NEW TECHNIC AND INSTRUMENT FOR OBTAINING BIOPSY SPECIMENS

WILLIAM J. HOFFMAN, M.D.

(From the Memorial Hospital, New York City)

In the clinical diagnosis of tumors, the final decision as to the nature of the growth often can be determined only when a piece of the tumor, or a part of its contents, is obtained for pathological examination. Many questions can be definitely settled when biopsy material is once obtained in sufficient amount, and in unchanged condition. Some of these are: whether the tumor is inflammatory, benign, or malignant; the type of the tumor; the grade of malignancy, and the degree of radiosensitivity. Based on this information, further deductions may be made relative to the prognosis and to the treatment of choice. Knowing these facts, one can decide whether surgery or radiation alone, or a combination of both, offers most for the patient.

Present methods of obtaining biopsy material include: (1) excision by scalpel, cautery, or endotherm knife; (2) aspiration; (3) various punch methods, making use of cylindrical punches, barbed hooks, "harpoons," punch forceps, gouges, dental broaches. The disadvantages of each of these methods may be briefly mentioned.

Excision by scalpel affords a method of obtaining a specimen readily enough, but has the serious disadvantage that it creates a relatively large breach in the capsule of the tumor, and prepares a route along which a malignant tumor may rapidly spread. Recurrences of such tumors in surgical incisions amply demonstrate this fact. A further disadvantage is that an incision of greater or less extent is necessary. Not only does this mean a surgical exposure under aseptic conditions, with a more or less elaborate set-up in the operating room, but subsequent suture of the wound, a sequence of surgical dressings, and a greater cosmetic blemish by reason of the larger scar.

Excision by actual cautery or by endotherm knife is relatively safer than excision by scalpel. Properly used, these instruments so devitalize the tissues of the tumor and its bed that the likelihood of implantation of viable tumor cells and subsequent recurrence along the incision is reduced. These methods, however, are open to the same objection as excision by scalpel, in that they are part of an elaborate procedure, and result in a definite scar.

Aspiration of a tumor by means of a syringe and hollow needle is simple and easy, and the equipment is readily available. At the Memorial Hospital, in the hands of Dr. Hayes E. Martin, this method has proved itself of great value. It works best in fluid, or semi-fluid tumors, excellently in soft, highly cellular tumors, but less satisfactorily in those of denser structure. Ferguson (1), using the technic of Martin and Ellis (2), obtained tissue or cells in 86 per cent of a series of prostatic tumors which he aspirated. He was most successful with the more cellular types of tumor. Most of his failures occurred in those of firm, dense structure or those which were the seat of fibrosis, especially that following irradiation. The method entails a minimal amount of trauma to the tumor, except in those cases where repeated failures to obtain cells or tissue have necessitated multiple punctures. One objection which might be raised is that withdrawal of the needle, contaminated as it is by tumor cells on its surface, might implant these along the needle track.

Various punch methods have been devised. The instruments vary more or less in construction, but depend upon a barbed hook, cylindrical punch, gouge or dental broach, to cut off or tear away a piece of tumor tissue. They vary greatly in efficiency, according to their construction and the principles on which they are designed to operate. All are open to the great objection common to the aspiration method and to excision by scalpel, namely that they draw living tumor tissue out through a breach in the tumor wall, and implant it along the track (3, 4, 5, 6).

An ideal technic and instrument for biopsy should satisfy the following requirements:

1. It should be safe.
2. It should not favor the spread of the tumor.
3. The instrument should be simple and sturdy in construction, easily adjusted and assembled, easily cleansed of all tumor tissue, and easily sterilized.
4. It should be possible in nearly all cases to obtain with the instrument a piece of tissue through a small puncture wound on the first attempt, inflicting the minimum of trauma.

5. If a greater quantity of material is desired, it should be possible to remove additional tissue without making a new opening in the capsule of the tumor.

