Technical method

A new bone marrow aspiration needle to overcome the sampling errors inherent in the technique of bone marrow aspiration

ANWARUL ISLAM *MRC Leukaemia Unit, Royal Postgraduate Medical School, Hammersmith Hospital, Ducane Road, London W12 0HS*

The technique for examination of the bone marrow by aspiration is widely used in the investigation and diagnosis of haematological as well as non-haematological malignant conditions.¹⁻³ However, with conventional bone marrow aspiration needles, sampling error remains a major problem⁴ and pathological lesions may be missed when the marrow is not involved uniformly.^{5,6} To overcome this, an instrument has been designed* which should reduce the chances of failure in cell aspiration in small focal infiltrates.

The needle has been designed to obtain bone marrow samples from the posterior iliac crests. In addition to the opening at the end of the needle there are 14 side holes in the 17.5 mm distal portion of the needle. The tip of the stylette and the needle have been designed for easy penetration of the soft tissue as well as the bony cortex and resharpening after each use is not necessary. The proximal end of the needle has been fitted with a large metal bar allowing a firm grip and has a smooth handle for operator comfort.

Material and methods

INSTRUMENT

The steel instrument (Fig. 1) consists of two parts. (a) *The needle* has an overall length of 80 mm, a uniform external diameter of 2.35 mm and a constant internal diameter of 1.78 mm except for the 1.25 mm distal portion where it is bevelled to 18°. The 17.5 mm distal portion of the needle has 14 holes made by through and through perforations yielding 4 rows with 8 holes in one plane and 3 rows

with 6 holes in another plane. The rows of holes are 2.5 mm apart and drilled at right angles to each other. The first row of holes is made 3.0 mm from the end of the bevelled point and the diameter of each hole is 1.0 mm. The proximal end of the needle has been fitted with a large metal bar specially shaped for firm grip and a standard male luer lock to receive the nozzle of a syringe and to fit the female luer lock of the stylette and handle.

(b) *The stylette* is a solid shaft of 1.62 mm in diameter except for the distal portion where it ends with a 3.0 mm long three-faceted, sharp-pointed cutting tip which projects beyond the tip of the needle to provide means of easy penetration of the soft tissue and bony cortex. The proximal end of the stylette has been mounted on to a female luer lock buried inside the handle to receive the male luer lock of the needle. The proximal end of the stylette is capped with a hemispherical smooth dome-shaped solid nylon handle 30 mm in diameter and 15 mm deep with 5 mm lightly milled edge. It rests snugly in the operator's hand and is comfortable if forceful thrusting is necessary.

ASPIRATION PROCEDURE

The patient is placed in a right or left lateral position with the knees drawn up and back comfortably flexed or in the prone position with a pillow beneath the hips. The posterior iliac crest is located and following the usually accepted⁷ precautions of skin sterilisation and local anaesthesia of the skin, subcutaneous tissue and periosteum the needle with the stylette in place is slowly advanced through the skin and subcutaneous tissue pointing towards the anterior superior iliac spine and when the posterior iliac crest is reached it is penetrated by rotary motion of the needle. Once the cortex is penetrated the needle is slowly advanced into the marrow cavity with gentle clockwise-anticlockwise rotary motions until an adequate depth (2.5-3.0 cm) is reached. All the holes near the distal portion of the needle must be introduced into the marrow cavity beyond the cortical bone otherwise air bubbles may appear along with the aspirated marrow.

Once the needle is in place the stylette is removed, a syringe is attached and the aspiration is performed. Following aspiration, the stylette is promptly replaced and the needle is withdrawn by firmly holding the shaft and bar together with the handle of the stylette. After withdrawal of the needle firm pressure is applied for one or two minutes over the site of the puncture to stop any bleeding and then a small gauze dressing is applied.

*The instrument is available in three sizes; (i) paediatric (ii) standard (iii) large, for bone marrow harvest. (Downs Surgical plc, Church Path, Mitcham, Surrey, England).

Fig. 1 The needle (a), stilette (b) and the handle (c). The inset 1 shows the details of the distal 17.5 mm portion of the needle and the inset 2 shows the details of the luer lock attachment of the needle and the handle.

Results

The needle has been extensively tested on cadavers and later on 20 patients suffering from various haematological malignancies. Large amounts of marrow have been obtained at each attempt without difficulty. No aspirate was obtained in two cases where the marrow was replaced by fibrous tissue. This needle has been used in three different centres; the operators have found the handling easy and convenient and the patients have accepted the procedure without complaint.

