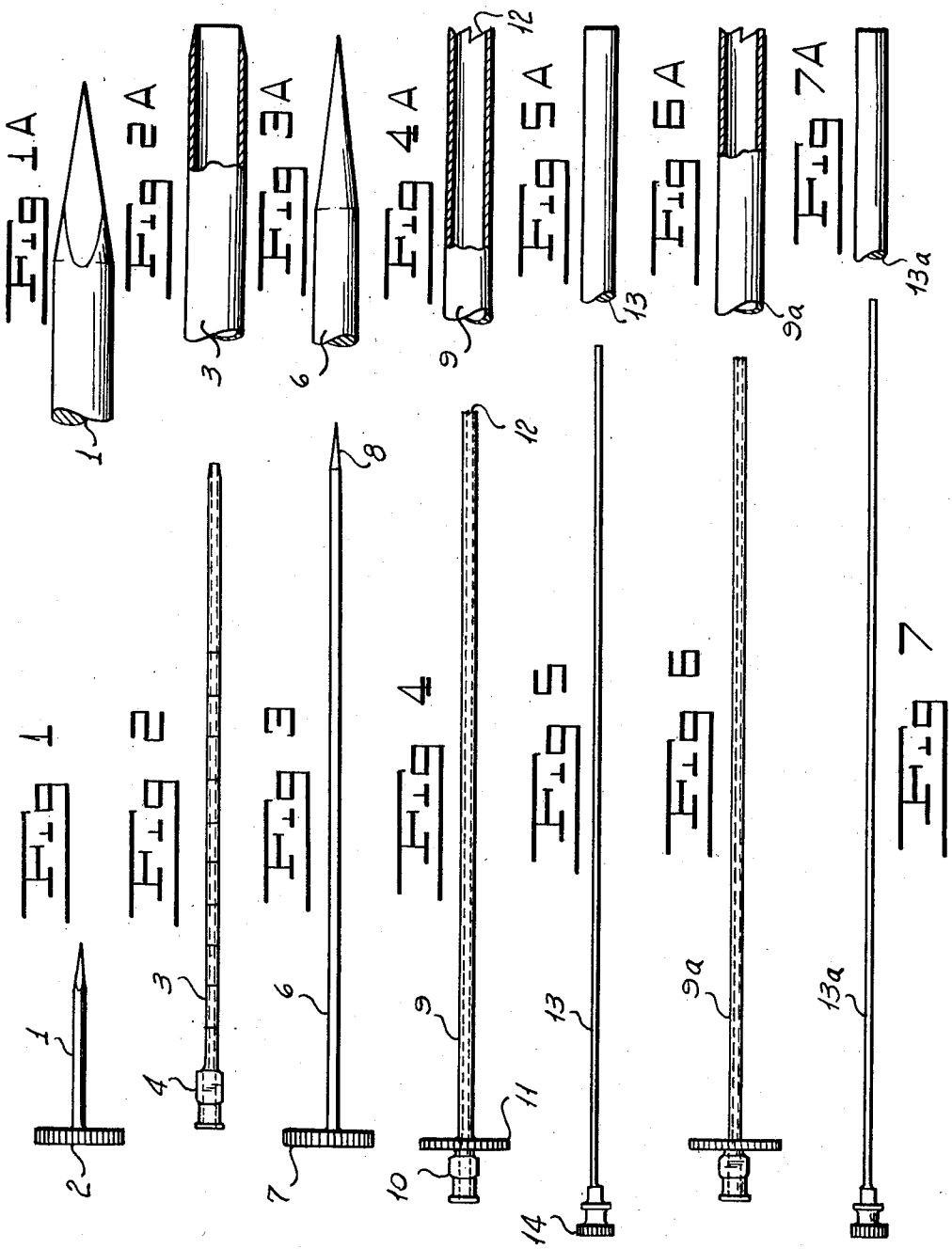
Jan. 5, 1960 W. ACKERMANN 2,919,692

VERTEBRAL TREPHINE BIOPSY INSTRUMENTS

Filed Feb. 23, 1956 2 Sheets-Sheet 1



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VERTEBRAL TREPHINE BIOPSY INSTRUMENTS