6. The method should be applicable for withdrawal of a wide variety of material, whether fluid, semi-fluid, caseous, soft cellular, densely fibrous, cartilaginous, or bony in character.

7. An actual piece of tissue, not just a few cells, should be obtained. The specimen should be large enough to exhibit its characteristic structure and to furnish material for an immediate smear and for a later paraffin preparation.

8. Since all instruments which attempt to remove a piece of tissue must necessarily make a breach in the defensive wall about a tumor, the method must provide some way of sealing that breach and of killing all tumor tissue adherent to the surface of the instrument or leaking out around it or in any manner deposited along the track, before the instrument is withdrawn.

With the instrument and technic about to be described, the author believes that he has met these requirements.

The new biopsy instrument consists essentially of a slender steel sheath, 14 cm. long. Its outside diameter is slightly over 2 mm. (about twice the diameter of an 18 gauge needle). The outer surface of this sheath is electrically insulated except for a narrow band of exposed metal at one end. This end is honed to a cutting edge. The other end of the steel sheath is fitted with a tapered collar of such dimensions as to receive the tip of a standard syringe. This hollow sheath will receive any one of several members designed to puncture a hole, to cut off and grasp a piece of tissue, to withdraw the tissue fragment through the sheath, and later to coagulate the track by high-frequency current. The first of these members is a steel obturator which fits snugly within the sheath and has a point at one extremity, and a knurled knob at the other. In the center of this knob is a socket for reception of a plug tip of a wire leading from a source of high-frequency (coagulating) current. The other internal members are similar steel rods whose distal ends constitute tools of various shape and design, intended to enter a tumor and cut off a piece of it and convey it outward through the inside of the sheath.

1. The first of these is a straight solid steel rod bearing on one end a knurled knob, and on the other a conical point. This point is tapered evenly for a short distance, terminating in a base of such diameter as to fit snugly into the steel sheath. The base of

the cone is ground to a keen edge, and the inside of the cone is hollowed out so that the whole forms a miniature pointed bucket on the end of the steel rod projecting beyond the sharpened end

