SHORT REPORT

Bone marrow aspiration before bone marrow core biopsy using the same bone marrow biopsy needle: a good or bad practice?

Anwarul Islam

J Clin Pathol 2007;**60**:212–215. doi: 10.1136/jcp.2006.037341

A single-needle single-site technique for bone marrow aspiration and core biopsy has been compared with a two-needle technique, using 30 randomly selected patients who required these two investigations. In addition, two single-needle techniques were compared, aspirating immediately after penetrating the cortex or, alternatively, aspirating after the needle (without the stylette) had been advanced 20–25 mm. The two-needle technique was found to be superior to either of the single-needle techniques, which often resulted in a biopsy specimen that was denuded of bone marrow cells.

Bone marrow aspiration and core biopsy have an important role in the investigation and diagnosis of haematological as well as non-haematological malignancies and various other diseases.^{1–6} They are also important in the management of these conditions particularly in the follow-up evaluation of patients undergoing chemotherapy, bone marrow transplantation and other forms of medical treatment.^{7–9} The procedure usually involves aspiration of a fluid suspension of bone marrow from the sternum (using the Salah and Klima sternal biopsy needle (Bignell Surgical Instruments, West Sussex, England) or a sternal puncture needle¹⁰) or from the posterior iliac crest by using a sternal puncture or similar needles, or with longer needles specially designed to obtain plasma-suspended (liquid) marrow.¹¹ The bone marrow core biopsy specimens are usually obtained from the posterior iliac crest with a Jamshidi needle,¹² an Islam needle¹³ or similar needles¹⁴ (eg, Core-Lock bone marrow biopsy system, Worldwide Medical Technologies, Connecticut, USA). As the aspirate and core biopsy specimen provide complimentary information, both are routinely obtained at the same time and usually from the same site in a large majority of cases. The posterior iliac crest is most commonly the site of choice. However, owing to the additional time required and the inconvenience of using two needles, one for aspiration and one for core biopsy, and the additional cost involved in using the two needles, some investigators use a single bone marrow core biopsy needle for both purposes. The technique of aspiration and obtaining a core biopsy specimen at the same time and at the same site using the same needle may have inherent technical problems and other disadvantages. We investigated the two techniques: (a) aspiration before core biopsy using the same bone marrow core biopsy needle (one needle technique) and (b) aspiration before core biopsy using an aspirate needle for aspiration and a separate bone marrow core biopsy needle for obtaining the solid core (two-needle technique). This study was purely observational and aimed to identify technical difficulties and gross observational changes that occur in these two techniques of aspiration and biopsy procedures. Diagnosis and interpretation was never the purpose of this study, although diagnoses in all the studied cases were established from the analysis of a bone marrow aspirate and

a trephine biopsy, as well as flow cytometric, cytogenetic and molecular studies when indicated.

The findings of the study indicate that the two-needle technique has definite advantages. It is technically neater and less messy. It also avoids spilling of blood and keeps the surgical area uncontaminated while yielding an optimal aspiration and distortion-free core biopsy specimen. It also avoids compromising the technical quality and morphological integrity of the biopsy specimens.

MATERIALS AND METHODS

Bone marrow aspiration before obtaining a bone marrow core biopsy specimen using the same bone marrow core biopsy needle is called the one-needle technique. There are two methods by which this can be achieved. In one method (fig 1), the bone marrow biopsy needle with its stylette in place is first introduced to a few millimetres beyond the cortical bone and into the marrow cavity. Once the mouth of the needle is securely placed inside the marrow cavity, the stylette is withdrawn and aspiration performed with a syringe. Alternatively (fig 2), the bone marrow biopsy needle with its stylette in place is introduced just beyond the cortical bone. The stylette is then withdrawn and the needle advanced slowly by clockwise and counterclockwise rotary motion deep into the marrow cavity until an adequate depth (20–25 mm) is reached. A syringe is then attached at the proximal end of the needle and the aspiration is performed while the core biopsy specimen remains in the lumen of the biopsy needle. After the aspiration, the needle is rotated several times to break loose the core biopsy specimen and the needle containing the core biopsy specimen is then withdrawn.