Discussion

The Salah and Klima needles are the two commonly used for bone marrow aspiration. They were designed for obtaining bone marrow aspirate samples from the sternum in the 1930s but except for the introduction of various kinds of stops and guards there has been little change in their basic structure or design. The sternum remains the most commonly employed aspiration site but has disadvantages. Firstly, the patient can see the whole procedure and becomes apprehensive as the needle is introduced into the chest just over the heart; secondly, deaths have been reported due to injury to heart or pericardium; thirdly, the usual site of sternal puncture contains only small areas of marrow tissue, and large amounts cannot be aspirated from this site. These long recognised disadvantages⁸⁻¹¹ of sternal puncture do not apply to posterior iliac puncture yet sternal puncture still remains popular perhaps

because the instruments designed for it are not particularly suited for the ilium.

Inherent in the structure of the conventional sternal puncture needle, but almost totally unappreciated, is the fact that marrow fragments are only obtained from a limited volume of tissue near the open front end of the needle. But bone marrow is patchily involved in many pathological processes and morphological discordance is well known from multiple aspiration specimens in various haematological malignant conditions.¹²⁻¹⁴ The aspiration needles have only one opening through which marrow can be aspirated. Thus if the needle passes-by or goes through a discrete pathological lesion in the marrow (Fig. 2a) during its progress through the marrow cavity, cells from the lesion will not be present in the samples obtained. For example, in a recent case of acute lymphoblastic leukaemia with clinical evidence of relapse a bone marrow aspirate sample from one site was normal while aspiration from another site yielded an unsatisfactory specimen. A long core trephine biopsy however, confirmed the clinical diagnosis. The histological appearance was different in three different areas of the same section. The inner portion of the core—that is, the deepest marrow, showed extremely hypocellular and grossly oedematous marrow with widely dilated sinuses and no haemopoietic activity or evidence of relapse (Fig. 3a). The middle portion of the core showed normal marrow (Fig. 3b), but the outer portion—that is, marrow near the cortical bone, showed dense infiltration by blast cells (Fig. 3c) confirming the

Fig. 2(a) Schematic representation of the aspiration procedure by the conventional aspiration needle. This shows that the needle with the stylette in place, has gone through a lesion (a) during insertion, by-passed a lesion (b) and lodged its opening into an area of normal marrow (c).

Fig. 2(b) Schematic representation of the aspiration procedure by the author's needle. This shows that, the needle with the stylette in place has also gone through the lesion (a) during insertion, by-passed the lesion (b) in exactly the same way as the conventional needle, and the terminal opening is lodged in an area of normal marrow (c). However, because of the multihole system of the needle it has gained access to both lesions (a) and (b) in addition to the area of normal marrow.

Fig. 3 Bone marrow section of the marrow core obtained from a patient with acute lymphoblastic leukaemia in relapse, demonstrating morphological discordance in three different areas of the same section. (a) Field from inner portion of marrow core showing extremely hypocellular and grossly oedematous marrow with widely dilated sinuses and no haemopoietic activity (methacrylate. MGG $\times 600$). (b) Field from the middle portion of the marrow core showing normal marrow appearance with good haemopoietic activity consisting of erythro (e) and granulopoietic (g) cells and scattered megakaryocytes (m) (methacrylate. MGG $\times 600$). (c) Field from the outer portion of the marrow core showing dense infiltration by blast cells (methacrylate. MGG $\times 600$).

clinical suspicion of marrow relapse. A multihole aspiration needle such as the one described here would have permitted the withdrawal of marrow from many different areas at the same time (Fig. 2b) and the recognition of relapse could have been made earlier.

The posterior iliac spinous area is the thickest and largest marrow-containing area in the child and adult.⁷ It is easily accessible and large amounts of red marrow can be obtained. The mass of bone in this region is also distant from any important structures; complications are unlikely and as the patient cannot see the procedure, the anxiety associated with sternal puncture is avoided.

The present aspiration needle was designed to be used on the posterior ilium and to overcome the sampling error inherent in the technique of bone marrow aspiration. The advantageous features of the new needle are as follows: (i) the three-edged, sharp-pointed cutting tip of the stylette easily penetrates the soft tissue as well as the bony cortex and does not require resharping after each use; (ii) the large metal bar at the proximal end of the needle permits a secure and firm grip, while the smooth dome shaped handle fits easily in the palm of the hand so that there is no discomfort even when forceful thrusting is necessary; (iii) the most important feature of the instrument is the carefully tooled distal 17.5 mm portion of the needle with multiple holes in addition to the opening at the front end of the needle. This permits the aspiration of large quantities of marrow if required for harvesting, and increases the chance of securing a representative sample for diagnosis.

