

INFUSIONS VIA THE BONE MARROW AND BIOPSY OF THE BONE AND BONE MARROW • ||

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EVERY anesthesiologist has been faced with the problem of a patient who must have an immediate transfusion and whose veins are not adequate. The veins are too small (as in children), collapsed (as in shock), obliterated (as in burns or injuries), or covered with voluminous bandages. The knowledge and application of the technic of infusions by way of the bone marrow may be life-saving.

None of the advocates of bone marrow infusions infer that this technic should be used routinely. Rather, they state that it should be utilized as an alternate method when it is impractical to employ the peripheral vein route.

The following substances have been infused through the bone marrow (1): whole blood, serum, plasma, normal saline and other similar solutions, vitamins, coramine and other analeptics, the sulfonamide drugs, penicillin and other antibiotics, digitalis and similar products for the heart, heparin, insulin, antitoxins, antiserums and sympathomimetic amines.

Opaque substances (lipiodol and diodrast) have been used to outline in the roentgenogram the circulation in the bone marrow.

Of particular interest to anesthesiologists is the fact that, because of the extensive blood supply within bone marrow (fig. 1) (3), the agents used in anesthesia may be given by way of the bone marrow with as rapid effect as when given intravenously (2).

Thus, bone marrow infusion is actually an intravenous transfusion through blood vessels within bone marrow surrounded and protected by a hard, noncollapsible bony wall.

The same precautions exercised in intravenous transfusions must be taken when an infusion is given through the blood vessels within bones. It is just as important to prevent small particles from entering

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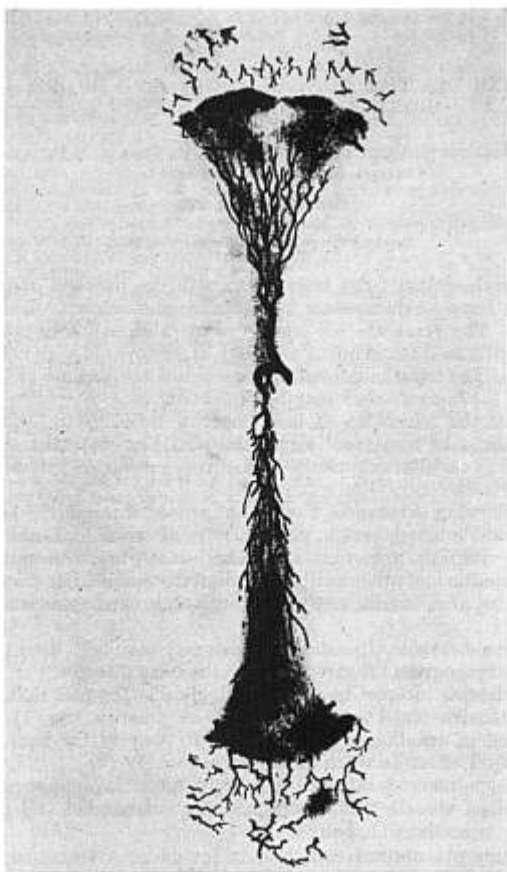


FIG. 1. Roentgenogram with contrast medium of blood vessels within the humerus.

the circulation by the intramedullary route as it is by the intravenous route. This is accomplished by using the needles mentioned herein which extract the particles instead of pushing them into the bone marrow.

Intramedullary infusions are advantageous and useful in the following conditions: (1) in cases of *circulatory collapse* that results from

hemorrhage, burns, injuries and allergic reactions; (2) when veins are poorly accessible as in infants, and patients who are edematous, obese or uncooperative because of convulsions or psychosis; (3) when veins cannot be used because they are fragile, too narrow, thrombosed, collapsed or burned; (4) when *complications*, such as venous thrombosis or thrombophlebitis, develop as a result of *prolonged and frequent intravenous transfusions* of penicillin, amino acids, antisyphilitic agents, hypertonic glucose and salt, and in cases of extensive burns; (5) when there is insufficient time to "cut down" on veins, as in patients who are in states of severe shock, or in patients who are undergoing operative procedures, and (6) when *continuous infusions are contemplated* and the needle may be left in place for several days. The patient is then free to move about in bed.

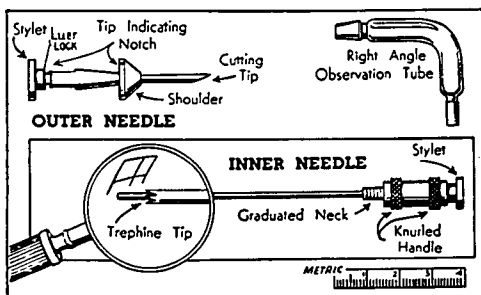


FIG. 2. The trephine needle set (styler, outer needle and trephine).

