CT ART

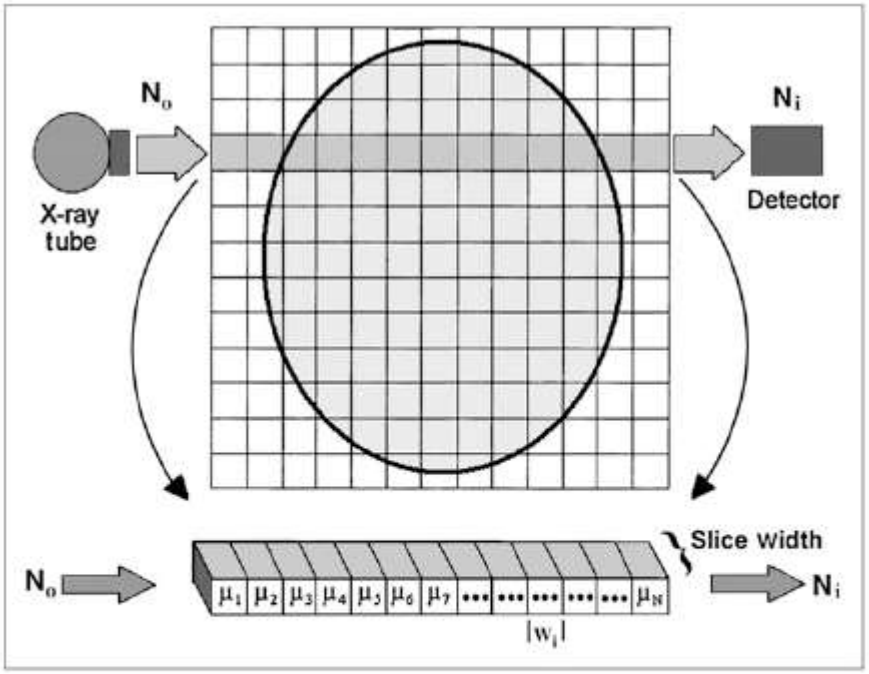

FIGURE 3. Reconstruction matrix. Hounsfield envisioned scanned slice as being composed of matrix of small boxes of tissue called voxels, each with attenuation coefficient μ. x-Ray transmission measurements (N_i) can be expressed as sum of attenuation values occurring in voxels along path of ray for N_i.

Table 5.1. Reconstruction techniques

- Back-projection (simple back-projection, summation method, method of linear superposition)
- Iterative reconstruction
  - Simultaneous correction (iterative least squares technique, ILST)
  - Ray-by-ray correction (algebraic reconstruction technique, ART)
  - Point-by-point correction (simultaneous iterative reconstruction technique, SIRT)
- Analytical reconstruction
  - Two-dimensional Fourier reconstruction
  - Filtered back-projection (convolution method, convolutional integral, integral equation)
    - Fourier filtering
    - Radon filtering
    - Convolution filtering

Table 3-1 Image reconstruction algorithms

Projection Reconstruction (PR)	2-D PR	Filtered Backprojection (FB)	Parallel-Beam Mode
			Fan-Beam Mode
		Backprojection Filtering (BF)	Parallel-Beam or Fan-Beam Mode
	3-D PR	True Three-Dimensional Reconstruction (TTR)	Parallel-Beam Mode
			Cone-Beam Mode
		Generalized TTR (GTTR)	
		Planar-Integral Projection Reconstruction (PPR)	
Iterative Method	Algebraic Reconstruction Technique (ART)		
	Maximum Likelihood Reconstruction (MLR) or Expectation Maximization (EM) Reconstruction		
Fourier Reconstruction (FR)	Direct Fourier Reconstruction (DFR)		
	Direct Fourier Imaging in NMR		

