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Treatment of Penetrating Gunshot Wounds of the Cranium.

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REPRINTED FROM

The New York Medical Journal

for May 5, 1888.

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TREATMENT OF PENETRATING GUNSHOT WOUNDS OF THE CRANIUM.*

By JOSEPH D. BRYANT, M. D.

It is not my intention to fatigue you with either a long or a critical consideration of the generally accepted steps of treatment of penetrating gunshot wounds of the cranium. I do not desire to disturb in the least the well-established measures that are found along the paths of surgical inquiry, which have served as satisfactory guides both to the inexperienced and the experienced alike, on all occasions. It should be the purpose of each one who acts on principle, rather than on impulse or from policy, to do his share in so directing the lines of thoughtful consideration and conclusion in respect to professional methods that the profession of which he is a member may not be exposed to satirical expressions not unlike the one used by Young, who said in his epistle to Pope: "*And* oftener changed their principles than *shirt*." It is the purpose of this paper to add somewhat to the accepted method of the treatment of these forms of injury, or, at least, it is hoped that its pres-

* Read before the Medical Society of the State of New York at its eighty-second annual meeting.

entation and discussion may inspire a fuller confidence in the modern deviations of treatment—deviations that are recognized as the legitimate issue of antiseptic cleanliness and inventive genius. This paper will be devoted almost entirely to the consideration of the indications for treatment of the injuries which give to the paper its title. This course is thought to be an eminently proper one, since the indications for the treatment of a condition bear the same important relations to the treatment itself as exist between the compass point and the trusted pilot at the wheel. The indications for treatment are divided properly into constitutional and local. The local indications only will engage our attention at this time, together with the consideration of the deviations in the fulfillment of them that appear to be warranted by the recent advance in surgical technic. The commonly accepted local indications for treatment of these injuries may be enumerated as follows:

1. The arrest of hæmorrhage.
2. The elevation of depressed fragments of bone.
3. The removal of foreign bodies from the wound.
4. The establishment of good drainage.
5. The combating of inflammation.

The means to be adopted for the arrest of hæmorrhage will depend on the source from which it comes. If it comes from the scalp, the common means employed for the arrest of hæmorrhage in other situations will be found to be ample in this instance. If the flow of blood comes from the bone itself, I am accustomed to plug the bleeding-point with catgut. The shape and size of the catgut plug are made to correspond to the requirements of the case. The employment of this agent in the manner indicated possesses this virtue: the plug can be permitted to remain in position without the least concern, since it will become absorbed after having performed its obstructive function, and in no

instance need fear be had of any septic influence by reason of its presence.

Hæmorrhage from Meningeal Vessels.—Hæmorrhage from the vessels of the pia mater can be controlled usually by simple pressure alone. The vessels associated with the dura mater, however, bleed with a much greater degree of persistence. The middle meningeal artery, for instance, and also its branches, not infrequently cause much hæmorrhage, and not a little difficulty is experienced in arresting the bleeding. If the bleeding-point can be caught as it makes its appearance near the border of the fractured bone, the hæmorrhage is easily controlled by ligature. In my observation of this class of cases, the open end of the bleeding vessel is drawn so far beneath the border of the fractured bone that it can not be seized with a forceps directly. In this emergency I have employed the following plans for the arrest of hæmorrhage:

1. Plugging the bleeding-point with catgut. This is insecure and should not be employed if the hæmorrhage is persistent.

2. Clamping the bleeding vessel against the inner surface of the bone beneath which it runs. This plan can be carried into effect easily by aid of the Langenbeck clamp, or of any other that will meet the indication. The blade of the clamp may be applied directly to the lower surface of the vessel, or an antiseptic compress may be interposed between the blade and the vessel.

3. Cutting away the portion of bone that obscures the bleeding-point with a rongeur and catching and tying the point directly. The latter is the surer, consequently the better plan.