The following disadvantages and difficulties have been encountered with bone marrow infusions (4, 5): (1) penetration of the needle through the sternum into the mediastinum; (2) osteomyelitis as a result of contamination; (3) local abscesses and subcutaneous infections; (4) leakage around the needle with accumulation of fluid in adjacent soft tissues; (5) leakage from the original puncture site after repeated punctures in the same bone, and (6) necessity for positive pressure for rapid infusions of viscous materials such as whole blood. The patient who is not under anesthesia may find positive pressure uncomfortable. There is no need for positive pressure, even for rapid infusions, when less viscous materials are given.

TECHNIC

The principles of technic for infusion or to obtain a biopsy specimen, using the trephine method with Turkel needles, are the same. The site for infusion or biopsy must be free of infection and is prepared as for any surgical procedure. Procaine hydrochloride is infiltrated into the

skin and to the periosteum. This infiltration is unnecessary if the patient is under anesthesia. When large needles, for example, vertebral body biopsy needles are to be used, a small "nick" must be made to facilitate penetration of the skin. An outer splitting needle, with stilet in place, is pushed through the tissues until bone is reached (fig. 2). The stilet is then removed and replaced by the trephining insert (inner needle), which cuts through the table of bone into the marrow cavity. Broken particles are retained and removed as a core. The outer needle is rotated around the trephine until it also enters the marrow cavity; the trephine is then removed. The glass adapter is attached and the infusion started. For rapid transfusion, positive pressure may be applied directly through the bottle of blood, or a 50 cc. syringe may be attached to a three-way stopcock.

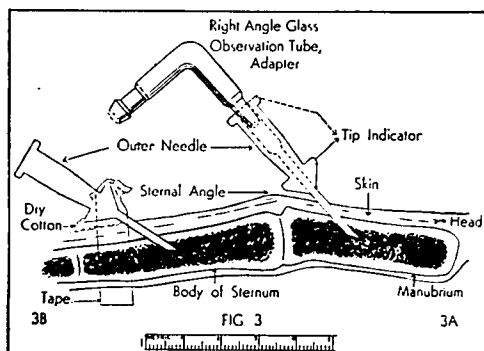


FIG. 3. Insertion of sternal needle.

If a bone biopsy specimen is to be obtained, material may be found in the trephine needle. It is pushed out easily with a stilet. When biopsy only is to be performed the trephine is not removed and a glass adapter is not attached.

A more detailed description of the trephine technic for each of the different sites of puncture follows.

When the body of the sternum is to be used, the puncture should be made approximately 3 cm. from the manubriosternal junction. If the manubrium is to be used, the puncture should be made approximately 2 cm. from the same junction. The needle is always directed cephalad. The outer needle with stilet in place is advanced to the periosteum at an angle of 50 to 60 degrees, with the bevel of the needle parallel to the sternal plate. A notch is placed on the needle for this purpose. This notch must always be toward the operator and away from the patient.

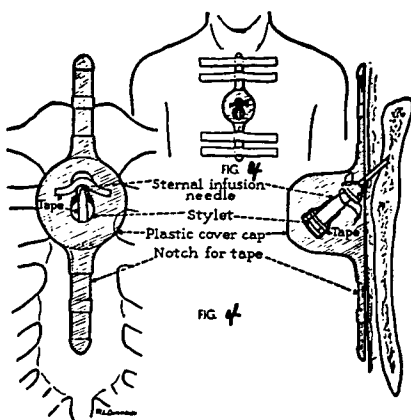


FIG. 4. Plastic cover for repeated sternal infusions.

After the needle is inserted into the marrow cavity, it is advanced not more than the length of the needle neck (6 mm.) or until the shoulder of the needle rests on the skin, whichever is the lesser distance. If the needle is inserted properly, this shoulder will be parallel to the skin.

For repeated transfusions, the needle may be covered with a sterile plastic cap and the surrounding skin area maintained in a sterile condition (fig. 4).

Tibial or femoral puncture (fig. 5 and 6) (1) is the preferred route for children under five years of age. Such punctures may be employed in older children, but a larger needle must be used, and drilling must be more vigorous to penetrate the heavier bone.

Before the infusion is started, aspiration of marrow contents is mandatory. Whereas in the sternum, air bubbles are filtered through

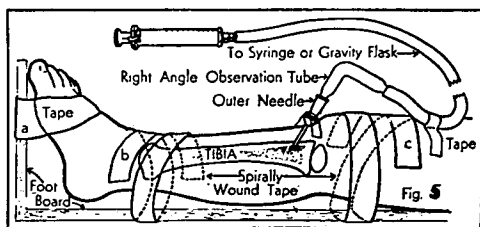


FIG. 5. Tibial puncture.

