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Special Article

Historical Vignette: Introduction of Computed Tomography in North America

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Editor's note: 1993 marks the 20th anniversary of the installation of the first CT scanner in North America. Therefore, I have prevailed upon Dr Baker to share his memories of that period with the readers of the *AJNR*. At that time Dr Baker was a neuroradiologist at the Mayo Clinic. He later served as Chairman of that department and is currently Emeritus Professor of Radiology at the Mayo Medical School. Dr Baker is a Past President of both the American Society of Neuroradiology and the Radiological Society of North America.

On June 19, 1973, the EMI-Scanner, or computerized axial tomographic instrument (CAT), was utilized clinically for the first time in North America to examine a patient at the Mayo Clinic. The scanner itself, manufactured by EMI, Ltd, of Hayes, Middlesex, England, was conceived by Godfrey N. Hounsfield, a senior research scientist at the EMI Central Research Laboratories (Fig. 1). Hounsfield had also supervised construction of the first clinical scanner unit (1970–1971) (1) which was then applied in clinical trials (1971–1972) (2) by James Ambrose, the neuroradiologist at the Atkinson Morley's Hospital in south London.

Because Hounsfield was dedicated to the principles of extreme accuracy and sensitivity of attenuation detection, the instrument had provisions not only for multiple scans and a strong x-ray beam, but also for measurement through a fixed-length water bath. This latter feature essentially limited the use of the scanner to evaluation of the cranium and brain in that only the head could be easily placed into a rubber cap that projected into the water bath (Figs. 2 and 3). This first scanner was, therefore, designated as a "brain examination system" (Fig. 4).

The early results that Ambrose achieved seemed to indicate that a major advance in radiology was at hand, so James W. D. Bull, pioneer neuroradiologist at the National Hospital for Nervous Diseases, Queen Square, London, and a primary consultant to EMI, undertook to share this information with others of the international neuroradiologic community. An early opportunity came in the autumn of 1971 at the annual New York City neuroradiology refresher course, conducted in that year by Mannie Schechter, chief neuroradiologist at the Albert Einstein School of Medicine. Bull, a member of the faculty, was

Fig. 1. Godfrey N. Hounsfield—CBE, FRS, Nobel laureate—who conceived and supervised construction of the first CAT instrument.

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Neuroradiology and neuroradiologists; history; Computed tomography

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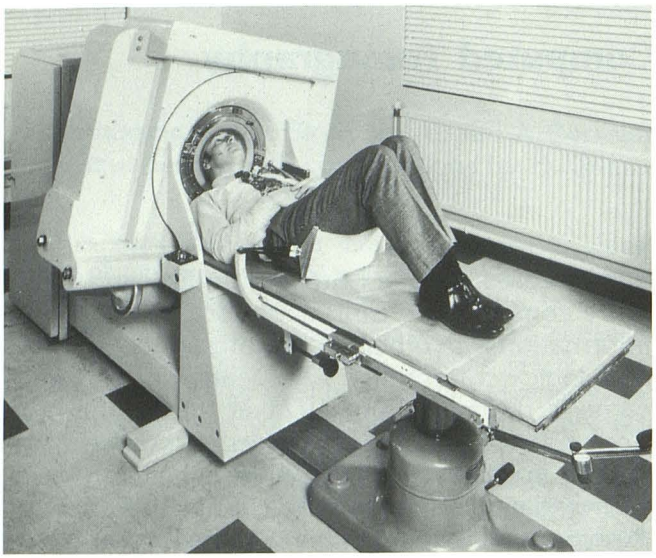


Fig. 2. Demonstration of the EMI scanner shows the subject's head enclosed in the rubber cap of the scanner unit.

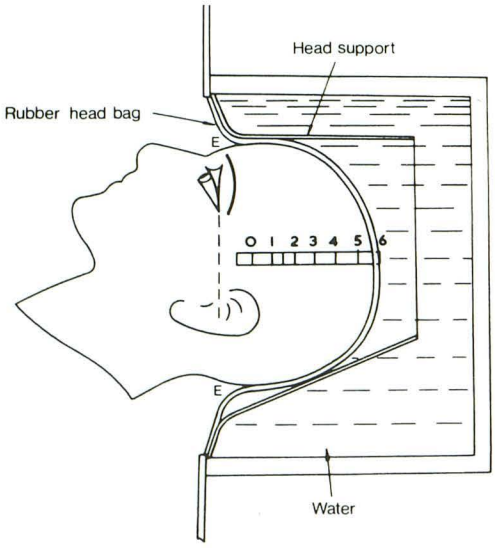


Fig. 3. Line drawing from the EMI-Scanner Operator Instruction Manual illustrating the correct positioning of a subject's head in the rubber cap and water bath.