Filed Feb. 23, 1956 2 Sheets-Sheet 2

Fig 8

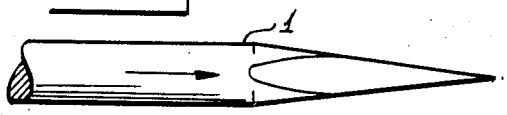


Fig 9

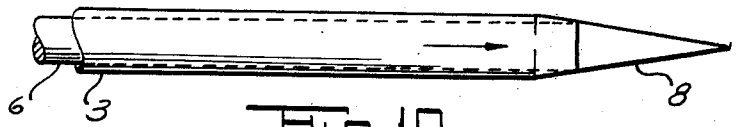


Fig 10

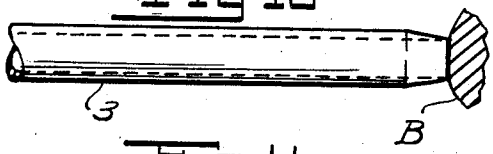


Fig 11

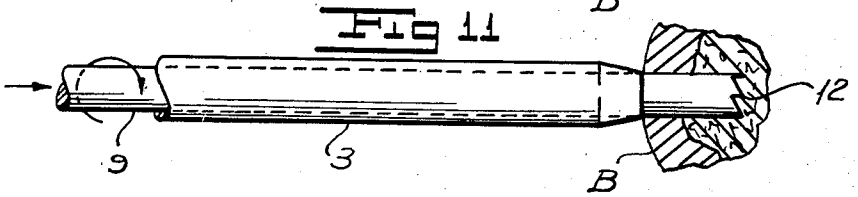


Fig 12

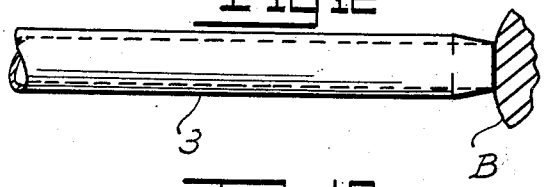
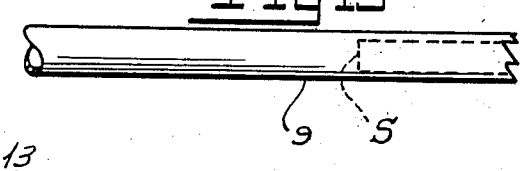


Fig 13



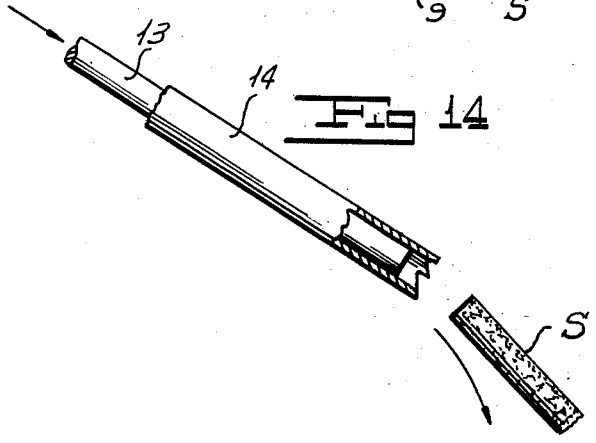


Fig 14

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United States Patent Office 2,919,692 Patented Jan. 5, 1960

2,919,692

VERTEBRAL TREPHINE BIOPSY INSTRUMENTS

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Application February 23, 1956, Serial No. 567,284

1 Claim. (Cl. 128—2)

This invention relates to instruments employed primarily in vertebral trephine biopsies.

Bone biopsy involves, generally speaking, the removal of the external or cortical portion of a bone and the sampling of the internal or deeper part of the marrow of such bone by extracting therefrom a relatively small portion of the bone and a larger portion of the marrow therein for the determination of the presence or absence of pathology by microscopic analysis.

The procedure has heretofore been carried out essentially through the employment of a hollow instrument, which originally had a square end. Later it was pointed like a needle, but more recently was made into what is known as a trephine, the operating end of which is serrated to provide, in effect, a hollow bit which, when manually rotated, serves to cut through the bone into the interior thereof and then enter into the marrow for a predetermined distance. This separates a cylindrical segment of the bone from the remainder of the latter, except for the distal end, to leave within the interior of the trephine an almost disconnected plug constituting a specimen which may be removed by withdrawal of the trephine, after breaking off the distal end of the bone by rotation of the trephine and subsequently expelled from the operating end of the latter by a solid extruder passed through the interior of the instrument. This specimen is then subjected to sectioning, embedding, staining and other appropriate treatment well understood in the profession and utilized for the determination of the disease that may be present.