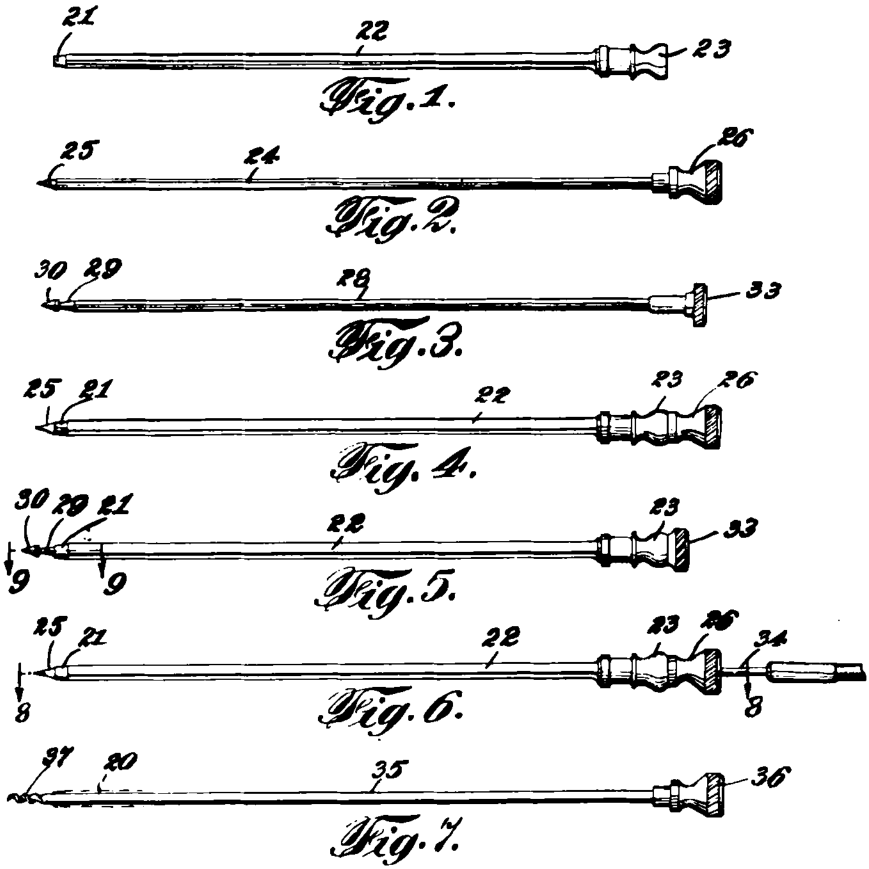


FIG. 1. INSULATED STEEL SHEATH. (21) cutting edge; (22) insulation; (23) syringe collar.

FIG. 2. STEEL OBTURATOR. (25) pointed tip; (26) knurled knob.

FIG. 3. INNER MEMBER. (28) steel rod; (29) constriction; (30) hollow cone; (33) knurled knob.

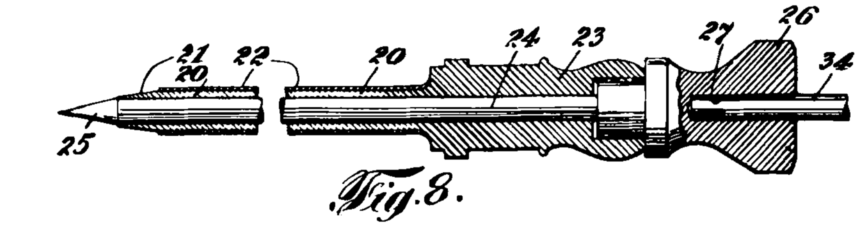
FIG. 4. OBTURATOR INSIDE SHEATH, READY TO ENTER TUMOR.

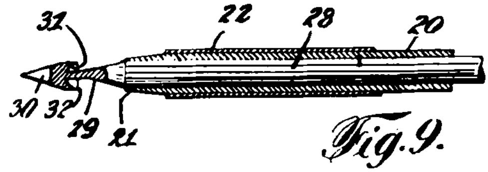
FIG. 5. INNER MEMBER WITHIN SHEATH. As inner member is withdrawn, tumor tissue occupying space at constriction (29) will be sheared away between edge of cone (30) and edge of sheath (21).

FIG. 6. OBTURATOR REINTRODUCED AND CONNECTION MADE TO HIGH-FREQUENCY COAGULATING CURRENT BY PLUG (34).

FIG. 7. SPIRAL CONVEYOR CUTTER.

of the steel sheath. When this is plunged into a tumor and the outer sheath is held in position, the inner member is thrust in to its full depth so that the hollow cone enters somewhat more deeply than the outer sheath. The inner member is then withdrawn slowly so that the part of the tumor which bulges inward around the base of the cone is caught between the sharp edge of





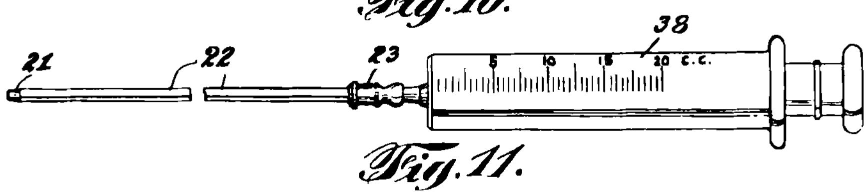


FIG. 8. DETAIL DRAWING OF SHEATH AND OBTURATOR WITH CONNECTION TO HIGH-FREQUENCY COAGULATING CURRENT. (20) steel sheath; (21) cutting edge; (22) insulation; (23) syringe collar; (24) steel obturator; (27) plug tip connection to high frequency coagulating current.