Hæmorrhage from a Sinus.—This form of hæmorrhage is often troublesome, but need not excite much apprehension if the blood does not collect in the cranium in an

amount sufficient to cause cerebral compression. The blood should be permitted to escape or be removed, and further accumulation of it be obviated by directly closing the bleeding-point of the sinus. The closure can be accomplished easily by the direct application of an antiseptic compress to the wound of the vessel, if the wound is accessible. If the bleeding-point is inaccessible through the brain-wound and the hæmorrhage is persistent or dangerous and not controllable by other means, then the seat of the wound of the sinus should be located with the probe, as in the case of a ball, and it should then be approached from without by aid of the trephine when practicable. If a rent is present in the sinus, its border can be united with fine catgut. The application of a simple compress to the wound of a sinus, however, is usually sufficient to meet the indications. If the hæmorrhage arises from injury of a sinus of the base of the brain, especially the petrosal, the application of direct pressure on the bleeding-point can not be so well accomplished. In this instance a fatal flow of blood may be prevented by closing the external wound, even at the risk of causing compression of the brain by accumulation of blood in the wound. Problems of this character are not presented often for solution, since the missile that wounds a sinus in this situation causes almost immediately fatal injuries of the brain-substance at the same time. It is not impossible in sinus wounds to pass by means of a probe a small tampon of an antiseptic astringent substance connected with a long thread through a straight channel to the point of hæmorrhage. This tampon should be of proper size to admit of its easy passage along the track made by the ball. When it has been properly applied against the bleeding-point the probe can be withdrawn and the tampon permitted to remain in position. The thread connected with it is allowed to hang from the wound, and is for

the purpose of withdrawing the tampon when necessary. This plan has been employed successfully by Dr. Girdner on several occasions for the purpose of checking hæmorrhage from the brain-substance. In many of these cases, however, death from compression by blood, or from injury of important nervous centers, ensues too quickly to permit the services of a surgeon to be of avail, even though they are exercised without delay.

Hæmorrhage from the Brain.—If considerable blood escapes from a wound of the brain, it is probable that the vascular structures in or about the ventricles are lacerated; to use a practical expression, "The ball has gone through the ventricles." Severe hæmorrhage from a wound of the brain may be caused by the wounding of a sinus, or of an intracerebral vessel of considerable size. Fortunately, hæmorrhage from a wound of the brain-substance only need cause no apprehension. Moderate, gentle pressure over the external opening, or tamponing the track of the ball, and elevation of the head when permissible, are sufficient to control it. The dusky color of the blood, the direction of the wound of the brain-substance, and the persistency of the flow will indicate whether or not a sinus has been injured. As to the direction of the wound: It should not be forgotten that the impingement of a ball on a prolongation of the dura mater, while passing, may cause such a deflection of the ball as to render its course after this time entirely a matter of conjecture. The manipulations to be made along the track of a missile for the purpose of locating or removing it, or for the purpose of making a counter-opening through the skull, should not be attempted until the danger from hæmorrhage has disappeared. The passage of a ball into or through normal brain-structure at other situations than those already mentioned is not attended with hæmorrhage of a dangerous nature, consequently any steps thought

to be necessary as a means of treatment for the removal of a ball in the latter instance need not be delayed for this reason alone.

Elevation of Depressed Fragments.—The importance of this indication and the means of meeting it are so well understood already that it is superfluous to take the time for its consideration.

Removal of Foreign Bodies.—This indication is a most important one, and it is in its fulfillment that the principal deviations from the previously accepted course of treatment will be noticed. The foreign bodies requiring removal from the brain are (1) fragments of bone, hair, textile fabrics, etc.; (2) the missile itself. Such of these agents as may be located around the open mouth of the wound, or have entered an inch or two within the brain, have been removed frequently and with complete success. However, the manipulation employed to remove a ball from the brain, even if it has entered that structure but a short distance, has been deemed a sufficient deviation from the proper course of treatment, at a recent date, to be presented in a court of justice as contributive to the death of the patient. It is not now worth the while to enter into the consideration of the exact distance the surgeon may explore the brain for the purpose of locating and removing a ball, since the object of this paper will be to commend the removal from the brain of such bodies at once, in nearly all instances, when their exact location can be determined. Let us pass now to the consideration of the questions:

1. Should a ball be removed from the brain? 2. If so, how should it be done? To determine a general rule of action regarding the first question, it is only necessary to inquire whether or not a greater number of patients have recovered after removal of balls from the brain, or after the missiles had been permitted to remain within it. It must

be presumed, of course, that all other things were equal in the two classes of cases.