Before the bone cutting instrument is inserted, it has been most frequently the practice to introduce a hollow instrument with an oblique cutting end. Into this so constructed hollow instrument or needle is interfitted a stylet having an end corresponding to the operating end of the needle and coincident therewith. These assembled instruments are forced through the skin and other soft tissues until the sharp point of the needle contacts the bone to be sampled or bisopsied. The stylet is then removed from the hollow instrument and in its place a trephine is inserted and passed through and brought in contact with the bone and manually driven into the bone to a predetermined depth to finally extract a specimen as hereinbefore described.

The operations and technic hereinbefore described do not raise any serious problems in the practice of biopsy on the exposed or superficial parts of the bones, but are fraught with many difficulties and dangers to the patient when performed upon deeper seated bones, especially upon the bodies of the vertebrae. The reason for this is that the vertebral bodies are in very close proximity to large arteries and veins, nerve roots, nerves, spinal cord, and other vital parts which, if punctured or torn, are apt to result in serious consequences to the patient, such as internal hemorrhages, severing of nerves, tearing of meninges and piercing the spinal cord, resulting in partial paralysis, puncturing of the intestines, kidneys, lungs and even the heart. It therefore becomes extremely important in vertebral biopsy to conduct the same with great care and with such instruments as will permit of the operations described wtihout perforation or other damage to the vital organs and structures named, in the path of the operating field.

Up to the present time, none of the heretofore described methods has been generally accepted by the medical profession for this highly important diagnostic procedure because the various sets of instruments available were not consideerd safe enough for common use. Needless to say, many futile operations could have been avoided if this procedure could have been universally carried out without damage to the patient.

Exhaustive experimentation and research have convinced me that it is possible to avoid injury to the patient through the use of proper instruments, utilizing, generally speaking, the essential instrumental elements so employed, but so constituting them that, when introduced through the soft tissues to the bone structure, because of their simplicity in construction, greater adaptability and flexibility in handling, no injury would result to the patient and the diagnosis would be readily established, a factor which is of vital importance in the treatment of cancer.

I have found that it is essential to the carrying out of safe vertebral biopsies to employ instruments of minimum dimensions. My research has shown that, in order to microscopically analyze a biopsy specimen obtained, it does not need to have a diameter larger than 1.5 mm., irrespective of its length. That is the proper size required for effective examination and diagnosis.

I employ a short and a long trephine both of tubular cylindrical form having an internal diameter of 1.5 mm. in which the specimen may be collected. In lieu of a stylet, I employ a locator which is 2 mm. in diameter and the external diameter of the trephine is also 2 mm. Thus the wall of the trephine is made relatively light and is adapted to have a close sliding fit within the interior of a tubular trephine guide, which also has a wall of minimum thickness, so that the overall diameter of the instrument, as introduced into the tissue, is at the very minimum. This is in pronounced contradistinction to prior biopsy instruments which have been and are universally made of so much greater overall diameter that, when introduced through the tissue, it is practically impossible for them to pass by nerves and blood vessels without causing serious trauma.

Furthermore, prior instruments are, in many instances, so shaped on their operating ends as to cut and tear the tissues, specifically blood vessels and nerves because their ends have needle points. The operating ends of my trephine guide and locator are, in contradistinction, so constituted that they push aside these vital parts of the body and enter between them without damage to them. For this purpose, the locator is made with a pointed tip sufficiently sharp to pass through muscle tissue and fasciae, but not so sharp as to puncture blood vessels or nerves and the wall at the outer end of the trephine guide is externally thinned or tapered to merge into the outer surface of the locator without providing a cutting edge or shoulder at the juncture where the two surfaces merge. Thus, when the trephine guide and locator are simultaneously introduced with the latter within the former, the tip at the end of the locator forms a path for the trephine guide and in which path the guide follows between the blood vessels and nerves until that guide engages the bone surface.