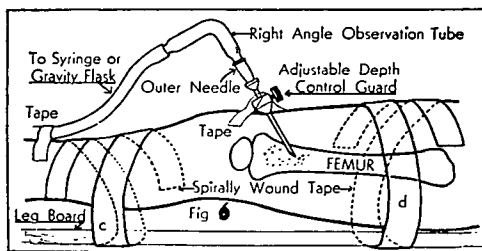


FIG. 6. Femoral puncture.

capillaries before they pass into the venous plexuses, in the long bones air bubbles pass directly through the large nutrient veins into the general circulation.

A 17 mm. needle is used for the tibia and 37 mm. needle for the femur. Tape must be applied so that there is no constricting circular bandage in any one area. The needle is inserted at least 3 cm. from the epiphysis of either the femur or the tibia at the knee joint, at an angle of 45 to 60 degrees, pointing away from the knee joint. The flat surfaces of the tibia and femur are easily palpable 3 cm. from the epiphysis. Either bone is grasped with the thumb and forefinger and the needle is inserted midway between the two fingers. Once the needle is fixed in the periosteum, the hands may be released for trephining.

When *puncture of the iliac crest* is employed, there is little danger of injury to the patient even if the pelvic cavity is penetrated partially. There are few adjacent structures which can be injured by puncture (fig. 7) (1). Metastases from the pelvic structures are easily demon-

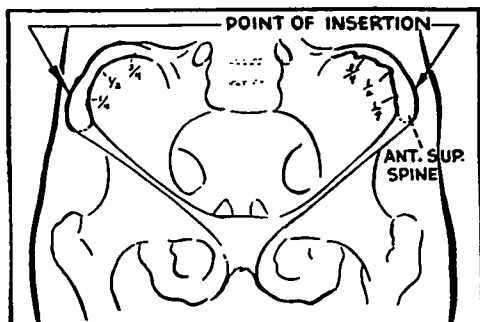


FIG. 7. Puncture of the iliac crest.

strated by means of this puncture. The iliac crests may be difficult to locate in patients with much adipose tissue.

The site to be used is elevated by placing a blanket or pillow under the patient. A site is selected about one-quarter the distance from the anterior superior spine to the posterior spine. Because of the size of the needle (number 13), a small "nick" should be made for easy penetration of the skin. The needle is inserted in the direction of the leg at about 45 degrees from the long axis of the body.

OTHER USES OF THE TREPHINE TECHNIC OF BIOPSY

Biopsy of the prostate gland is performed advantageously by this method because specimens of the posterior lobe can be obtained without recourse to operation. Only the anterior lobe can be reached with transurethral biopsy (6).

Biopsies of the liver and spleen may be performed without surgical intervention (7).

Muscle biopsies may be performed with a special muscle needle (1).

Punctures of the vertebral spines or bodies are of aid for diagnosis of inflammatory or neoplastic lesions. Infusions are never given into the vertebral bodies.

The approach to the vertebral bodies is similar to the lateral approach to the paravertebral sympathetic ganglions. Because of the size of the biopsy needle, care must be taken not to advance it too far from the anterior surface of the vertebra, where it might puncture the aorta or vena cava. In the thoracic region, the needle must be directed so that the pleura remains intact. The approach to the vertebral spine is obvious and presents no difficulty.

Surgical biopsy of the vertebral body is a major procedure. Although the trephine biopsy is not simple to perform, it is much easier than the surgical approach from the viewpoint of both the surgeon and the anesthesiologist. Because the trephine technic is so similar to paravertebral sympathetic block, the anesthesiologist is frequently called on to assist or perform this procedure.

When biopsy of the vertebral body is to be performed, the patient is placed in a true lateral position so that the position of the needle shown in the roentgenograms is accurate. A pillow is placed beneath the lower flank so that the spinal column does not sag and the interstices between the vertebrae are spread.

Some degree of analgesia should be induced by intravenous administration or inhalation of an anesthetic agent. The needle is too large and the passage of the needle through the tissues is too painful to permit this procedure to be done with the patient awake, except in unusual circumstances. It is only necessary to have the patient heavily sedated or in light planes of anesthesia so that he will not move.

After the usual skin preparation, a skin incision is made to allow penetration of the 11 or 12 gauge needle.

The needle is placed on the body of the vertebrae from which a biopsy specimen is to be obtained, and its position checked by antero-posterior and lateral roentgenograms. Fluoroscopy may be used.

After biopsy, it is possible to aspirate, irrigate or inject various drugs (streptomycin, penicillin, and so forth) through the outer biopsy needle.

DISCUSSION

The technic of using the trephine method of infusion with Turkel needles through the bone marrow is safe and simple in the hands of trained personnel.