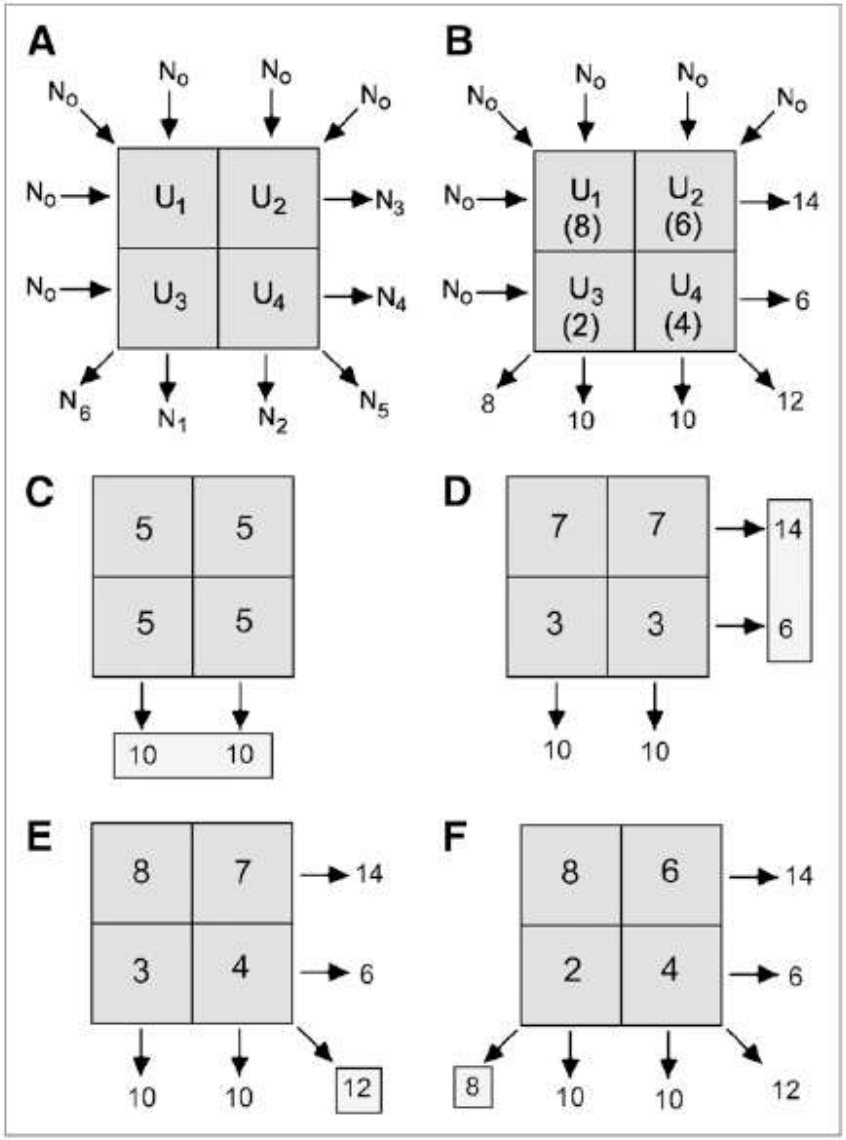

FIGURE 4. ART. (A) ART algorithm for 4-voxel "patient." (B) Attenuation measurements. (C) Starting estimate is constructed by dividing measurements from first view equally along their ray paths. (D–F) This estimate is iteratively adjusted to match measurements for each consecutive view, stopping when transmission measurements predicted by current estimate match all actual measurements to within some preset tolerance.