One important feature of the invention therefore resides in a tubular trephine having a bore of uniform diameter throughout and of the order of 1.5 mm. internal diameter with cooperating instruments of correspondingly small dimensions, their dimensions being only that necessary to impart to each of them the requisite mechanical strength. Such instruments may be utilized to safely perform vertebral biopsies for the reasons hereinbefore described and hereafter referred to.

Features of the invention, other than those adverted to, will be apparent from the hereinafter detailed description and appended claims, when read in conjunction with the accompanying drawings.

The accompanying drawings illustrate one practical embodiment of the invention, but the construction therein shown is to be understood as illustrative, only, and not as defining the limits of the invention.

Sheet 1 of the drawings, embodying Figures 1–7A inclusive, shows the instruments of this invention separated from one another. In these views:

Fig. 1 is a side elevation of a perforator.

Fig. 2 is a side elevation of a trephine guide embodying this invention.

Fig. 3 is a side elevation of a locator.

Fig. 4 is a side elevation of a short trephine.

Fig. 5 is a side elevation of a short extruder.

Fig. 6 is a side elevation of a long trephine.

Fig. 7 is a side elevation of a long extruder.

Fig. 1A through 7A, inclusive, are fragmental end views on greatly enlarged scale of the parts shown in Figs. 1–7, respectively, with certain parts of Figs. 2A, 4A and 6A shown in central section.

Sheet 2 of the drawings shows the manner in which the several instruments of Sheet 1 are utilized in conjunction with one method and the steps performed in obtaining a biopsy specimen. In these views, all of which are on greatly enlarged scale:

Fig. 8 shows the operating end of the perforator.

Fig. 9 shows the locator positioned in the trephine guide ready for insertion into the body tissues.

Fig. 10 shows the trephine guide as having been introduced so that its operating end contacts the bone to be biopsied and with the locator removed.

Fig. 11 shows the trephine in the trephine guide and in the act of being introduced into the marrow of a bone.

Fig. 12 shows the trephine guide remaining in place against the bone but with the trephine removed.

Fig. 13 shows the trephine after it has been removed from the trephine guide and with a specimen therein.

Fig. 14 shows the extruder in the act of removing the specimen from the trephine.

The various instruments which enter into the present invention will next be described in detail. In describing these instruments, I will set forth the instruments as they have been actually made and used and will give the dimensions which have been employed in the related parts. I wish it understood that the diameters of these parts are critical within very close dimensions, but the length of the respective instruments may be changed within reasonable limits without departing from this invention, provided that the relation of the length of the trephines to the length of the trephine guide remains constant.

Perforator.—The perforator is shown in Figs. 1, 1A and 8. It has an overall length of 4.5 cm. It has a solid shank **1** with a diameter of 2.5 mm. and ends in a 1 cm. long three edged sharp pointed cutting tip which serves to cut the skin and dense fasciae down to the muscles. It does this with ease, causing hardly any bleeding, unlike the knife customarily used. The shank **1** is provided with a solid knurled head **2** by which it may be manually manipulated.

Trephine guide.—This guide **3** is shown in Figs. 2, 2A and 9–12 inclusive. It is a tube of uniform external and internal diameter throughout and has an overall length of 14 cm. At its outer end it is provided with a 15 mm. long Luer needle hub **4** which may be used to manually manipulate it and to connect to it a syringe for the introduction of an anesthetic if desired. Its gauge is 2.5 mm. and its inner diameter readily admits both the locator shown in Fig. 3 and the trephine shown in Fig. 4. Its operating end is externally reduced to substantially intersect with its inner surface and the outer surface of the tube beginning at 4 cm. from its operating end is provided with graduations at intervals of 1 cm. up to 10 cm. These graduations are designated **5**.