accompanied by Hounsfield who was making his first visit to the United States. On the final day of the course, after all of the scheduled lectures had been presented, Bull was allowed to introduce Godfrey Hounsfield "who would make an extra presentation." What followed was the first report in the United States outlining the features of the computed tomographic (CT) system and illustrating its use for the diagnosis of intracranial pathology. The crude (80 × 80 matrix) CT images (Fig. 5) unequivocally demonstrated intracranial masses, hemorrhages, and infarcts and set in motion a series of events that culminated in the installation of the first CT machine in America at our institution.

Another member of the course faculty who heard the "extra presentation" was my longtime neuroradiologic colleague, Colin B. Holman. Colin was deeply impressed by what he had seen and, therefore, asked James Bull, who was a good friend to both of us, if he could borrow several slides to bring back to Rochester so all members of the department could view them. Despite the crudity of the images, it was immediately apparent to all that structures inside the skull and brain could be seen with some clarity and that this new technique was a major advance in imaging. After some discussion within the department and the institution, I was asked by our departmental chairman, John R. Hodgson, to go to England and evaluate the machine, as well as Dr Ambrose's patient studies, on site at the Atkinson Morley's Hospital. Before leaving I consulted with James Bull who was very cordial and offered to arrange introductions to Ambrose, as well as to the principals at the Central Research Laboratories and corporate headquarters of EMI. I also asked Jack Hodgson to obtain permission from the Mayo Board of Governors which would allow me to place an order for a scanner "on the spot" if, indeed, the instrument looked to be as valuable to our practice as it appeared in our early but superficial introduction. In due course, this permission was granted, although such a setup was somewhat unusual in that these instruments cost about $350,000 at that time—enough money to

Fig. 4. A portion of the original advertising brochure issued by EMI Ltd in 1974 when the scanner reached market.

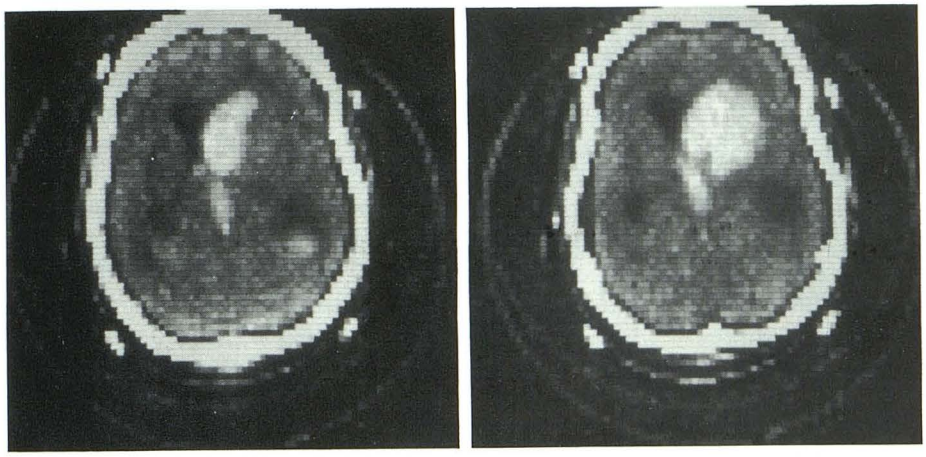


Fig. 5. Sample 80 × 80 matrix tomographic section shows a large intracerebral hematoma in the right frontal lobe that has ruptured into the ventricles.

furnish several regular radiographic rooms with standard equipment or one or two angiographic rooms with more sophisticated equipment.

On July 18, 1972, I arrived in London accompanied by several members of my family. While they enjoyed sightseeing for the next several days, my time was occupied by the important evaluation I was sent to accomplish. True to his promise, James Bull had made the necessary arrangements and, on the 19th of July, I spent the day with the people of EMI. In the morning at the Central Research Laboratories, I met with William E. Ingham, director of the laboratories; Alan G. Blay, the assistant director; Godfrey Hounsfield; Edward Gowler, a production engineer; and a very personable administrator, Robert Froggatt, who gave me a guided tour of the entire installation in which multiple electronic projects, in addition to the CT effort, were in progress. Hounsfield's so-called laboratory was a large shop-like room with various machine tool and electronic installations used in assembling the prototype EMI scanner. The room appeared to contain everything needed except large casting and stamping equipment for fashioning major metal parts. Laboratory personnel explained how the instrument worked and they scanned a phantom that was on hand, to demonstrate how rapidly and well the image could be reconstructed and displayed. After luncheon we went to EMI corporate headquarters on Manchester Square in central London where I met Sir John Read, CEO of EMI, Ltd. Sir John briefly outlined the history of CAT scanner development and invited me back for further talks after I had visited James Ambrose and his installation at the hospital.