Dr. R. H. Wharton, of Philadelphia, published in the "Philadelphia Medical Times" of July 19, 1879, a concise tabulated statement of the results of "an analysis of 316 cases in which foreign bodies were lodged in the brain." It is thought by the writer of the present paper that this number is entirely sufficient for the purpose of establishing the conclusions that will be drawn from them—conclusions which must be recognized as having little or no practical reference to antiseptic methods. An analysis of these cases shows that 236 of the entire number of missiles were "balls," "portions of balls," and "buck-shot." Of this number the missiles were removed from the brain in 66 instances, and in 170 instances they were permitted to remain. Of the 66 cases in which removal was resorted to, 27 of the patients (40 per cent.) died and 39 (59 per cent.) recovered. Of the 170 cases in which the missiles were not removed, 97 of the patients (57 per cent.) died and 73 (43 per cent.) recovered. It is now easy to be seen that the death-rate is 17 per cent. greater when the missiles are allowed to remain unremoved.

In order to determine the relative rates of death and recovery after gunshot wounds of the different lobes of the brain, with and without removal of the missile, a series of 140 cases were collated at my request by Dr. Glover C. Arnold upon which to base the calculations. The great majority of these cases were taken from the history of the late civil war. It is proper to state that all possible caution was enjoined on Dr. Arnold in the selection and study of the cases. With but few exceptions, they were taken consecutively as placed on record by the different authors. The point of entrance and the track of each missile, together with the situation and final lodgment or exit of it,

were carefully determined by comparing the statements of the records of each case with the topography of the normal brain as set forth in the works of accepted authorities of the topography of this organ. Of the 140 cases, 60 implicated the frontal lobes alone, and one half of the patients died. Of the 60 cases, in 3 only did the missile pass directly through and out of the cranium, and 1 of the patients died and 2 recoverd. Of the remaining 57 cases, in 30 the missiles were removed; 16 patients died and 14 recovered. The missiles of the remaining 27 were not removed; of these, 13 died and 4 recovered. The parietal lobes were involved alone in 11 of the 140 cases, and 5 patients died. In 6 of the 11 cases the missiles were removed; 1 died and 5 recovered. Of the 5 remaining patients, 4 died and 1 recovered. Of the 140 cases, the temporo-sphenoidal lobes were penetrated in 24 instances, and 9 patients died and 15 recovered. The missiles were removed in 7 of the 24 cases; 2 of the patients died and 5 recovered. In 8 of the 24 cases the missiles passed through both lobes, and escaped from the cranium at the opposite side of the head; 1 of the patients died and 7 recovered. In 9 of the 24 cases the missiles were not removed; 6 of the patients died and 3 recovered. In 14 instances the occipital lobes were penetrated; of the patients, 6 died. Of the entire number, in 3 the missile passed completely through and out of the skull; 1 patient died and 2 recovered. In 5 of the entire number the missiles were removed; 2 patients died and 3 recovered. In 6 of the entire number they were not removed; 3 patients died and 3 recovered. The cerebellum was penetrated in 6 instances, in 3 of which the ball passed completely through and escaped from the skull. All of these patients died. Of the remaining 3, in 1 the missile was removed and the patient died. Of the 2 in which the missiles were not removed, 1 patient died and 1 recovered. The frontal

and parietal lobes suffered in 4 instances, and 2 of the patients died. Of the entire number, the balls were removed in 3 instances; 1 patient died and 2 recovered. In one case the ball was not removed; this patient died. In 6 instances the frontal, temporal, and sphenoidal lobes were penetrated conjointly. In each of these instances the missile escaped primarily. Three of the patients died and 3 recovered. The frontal, temporo-sphenoidal, and occipital lobes were involved simultaneously in 8 instances; 6 patients died and 2 recovered. In 3 of the 8 cases the missiles escaped primarily; 2 patients died and 1 recovered. In 2 instances the missiles were removed; 1 patient died and 1 recovered. The balls were permitted to remain in 6 instances, and all the patients died. Two examples of conjoined perforation of the parietal and occipital lobes were found, of which 1 ended fatally and 1 in recovery. In the fatal case the ball had escaped primarily. The ball was removed in the successful case. The temporo-sphenoidal and occipital lobes were implicated in 4 instances, and 2 patients died. One of these results followed the primary escape of the missile. The other ball was removed, and the patient recovered. Of the 2 in whom it was not removed, 1 died and 1 recovered. In 1 case of the 140 the ball traversed the temporo-sphenoidal lobe, pons, and crura cerebelli; this patient died. The following table of the 140 cases will enable the reader to note the facts more readily than can be done from the text:

LOBES OF BRAIN IMPLICATED.	BALLS REMOVED AND ESCAPED PRIMARILY.			BALLS NOT REMOVED.		
	No.	Died.	Recovered.	No.	Died.	Recovered.
Frontal	33	17	16	27	13	14
Parietal	6	1	5	5	4	1
Temporo-sphenoidal	15	3	12	9	6	3
Occipital	8	3	5	6	3	3
Cerebellar	4	4	0	2	1	1
Frontal and parietal	3	1	2	1	1	0
Frontal and temporo-sphenoidal	6	3	3	0	0	0
Frontal, temporo-sphenoidal, and occipital	5	3	2	3	3	0
Parietal and occipital	2	1	1	0	0	0
Temporo-sphenoidal and occipital	2	1	1	2	1	1
Temporo-sphenoidal, pons, and crura cerebelli	1	1	0	0	0	0
Total	85	38	47	55	32	23

It is to be seen with a glance that the missiles were removed or escaped primarily in 85 of the 140 cases. Of the 85 patients, 47, or 55·3 per cent., recovered. In 55 of the 140 cases the missiles were allowed to remain unmolested; of the patients, only 23, or 41·8 per cent., recovered. This showing places the rate of recovery when the missiles escape primarily and are removed 13·5 per cent. higher than when they were allowed to remain unmolested. The rate of recovery under similar circumstances was 17 per cent. as shown by the series of 236 cases selected from Dr. Wharton's collection. The difference of percentage between these two series of cases is too small to be of special practical utility. However, the great care that was exercised by Dr. Arnold in the collection of the 140 cases makes the deductions that can be derived from them especially valuable. Dr. Arnold read the history of each case carefully and established the facts on which the conclusions are based by

topographical measurements. In many instances the facts were verified by comparing them with the report of the autopsies of the cases. Only such of the 140 cases as possessed a reasonably complete history in all important respects were reported. It is interesting also to note the frequency of primary escape of missiles from the skull, and the relation which the escape bore to the frequency of recovery.

Tabulated Statement of the Cases in which Missiles escaped primarily:

FROM	No.	Died.	Recovered.
Frontal lobes	3	1	2
Parietal lobes	0	0	0
Temporo-sphenoidal lobes	8	1	7
Occipital lobes	3	1	2
Cerebellar lobes	3	3	0
Frontal and parietal lobes	0	0	0
Frontal and temporo-sphenoidal lobes	6	3	3
Frontal, temporo-sphenoidal, and occipital	3	2	1
Parietal and occipital lobes	1	1	0
Temporo-sphenoidal and occipital lobes	1	1	0
Temporo-sphenoidal, pons, crura cerebelli	1	1	0
Total	29	14	15

It is noticeable, from observation of the preceding statement, that a majority of the patients recover when the missiles escape primarily. The difference, however, is but a slight one, still this difference is an argument in favor of removal. It appears, by comparison of the two tables, that the results are much better when the missiles are removed by the surgeon than when they escape primarily. The greater force of the missile and the greater injury inflicted by it in the latter instance are substantial reasons for the dissimilarity of the results.

It can be stated, in view of the preceding results, as a principle that a ball should be removed from the brain. It is now proper to inquire as to the causes of death in con-

nection with these forms of injury. Abscess of the brain was the cause of death in 42 (18 per cent.) of the entire number of cases of the first series (236). In 13 of the 42 cases (31 per cent.) abscess followed removal of the ball at various periods of time. In one instance it occurred seven years after removal. Usually, however, its occurrence was closely associated with the time of the removal itself. In the remaining 29 cases of abscess (69 per cent.) the missiles were not removed. In these cases the abscesses formed at various intervals of time—from a few days to thirteen years. In three of the latter instances abscess formed seven years after the receipt of the injury.

We will inquire now as to the subsequent condition of patients in certain cases of so-called recovery. Fourteen were more or less afflicted with headache. Of these, in two only had the missiles been removed. Eight suffered from some form of paralysis of the trunk or limbs, and in but one of these had the missile been removed. Six suffered in a degree from mental impairment; in two of these the ball had been removed. In three instances partial or total blindness followed, in all of which the missiles remained in the brain. Epilepsy resulted in three cases, in one of which the ball had been removed. Sudden death while under excitement followed in three cases, in none of which the ball had been removed. In one case in which the ball had not been removed death followed a year after from pressure on important parts within the cranium. Of the 66 cases in which the missiles were removed from the brain, 27 (41 per cent.) ended in complete and permanent recovery. Of the 170 cases in which the missiles were permitted to remain in the brain, but 20 per cent. of the patients are reported to have recovered without sequels. It does not matter whether or not a ball may become encysted so long as it appears from the majority of cases that a larger percentage recover when