Locator.—The locator **6** is shown in Figs. 3, 3A and 9. It has a solid shaft 2 mm. in diameter, provided at its outer end with a knurled finger piece **7** and at its operating end it has a 1 cm. long smooth tip **8**, which gradually narrows down to a dull point. The purpose of the locator **6** is to direct the trephine guide **3** to the area to be biopsied. The locator is adapted to be inserted within the trephine guide, as shown in Fig. 9, the length of these two parts being such, as shown in Figs. 2 and 3, that when assembled as shown in Fig. 9, the finger piece **7** of the locator will butt against the outer end of the hub **4** of the trephine guide and so position the operating parts that the reduced end of the trephine guide will merge into the reduced pointed end of the locator, as shown in Fig. 9. While thus assembled, the parts are inserted into the opening made in the skin by the perforator and can be easily advanced through the thin fasciae and muscles. Experience has demonstrated that when thus inserted and moved forwardly into contact with the bone to be biopsied, the nerves and blood vessels will be pushed aside, so that the instruments may pass between them into contact with the bone without injury to the named structures, provided, of course, reasonable limited force is applied without attempt to unduly hurry the insertion.

Short trephine.—This trephine **9** is shown in Figs. 4, 4A, 11, 13 and 14. It comprises a cylindrical tube of uniform inner and outer diameter and of an overall length of 16.75 cm. At its outer end it has a Luer needle hub **10** for vertebral bone marrow aspiration and adjacent this hub is a knurled finger piece **11** by which this trephine may be manually rotated to cause its end to cut into the bone. The gauge of the trephine is 2 mm. and its inner diameter is 1.5 mm. Its operating end has a serrated edge **12** shown as provided with six very fine sharp teeth undercut on their leading edges for sawing purposes. The length of this short trephine is sufficiently greater than the length of the trephine guide **3** to permit the operating end of the trephine to project a distance beyond the operating end of the trephine guide sufficiently to project into the marrow of the bone the distance desired for the specimen to be obtained.

While the trephine guide is in place, as shown in Fig. 10, with its operating end in contact with the bone B, the trephine **9** is passed through the trephine guide **3** and rotated so that the saw toothed end **12** thereof saws its way into the bone B, as shown in Fig. 11. This procedure is carried out by rotating the finger piece **11** with slight pressure until the finger piece **11** engages the hub **4** of the trephine guide by which time the desired length of specimen has accumulated within the trephine. A few additional turns of the trephine will break loose the distal end of the specimen from the bone structure, so that the trephine may be withdrawn with the sample therein, leaving the trephine guide **3** in contact with the bone, as shown in Fig. 12, and the specimen within the withdrawn trephine, as indicated at S in Fig. 13.

Long trephine.—The long trephine **9***a*, shown in Figs. 6 and 6*a*, is exactly the same as the short trephine, except that it is 1.25 cm. longer. It thus has an overall length of 18 cm. and is used for the obtaining of a deeper biopsy specimen.

Short extruder.—This extruder is designated **13** and is shown in Figs. 5, 5A and 14. It is, in effect, a straight solid stylet of uniform diameter provided at one end with a finger piece **14** by which it may be manipulated and it is of a length sufficient to extend entirely through the interior of the short trephine. Its diameter is such as to provide a close sliding fit with the bore of the short trephine.

Long extruder.—This extruder is indicated at **13***a* in Figs. 7 and 7A and is identical with the extruder **13** except that it is 1.25 cm. longer.

The purpose of these extruders is to remove the specimens S from the respective trephines by passing the extruder through the trephine, as indicated in Fig. 14. By making the internal surface of both trephines cylindrical throughout I find that the specimen may be readily removed therefrom without crushing it or otherwise damaging the same, so that the specimen may be sent to the laboratory in the best possible condition for analysis.

In employing the instruments of this invention for obtaining vertebral biopsy specimens, the perforator 1 with its triangular tip is introduced through the skin and fasciae into the first underlying muscle. This provides a perforation. The assembled locator and trephine guide are then inserted as a unit at an angle of about 45° until the body of the vertebra is encountered, usually at a depth of 8–9 cm., as observed on the graduated scale 5, although in emaciated people the distance may be 6–7 cm. The point of the locator is bored or impressed into the cortex of the vertebra, so that it will stay in place and, while thus located, X-rays are taken and the position of the instruments checked, in relation to the exact area to be biopsied, in wet films. If their position does not appear satisfactory, the necessary adjustment is made by swinging the locator up or down anteriorly or posteriorly to obtain optimum angular relation. The trephine guide is then advanced 1 cm. to the point of the locator and thus brought in contact with the vertebral body and is manually held fast in this position.