FIG. 9. DETAIL DRAWING OF CONICAL TIPPED INNER MEMBER. (30) pointed tip; (31) hollow cone; (32) cutting edge; (29) constriction; (21) cutting edge of sheath; (22) insulation; (20) steel sheath; (28) steel rod.

FIG. 10. CONVEYOR CUTTER WITHIN SHEATH. (37) cutting edge.

FIG. 11. SYRINGE CONNECTED TO SHEATH FOR ASPIRATION OF TUMOR.

the base of the cone and the sharp edge of the end of the sheath. The biopsy specimen is thus sheared away and is drawn out through the sheath, the piece of tumor occupying the hollow of the conical tip. If additional tissue is required, the process may be repeated. The tumor tissue is thus drawn out through the inside bore of the sheath and does not come in contact with the walls of the puncture wound in the tissues. It thus cannot produce implantation of tumor along the track.

For the next step, the first member, the solid steel obturator, having a point on one end and an insulated knob on the other, is re-introduced into the sheath to its full extent, and a connection made by means of an insulated cable between the knob of the obturator and the active pole of a source of high-frequency (coagulating) current. The whole assembly is slowly withdrawn, the passage of the high-frequency current coagulating the adjacent tissues to whatever depth is desired, according to the time taken to exert the effect and the capacity and setting of the source of high-frequency current.

Besides the hollow, conical-tipped inner member, there are others designed to accomplish the same purpose.

2. One of these is a solid, straight rod of such length that, when introduced into the sheath, it is capable of being projected beyond the sharp edge of the sheath. This rod bears a knurled knob at one end and a spiral undercut conveyor on the other. This spiral is of such diameter that it is a snug fit within the sheath. The sides of the spiral are flat and smooth. The upper edge of each turn of the spiral is sharpened and this edge is undercut so as to leave a comparatively deep groove between adjacent turns of the spiral. The tip end of the spiral terminates at a point beyond the center of axis, and is flattened horizontally and ground to a flat, chisel-type cutting edge.

In action, the plain-pointed member (the trocar) is placed within the outer sheath and a puncture made through the skin as deep as the outer limit of the tumor. The trocar is then withdrawn. The sheath is then pushed into the tumor so that a cylinder of tumor is made to enter the hollow bore of the sheath. This specimen is thus cut free of the rest of the tumor on all sides except at its base, where it is still attached.

The spiral conveyor is introduced until it rests on the top of the plug of tumor now lying within the sheath. The spiral conveyor-cutter is rotated in a clockwise direction, and this motion winds the plug of tumor around the shaft, holding the tumor tissue in the undercut groove between the turns of the spiral. When the spiral has been fully introduced so that its tip has emerged below the edge of the sheath, further rotation causes the tip which projects beyond the center of axis, and bears the flat, chisel cutting edge, to sweep around in a circle, detaching the core of tumor from its base and leaving it wedged into the spiral groove of the inner member. This is then withdrawn through the sheath.

Now, by introducing the first member (the pointed trocar bearing the connection to diathermy current), the whole track is coagulated as the instrument is slowly withdrawn.

SUMMARY OF BIOPSIES

Case	Location	Pathologic Diagnosis	Remarks
R. R.	Nodule left breast	Scar tissue; no tumor cells	Interstitial irradiation six months previously
A. P.	Nodule left breast	Fibro-adenoma	
T. M.	Nodule left breast	Fat and fibrous tissue	Clinically carcinoma; instrument did not enter tumor
A. A.	Nodule right breast	Irradiation fibrosis; no tumor cells left	Confirmed by post-operative pathological examination
P. M.	Nodule right breast	Fibrous tissue; no tumor cells	Excision and pathological examination revealed fibro-adenoma
F. W.	Mass left breast	Carcinoma	Had received external irradiation one month ago
M. M.	Right tibia	Irradiation fibrosis; no tumor cells	A radiosensitive tumor which had received heavy dose of irradiation two months ago
J. A.	Cervical glands	Lymphadenitis; no tumor cells	Clinically lymphadenitis
H. W.	Mass in left cervical region	Muscle tissue; no tumor	Instrument not introduced into tumor
T. H.	Nodule in left cervical region	Chronic lymphadenitis	
G. B.	Mass in right cervical region	Squamous carcinoma	
P. C.	Mass in right cervical region	Squamous carcinoma	
P. Mc.	Mass over sternum	Chondrosarcoma	
F. K.	Mass in left pectoral region	Carcinoma; cannot determine type	
W. H.	Right cervical region	Abscess of cervical glands	
I. G.	Posterior aspect, right thigh	Sebaceous cyst	
M. F.	Right mastoid region	Abscess	
C. W.	Right inguinal region	Hodgkins disease	
C. O.	Right axilla	Hodgkins disease	
B. S.	Right hip	Neurogenic sarcoma	

