# Postural displacement of the brain: feasibility of using CT for determination of stereotaxic coordinates.

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# Postural Displacement of the Brain: Feasibility of Using CT for Determination of Stereotaxic Coordinates

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**Ten patients were studied with computed tomography (CT) in an attempt to determine if CT could be used preoperatively to establish stereotaxic coordinates for an operation and to find out more about how postural changes affect the position of the brain. Certain well defined cerebral structures were chosen as anatomic landmarks, and their relation to the skull determined with the patient in the supine, lateral, and prone positions. An external helmet fixation system was used to ensure consistent and reproducible CT slices. No displacement of the brain structures was observed in any of the positions, so it may be assumed that it is feasible to use CT-generated preoperative stereotaxic coordinates for reference during an operation, regardless of the patient's position. Four of the 10 patients were examined after lumbar intrathecal administration of metrizamide (200 mg I/ml). This small amount of positive contrast material did not seem to influence the position of the brain.**

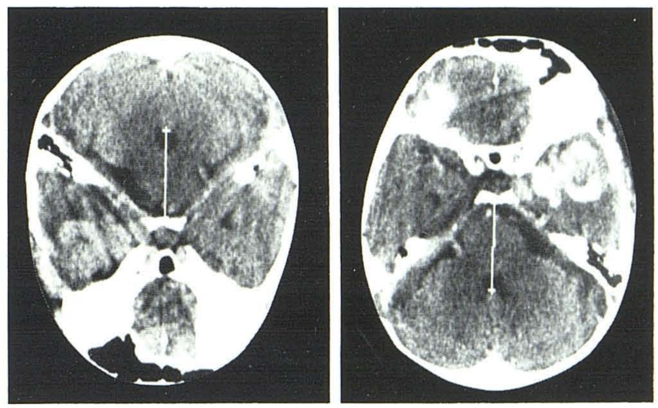
Stereotaxic computed tomography (CT) localization of intracranial lesions before operations, punctures, biopsies, or radiation treatment is an increasingly important part of diagnostic neuroradiology. The localization procedure, including the determination of stereotaxic coordinates, is mostly done with the patient in the supine position. But for various reasons, patients are often treated or punctured in either the prone or the sitting position. Such a change in position has been shown to influence the location of the brain relative to the skull during encephalography [1].

The influence of changes in skull position on the position of the brain when no contrast medium is introduced is largely unknown. The aim of this study was to investigate with CT the movement of the brain with postural changes under "normal" physiologic conditions (i.e., without the presence of contrast media that change the intracranial gravitational conditions).

## Materials and Methods

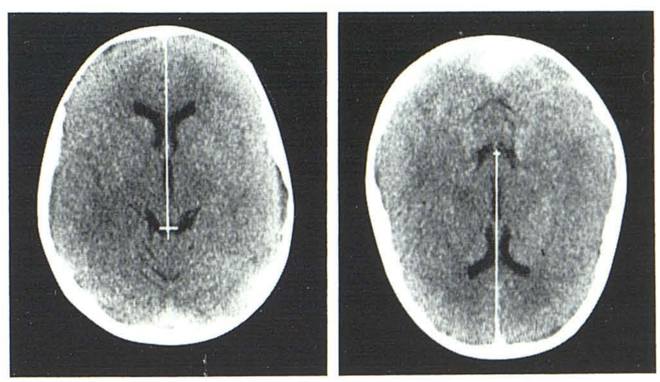
A GE 8800 CT scanner was used for examination of 10 patients (six men and four women) in the prone and the supine positions. Two patients were also examined in the lateral position. Individual plastic helmets for external fixation [2] were used in order to achieve corresponding slices.

Anatomic landmarks such as the fourth ventricle and the quadrigeminal plate were chosen. With the aid of a cursor, the distances to the skull were determined (figs. 1 and 2). These determinations were made twice by one neuroradiologist and then independently by another one. The Student *t* test was used for statistical analysis. During a metrizamide cisternography study the depth of the pontine cistern was also measured in one patient with that patient in prone and supine positions.