this form of missile is removed than when it is allowed to remain unmolested and amenable only to the efforts of Nature. It is doubtless true that in certain individual instances a patient might survive longer if a ball were allowed to remain unmolested, yet sooner or later, in the majority of these cases, disaster will occur. An encysted ball may gravitate toward the base of the brain, and, if it does not cause disturbance or death *en route*, it will be quite certain to do so at a later period. The possibility of a ball becoming encysted, and the method of its occurrence, can have but little practical bearing in the light of past experience, and the possibility of its occurrence or non-occurrence should not be given serious weight at the present time, except the consideration be coupled with recommendations which will lead to a far more frequent encystment than has heretofore taken place.

If a ball should be removed, how should it be done?

Mr. Thomas Longmore says in Holmes's "System of Surgery," vol. ii, p. 188: "If the site of lodgment . . . is obvious, it should be removed with as little disturbance as possible, but trephining for its extraction when the place of lodgment is not known . . . is an unwarrantable operation." I think all judicious surgeons of the present time will concur in this assertion. The removal of a ball from the brain is divisible into certain steps:

1. Ascertaining its location.

2. The selection of the most feasible route by which to reach it when located.

A ball may be located by probing the canal it has made in the brain-structure, if it has taken a straight line and is still lodged in the line of the course primarily taken. If, however, it has infringed in its course on a prolongation of the dura mater, or if the course has deviated for any other reason than this one, the missile is manifestly

inaccessible to the touch of a probe that is introduced at the entrance wound of the ball. To attempt to locate a ball in the brain by passing a probe of any pattern or material whatever along a devious track is not only unsurgical, but dangerous and culpable. It therefore follows that the surgeon should be able to determine at what point the ball-track deviates from a straight course at all times. This requires a delicate and cautious hand, a large, light probe, and the aid of gravity when it can be consistently utilized. The aluminium probe recently suggested by Dr. Fluhrer combines both the necessary lightness and the proper size for the purposes of exploration. A probe which is to be introduced into the brain should be quite as large at or near its middle as at the advancing extremity, since the form of the body of the probe serves to guide the advancing end correctly at all times, with reference to the center of the wound. The bulbous-end probe with a stem-like handle—Nélaton's, for instance—is not the proper instrument to introduce into the brain, for it may be carried astray unless the stem is kept exactly at the middle of the opening in the brain made by the ball. The ordinary small probe employed for the purpose of exploring other portions of the body should not be introduced into the brain for the purpose of locating a ball. Flexible probes, too, should likewise be avoided, for no one can tell the number of the false tracks which they may make by reason of the inability of the surgeon to control the advancing end, or calculate as to its exact situation.

Having selected the proper probe, then, when possible, place the head in such a position as to gain every advantage in the insertion of the probe along the tract of the wound that the force of gravity can offer. The probe is passed along the track of the missile, as long as it passes easily, until finally the ball, the opposite side of

the cranium, a prolongation of dura mater, or a change in the course of the track is encountered. The character of the obstacle arresting the advance of the probe may be determined by the firmness of the opposition, the direction taken by the probe, and the distance it is inserted. If the ball is touched, the opposing force will be slighter than if the probe impinges on the opposite side of the cranium. If a prolongation of the dura mater or a sudden curve in the ball-track is met with, the absence of the metallic and bony nature of the obstacle will be manifest. In either instance only a slight degree of force should be employed. If the ball is touched, it may then be removed with a suitable forceps passed along the tract of the wound to its location. If the ball is near the opposite side of the cranium, say within an inch or so of it, and can be located from without, it should then be removed through a counter-opening, especially when difficulty is experienced in grasping it with a forceps through the line of entrance. It is far better that a ball be removed by a short route through sound brain-tissue than that the already injured brain-tissue in the course of its track be further lacerated in almost vain endeavors to seize and remove it. The former method not only limits the amount of brain injury, but affords at once an opportunity for the establishment of through-and-through drainage. If the ball has gone straight through to the opposite side of the skull and has ricocheted from the point of impingement, the establishment of a counter-opening at this point not only permits of thorough drainage, but affords the only rational route by which to seek for the ball at its final location. It is proper to say at this time that the direction a ball may take after striking the inner table of the opposite side, and the distance it may go afterward, are purely matters of conjecture. No practical rule for the guidance of the surgeon can be laid down in these cases. The ball

should be sought for, however, in the direction of the inclination of the skull at the point of impingement. The distance the ball will go from this point will depend, of course, largely on the momentum and the amount of the resistance encountered. It is often somewhat difficult to determine the location at which to trephine so as to make the counter-opening at the point of actual or perspective impingement of the missile. In a case of my own in which the point of impingement was so low on the opposite side of the head