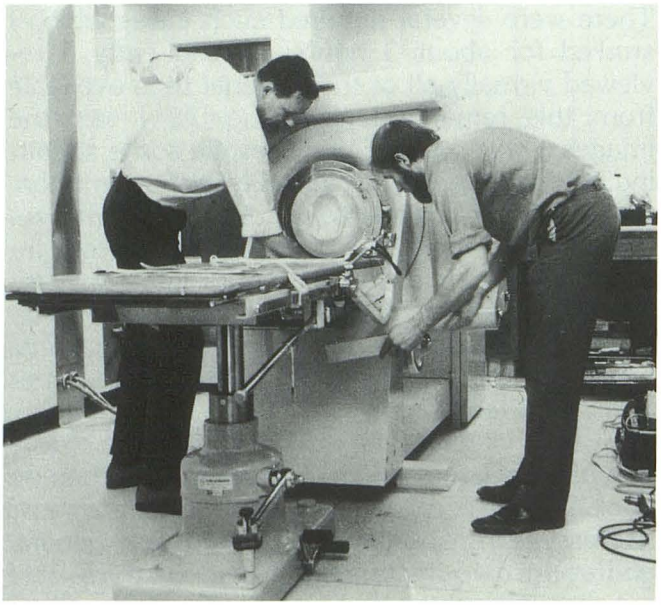
On the 20th day of July, I was taken to the Atkinson Morley's Hospital where I met James Ambrose, the neuroradiologist who was conducting evaluations of the EMI scanner on neurologic and neurosurgical patients. After we discussed machine operation, maintenance problems, downtime, and other pertinent points, I looked at the records of patient examinations. Dr Ambrose was quite meticulous in his record keeping and he had collected and mounted in loose-leaf binders the histories and images of all patients examined in the past year. Each case was consecutively numbered and, when available, histologic, surgical, or neurologic diagnoses were included. There were several hundred such cases which I studied for about 3 hours; consequently, I reviewed virtually all of the material then available from this remarkable machine. As I saw the images it was obvious that, despite some streaking on certain sections caused by patient motion, the system was capable of displaying with remarkable clarity many pathologic processes involving the brain, including tumors, infarcts, hemorrhages, and infectious processes. I came away with a very positive attitude but deferred final judgment until I had a chance to talk to James Bull that afternoon.

At the National Hospital later that day, over a cup of tea, James and I talked for more than an hour about the meaning of the CT scanner and its possible impact upon neuroimaging in general and at our two institutions in particular. He told me that a machine had been ordered for use in his department but, because of the age of the building and the weight of the equipment, as well as the inadequacy of the elevators, installation within his present department was impossible. A search was going on for adequate space in the

basement of the hospital buildings, which might be used for scanner installation. He estimated that the identification, clearing, and preparation of such space for equipment installation and use in patient care might take up to 2 years, so the instrument then being built for his use might be available for use outside of the United Kingdom. Bull's very positive response to CT, as well as the information he was able to impart to me, reinforced my tentative conclusion that the time was ripe for Mayo to acquire this technology. I, therefore, asked James to inform the people of EMI Central Research that I would like to visit Atkinson Morley's Hospital once more to further review the patient studies of Dr Ambrose.

On July 21, 1972, Bob Froggatt drove me to Dr Ambrose's department where I spent another hour re-reviewing scanner case material. As we walked back to the car, I informed Bob that I would like to place an order for an EMI scanner to be installed as soon as possible at the Mayo Clinic in Rochester, Minnesota. He was somewhat taken aback by this announcement and excused himself to call his office. When he returned to the car he informed me that we had a luncheon date with Sir John Read at corporate headquarters in London. After lunch, Sir John questioned me rather sharply concerning my impression of the CT system, its possible impact upon neuroradiology, and what I thought the market for these machines might be in the United States. My estimate was between 2000 and 2500 units, if all institutions with residency training programs in radiology, neurosurgery, and neurology found that they could not function without this technology (which I thought would be the case). This was apparently considerably higher than they had estimated but lower than the number of units actually installed in the next 5 or so years.

