

for Sylvia Meagher  
from Bernabei

THE DISPOSITION OF DUSTLIKE BULLET FRAGMENTS IN PRESIDENT  
KENNEDY'S BRAIN: EVIDENCE OF A SHOT FIRED FROM THE FRONT

by

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Of the wounds that the late President John F. Kennedy suffered when he was assassinated, the most deadly were those inflicted on his head. The Warren Commission, which was assigned the responsibility of investigating the assassination, concluded that the President was injured in the head by a bullet that struck from behind. The following discussion of ballistic matters pertaining to the head wounding does not dispute that conclusion, but sets forth reasons for believing that the President was wounded additionally by a bullet fired from the front, a bullet that fragmented very severely on impact with the right-front part of his head.

As a result of the shooting, the President's brain was lacerated throughout the right side; he suffered wounds of the scalp and skull in the rear of the head and in the side of the head. The most conspicuous

wound occurred in and around the region of the right temple, where gunfire created a massive cavity in the skull (the cavity was some five inches in diameter) and grossly mutilated the underlying brain tissue. A small hole in the back of the head displayed characteristics normally associated with a wound of bullet entry.

The gunfire that fatally injured the President produced numerous minute bullet fragments that became embedded in the right side of the brain. The Warren Commission asserted that all of these fragments evolved from a bullet that entered at the back of the President's head. This bullet, according to the Commission, partly disintegrated while passing through the brain, where it deposited the fragments, and emerged from the right side of the head.

Notwithstanding some medical evidence indicating that a bullet passed into the rear of the President's head and emerged from the right side, the ballistic evidence indicates that the minute fragments embedded in the brain were formed from a bullet that was fired from the front and fragmented on impact near the President's right temple. \*

X-ray films taken several hours after the shooting revealed the presence of about forty fragments of metal in the right side of the President's brain. These

fragments were irregular in shape and exceedingly small in size-- most of them less than one millimeter in maximum dimension. In testimony before the Warren Commission, Dr. James J. Humes, the hospital pathologist who was assigned to supervise the performance of an autopsy on the body of the late President, characterized the fragments as "extremely small, less than 1 mm. in size for the most part...dustlike...small, dust, of the size of dust particles."\* Indeed, Dr. Humes asserted that the dustlike fragments were actually somewhat smaller than they appeared on X-ray films, since, as he explained, "the X-ray pictures that were made would have a tendency to magnify these minute fragments somewhat in size."\*\* Other descriptions in the records of the Warren Commission similarly disclose that the metallic fragments in the brain were numerous and extremely small. \*\*\*

Regarding the question where in the brain the minute fragments were situated, the records of the Warren Commission are ambiguous and incomplete. They reveal that the fragments appeared only in the right side of the brain, but do not suggest that there was an obvious concentration of fragments in the front or rear of the brain. Rather, they cause the reader to reckon, incorrectly, that the fragments were distributed evenly in a "line" or "path" throughout the right side, front

and rear. For example, the official autopsy report, which was written by Dr. Humes, states that the fragments appeared "along a line corresponding with a line" extending between the small hole in the back of the head and an area just above the right eye.\* Similarly, an FBI report written by two agents who viewed the X-ray films during the autopsy says that "the path of disintegrated fragments could be observed along the right side.\*\*" Ambiguity arises in the use of such expressions as "along a line corresponding with a line" and "the path...along the right side." The Warren Report compounds the ambiguity by referring to the minute fragments as "running in a line.\*\*\*"

An elaborate description of the fragments, written a few years after the Warren Commission became defunct, discloses that the "line" or "path" was imaginary for all but 1 3/4 inches of its entire length. The incompleteness of statements in the Commission's records is made evident by the same elaborate description, which reveals that the fragments were not spread throughout the right side of the brain, but were concentrated in the front of the brain on the right side.

