Composite Addition Technique: A New Method in CT Scanning of the Posterior Fossa

Joseph M. Levy[1] and Rolf Hupke[2]

Since the advent of CT, imaging of the posterior fossa has posed problems. The proximity and density of the temporal bones have created artifacts at the interfaces with brain [1]. Nevertheless, thinner sections through the posterior fossa reduce the partial volume artifacts [2], and the use of a method we call the composite addition technique (CAT) together with higher tube voltage further reduce both partial volume artifacts and beam-hardening effects. Because of the speed at which these scans can be obtained, motion artifacts are reduced as well.

Materials and Methods

Scans were acquired on a Siemens Somatom Plus CT scanner (Siemens Medical Systems, Iselin, NJ), a third-generation scanner with continuous rotation of the whole measuring system. The technique, however, can be adapted to most CT scanners. Standard 8- and 5-mm scans of the posterior fossa were obtained at 120 kVp, 250 mA, and 2-sec scan time. The 2-mm scans used for the composite images were obtained at 137 kVp and 360 mAs.

Owing to the continuously rotating measuring system of the scanner, it is possible to collect raw data of multiples of 360° scans [3]. The technique involves obtaining M ($2 \geq M \geq 5$) contiguous, thin (2-mm), axial sections (tablefeed equal to the slice thickness). These M raw data sets are linearly averaged prior to reconstruction and after the logarithmic function has been applied, and, finally, one CT image is reconstructed.

CAT is implemented through a software program known as VAR (volume artifact reduction), which averages images from scans acquired with thin-slice thicknesses (Fig. 1).

The length-dose-product (LDP) was measured with a Radcal Electrometer (Radcal Corp., Monrovia, CA) with a 10-cm-long CT chamber in a 16-cm-diameter Lucite phantom at 1-cm depth.

Results

CAT reduces partial volume artifacts dramatically. Figures 2B, 3B, and 4B demonstrate a significant reduction in streak artifacts from the temporal bones in the middle cranial fossa and from the internal occipital protuberance in the posterior fossa. Hounsfield crossing artifacts in the region of the brainstem are also markedly reduced (Fig. 2).

The major reason for the reduction of artifacts is that a measurement based on thin slice thicknesses yields raw data sets with nearly no partial volume effects in each slice. An artifact that occurs in one slice (due to partial volume effect or vascular pulsation) will be reduced in the final image by the factor of $1/M$ as a result of the averaging (Hupke R, Pauli KH. Paper presented at the 17th International Congress of Radiology, 1989). In addition, when scanning with higher tube voltage (137 kVp), beam-hardening artifacts are further reduced [4].

The results of the dose (LDP) measured in 1-cm depth of a 16-cm Lucite phantom are presented in Table 1. In scanning with the measuring parameters described above, obtaining individual images for the CAT method (32.20, see Table 1) results in a reduction of the dose to the posterior fossa and to the lens of the eye of about 10% as compared with conventional CT scanning techniques (35.75, see Table 1). This statement is valid for our measuring parameters. However, when normalizing the dose to 100 mAs (last column,

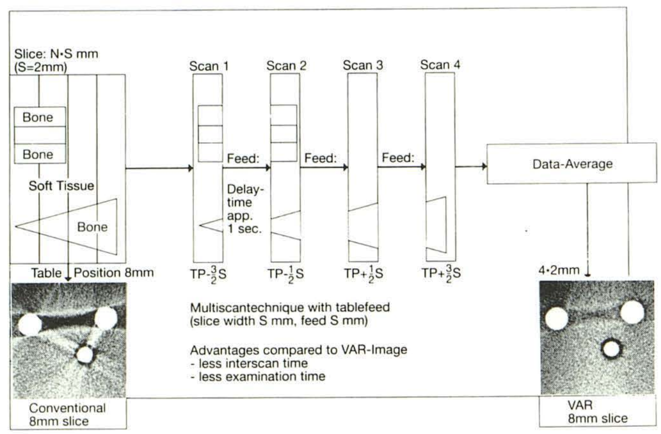

Fig. 1.—Schematic representation of composite addition technique (CAT) using volume artifact reduction (VAR) program. A larger volume is divided into thin slices; these measured data are averaged before image reconstruction.

