retrieved from hospital's laboratory. Total number of BM aspirations and trephines were counted and the subject's ages and genders recorded. Frequencies and percentages of patients with dry tap, in paediatric group (<15 years of age), young to middle-aged group (15–59 years) and the elderly (≥60 years) were calculated. Diagnoses of patients with dry tap made on BM biopsy were noted for each group and their frequencies calculated. **Results:** Of 548 BM aspirations, dry tap was encountered in 52 (9.5%) cases. Acute lymphoblastic leukaemia (ALL) was the commonest cause of dry tap in paediatric age, seen in 6 (60%) of 10 children. In young to middle-aged group, non-Hodgkin lymphoma (NHL) was the commonest cause, found in 6 (30%) of 20 cases. NHL and metastatic tumours, seen in 8 (36.4%) and 6 (27.3%) of 22 patients respectively, were the most frequent causes of dry tap in the elderly. **Conclusion:** Dry tap, in most of the cases, is like a diagnostic alert for the presence of an underlying BM pathology, nature of which depends upon age group.

Keywords: Bone marrow examination, biopsy, needle biopsy, lymphoma

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INTRODUCTION

Bone marrow (BM) examination is a very useful investigation for the diagnosis of a variety of haematological as well as non-haematological diseases.[1] According to an estimate, in United Kingdom alone more than 20,000 BM aspirates with or without trephine biopsy are being done annually.[2]

Although there are certain definite indications for BM trephine biopsy mentioned in the literature, failure to aspirate the marrow, referred to as a dry tap, makes it almost mandatory.[3] Dry tap is only rarely because of defective technique and is more commonly due to some underlying BM pathology.[4]

Dry tap, especially in cases where the diagnosis may hinge on BM findings, is indeed an annoying experience. Earlier studies have shown infiltration of BM by leukaemia, lymphoma, metastatic carcinoma, multiple myeloma, idiopathic myelofibrosis and aplastic anaemia, as common underlying causes of dry tap.[3–7]

Since all these diseases have a propensity to affect patients in different age groups, we can expect different underlying causes of dry tap predominantly involving various age groups. We carried out a study to see the frequency of various underlying conditions causing a dry tap, among the various age groups, on the basis of trephine biopsy results.

MATERIAL AND METHODS

This cross-sectional study was carried out at Pakistan Air Force (PAF) hospital, Mianwali, Pakistan from 1st January 2009 to 31st December 2012. Record of all the BM aspirations and trephines carried out during the period of study was retrieved from the hospital's laboratory. All the BM aspirations and trephines were performed by a qualified and experienced haematologist. Total number of BM aspirations and trephine biopsies was counted. Ages and genders of all the patients were also recorded. Patients were divided into paediatric (<15 years of age), young to middle-aged groups (15–59 years) and the elderly (≥60 years). Frequencies and percentages of patients with dry tap falling in each age group were calculated. The diagnoses of patients with dry tap made on BM trephine biopsy were noted to calculate their overall frequencies and frequencies within each age group.

The diagnosis of patients with dry tap had been made on history, examination, complete blood counts, BM trephine biopsy examination and other relevant investigations where ever indicated. Complete blood counts were done on specimens anticoagulated by ethylene diamine tetra acetic acid (EDTA) on an automated counter (Sysmex KX-21). Peripheral blood smears were stained by Leishman's

stain.[8] BM aspiration was attempted from posterior superior iliac spine in all patients except in infants less than 2 years of age wherein antero-medial aspect of tibia was punctured. For BM aspiration 16 gauge aspiration needle was used while trephine biopsy was done by means of 11 gauge Jamshedi needle.[3] Trephine biopsy specimens were fixed in 10% formal saline, buffered to neutral pH and decalcified in 3% nitric acid, before processing on automated machines (Sakura®, Japan). Embedding was done in paraffin wax and 4 µm-thick sections were prepared on rotary microtome. Sections were affixed on transparent microscopic slides and stained with Haematoxylin-and-Eosin and Reticulin stains.[9] The biopsy slides were reported upon by the haematologist or histopathologist included among the authors.