Bone marrow aspiration before obtaining a bone marrow core biopsy specimen using two separate needles, one for aspiration and one for bone marrow core biopsy, is called the two-needle technique. In this technique a bone marrow aspirate sample is obtained first from the posterior iliac crest using a bone marrow aspiration needle, after which a bone marrow core biopsy specimen is obtained from the same site but from a slightly different area of the posterior iliac crest from where prior bone marrow aspiration was performed using a separate bone marrow core biopsy needle.

Patients

In all, 30 patients diagnosed with various haematological disorders were randomly selected for this study. There were 17 men and 13 women aged 45–83 years, with a mean age of 63 years. Patients were divided into two groups, group A (20 patients) and group B (10 patients). Patients in group A were further divided into group A1 (10 patients) and group A2 (10 patients). In group A1 patients, aspiration before core biopsy was performed using the first method described earlier. In group A2 patients, aspiration before core biopsy was performed using the alternative method described earlier. In group B patients,

Figure 1 Schematic representation of bone marrow aspiration before core biopsy, method one. (1) The needle (a) with the stylette (b) in place is inserted down to the bone. (2) The cortex over the posterior ilium is then penetrated by gentle rotary motion of the needle. Once this penetration has been achieved and the mouth of the needle has entered the marrow cavity (spongy bone), the stylette is withdrawn. (3) A syringe is attached at the proximal end of the needle and a bone marrow aspiration is performed. (4) After the aspiration, the needle is advanced slowly with clockwise-counter-clockwise rotary motion. (5) When an adequate depth is reached, the needle is rotated several times along its long axis to break loose the core biopsy specimen, and the needle containing the biopsy specimen is then withdrawn.

aspiration was performed prior to core biopsy using an aspiration needle, followed by a core biopsy with a bone marrow core biopsy needle using the same puncture wound and at the same site, but at a slightly different area of the posterior iliac crest.

Instrument

Islam bone marrow core biopsy¹⁵ and aspiration needles (specially designed to obtain bone marrow aspirate samples from the posterior iliac crest)¹¹ were used to obtain bone marrow core biopsy and aspiration samples from the right or left posterior iliac crests.

Procedure

The technique of bone marrow aspiration and core biopsy was that described earlier.^{16–17} The patients were placed in a right or left lateral decubitus position, with the top knee bent forward and drawn up and the back comfortably flexed. The site of the posterior iliac crest was identified by palpation, and with the use of a sterile technique, the overlying skin was prepared with an antiseptic and draped. Then the skin, subcutaneous tissue and the periosteum were infiltrated with a local anaesthetic. A small 3 mm skin incision was made with a sharp pointed scalpel blade. In group A1 patients the core biopsy needle with the stylette in place was advanced slowly through the incision, pointing towards the anterior superior iliac spine. When the posterior iliac crest was reached, it was penetrated by gentle rotary motion of the needle. Once the cortex was penetrated and the needle was securely placed within the marrow cavity, the stylette was withdrawn, and the aspiration was performed with a syringe without withdrawing the needle. After aspiration, the biopsy needle was advanced further with slow, steady and controlled clockwise-counter-clockwise rotary motions until an adequate depth (about 20–25 mm) was reached. The biopsy needle was then completely rotated several times along its long axis to sever all the trabecular connections at its base and break the core sample loose from the surrounding spongy bone, and was then slowly withdrawn. The solid biopsy specimen was then removed from within the lumen of the needle with the help of a pusher (ie, an obturator), which was introduced through the distal cutting end of the needle. In

Figure 2 Schematic representation of bone marrow aspiration before core biopsy, method two. (1) The needle (a) with the stylette (b) in place is inserted down to the bone. (2) The cortex over the posterior ilium is then penetrated by gentle rotary motion of the needle. Once this penetration has been achieved, the stylette is withdrawn. (3) After the withdrawal of the stylette, the needle is advanced with slow, steady and controlled clockwise-counter-clockwise rotary motion until an adequate depth (20–25 mm) is reached. (4) A syringe is then attached at the proximal end of the needle and a bone marrow aspiration is performed. (5) After the bone marrow aspiration, the needle is rotated several times along its long axis to cut all the trabecular connections at the base of the core. (6) The needle containing the core biopsy specimen is then withdrawn.

group A2 patients the core biopsy needle with the stylette in place was advanced slowly through the incision, pointing towards the anterior superior iliac spine. When the posterior iliac crest was reached, it was penetrated by gentle rotary motion of the needle. Once the cortex was penetrated, the stylette was withdrawn and the biopsy needle was advanced further until an adequate depth (about 20–25 mm) was reached. Then, a syringe was attached at the proximal end of the needle and an aspiration was performed. After aspiration the needle was rotated completely several times along its long axis to sever all the trabecular connections and then slowly withdrawn. The solid biopsy specimen was then removed from within the lumen of the needle with the help of a pusher.