Received September 4, 1990; revision requested November 13, 1990; revision received January 16, 1991; accepted January 17, 1991.

[1] Section of Neuroradiology, Division of Radiology, Lutheran General Hospital, 1775 Dempster St., Park Ridge, IL 60068. Address reprint requests to J. M. Levy.
[2] Siemens Medical Systems, Inc., Iselin, NJ 08830.

AJNR **12:686–688, July/August 1991** 0195–6108/91/1204–0686

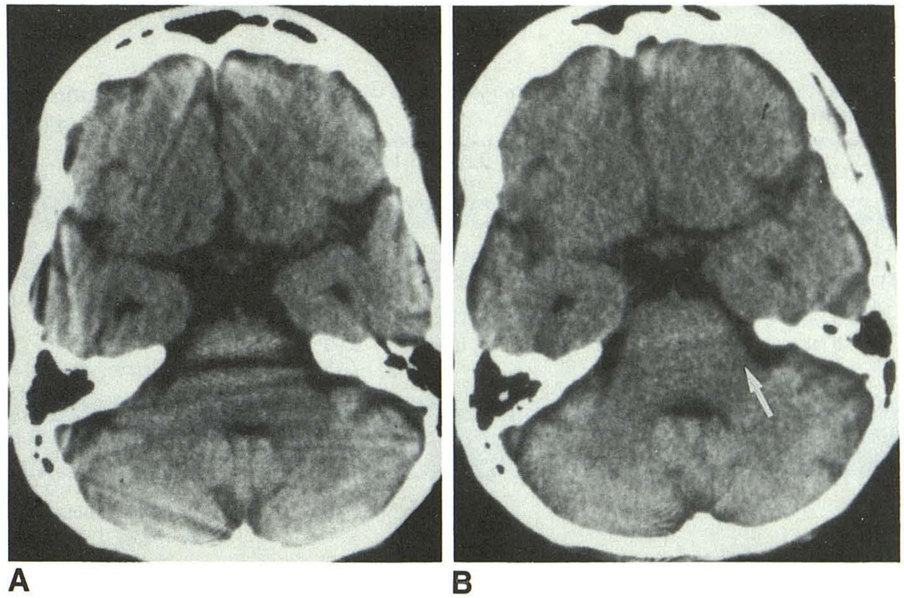

Fig. 2.—*A* and *B*, Noncontrast axial CT images obtained with conventional 8-mm scan (*A*) and four 2-mm contiguous sections that have been averaged (*B*). Note decrease in Hounsfield artifact in region of brainstem (*arrow*).

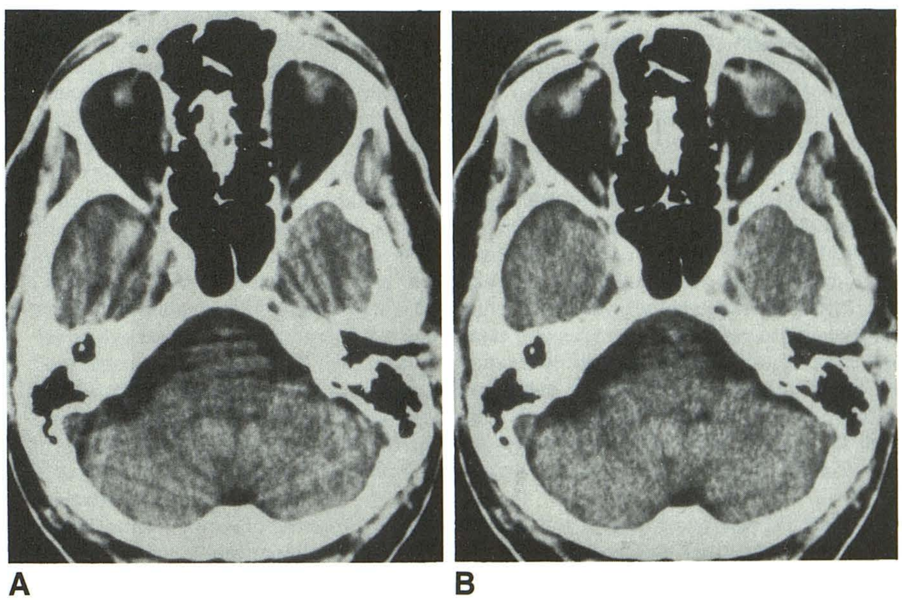

Fig. 3.—*A* and *B*, Noncontrast axial CT images obtained with conventional 5-mm scan (*A*) and two contiguous 2-mm sections that have been averaged (*B*). Streak artifact in temporal fossa is virtually eliminated.