I wish to thank Mr DR Bevan of Downs Surgical plc

for his useful advice and keen interest in the development of this instrument.

References

- Arinkin MJ. Intravital Untersuchungs Methodik des Knochenmarks. *Folia Haematol (Leipz)* 1929;38:233.
- Limarzi LR. Diagnostic value of sternal marrow aspirations. *Illinois Medical Journal* 1939;75:38.
- Rubenstein MA. The technic and diagnostic value of aspiration of bone marrow from the iliac crest. *Ann Intern Med* 1950;32:1095.
- Propp S. An improved technic of bone marrow aspiration. *Blood* 1951;6:585.
- Hann IM, Morris Jones PH, Evans DIK. Discrepancy of bone-marrow aspirations in acute lymphoblastic leukaemia in relapse. *Lancet* 1977;i:1215.
- Islam A, Catovsky D, Goldman JM, Galton DAG. Value of long core biopsy in detection of discrete bone-marrow lesions. *Lancet* 1979;i:878.
- Bierman HR, Kelly KH. Multiple marrow aspiration in man from the posterior ilium. *Blood* 1956;11:370.
- Leffler RJ. Aspiration of bone marrow from the anterior superior iliac spine. *J Lab Clin Med* 1957;50:482.
- Editorials and comments. Deaths following sternal puncture. *JAMA* 1954;156:992.
- Bennike T, Gormsen H, Møller B. Comparative studies of bone marrow punctures of the sternum, the iliac crest and the spinous processes. *Acta Med Scand* 1956;155:377.
- Bierman HR. The posterior iliac crest: an additional safe site for bone marrow aspiration. *California Medicine* 1952;77:138.
- Mathe G, Schwarzenberg L, Mery AM, Cattani A, Schneider M, Schlumberger JR. Extensive histological and cytological survey of patients with acute leukaemia in 'complete remission'. *Br Med J* 1966;i:640.
- Jacob P. Discrepant bone-marrow aspirations in leukaemia. *Lancet* 1977;i:356.
- Ragab A, Crist WM. Morphological discordance in acute leukaemia. *N Engl J Med* 1972;287:1134.

Requests for reprints to: A Islam, MRC Leukaemia Unit, Royal Postgraduate Medical School, Hammersmith Hospital, Ducane Road, London W12 0HS.

Letters to the Editor

The Howie code: is the price of safety too high?

Dr Whale¹ plays down the risk of encountering infectious tuberculosis post-mortem. In the mortuary at this hospital, in the last 2½ years, during which about 750 necropsies were performed, I have encountered five instances of pleural/pulmonary tuberculosis in which acid-fast bacilli were easily found microscopically. None of the deceased had been having steroids or cytotoxic drugs, and only one was non-Caucasian. In only one case was there a history of tuberculosis (that history relating to illness in the 1930s) and in no case had tuberculosis been suggested as a cause of death. In fact, in two of the cases I did not

feel that tuberculosis had contributed to death at all.

In several other cases detailed dissection of possible tuberculous lesions had been necessary to exclude the possibility of active tuberculosis. This is not just an academic exercise; the finding of active, possibly "open", pulmonary tuberculosis has implications for contacts at home and at work, and, increasingly frequently, for those involved in attempted resuscitation in cases of sudden death. Furthermore, the presence of possibly tuberculous tissue or fluids remaining in the body after necropsy necessitates warning undertakers against opening the body again for embalming.

In the light of current DHSS recommendations, the simplest course undoubtedly

would be not to become involved in tuberculous necropsies. Unfortunately, however, most cannot be predicted, and, when possible signs of pulmonary tuberculosis are found, there are good reasons for thorough examination, as opposed to closing the body as soon as possible. Regarding the frequency of tuberculosis in this country, notification of respiratory tuberculosis fell only slightly between 1971 and 1972, while notifications of non-respiratory tuberculosis remained almost constant.²

These considerations, coupled with personal knowledge of several acquaintances in morbid anatomy who have had tuberculosis, confirm my view that tuberculosis is by far the most important infective hazard of mortuary work. Whether the