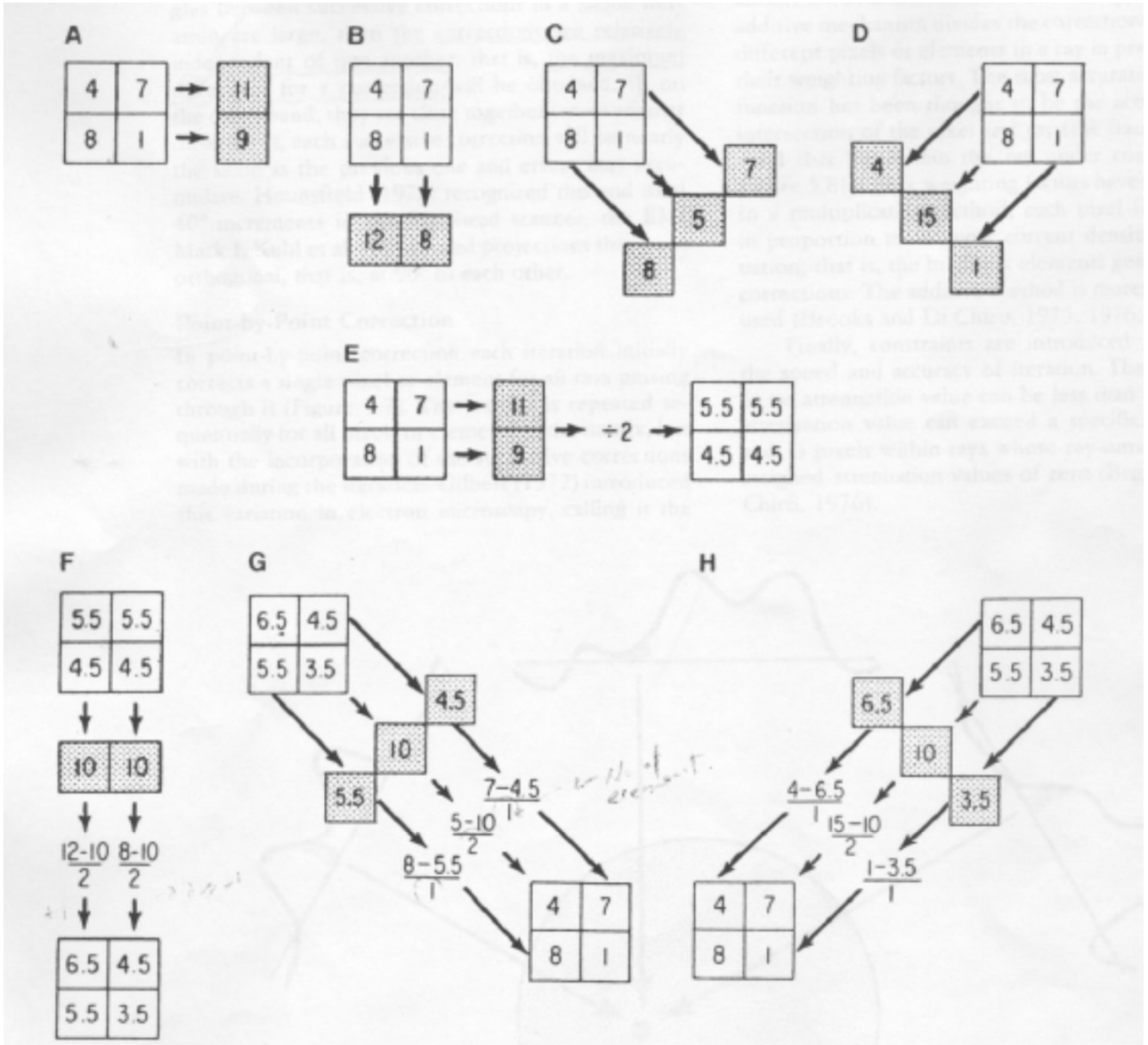

Figure 5.6. Ray-by-ray correction. Determination of experimentally measured ray-sums for horizontal (*A*), vertical (*B*), and oblique rays (*C* and *D*). *E*, Equal distribution of the ray-sum for horizontal rays among the elements in the ray. This is equivalent to back-projection. *F*, Vertical ray-sums are calculated from the matrix in *E* and compared to the true or measured values of the ray-sums from *B*. The difference between the calculated value and the measured value is distributed equally among the elements in each vertical ray. A new working matrix is obtained. *G*, Ray-sums from the new working matrix are calculated for oblique rays. These ray-sums are then compared to the true or measured ray-sums for these oblique rays from *C*. The difference is then distributed equally among each element in the ray. The original or true matrix has now been obtained. *H*, The ray-sums from the working matrix in *F* are calculated for a different set of oblique rays. These ray-sums are compared to the true or measured ray-sums for these oblique rays from *D*. The difference is then distributed equally among each element in the ray. The original or true matrix has now been obtained.