The locator is then removed and replaced by the short trephine 9 which is brought into contact with the vertebral body and rotated under gentle pressure, so that it cuts its way through the periosteum and cortex into the marrow spaces of the bone until the finger piece of the short trephine engages the hub of the trephine guide. X-rays are then taken in two views for a second time and the wet films checked for the exact location as well as for the angulation of the trephine. The trephine is then rotated several times without advancing or dislodging it, in order to break off the distal end of the core-like specimen and when this has been accomplished, the trephine is withdrawn with continuous slow rotating motions leaving the trephine guide in contact with the vertebral body.

The long trephine is then introduced through and beyond the guide into the bone through the track cut out by the short trephine through the cortex and is thereupon rotated under gentle pressure to bore deeper into the vertebrae and until the finger piece of said long trephine contacts the head 4 of the trephine guide. Since the long trephine cuts more deeply into the vertebral marrow than a short trephine, it obtains a specimen of the marrow at a greater depth and this specimen contains hardly any cortical bone but practically all marrow. The long trephine is then rotated, while its position is fixed, to break the specimen from the remaining portion of the marrow, after which the long trephine is withdrawn, carrying with it the second specimen which has been thereby obtained.

By the use of the short and long extruders, the specimens are expelled from the respective short and long trephines, observed as to color and general appearance and placed in Zenker's solution for fixation prior to processing in the pathological laboratory for diagnosis.

The procedure described for obtaining two specimens may, if desired, be repeated once or twice on the same vertebra, either above or below the area previously biopsied, thus providing pathological speciments from different depths and also at different levels. Since metastases in bones are nearly always multiple, it may be desirable to biopsy more than one vertebra. If the second vertebra to be biopsied is adjacent the first one, the procedure is carried out through the same entrance channel leading to the vertebrae by merely directing the instruments upwardly or downwardly at an appropriate angle in relation to the midline.

It will of course be understood that before starting the biopsy, a paravertebral nerve block is carried out and, if one or more additional biopsies are to be performed through the same track, additional nerve blocks will routinely be effected. After the specimens have been obtained, the trephine guide is removed and the exceedingly small wound which has been made is covered with a dry dressing.

A great number of biopsies have been performed through the employment of the instruments of this invention. Highly satisfactory specimens have been obtained and in no case has there been excessive bleeding or injury to any of the vital parts of the body. I attribute these facts largely to the critical dimensions of the instrumenhts which, as hereinbefore pointed out, provide for the obtaining of a specimen sufficiently large for accurate pathological examination and no larger than necessary to obtain such results.

This is in marked contradistinction to all instruments of the prior art, most of which have complicated parts, such as hooks, notches, screws, shoulders, springs, wrenches and tissue retaining means and other expedients. These instruments, in addition to all these enumerated complications, have been invariably made of much greater diameter and of a size which makes it practically impossible for the vital structures to be displaced without damage thereto. Moreover, in many instances, the instruments heretofore used have embodied cutting or tearing edges which, because of their construction and/or sharpness, actually cut their way into or through the blood vessels and nerves and thus initiate internal bleeding, severing of nerves leading to partial paralysis, puncture of the peritoneal cavity with resulting peritonitis, puncture of the pleural cavity and lungs resulting in pleurisy, pneumonia, etc.

In the many biopsies which have been performed according to this invention, no patient has experienced any discomfort or injury and the resulting wound is so minute that it heals in twenty-four hours.

The foregoing detailed description sets forth the invention and its uses in its preferred forms, but the invention is to be understood as fully commensurate with the appended claim.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

Means for performing bone biopsies comprising: a tubular trephine guide having an internal diameter of approximately 2 mm. and provided on its exterior with a longitudinally disposed graduated dimensional scale to indicate when the desired depth of penetration has been attained to reach the predetermined bone structure, the free end of said guide being externally tapered, a solid rod locator projectable through said trephine guide to and beyond the tapered end of the latter with the projecting end of the locator of greatly elongated conical shape terminating in a point of such degree of sharpness as to pass through fascia and muscles but not so sharp as to puncture blood vessels and nerves, the tapered surface of the guide forming substantially a continuation of the conical end surface of the locator, whereby the assembled guide and locator push aside nerves and blood vessels without damage thereto until they arrive at the predetermined point of the bone to be biopsied.

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