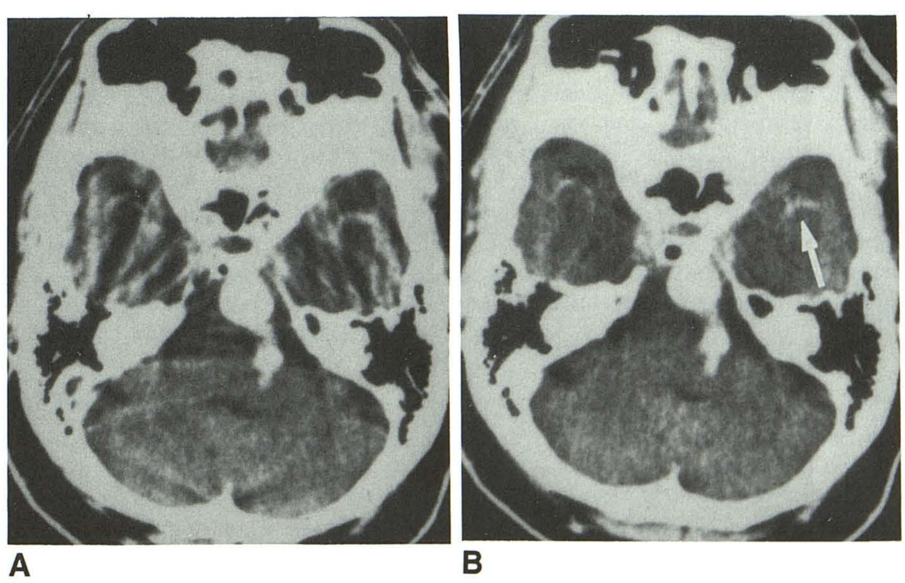

Fig. 4.—*A* and *B*, Contrast-enhanced axial CT images obtained with conventional 8-mm scan (*A*) and four contiguous 2-mm sections that have been averaged. (Note basilar artery aneurysm in *A*). Enhancement of choroid plexus (*arrow* in *B*) in temporal horns of lateral ventricles can be seen clearly once most of streak artifact has been reduced.

TABLE 1: Results of LDP Measured in 1-cm Depth of 16-cm Lucite Phantom

Measuring Parameters	LDP in mGy·cm	LDP/H in mGy	LDP/H in mGy per 100 mAs
Composite Addition Technique: (137 kVp, 2 sec, 360 mAs)			
H = 2 mm	6.44	32.20	8.94
Standard Method: (120 kVp, 2 sec, 500 mAs)			
H = 2 mm	6.85	34.25	6.85
H = 5 mm	17.33	34.66	6.93
H = 8 mm	28.20	35.75	7.15
H = 10 mm	37.91	37.91	7.58

Note.—LDP = length-dose product.

Table 1), the LDP values for CAT are higher because of the higher tube voltage and the overlapping of the dose profiles of thin slices.

In conclusion, CT scanning of the posterior fossa using CAT dramatically improves image quality by reducing both partial volume artifacts and beam-hardening effects.

ACKNOWLEDGMENTS

We gratefully acknowledge the scanning assistance of Lynne Davidson and the assistance of Joyce Mahon in preparing the manuscript. Dose measurements were performed by Allen Hrejsa.

REFERENCES

1. Lee SK, Sagel SS, Stanley R. *Computed body tomography with MRI correlations*, 2nd ed. New York: Raven Press, **1989**
2. Moestroem U, Ytterbergh C. Artifacts in computed tomography of the posterior fossa: a comparative phantom study. *J Comput Assist Tomogr* **1986**;10:560–566
3. Hupke R. The advantages of fast and continuously rotating CT systems. In: Fuchs WA, ed. *Advantages in CT*. New York: Springer-Verlag, **1990**: 3–15
4. Ruehrnschopf EP, Kalender WA. Artifacts caused by nonlinear partial volume and spectral hardening effects in computerized tomography. *Electromedia* **1981**;2:96–105