RESULTS

Out of a total of 548 BM aspiration procedures done during the 4 year-period of study 52 (9.5%) were dry taps. The age and sex distribution of patients with dry tap along with their frequencies are shown in Table-1. Diagnoses made on BM trephine biopsy in patients with dry tap in different age groups along with their frequencies are summarized in Table-2.

Table-1: Age and sex distribution of patients with dry tap

	Total number of patients (n=548)	Dry taps n=52 (9.5%)
Male	336	40 (11.9%)
Female	212	12 (5.6%)
Male: Female	1.6	3.6
Patients <15 years	158 (28.8%)	10 (19.2%)
Patients 15–59	260 (47.4%)	20 (38.5%)
Patients ≥60	130 (23.7%)	22 (42.3%)

Table-2: Frequencies of various diseases causing a dry tap in paediatric, young to middle aged and the elderly groups

Diagnosis of patients with dry tap on trephine biopsy	Relative frequencies of diseases causing dry tap in different age groups			Over all frequencies (n=52)
	<15(n=10)	15–59(n=20)	≥60(n=22)	
NHL		6 (30%)	8 (36.4%)	14 (26.9%)
ALL	6 (60%)	2 (10%)		8 (15.4%)
Metastatic tumour	2 (20%)		6 (27.3%)	8 (15.4 %)
Myeloproliferative disorder		2 (10%)	2 (9.1%)	4 (7.7%)
MDS			4 (18.4%)	4 (7.7%)
Caseating granuloma		4 (20%)		4 (7.7%)
Normal	2 (20%)		2 (9.1%)	4 (7.7%)
Idiopathic myelofibrosis		3 (15%)		3 (5.8%)
Mixed deficiency anaemia		2 (10%)		2 (3.8%)
Hypocellular marrow		1 (5%)		1 (1.9%)

Key: NHL=Non Hodgkin lymphoma, MDS= Myelodys plastic syndrome, ALL= Acute lymphoblastic leukaemia

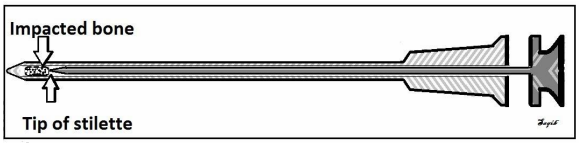

Figure-1: Longitudinal section of aspiration needle, showing impacted cortical bone piece, displacing the ill-fitting stilette and occluding the lumen to prevent the bone marrow extraction.

DISCUSSION

Dry tap is generally attributed to conditions which result in either fibrosis or hypercellularity of the BM.[4,10] Diseases such as leukaemia and myelodysplastic syndromes, which cause hypercellularity of BM also produce variable amount of reactive fibrosis.[11] In this study, either hypercellularity or some degree of marrow fibrosis was seen in 47 (90.4%) out of 52 cases of dry tap. The cases without either fibrosis or hypercellularity included 4 patients with normal marrow and 1 of hypocellular marrow.

During the period of study 52 (9.5%) out of a total of 548 BM aspirations resulted in a dry tap. Various studies have mentioned a dry tap rate of 4–10%.[3–7] In our study, dry tap was seen in a higher proportion of males as compared to females, i.e.; 40 of 336 (11.9%) males vs 12 of 212 (5.6%) females subjected to BM examination. One of the plausible causes may be that in Pakistan the underlying diseases which can affect the BM resulting in dry tap, such as leukaemia, lymphoma and carcinomas are more common in males than in females.[12–14]

Among the various age groups, dry tap was most frequently seen in the elderly patients. Of 130 patients, over 60 years of age, dry tap was seen in 22 (16.9%) patients. This is understandable because both, the haematological malignancies such as low grade lymphomas and metastatic non-haematological malignancies with a known tendency to infiltrate the marrow and cause a dry tap, are more commonly seen in the elderly.