The sheath of this biopsy instrument is fitted with a tapered collar ground to receive the tip of a standard 10 c.c. syringe. When the tumor is of such character as to be suitable for aspiration, this may be done before coagulating the track and withdrawing the sheath. It is often desirable to make a smear for immediate diagnosis. This may be made by crushing one of the smaller pieces of tissue between two glass slides and smearing it in a drop of saline solution. From this smear a pathologic diagnosis may be obtained in a few minutes, with the rapid staining technic described by Ellis (7). The larger pieces of tissue are placed in formalin and made into routine paraffin sections. If greater haste is required, a quick paraffin section may be prepared in three hours (8).

The instrument described has proved to be effective in obtaining tissue. At the time of this report, biopsies have been attempted with it on 20 tumors of various types—inflammatory, benign, and malignant. These included breast nodules, cervical glands, subcutaneous metastatic deposits, and tumors of the chest wall. There was a wide variation in size and in consistency. Three of the growths had previously received heavy doses of radiation and had been reduced to dense nodules of fibrous tissue. In all cases tissue was obtained on the first attempt. In two instances the instrument had not been introduced into the tumor, so that the specimen obtained proved to be a piece of muscle or fibrous tissue. In one case a diagnosis of "fibrous tissue, no tumor cells," was made. Subsequent excision revealed fibro-adenoma. In each of the 17 remaining cases a positive diagnosis was made.

Summary

A new technic and instrument are presented for obtaining specimens for biopsy. By this means a piece of the tumor is punched out and removed through an outer insulated sheath. The outer sheath of the instrument may be used in conjunction with a syringe for aspiration of the tumor. By connection to a source of high-frequency current the needle track is coagulated and any adherent tumor tissue devitalized, thus preventing implantation of tumor tissue along the course as the needle is withdrawn. The action of the instrument is safe, simple, and positive, obtaining tissue on the first attempt in all cases to date, including many dense, fibrous tumors.

This paper is a preliminary report. Further biopsies obtained by this technic and instrument will be reported in a subsequent paper.

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References

1. Ferguson, R. E.: Prostatic neoplasms, their diagnosis by puncture and aspiration, Am. J. Surg. 9: 507, 1930.
2. Martin, Hayes E., and Ellis, Edward B.: Biopsy by needle puncture and aspiration, Ann. Surg. 92: 169, 1930.
3. Ward, G. R.: Bedside hæmatology, W. B. Saunders Co., Philadelphia, 1914, p. 129.
4. Guthrie, C. G.: Gland puncture as a diagnostic measure, Bull. Johns Hopkins Hosp. 32: 266, 1921.
5. Barringer, B. S.: Carcinoma of prostate, Surg. Gynec. Obst. 34: 171, 1922.
6. Forkner, C. E.: Material from lymph nodes of man, Arch. Int. Med. 40: 532; 647, 1927.
7. Ellis, E. B.: Cancer cells in pleural fluid, Int. Assoc. Med. Museums and J. Technical Methods, Bulletin No. VIII, 1922.
8. Warthin, A. S.: Practical pathology, George Wohr, Ann Arbor, Mich, 1911.