Currently, the most complete and unambiguous account of the minute fragments is contained in a report prepared early in 1968 by three forensic pathologists and a radiologist. Responding to public criticism that the official autopsy report and other medical records improperly

represented the nature of the President's wounds, the government secretly commissioned the four medical experts as a panel to examine (among other things) X-ray films of the President's head, and to report on the contents of those films. Kept secret for nearly a year, their report was unexpectedly released early in 1969.\*

The new description corresponds with what is known about the fragments from the records of the Warren Commission, but it adds that the fragments were situated mostly in the front of the brain on the upper right side:

Distributed through the right cerebral hemisphere are numerous small, irregular metallic fragments, most of which are less than 1 mm. in maximum dimension. The majority of these fragments lie anteriorly and superiorly.\*\*

More than that, the panel doctors provide the information that the fragments were not distributed evenly through the area where they penetrated. They specify that the fragments formed two groups which were distinct from one another both in size and in distribution. One group was composed of "relatively large" fragments spread randomly in the front of the brain and somewhat toward

the rear. The other group consisted of discernibly smaller fragments concentrated in a compact formation only in the region of the right temple. On one X-ray film this distinct formation of "finely divided" fragments appeared elongated in shape, with its long axis oriented in the direction of the hole in the back of the head. The panel's report states:

The metallic fragments visualized in the right cerebral hemisphere fall into two groups. One group consists of relatively large fragments, more or less randomly distributed. The second group consists of finely divided fragments, distributed in a postero-anterior direction in a region 45 mm. long and 8 mm. wide. As seen in lateral film #2 this formation overlies the position of the coronal suture; its long axis if extended posteriorly passes through the above-mentioned hole (in the rear of the skull).\* It appears to end anteriorly immediately below (i.e., under the surface of) the badly fragmented frontal and parietal bones just anterior to the region of the coronal suture.\*\*

Physical principles governing the penetration of projectiles dictate that minute fragments of a bullet should come to rest very near the place where they are formed-- that is, the place where the bullet breaks apart. Although collectively they generate enormous pressure in and around the area where they penetrate, and cause great damage there, minute projectiles individually possess very little energy, and they expend it almost instantly. The result is that such projectiles penetrate for very short distances. The presence of numerous dustlike fragments of metal concentrated in the right-front part of the President's brain, and apparently their absence from the area far back in the brain, indicate that President Kennedy was wounded by a bullet that fragmented on impact with the right-front part of his head.

Moreover, referring to different sized fragments that are formed from one bullet, the same physical principles dictate that the smaller fragments should come to rest nearer to the area where they are formed than the larger fragments, and that they should spread less diffusely than the larger fragments. Of the two groups of fragments in President Kennedy's brain, the "finely divided" fragments all came to rest compactly in the front, whereas the "relatively large" fragments

were spread both in the front and, to some extent, in the rear. This arrangement of fragments strengthens the conclusion that they were formed from a bullet that struck and fragmented in the right-front part of the President's head.

Several factors determine the ability of projectiles to penetrate tissue, but in this discussion the pre-eminently relevant factor is the size of the fragments in question. Other factors-- for example, the density of the substance being penetrated, the composition of the fragments, and their velocity as parts of the whole bullet-- were essentially the same for all of the fragments, so that they do not account for differences in the disposition of the "relatively large" and of the "finely divided" fragments. But in size and in features such as weight and area, which are directly related to size, the individual fragments differed discernibly, and the differences were prominent enough to cause obvious differences in their depths of penetration.

Physical principles affecting the penetration of projectiles are explained succinctly in the National Rifle Association's NRA Firearms and Ammunition Fact Book. This explanation refers specifically to the penetrating ability of spherical shotgun pellets of different sizes, but it applies generally to any



projectiles which differ essentially only in size (and correspondingly in weight and area):

The only force carrying a projectile through its target arises from its own velocity and weight. Assuming like velocities, then the only factors making for different penetrations by non-deforming round shot will be weight and area. The weights of spheres of the same material will be to each other as the cubes of their diameters. With the available force varying as the diameter cubed, and the resistance varying only as the diameter squared, it is obvious that the penetration will be as  $D^3$  divided by  $D^2$ , which equals  $D$  itself. That is, penetration goes up strictly in accordance with the diameter of the shot.\*

In other words, with other factors being equal (as they were in the wounding of President Kennedy), the larger the projectiles, the more deeply they penetrate; conversely, the smaller the projectiles, the less deeply they penetrate.