A B

Fig. 1.—Case 10. Distance between posterior part of fourth ventricle and clivus is 4.24 cm in both prone (**A**) and supine (**B**) positions.



A B

Fig. 2.—Case 1. Distance between quadrigeminal plate and frontal bone is 11.68 cm in supine (**A**) and 11.60 cm in prone (**B**) positions.

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TABLE 1: **Distances between Anatomic Landmarks, by Patient Posture**

| Anatomic Landmarks: Case No. | Distance by Position (cm) | | Difference (cm) (Supine − Prone) |
|---|---|---|---|
| | Supine | Prone | |
| Fourth ventricle, posterior part, to clivus: | | | |
| 1 | 3.76 | 3.76 | 0.00 |
| 2 | 4.28 | 4.32 | −0.04 |
| 4 | 3.60 | 3.68 | −0.08 |
| 5 | 3.84 | 3.84 | 0.00 |
| 7 | 3.92 | 4.00 | −0.08 |
| 9 | 4.16 | 4.24 | −0.08 |
| 10 | 4.24 | 4.24 | 0.00 |
| Quadrigeminal plate to frontal bone: | | | |
| 1 | 11.68 | 11.60 | +0.08 |
| 10 | 10.32 | 10.24 | +0.08 |
| Pineal gland to frontal bone: | | | |
| 3 | 11.44 | 11.36 | +0.08 |
| 7 | 11.68 | 11.68 | 0.00 |
| 9 | 10.56 | 10.64 | −0.08 |
| Foramen of Monro to frontal bone: | | | |
| 2 | 7.76 | 7.84 | −0.08 |
| 4 | 7.80 | 7.92 | −0.12 |
| 6 | 6.00 | 6.00 | 0.00 |
| 8 | 7.60 | 7.60 | 0.00 |
| Frontal horns to frontal bone: | | | |
| 5 | 4.72 | 4.72 | 0.00 |
| Pontine cistern (depth): | | | |
| 3 | 0.64 | 0.72 | −0.08 |

Note.—No differences were greater than the error of measurement.

## Results

In no case did significant displacement of the brain occur (table 1). The displacements observed were all within the error of measurement.

## Discussion

Until recently, no method has been available to study the movements of the brain within the cranial cavity caused by body position changes. When air or positive contrast media are used the brain is no longer surrounded by cerebrospinal fluid (CSF) in the usual way, and brain position changes observed therefore are not the result of true physiologic conditions. For this reason the Liliequist [1] findings do not agree with ours. On the other hand, our work does not refute the observations of Ruggiero et al. [3] concerning spontaneous movements of the third ventricle seen during encephalography, stereotaxy, and rapid seriography. The Ruggiero experiments were done without changing the position of the patient's head. Our results seem to indicate that, during physiologic conditions as they exist during CT examination, brain movements due to changes in the position of the head are minimal, if they occur at all. It is thus possible to do stereotaxic operations even when the coordinates have been calculated with the patient in a different position from that used at operation. If air is used for localization of anatomic landmarks one must consider the possibility that gravity might cause the brain to change position with postural changes. However, the slight increase in density of the CSF during CT cisternography does not seem to influence the position of the brain.

Our results show the feasibility of using coordinates of the brain structures obtained at CT irrespective of the position of the head during the examination versus its position during treatment.

## REFERENCES

1. Liliequist B. The subarachnoid cisterns, an anatomic and roentgenologic study. *Acta Radiol [Suppl]* (Stockh) **1959**;185:39–40
2. Greitz T, Bergstrom M, Boethius J, Kingsley D, Ribbe T. Head fixation system for integration of radiodiagnostic and therapeutic procedures. *Neuroradiology* **1980**;19:1–6
3. Ruggiero G, Trevisan C, Manno A. Méthode radiographique pour mesurer les mouvements des structures endocraniennes. *Acta Radiol [Diag]* (Stockh) **1969**;9:72–76