Upon my return home, the order was confirmed by the Mayo Board of Governors and the remaining negotiations concerning modes of transportation and time of machine delivery, review of specifications, size and weight of components, and the details concerning payment for the unit were determined through correspondence. When all information was in hand, a room was built and prepared in the radiology department to receive the scanner when it arrived. In early May 1973, a team from Hayes (Fig. 6), which included Godfrey Hounsfield, David G. King, and Peter Clarke, arrived in Rochester, along with the component parts of the scanner. Installing, calibrating, and checking the system required about 6 weeks (Fig. 7) and clinical utilization commenced a short time later. CT was



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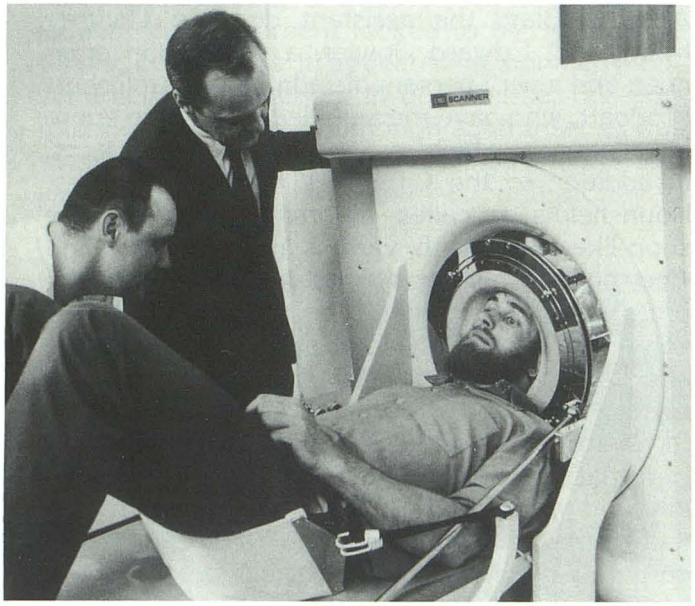

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Fig. 6. David G. King (*right*) and Peter Clarke in the process of assembling and installing the EMI scanner at the Mayo Clinic in May 1973.

Fig. 7. David King as the "subject" during calibration and checking of the system in early June 1973. Darrell Holtz, first American scanning technologist, adjusts the machine as the author looks on.

rapidly and universally adopted by neuroscientists and *has* changed the practice of neuroradiology. The specific impact upon the neuroradiologic activities at the Mayo Clinic has been amply documented in the scientific literature (3–8) and similar experiences have been repeated worldwide.

Addendum: This remarkable instrument not only changed the face of neuroradiology but stimulated others to devise improvements resulting in faster, more precise, and higher resolution scans. Within just a few years the original system, having given honorable service, was declared obsolete. The USA EMI-Scanner #1 was retired to the Mayo Medical Museum for future generations to see, but all our other "translaterotate"-type machines were unceremoniously hauled away to the salvage yard (Fig. 8).

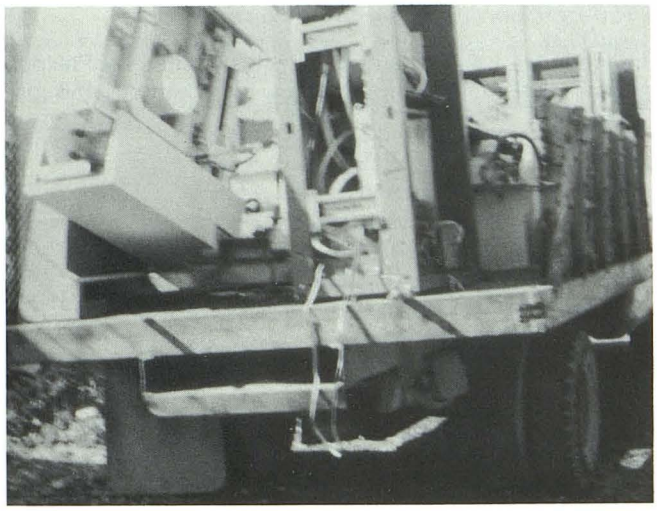

Fig. 8. Obsolete "translate-rotate" scanner being ignominiously hauled away to the salvage yard, 1978.

Acknowledgments

I would like to thank Godfrey N. Hounsfield and David G. King for their help in recalling the finer details of this adventure.

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