With very small projectiles there is very slight penetration. This is especially true if the projectiles, in addition to being small in size and light in weight, are irregular in shape. Although their shape does not apply in considering why the "relatively large" fragments penetrated the President's brain differently from the "finely divided" fragments (for all of the fragments are described as irregular), shape was a prominent factor affecting penetration by the minute fragments as a whole. The U.S. Army Medical Service's book, Wound Ballistics, characterizes irregular shape as a factor that greatly reduces the ability of projectiles to penetrate substances. It asserts:

Random fragments frequently have a shape conducive to excessive retardation... For minimal retardation, surfaces should be smooth.\*

Thus, fragments of irregular shape, such as those embedded in the President's brain, are subject to excessively retarding forces; they do not have the ability to penetrate as far as correspondingly small spherical projectiles.

Mr. Shelley Braverman, a firearms consultant, explained why it is that very minute fragments, described as "dustlike" in size, should not penetrate very deeply:

Other things being equal, halving the diameter of a ball-projectile results in only 1/8 energy remaining. Thus, if a bullet had a portion of itself reduced to "dustlike" fragments, the particles would be so bereft of energy that they could not be expected to achieve any substantial penetration beyond the point of genesis.\*

Clearly, the "relatively large" fragments in the President's brain were possessed of considerably greater energy than that of the "finely divided" fragments. If, on the whole, the larger fragments were but twice the size of the smaller fragments, they would possess eight times the energy of the smaller fragments, and would be able to penetrate correspondingly farther than the smaller fragments.

The results of carefully controlled experiments dealing with the penetration of projectiles into tissue and tissuelike substances are discussed and illustrated photographically in Wound Ballistics. The experiments verify in practice what the discussions describe in theory: that minute projectiles do not have the ability to penetrate deeply into tissue, especially if they are irregular in shape. The experiments discussed in Wound

Ballistics further verify that, with projectiles differing only in size and in features related to size, the smaller projectiles penetrate less deeply than the larger. *W*

Yet another factor bearing on the penetration of projectiles should be considered in reference to the disposition of the minute metallic fragments in the President's brain.

When numerous minute fragments are formed from a frangible bullet, the fragments spread in all directions forward of the place where the bullet breaks apart. Many such fragments diverge sharply from their original trajectory-- that is, their trajectory when they were parts of the whole bullet. The very process whereby projectiles are caused to diverge from an original trajectory entails loss of energy in the projectiles. Therefore, with other things being equal, projectiles which diverge from their original trajectory would penetrate less deeply than similar projectiles which maintain their original trajectory.

This factor, the loss of energy in projectiles through divergence from their original trajectory, explains why minute fragments formed from a bullet that struck at the right side of President Kennedy's head did not penetrate into the left side of his brain. The

divergent fragments would be expected to penetrate less deeply than similar non-divergent fragments. A frangible bullet fired from a location forward of the President and striking him tangentially in the right-front part of the head would be expected to produce fragments penetrating somewhat deeply toward the rear, with shallow penetration of fragments that were diverted elsewhere than toward the rear. This seems to be precisely the case in the disposition of the "relatively large" fragments, which spread diffusely from the area where they were formed. Those that maintained their original trajectory penetrated relatively far toward the rear of the brain; those that diverged penetrated for relatively short distances. A similar pattern appears on a small scale in the elongated formation of "finely divided" fragments. In relation to one another, these, too, seem to have penetrated relatively far in the direction of their original trajectory, with little or no penetration to the sides.