Illustrative Example of Computed Tomography

- Linear Projection
- Image Reconstruction: Algebraic Reconstruction

5	7
6	2

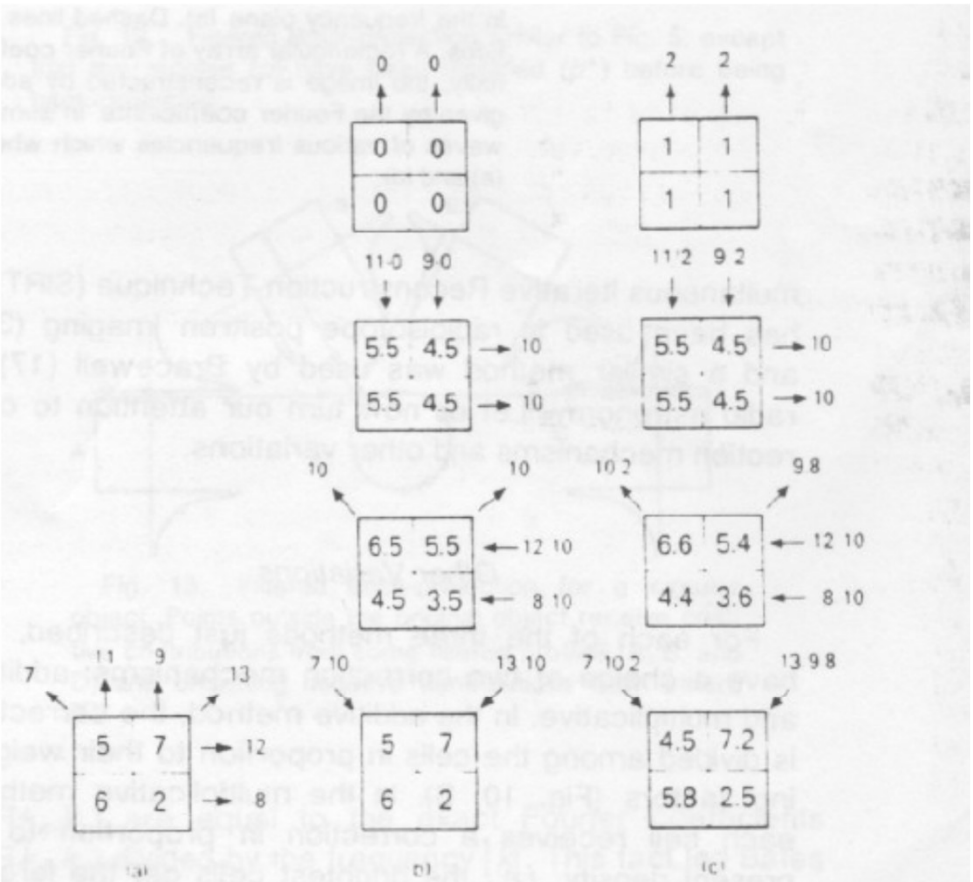

Fig. 10. Numerical illustration of iterative reconstruction (ART).
(a). Original object and six ray-sums.

(b). Additive correction. Upper box shows the starting values (0). A correction is first applied for the two vertical rays by subtracting the calculated values (0 and 0) from the measured values (11 and 9) and distributing the difference between the two cells that make up each ray (2d box). This process is repeated for the two horizontal rays (3d box) and diagonal rays (4th box), thus completing one iteration. In this simple example, the reconstruction after one iteration is perfect.

(c). Multiplicative correction. The starting values (1) shown in the upper box are multiplied by the ratio of the measured vertical ray-sums (11 and 9) to the calculated values (2 and 2). This procedure is repeated for the horizontal and diagonal rays. In this example, errors persist and further iterations are required.