Infiltration of the BM by lymphoid cells due to non-Hodgkin lymphoma was seen as the commonest cause of dry tap, not only as a whole, but also in the young to middle-aged adults and the elderly groups. All these cases were till then undiagnosed and BM was done due to cytopenias. BM reacts to the lymphomatous infiltrate by a variable amount of desmoplasia which may result in a dry tap. Low grade lymphomas more commonly involve the BM than the high grade lymphomas.[10,15] According to studies, overall incidence of involvement of BM by lymphoma varies from 45% to 55%.[15] Mantle cell lymphomas and splenic marginal zone B-cell lymphoma almost invariably

involve BM with incidence of involvement ranging between 80 to 90%.[15–17] Incidence of BM infiltration by follicular centre cell lymphomas and large cell lymphomas has been reported as 60–70% and 20–30% respectively.[15]

Acute lymphoblastic leukaemia was the commonest cause of dry tap in the children and the second most common cause, overall. Out of 8 patients, 6 (75%) were children less than 15 years of age. Densely packed blast cells in the BM and reactive fibrosis hamper the extraction of marrow in cases of acute leukaemia.[4]

Infiltration of the marrow by non-haematological, metastatic tumours was the third commonest cause overall, while in the elderly it was the second leading cause of dry tap. The BM is one of the commonest sites of metastatic tumours. In adults, metastatic tumours of the lung, breast and prostate are often found infiltrating the BM.[10] The bone marrow has also been reported to be the sole site of detected metastatic disease in less than 2% cases.[18] In children, neuroblastoma, rhabdomyosarcoma and medulloblastoma, have a predilection for marrow involvement.[10] In our study, an infant, six months of age admitted with the suspicion of acute leukaemia, was diagnosed to be suffering from neuroblastoma. All the three elderly patients in our case series were hitherto not being suspected for any particular malignancy and the discovery of metastatic tumour elicited the investigations to search for the primary tumour. Since these patients were referred to oncology centre in bigger cities, the result of investigations could not be tracked.

In our study caseating granulomas were found in the BM of 4 (7.7%) out of 52 patients with dry tap. Both were young adult males, already diagnosed as suffering from tuberculosis and BM was done to find out the cause of pancytopenia. In countries where tuberculosis is common, pancytopenia and a dry tap should raise the suspicion of involvement of BM with granulomas.

A couple of cases, one each of myelodysplastic syndrome and myeloproliferative disorder; and a single case of idiopathic myelofibrosis also had a dry tap. All the patients were middle-aged adults. Dry tap is invariably encountered in patients suffering from idiopathic myelofibrosis and BM trephine biopsy is mandatory. We found hypocellular marrow in only one, 26 year old female, patient who was diagnosed to be suffering from systemic lupus erythematosus. One of the earlier studies has reported aplastic anaemia as the commonest cause of dry tap.[6]

Another young woman, aged 22 years, from poor socioeconomic status was found to be suffering from mixed (iron, vitamin B_{12} and folate) deficiency anaemia. Although the BM was hypercellular but there was no fibrosis. BM is generally readily extractable in patients with iron deficiency anaemia and megaloblastic anaemia. The exact cause of dry tap in this patient could not be known.

We also found 4 cases with dry tap having a normal BM on trephine biopsy. Although faulty technique may be considered as a cause in these cases but the possibility of patchy involvement of marrow with some pathology, not picked up by trephine biopsy from a single site, cannot be ruled out in such cases. Faulty technique, a rare cause of dry tap, may be due to inexperience on the part of operator, resulting in the misdirected needle tip lodging in the cortical bone instead of spongy marrow cavity.

Ill-fitting stilettes, inside the worn out, reusable aspiration needles, also cause a dry tap. BM aspiration should be done with a hard stainless steel needle with well-fitting stilette.[19] During penetration of the bone, impaction of a cylindrical piece of cortical bone in the gap between the tip of the needle and the tip of ill-fitting stillette blocks the lumen of the needle, which results in a dry tap (Figure-1). With the advent of good quality disposable needles, this problem is hardly seen any more.

The present study has been done in a secondary care hospital with limited number of patients. The study consisted of only 52 cases of dry tap. A larger study may be may be able to better predict the causes of dry tap in various age groups.