In group B patients, the aspiration needle with the stylette in place was advanced slowly through the skin incision, pointing

Figure 3 Photograph of an elongated blood clot that preceded the expulsion of the core biopsy specimen (arrow) during its removal. In this case, bone marrow aspiration was performed before bone marrow core biopsy using the method described for group A2 patients.

Figure 4 Histological section of a bone marrow core biopsy specimen obtained from a group A1 patient showing denuded areas from where the marrow tissue was forcefully removed during aspiration before core biopsy. Note the preservation of some marrow tissue (arrow).

towards the anterior superior iliac spine. When the posterior iliac crest was reached, it was penetrated by gentle rotary motion of the needle. Once the cortex was penetrated and the mouth of the needle was inside the marrow cavity, the stylette was withdrawn and bone marrow aspiration was performed with a syringe. After aspiration, the stylette was replaced and the needle assembly was completely withdrawn from the patient's body. After withdrawal of the aspiration needle, a separate bone marrow core biopsy needle was introduced through the same incision but directed to a slightly different area of the posterior iliac crest. Once the cortex was penetrated, the stylette was withdrawn and the needle was advanced slowly until an adequate depth (about 20–25 mm) was reached. The core biopsy needle was then rotated several times along its long axis to sever the trabecular connections at its base and then slowly withdrawn. The biopsy specimen was then removed from the needle with the aid of the described probe. It was placed in Zenker's fixative and forwarded to the pathology laboratory for processing. Once the aspiration and trephine biopsy procedures were completed, the edges of the wound were pressed together with adhesive tape. A gauze dressing was applied, and the patient was instructed to lie on his or her back for 10–15 min. After fixation and decalcification, each bone marrow biopsy specimen was embedded in paraffin wax, sectioned at 3–5 μ m and stained with haematoxylin and eosin. Each section was then studied under low-power objectives for structural preservation and morphological integrity.

RESULTS

An adequate bone marrow core biopsy specimen was obtained from each patient, and the length of the core biopsy specimens varied from 12 to 25 mm. An adequate bone marrow aspirate sample was obtained from all but three patients where bone marrow was compromised with the coexistence of marrow fibrosis ("dry tap"). Considerable technical difficulty was observed in groups A1 and A2 patients where bone marrow aspiration was performed before core biopsy using the same core biopsy needle. However, there was no problem with aspiration of marrow in either of these two groups of patients, as it flowed readily and without a tendency to clot. However, the subsequent biopsy process in these cases was bloodier and technically cumbersome because of the spilling of blood through the proximal end of the needle. In addition, after the aspiration process had been completed, the wide-bore biopsy needles usually still contained a considerable amount of blood which often clotted; as a result, there was always an elongated thread of

Figure 5 Histological section of a bone marrow core biopsy specimen obtained from a group A2 patient showing denuded areas from where the marrow tissue was forcefully removed during aspiration before core biopsy. Note the absence of any preserved marrow tissue.

clotted blood that preceded the biopsy specimen when it was pushed out of the needle through its proximal end (fig 3). This, on occasion, also obscured the identification of a clot versus the core sample when ejected from the needle.

Another important problem observed in most of these cases (groups A1 and A2) was that some areas of the sections were depleted or even denuded of marrow cells from the inter-trabecular marrow spaces (fig 4). This observation was easily visualised even under low power. Such artefactual change and tissue distortion also interfered with proper histological evaluation and interpretation of core biopsy specimens.

Tissue damage was more pronounced in the core biopsy specimens obtained in group A2 patients (fig 5). This occurred presumably because the outward flow of the aspirated marrow had to traverse through the core specimen within the lumen of the needle and caused the core specimen to lose more of its marrow cells. However, tissue distortion was minimal and gross artefactual change was not noted in group B patients (fig 6) where aspiration was performed first using a bone marrow aspiration needle, followed by a bone marrow core biopsy using a separate bone marrow core biopsy needle (two-needle technique). Although, a modest degree of artefactual change can be induced by laboratory processing even under normal conditions, the extent of the structural changes seen in patients of groups A1 and A2 were of such magnitude that they could have occurred only because of the prior aspirational dislodgement of marrow.