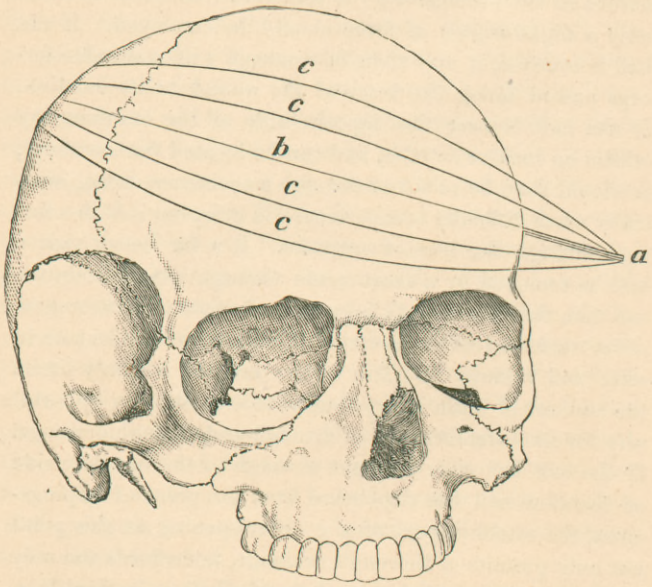

FIG. 1.—*a*, the extra-cerebral portion of a probe; *b*, the line taken by the probe through the brain; *c c c c*, lines placed parallel with the probe with the aid of a string.

that the situation of the arrested end of the probe could not be well judged by the eye, I resorted to the following plan, which pointed out the location at once, and can not

fail to do so at all future times: A perfectly straight, long probe of large size was carried carefully along the track of the ball till the extremity was arrested by the opposite side of the skull. About four inches of the probe then remained outside of the skull. A string was then attached to the extreme end of the outer portion, and was caused to pass across the convexity of the cranium in several directions (Fig. 1) to the side opposite the point of entrance. The portion of the string corresponding to the extra-cranial portion of the probe was caused to be parallel with this portion of the probe in each instance while being carried across to the opposite side of the cranium. The point of crossing of the lines on the opposite side corresponded of necessity

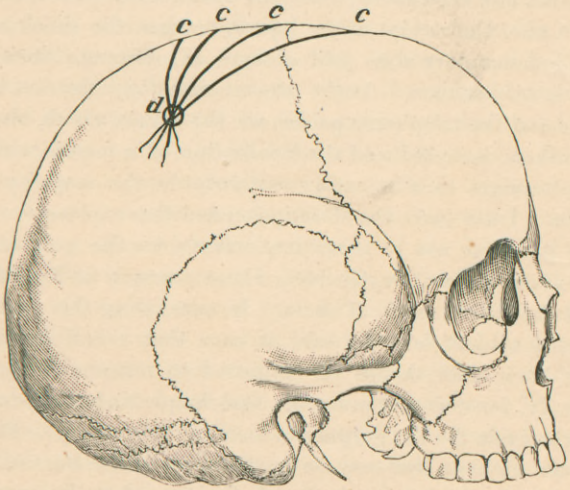

FIG. 2.—*c c c c*, lines converging on opposite side of head; *d*, point to trephine.

to the actual or perspective location of the distal end of the probe, as the parallelism of the lines with the probe was preserved in each instance (Fig. 2). Thus the proper situa-

tion for making a counter-opening through the skull was indicated unerringly at once. In my own case the inner surface of the button of bone that was removed bore the imprint of the ball impingement.