The conclusion that an assailant was firing upon President Kennedy from the front rests not only on data pertaining to the minute fragments embedded in his brain, but also on evidence independent of the fragments. Although there are numerous indications, corroborating one another, that the President was fired upon from the front, I refer only to that which bears most directly on

the question whether he was wounded in the right-front part of the head by a bullet fired from the front. I refer, that is, to the sudden swift movement of the President backward and leftward instantly after he was wounded in the head.

President Kennedy's movements are recorded in three color movies, the most revealing of which is the one filmed by Abraham Zapruder, who was standing directly to the right of the President at the time of the head wounding.

Observation of the films, especially of Zapruder's film, discloses the following events, all of which occurred in less than a half-second of time: Momentarily appearing and disappearing near the President's face, a large crimson spray of bloody debris erupting from the head identifies the instant when a bullet impacted violently on the head. Zapruder's film shows that the smashing blow of this bullet grossly ruptured bone and tissue in the upper right side of the head forward of the right ear. Following the instant of violent impact, the President's head and torso suddenly lurch backward with enormous speed. Whereas before this wounding the President was leaning slightly forward and facing generally toward the front of the open convertible in which he was riding, immediately after the wounding

his head pivots leftward, while both head and torso speed continuously to the rear. The course of this swift backward movement is stopped only when the President's body rams forcibly against the back of the car seat.

Such swift, violent movement of the President's head and body backward and leftward seems the natural, predictable outcome of an impacting force that brought immense pressure to bear on the right-front part of the President's head, an impacting force delivered from the front by a bullet that struck and fragmented at the right-front part of the President's head.

Referring only to the concentration of minute fragments and to the President's movements, the proofs of a shot fired from the front seem positive, not subject to revision or to contradiction. The films depicting the head wounding cannot now be made to show that the President was thrust continuously forward when he was wounded, as he ought to have been thrust if the bullet which mutilated the right-front part of his head had been fired from the rear. The minute fragments, especially the "finely divided" fragments, cannot now be made to appear concentrated in the back of the head, where they ought to appear if a bullet struck and broke into dust-like fragments in that area.

These and other evidences establishing that President Kennedy was wounded by a bullet fired from the front are not in the least weakened by evidence establishing that he was wounded by a bullet that struck him from behind. Neither of the two sets of evidence cancels the other, for both sets seem positive, incapable of contradiction. Regarded individually, each set forms part of the whole truth: that President Kennedy was wounded in the head by two separate bullets, one of which struck him at the back of the head, the other at the front.



Footnotes

- p. 2 ... \* Throughout this discussion I refer only to those fragments which were mostly less than one millimeter in size and embedded in the President's brain. Other metallic fragments associated with the head wounding, fragments which were either considerably larger than one millimeter in size or were embedded in the skull, are discussed in Appendix A, where no opinions are offered regarding from which bullet they originated. I do not contend that all of the fragments associated with the head wounding evolved from the same bullet.
- p. 3 ... \* Hearings Before the President's Commission on the Assassination of President Kennedy (U.S. Government Printing Office; Washington, D.C.; 1964), vol. 2, p. 359.
- \*\* ibid., p. 353.
- \*\*\* Besides Dr. Humes, four other persons who viewed the X-ray films on the evening of the assassination gave information about the minute fragments. Brief statements by two Secret Service agents appear in Hearings, etc., vol. 2, pp. 100 and 128. Descriptions in a report prepared by two FBI agents appear in Edward Jay Epstein, Inquest (Bantam Books; N.Y.; 1966), pp. 162 and 168.
- p. 4 ... \* Hearings, etc., vol. 16, p. 980.
- \*\* Inquest (Bantam), p. 168.
- \*\*\* Report of the President's Commission on the Assassination of President Kennedy (U.S. Government Printing Office; Washington, D.C.; 1964), p. 60.
- p. 5 ... \* The suppression and eventual release of the panel's report are discussed in detail by Harold Weisberg, Post Mortem III: Secrets of the Kennedy Autopsy (Frederick, Md.; 1969).
- \*\* "1968 Panel Review of Photographs, X-ray Films, Documents and Other Evidence Pertaining to the Fatal Wounding of President John F. Kennedy on November 22, 1963, in Dallas, Texas," a mimeographed report released in 1969 by the U.S. Department of Justice, Washington, D.C., p. 10.