In infants and children, particularly, in whom veins are not available without cutting procedures, the bone marrow route is efficacious. It may be even more efficacious than the intravenous route in an emergency with children in the following instances.

Children frequently arrive in the operating room after a vein has been cut with the cut infiltrating or the needle pulled out entirely.

"Cut-down" procedures take time. It is possible to scrub an area with septicol, with G-11 or other such preparations for three minutes and then quickly insert the bone marrow needle into the tibia. Total time can be less than five minutes.

After polythene tubing or a stiletted trochar is inserted into a small vein, the flow of the infusion may be slow. Blood may be needed quickly. By means of a tibial puncture it is possible to force 100 to 200 cc. of whole blood into the general circulation within minutes.

It may be necessary to alter the position of the patient on the operating table to cut a vein. However, an infusion into the bone marrow of the tibia can be carried out with the patient in any position.

In the patient who has sustained a burn and in whom no veins are available, or in patients with collapsed veins, the insertion of a bone marrow needle may be life-saving. The needle may be left in place for days if precautions are taken to keep the area sterile.

The most serious disadvantages of bone marrow infusion are as follows: Skill and sterility are needed to insert the needle. This precludes its use by the untrained. Osteomyelitis may develop if the site of puncture is contaminated or bacteria are present. Positive pressure is required when small needles are inserted into the tibia or femur and viscous fluids must be infused rapidly. This is painful if the patient is not under anesthesia. The sternum may be penetrated and mediastinitis result. (No case of penetration has yet been reported when the controlled technic mentioned above has been employed.)

CONCLUSIONS

The advantages and disadvantages of the trephine technic of bone marrow infusion and biopsy, using Turkel needles, are discussed.

The technic for biopsies or infusions, or both, of the sternum, tibia and femur, iliac crests and vertebral bodies is described in detail.

REFERENCES

1. Turkel, H.: *Trephine Technique of Bone Marrow Infusions and Tissue Biopsies*, ed. 5, Detroit, Gale Printing Company, 1951.
2. Macht, D. I.: Studies on Intravenous Injection of Epinephrine, *Am. J. Physiol.* **138**: 269-272 (Jan.) 1943.
3. Lexer, E., Kuliga and Tirk, W.: Untersuchungen über Knochenarterien mittelst Röntgenaufnahmen injizierter Knochen und ihre Bedeutung für Einzelne Pathologische Vorgänge am Knochen-Systeme, Berlin, 1904.
4. O'Neill, J. F.; Tocantins, L. M., and Price, A. H.: Further Experiences with Technique of Administering Blood and Other Fluids via Bone Marrow, *North Carolina M. J.* **3**: 495-500 (Sept.) 1942.
5. Quilligan, J. J., Jr., and Turkel, H.: Bone Marrow Infusion and its Complications. *Am. J. Dis. Child.* **71**: 457-465 (May) 1946.
6. Roth, A. A., and Turkel, H.: A Technique of Prostatic Biopsy, *J. Urol.* **51**: 66 (Jan.) 1944.
7. Davis, W. D.; Scott, R. W., and Lund, H. Z.: Needle Biopsy of Liver, *Am. J. M. Sc.* **212**: 449-461 (Oct.) 1946.

(Continued from page 487)

Tuesday, November 11, 1952

AFTERNOON: MEETING OF THE BOARD OF DIRECTORS

GENERAL SCIENTIFIC SESSION:

Oxygen Tension Utilizing the Semi-Closed and the Closed Systems for the Flow of Anesthetic Gases—John Adriani, M.D.

The Site of Action of Spinal and Peridural Anesthesia in Man—M. J. Frumin, M.D., J. J. Burns, Ph.D., H. Schwartz, M.D., B. B. Brodie, Ph.D., and E. M. Papper, M.D.

Preliminary Presentation Section

Metabolism of Procaine Following Its Subarachnoid Injection—Paul H. Lorhan, M.D., Gretchen Guernsey (Leigh), M.D., and Marguerite M. Devine, M.D.

Cortisone Problems Involving Anesthesia—John S. Lundy, M.D.

Laboratory Investigation of Pain—Frederick P. Haugen, M.D.

Vinyl Ethyl Ether—A New Anesthetic Agent—Max S. Sadove, M.D.

New Intravenous Barbiturates—V. K. Stoelting, M.D.

The Intravenous Use of a Thiophanium Derivative (Arfonad—RO2-4222) for the Production of Flexible and Rapidly Reversible Hypotension During Surgery—Morris J. Nicholson, M.D., Stanley J. Sarnoff, and Joseph P. Crehan, M.D.

The Use of Succinylcholine to Facilitate Endotracheal Intubation—David M. Little, Jr., M.D., and L. Jennings Hampton, M.D.

EVENING: RECEPTION FOR BOARD OF DIRECTORS

(Program Continued on page 544)