Figure 6 Histological section of a distortion-free bone marrow core biopsy specimen showing intact marrow for histological evaluation. In this case, a separate bone marrow core biopsy needle was used to obtain the core biopsy specimen. Aspiration before coring was performed with a separate aspiration needle at the same site but from a slightly different area of the posterior iliac crest from where the core biopsy specimen was obtained.

DISCUSSION

Bone marrow may be examined either by an aspiration biopsy or by a trephine biopsy; trephine biopsy is also known as a core biopsy.¹⁸ Bone marrow core biopsy, since its introduction by Ghedini in 1909,^[19] and bone marrow aspiration biopsy, since its introduction by Arinkin in 1929,^[20] have achieved considerable importance in medicine, and haematology and oncology in particular. They are now routinely used in the investigation, diagnosis and management of various haematological and non-haematological malignant conditions as well as in other diseases.¹⁻⁶ They also play an important part in monitoring the course of medical treatment. Useful and much needed diagnostic, prognostic and scientific information can be obtained from adequately processed and properly stained bone marrow aspirate and core biopsy specimens.⁷⁻⁹

Aspiration biopsy usually involves suction of plasma-suspended liquid bone marrow from the sternum with a sternal puncture needle (eg, the Salah and Klima sternal biopsy needle or the Islam needle¹⁰), or from the posterior iliac crest using sternal puncture needles or needles especially designed to obtain marrow from the posterior iliac crest.¹¹ Bone marrow aspiration using sternal puncture (or similar) needles can also be obtained from the anterior iliac crests, ribs, spinous processes of lumbar vertebrae or from any other superficial and easily accessible bones, which show radiological or other evidence of osseous lesions. Bone marrow core biopsy specimens are usually obtained from the posterior iliac crest with a Jamshidi needle,¹² an Islam needle¹³ or similar needles¹⁴ (eg, Core-Lock bone marrow biopsy system). They may also be obtained from anterior iliac crests or other accessible bony sites, such as vertebral bodies, if radiological or other evidence of osseous lesions are present. The advantages of unadulterated bone marrow aspirates and distortion-free, cleanly severed bone marrow core biopsy specimens cannot be overemphasised. To obtain ideal specimens, some investigators have consequently elected to perform biopsy at two independent sites (one for aspiration and one for core biopsy) with two separate needles. Sternal puncture has rare but serious disadvantages. Considerable morbidity and even death have been reported after sternal puncture because of pericardial tamponade as a result of through-and-through passage of the needle.¹⁸ The sternum also contains a small amount of marrow, and in older patients it contains more fat than marrow. It is also considered to be a less desirable site for aspiration as it causes the most pain and patient apprehension.¹⁷ Nowadays, marrow aspiration from the sternum is usually performed only when the posterior and anterior iliac crests are diseased or inaccessible because of massive obesity. Owing to the aforementioned disadvantages associated with the sternal puncture, in a large majority of cases, both aspiration and core biopsy procedures are performed at the posterior iliac crests. Although the percentages of patients undergoing a trephine biopsy in addition to an aspiration biopsy vary considerably (from 8% to virtually 100%),¹⁸ the trend towards performing both at the same time to

avoid a repeat procedure later is increasing. In addition, as the aspirate and biopsy specimens provide complimentary information, some investigators (we and others) now routinely obtain both specimens at the same time. However, owing to the inconvenience of using two needles, one for aspiration and one for core biopsy, and the additional cost involved in using the two needles at the same time, some investigators use a single bone marrow core biopsy needle for both purposes. The need for quality aspirates and biopsy specimens cannot be overemphasised. The complementary nature of the two procedures is also important and performing both in most patients is desirable. Shortcuts, particularly to save the cost of a needle, can compromise the quality of such specimens and should be avoided if possible. From our study, we suggest that aspiration before core biopsy using the same bone marrow core biopsy needle should be avoided, and if aspiration and core biopsy are to be performed at the same site (posterior iliac crest) and at the same time, the two-needle approach should be used.

ACKNOWLEDGEMENTS

I thank Professor Chester Glomski, MD, and Pierre Islam for editorial assistance.

Funding: The author has not received any financial support for the preparation of this scientific report.

Competing interests: None declared.