The modifications of the functions of the special areas and nerves of the brain that may result from a gunshot wound of it are entitled to respectful consideration as means of determining the *course* taken by the missile. They are not to be relied on, however, in locating the resting-place of the missile. Their condition ought always to be interrogated at the onset, and, in fact, should be carefully scrutinized during the entire observation of the case. The later manifestations of these areas will be more distinct and trustworthy than the manifestations following soon after the receipt of the injury, because the shock and the inflammatory state will obscure or obliterate them in the latter instance. At the present time the induction balance and the telephonic probe are the agents which, above all others, have reduced the localization of a missile within the cranium to a scientific certainty in the majority of cases. I will leave the description and the explanation of the practical use of these implements to the gentleman who is to follow, Dr. Girdner, whose name is indissolubly associated with each of them. In concluding this portion of the subject, let it be said at once that a ball that can not be located should be permitted to remain unsought. Finally, force should never be used in probing a ball-track in the brain for the purpose of locating the missile. Fragments of bone that may be scattered along the tract of the wound should be removed with forceps when discovered. The fragments of skull found in and about the wound should be preserved and carefully fitted together and compared with the area of the opening in the skull to determine if other fragments have escaped notice. Finer frag-

ments in the course of the wound will escape with the discharges, and the head should be so placed as to facilitate their escape at the most dependent point of the wound.

Good Drainage of the Wound.—Good drainage can be secured best by making a counter-opening and by enlarging somewhat the bony rim of the point of entrance. In the case of my own already mentioned, after the counter-opening had been made, numerous carbolized horse-hairs were passed along the track of the ball and allowed to protrude from both openings of the wound. With this material for drainage of the brain, individual hairs can be withdrawn as healing advances, as has been done for a long time in other parts of the body. This method will provide continuous drainage until the withdrawal of the last few hairs will permit the final healing of the wound. If a counter-opening is not made, then the external wound should be kept open, and the discharge from it facilitated by a dependent position of the lower end of the track. If the brain-substance protrudes, it can be retained in place by a thin sheet of aseptic metal, with a small opening in the center to correspond with the opening of the wound of the brain. If the dependent end of the wound tends to close, its patency can be maintained by inserting into it through the opening in the plate a small, short, fenestrated drainage-tube. The upper open end of the tube may be sufficient for the purposes of drainage without the fenestra. The introduction into the wound and through it of a gentle stream of antiseptic fluid with the first dressing, and afterward when necessary, should be practiced. Salicylate-of-sodium solutions and Thiersch's fluid are highly commended for the purpose. A counter-opening at the seat of impingement of the ball enables the surgeon to continue the search for the ball with the least possible injury to the brain-structure. If

the ball is not found at the seat of impingement, it will have ricocheted from this point in a course that is best indicated by the direction of the inclination of the inner table of the skull at the point of impingement. However, this indication is too problematical to permit free probing of the brain in the absence of other evidence of the course taken by the ball. A careful examination of the brain at this point will probably reveal the direction taken by the missile, which should be followed carefully as in the former instance. In the case of my own this plan was observed, and, although the signs indicative of the secondary course of the ball were plainly to be seen in the brain-substance, still it was not practicable to touch the ball with a probe. The autopsy revealed the fact that the probe had gone the entire distance traveled by the ball from the point of impingement, yet the ball had not been touched by the probe because it had dropped or gravitated between the borders of a deep sulcus which ran nearly at right angles to the secondary track of the ball. The ball could not have been touched by a straight probe without damaging the, as yet, healthy brain-substance directly between it and the counter-opening. The counter-opening will drain not only the primary, but the secondary track of the ball as well, if the force of gravity will permit. It will likewise favor the discharge of pus that may be formed as a result of the presence of the ball or the injury of the brain. The ball itself may be aided to gravitate toward the counter-opening, especially if it has remained unmolested. Good drainage must be sought for at all times; in fact, if good drainage is not established, little benefit need be expected from other steps of treatment.

Combating Inflammation.—This indication need not occupy our time now, for the means employed to meet it at the present offer but little of a novel nature when compared

with those of the past. Finally, the strictest antiseptic technics must be employed with every step, whatever plan of treatment is selected. I respectfully submit the following conclusions for your consideration:

1. A bullet should be removed from the brain as soon after its reception as its situation can be determined and the patient's condition will permit.

2. A bullet should be removed from the brain at a later period if symptoms supervene and it can be located.

3. A bullet that has been located in the brain and has not been removed should be removed before the supervention of symptoms, when it assumes a migratory character.

4. No effort should be made to remove a ball from the brain if it can not be located.

A MANUAL OF

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