- p. 6 ... \* All parentheses are my additions.
- \*\* "1968 Panel Review, etc.," p. 11. The diagrams in Appendix B depict approximately the areas where the two groups of minute fragments were located in the President's head. The diagrams are conjectural and do not constitute the basis for any analysis. Conclusions pertain only to written descriptions.
- p. 9 ... \* NRA Firearms and Ammunition Fact Book, published by the National Rifle Association of America, Washington, D.C., p. 193. A thorough discussion of the physical forces affecting penetration of projectiles is presented in the U.S. Army Medical Service's book, Wound Ballistics (U.S. Government Printing Office; Washington, D.C.; 1962), pp. 115-235.
- p. 10... \* Wound Ballistics, p. 123. See also Figure 142 on p. 232.
- p. 11... \* Personal correspondence from Mr. Shelley Braverman.

Appendix A: Other metallic fragments associated with the wounding of President Kennedy's head

The wounding of President Kennedy's head resulted in the production of metallic fragments other than those mentioned in the foregoing discussion.

In X-ray films Dr. Humes located two fragments which appeared to be conspicuously larger than the "dustlike" fragments. Measuring 7 x 2 and 3 x 1 mm. respectively, these two fragments were situated in the front of the brain, slightly above and behind the right eye. Dr. Humes removed them from the brain and transferred them to the two FBI agents who were present at the autopsy. The two fragments were later subjected to spectrographic analysis, the results of which have not been fully and properly disclosed. (The results of spectrographic analysis were reported vaguely and by hearsay. In spite of vigorous efforts to secure its release, the detailed technical report on the spectrographic analysis, filed with the FBI among secret documents that may never be declassified, has been withheld from public scrutiny on grounds that its disclosure would not be in the national interest. On the deficiencies of statements concerning the spectrographic analysis, see Harold Weisberg, Post Mortem I: Suppressed Kennedy Autopsy; Frederick, Md.; 1969; pp. 21 ff., and the references cited there.)

The official autopsy report and statements by Dr. Humes suggest that the 7 x 2 and 3 x 1 mm. fragments were the largest visible in X-ray films of the President's head. However, the FBI agents' report states that the second largest fragment "appeared to be at the rear of the skull at the juncture of the skull bone." The report of the four-doctor panel refers to a roughly circular fragment, 6.5 mm. in diameter, situated at the site of the small hole in the rear of the skull. Although this fragment appeared to be the second largest in length, it was probably the greatest in mass of all the fragments embedded in the head. We do not know whether this fragment was recovered for analysis.

Additional fragments were depicted in X-ray films showing a section of skull bone that evidently had been detached from the President's head at the time of the wounding (the section of skull bone was alleged to have been found on the ground at the site of the shooting). These particles of metal, similar in size to those embedded in the brain, appeared in a margin of the skull section where evidently a missile had passed through the skull. In his autopsy report, Dr. Humes indicates that he presumed this to be a wound of exit. The panel doctors examined X-ray films of the skull section, but did not report on their contents.

