Localization of vertex lesions seen on CT scan

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A simple method is presented for localizing the anatomical site of vertex lesions seen on a computerized tomography (CT) brain scan, using the patient's plain lateral skull film.

Materials and Methods

Physicians may experience difficulty in placing an abnormality seen on the computerized tomography (CT) brain scan into its precise anatomical localization. This problem is especially evident when dealing with lesions apparent on the CT scan, but not on cerebral angiogram. The exact anteroposterior localization of the anatomy viewed on the uppermost CT sections varies from patient to patient due to the alteration of the angle at which the scan was performed. Thus, a small parasagittal lesion may appear to be anterior or posterior to its actual location depending upon whether the scan was done at +15° or +20° to Reid's baseline (infraorbital-meatal line). Direct determination of the scanning angle with the patient in the scanner is difficult due to the constraints of the head unit. Norman and Newton deal with this problem in a prospective fashion by obtaining lateral and anteroposterior skull films while the patient is in the scanner, and constructing transverse CT planes on those films. Their technique, while both accurate and useful, suffers in that it must be performed at the time of the scan. Our determinations can be carried out retrospectively.

The scans described in this paper were performed on the EMI 1005 unit (160 × 160 matrix); the scan thickness was 8 mm. The angulation of the head during the CT study is determined by selecting an inferior section from the CT study on which three or more prominent bony landmarks are seen, such as the anterior or posterior clinoid processes, the external occipital protuberance, or the petrous pyramids. One then identifies and marks on the patient's plain lateral skull film with a wax pencil those points that correspond to the level at which each bony landmark is transected on this lower, or basal, CT section. Any intracerebral structures seen on the basal CT section that can be related to the skull film, such as the fourth ventricle, can serve to provide additional localizing points. A straight line drawn on the lateral skull film linking these points demonstrates the degree of angulation at which this particular study was performed. Since this baseline is constructed from points seen in a CT section 8 mm thick, errors in exact localization due to partial volume phenomenon are theoretically possible. In practice, however, they have not
been found, due to the relatively large size of these lesions (greater than 1.0 cm). All other sections obtained during the CT examination are parallel to this constructed baseline, provided that the patient's head has remained fixed (Fig. 1).

Next, the distance is measured from the upper edge of the transparency or Polaroid picture to the center of the lesion on the CT section that best demonstrates the abnormality. This is the only measurement made on the higher section, and it may now be set aside. This same distance down from the upper edge is measured on the basal CT transparency or Polaroid picture, and this point marked with a dot on the basal CT image. The point marking the center of the lesion on the higher section and the point transposed to the lower section should be exactly superimposable (Fig. 2).

In order to determine where the lesion seen on the CT scan should be located on the lateral skull film, proportionate relationship must be established between the two studies. This relationship is termed the "enlargement ratio" and is defined as the length of the baseline measured on the lateral skull film from outer table to outer table divided by this same distance as measured on the basal CT section (Fig. 3). This step only needs to be performed if the minification factor of the CT scan or the magnification factor of the lateral skull film are not known. If these are known, the minification factor of the CT image is divided by the magnification factor of the skull film to obtain the "enlargement ratio."

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Fig. 1. Basal computerized tomography cut (left) with discernible bony landmarks from which the baseline drawn upon the lateral skull film (right) has been obtained.

Fig. 2. Left: Vertex computerized tomography (CT) section with center of lesion measured 4.5 cm down from the top of the Polaroid picture. Right: Same CT point transposed upon lower CT section.
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Finally, from the basal CT section the distance is determined from the anterior outer table to the dot already placed on that picture corresponding to the position of the vertex lesion transposed to this lower section. This number multiplied by the "enlargement ratio" exactly places the lesion on the baseline previously drawn on the lateral skull film (Fig. 4).

If, for example, the distance from the anterior outer table to the posterior outer table along the baseline is 29.0 cm, and the same distance measured on the basal CT section is 4.2 cm, then the "enlargement ratio" will be 29.0 divided by 4.2. The answer of 6.9 is identical to that obtained by dividing the minification factor of the CT scan (3.7) by the magnification of the zero film from the angio-gram used in this example. The distance from the anterior outer table to the transposed dot on the basal CT section measures 2.1 cm. This number, when multiplied by the "enlargement ratio" of 6.9, yields 14.5 cm, exactly half-way along the baseline of 29.0 cm. A perpendicular erected to the baseline at this calculated point should intersect the lesion (Fig. 5).

The height of the lesion above the baseline can be calculated given the thickness of the intervening CT sections, the minification factor of the scanner, and any magnification factor relating to the lateral skull film.

Discussion

The method described here permits the physician viewing a CT brain scan done in the standard transverse plane to localize with reasonable accuracy the anatomical site of a vertex lesion by a simple calculation, avoiding the need for repeat scanning or other studies.

Fig. 3. Left: Measurement of length of baseline on plain lateral skull film (29 cm). Right: Same distance measured on the basal computerized tomography scan (4.2 cm).

Fig. 4. Distance measured on the basal computerized tomography section from anterior outer table to transposed site of lesion (2.1 cm).
An alternative approach would be to use reconstruction techniques to obtain the same information. Glenn, et al., first described the technique of obtaining multiple overlapping sections in the transverse plane and then manipulating the computerized data to permit reconstructions in the coronal, sagittal, and oblique planes. Rosenbaum employed a similar technique with an Artronix scanner to obtain approximately 32 non-overlapping sections, each 3 mm thick, for an individual study. This provides sufficient data to permit sagittal and coronal reconstructions without rescanning. Finally, it is now possible to obtain brain scans in the coronal plane directly without employing reconstruction techniques using the body scanner with its larger scanning aperture.

There are at least two major disadvantages to each of these approaches. First, they require access to equipment not available at many hospitals. Second, as with Norman and Newton's technique of obtaining skull films while the patient's head is in the scanner, they cannot be performed retrospectively. Our method enables the neurosurgeon to calculate the location of the lesion and determine his operative plan from the CT transparencies retrospectively. We have been successful in guiding the surgical approach to high frontoparietal lesions by using this simple calculation.

Acknowledgments

We wish to thank Drs. Glenn H. Roberson, Kenneth R. Davis, and Jonathan Kleefield for their critical review of this manuscript.

References