I wish to disclose that I am the designer of the bone marrow needles used in this study, and they are commercially available through a manufacturer of medical instrumentation.

Correspondence to: Dr A Islam, Division of Haematology/Oncology, Department of Medicine, Buffalo General Hospital, 100 High Street, Buffalo, NY 14203, USA

Accepted 21 March 2006

Published Online First 2 June 2006

REFERENCES

- 1 Brynes RK, McKenna RW, Sundberg RD. Bone marrow aspiration and trephine biopsy an approach to a through study. *Am J Clin Pathol* 1978;**70**:753-9.
- 2 McFarland W, Dameshek W. Biopsy of bone marrow with the Vim-Silverman needle. *JAMA* 1958;**166**:1464-6.
- 3 Ellman L. Bone marrow biopsy in the evaluation of lymphoma, carcinoma and granulomatous disorders. *Am J Med* 1976;**60**:1-7.
- 4 Burke JS. The value of the bone marrow biopsy in the diagnosis of hairy cell leukaemia. *Am J Clin Pathol* 1978;**70**:876-84.
- 5 Brunning RD, Bloomfield CD, McKenna RW, et al. Bilateral trephine bone marrow biopsies in lymphoma and other neoplastic disease. *Ann Intern Med* 1975;**82**:365-6.
- 6 Islam A, Henderson ES. The role of bone marrow biopsy in haematological disorders with special reference to plastic embedded material. *Haematol Rev Commun* 1990;**4**:1-12.
- 7 Goldman JM, Johnson SA, Islam A, et al. Haematological reconstitution after autografting for chronic granulocytic leukaemia in transformation: the influence of previous splenectomy. *Br J Haematol* 1980;**45**:223-31.
- 8 van den Berg H, Kluijn PM, Vossen JM. Early reconstitution of haematopoiesis after allogeneic bone marrow transplantation: a prospective histopathological study of bone marrow biopsy specimens. *J Clin Pathol* 1990;**43**:365-9.
- 9 Liso V, Albano F, Pastore D, et al. Bone marrow aspirate on the 14th day of induction treatment as a prognostic tool in de novo adult acute myeloid leukemia. *Haematologica* 2000;**85**:1285-90.
- 10 Islam A. A new sternal puncture needle. *J Clin Pathol* 1991;**44**:690-1.
- 11 Islam A. A new bone marrow aspiration needle to overcome the sampling errors inherent in the technique of bone marrow aspiration. *J Clin Pathol* 1983;**36**:954-8.
- 12 Jamshidi K, Windschitl HE, Swaim WR. A new biopsy needle for bone marrow. *Scand J Haematol* 1971;**8**:69.
- 13 Islam A. A new bone marrow biopsy needle with core securing device. *J Clin Pathol* 1982;**35**:359-66.
- 14 Goldenberg AS, Tiesinga JJ. Clinical experience with a new specimen capturing bone marrow biopsy needle. *Am J Hematol* 2001;**68**:189-93.
- 15 Islam A. A new single use bone marrow biopsy needle. *J Biomed Instrum Technol* 2005;**39**:391-6.
- 16 Islam A. *Manual of bone marrow examination*. Amsterdam: Harwood Academic, 1997:55-109.
- 17 Knowles S, Hoffbrand AV. Bone marrow aspiration and trephine biopsy (1). *BMJ* 1980;**281**:204-5.
- 18 Bain BJ. Bone marrow biopsy morbidity and mortality. *Br J Haematol* 2003;**121**:949-51.
- 19 Ghedini G. Studi sulla patologia del midollo osseo umano vivente. I. Puntura esplorativa tecnica. *Clin Med Ital* 1908;**47**:724-7.
- 20 Arinkin MJ. Die intravitale Untersuchungsmethodik des Knochenmarks. *Filola Haematol (Leipzig)* 1929;**38**:233-40.

Take-home messages

- The bone marrow aspirate and core biopsy specimen are usually obtained from the posterior iliac crest. The technique involves aspiration before core biopsy using the same bone marrow core biopsy needle (one-needle technique) or aspiration before core biopsy using an aspiration needle (first) and then using a separate bone marrow core biopsy needle to obtain the solid core sample (two-needle technique).
- Our findings indicate that the two-needle technique has definite advantages. It is neater, and provides optimal aspiration and distortion-free core biopsy specimens.