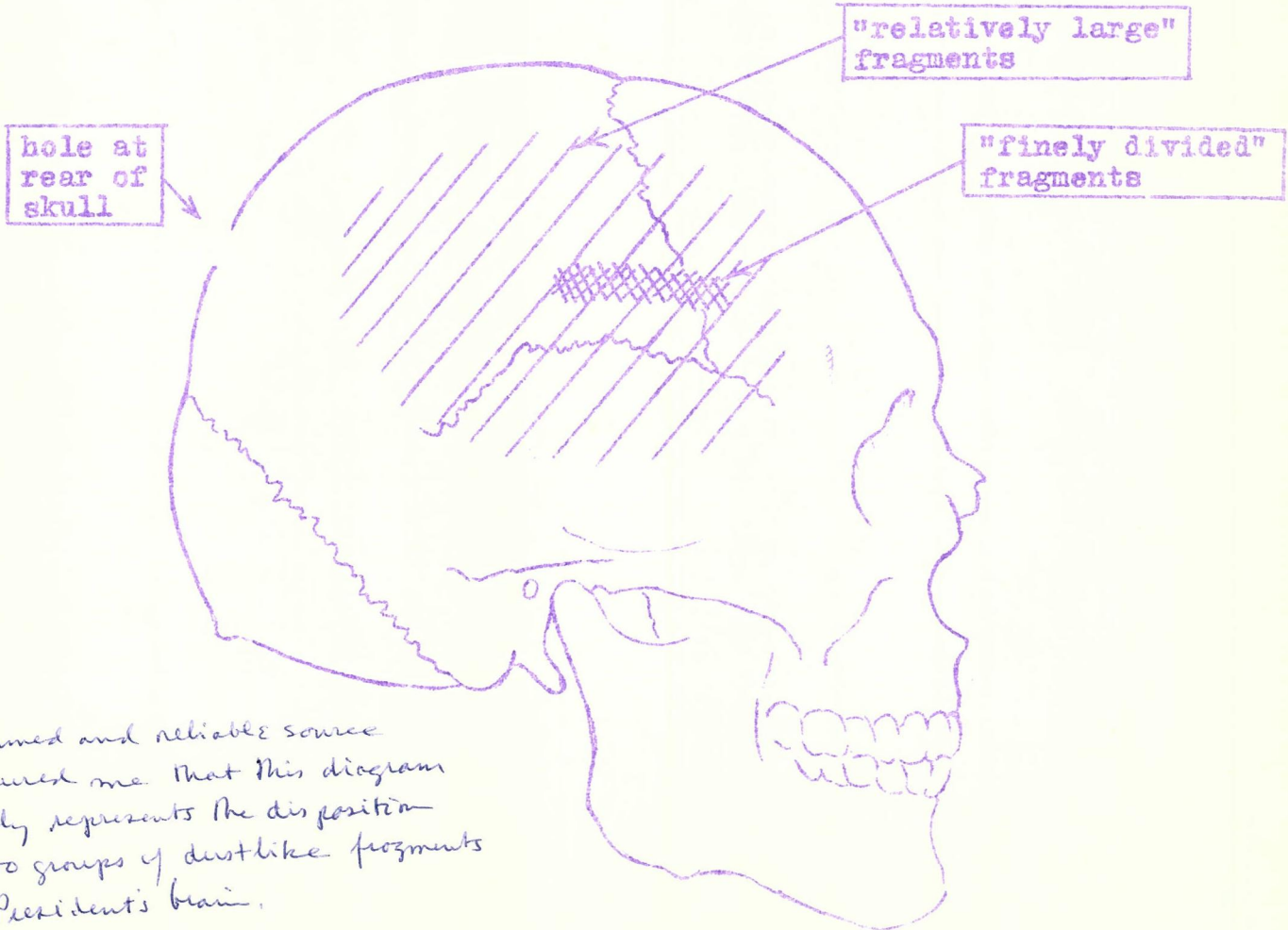
Information about the multiple minute fragments embedded in the brain and about the other fragments associated with the head wounding is given in the records of the Warren Commission cited in the footnotes on pp. 3 and 4, and in the "1968 Panel Review, etc.," cited in a footnote on p. 5.

Appendix B: Three conjectural diagrams illustrating approximately the location of multiple minute fragments of metal in the head of President Kennedy

Note: Diagram "a", representing the right side of a skull, is developed from information based on the examination of two X-ray films depicting the President's head as viewed from the left side at slightly different angles from one another. The panel doctors examined only these two left-lateral films and one film depicting the head as viewed from the front ("1968 Panel Review, etc.," p. 5).