CONCLUSION

Dry tap, in most of the cases, is like a diagnostic alert for an underlying BM pathology. In our study, the commonest cause in children was acute leukaemia, while in the adults it was involvement of the BM by NHL or metastatic malignancy. Instead of dismissing it as an outcome of faulty technique, the dry tap must be followed by a thorough review of the patient in the light of possible causes according to age group.

REFERENCES

1. Bain BJ. Bone marrow aspiration. J Clin Pathol 2001;54:657–63.
2. Bain BJ. Bone marrow biopsy morbidity: review of 2003. J Clin Pathol 2005;58:406–8.
3. Riley RS, Hogan TF, Pavot DR, Forysthe R, Massey D, Smith E, Wright L Jr, Ben-Ezra JM. A Pathologist's perspective on bone marrow aspiration and biopsy: I. Performing a bone marrow examination. J Clin Lab Anal 2004;18(2):70–90.
4. Humpries JE: Dry tap bone marrow aspiration: Clinical significance. Am J Hematol 1990;35:247–50.
5. Navone R, Colombano MT. Histopathological trephine biopsy findings in cases of 'dry tap' bone marrow aspirations. Appl Pathol 1984; 2:264–71.

6. Mukiibi JM, Paul B, Gordeuk VR. The significance of 'dry tap' bone marrow aspirations in Zimbabweans. East Afr Med J 1989;66(7):481–4.
7. Khanum F, Rehman A U, Ahmad S, Anwar J. "Dry tap" of bone marrow and its clinical importance. Pak J Med Health Sci 2009;2(4):292.
8. Bain BJ, Lewis SM. Preparation and staining methods for blood and bone marrow films. In: Lewis SM, Bain BJ, Bates I, eds. Practical Haematology, New Delhi: Elsevier, 2006; pp 59–77.
9. Wick MR, Mills NC, Brix WK. Tissue procurement, processing, and staining techniques. In: Mark R. Wick, ed. Diagnostic Histochemistry, New York: Cambridge University press, 2008; pp 1–27.
10. Riley RS, Williams D, Ross M, Zhao S, Chesney A, Clark BD, Ben-Ezra JM. A Pathologist's perspective-II. Interpretation of bone marrow aspirate and biopsy. J Clin Lab Anal 2009;23:259–307.
11. Hasserjian RP. Reactive versus neoplastic bone marrow. Arch Pathol Lab Med 2008;132:587–94.
12. Jamal S, Moghal S, Mamoon N, Mushtaq S, Luqman M, Anwar M. The pattern of malignant tumours: Tumour registry data analysis, AFIP, Rawalpindi, Pakistan (1992–2001). J Pak Med Assoc 2006;56:359–62.
13. Yasmeen N, Ashraf S. Childhood acute lymphoblastic leukaemia; epidemiology and clinicopathological features. J Pak Med Assoc 2009;59:150–3.
14. Atique M, Leghari MJ, Amin MS, Parveen S, Mushahid N, Khan MAU. Cancer data analysis in the pathology department, Combined Military Hospital, Multan, Pakistan 2002–2007. Asian Pacific J Cancer Prev 2008;9:679–81.
15. Brunning RD, Arber DA. Bone marrow. In: Rosai J edi. Rosai and Ackerman's Surgical Pathology, New Delhi: Reed Elsevier, 2011; pp 1927–2012.
16. McKay P, Leach M, Jackson R, Cook G and Rule S. Guidelines for the investigation and management of mantle cell lymphoma. Br J Haematol 2012;159(4):1–22.
17. Franco V, Florena AM, Iannitto E. Splenic marginal zone lymphoma. Blood 2003;101:2464–72.
18. Bain BJ. Bone marrow trephine biopsy. J Clin Pathol 2001;54:737–42.
19. Bates I. Bone marrow biopsy. In: Lewis SM, Bain BJ, Bates I, eds. Practical Haematology, New Delhi: Elsevier, 2006; pp 115–30

Address for Correspondence:

Dr Saqib Qayyum Ahmad, Pathologist, Army Medical College, Abid Majeed road, Rawalpindi-Pakistan
Cell: +92 345 331 5245
Email: saqib447@gmail.com