In diagram "a" I neglect to indicate the formation of "finely divided" fragments, but rather show the approximate location of the mass of fragments taken as a whole. The panel's description of the orientation of the "finely divided" fragments in the direction of the hole in the back of the head refers only to their appearance in left-lateral X-ray # 2. A view from above might show, for example, that the group of "finely divided" fragments was oriented to the left or right of the hole, that it was wider or narrower than its appearance in the lateral X-ray, or other things. Therefore, rather than set forth what cannot be known even approximately, I elect to delete reference to the "finely divided" fragments in diagram "a".

(a) Skull viewed from the right side

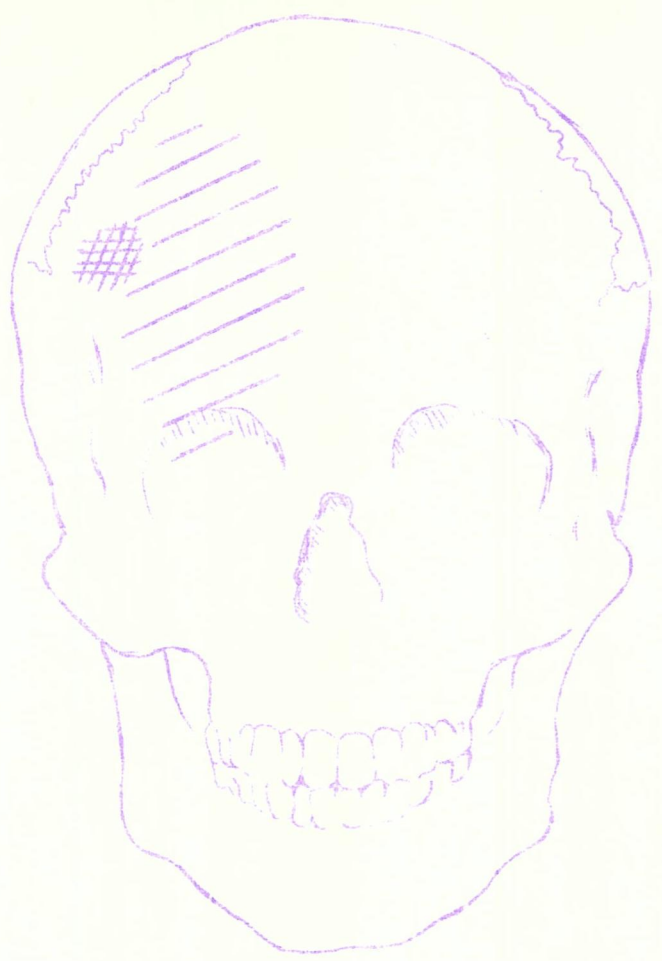


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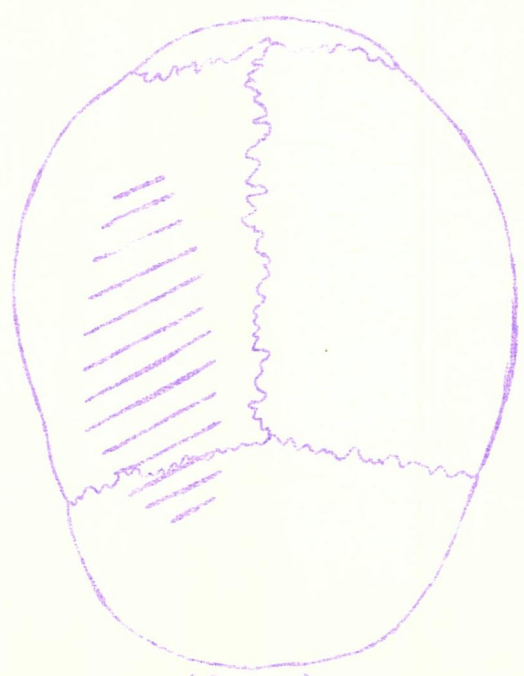
An informed and reliable source has assured me that this diagram accurately represents the disposition of the two groups of dustlike fragments in the President's brain.

RB

(b) Skull viewed from the front



(c) Skull viewed from above



(front)