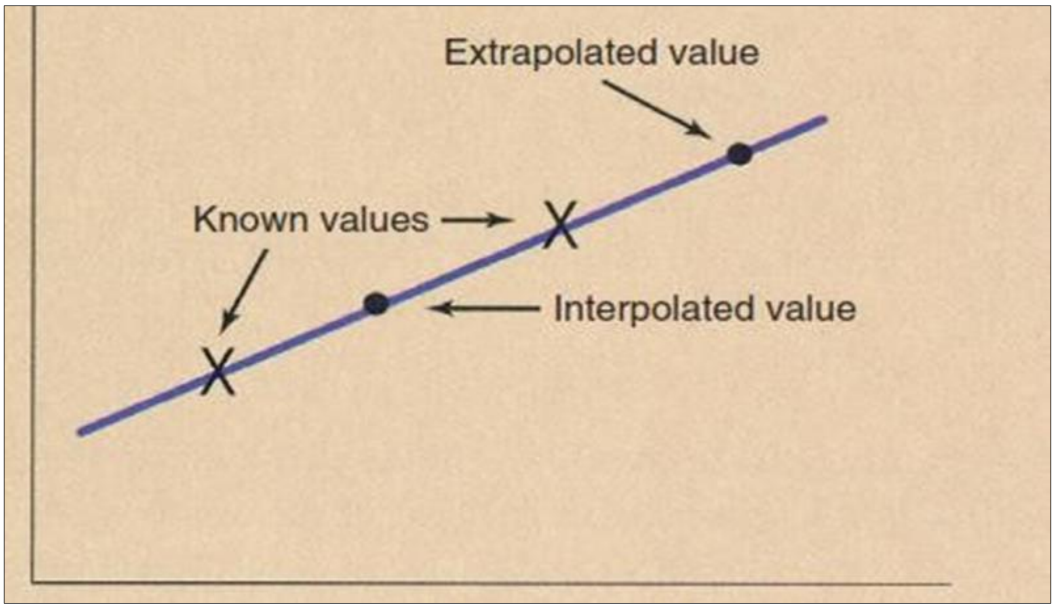
Interpolation Algorithms

Reconstruction of an image at any z-axis position is possible because of a mathematical process called ***interpolation***. **Figure (1)** presents a graphic representation of interpolation and extrapolation. If one wishes to estimate a value between ***known values*** that is an ***interpolation***; if one wishes to estimate a value ***beyond the range*** of known values that is an ***extrapolation***.



Fig(1): Interpolation estimates a value between two known values. Extrapolation estimates a value beyond known values.

During ***helical CT***, image ***data are received continuously***, as shown by the data points in Figure 2 A. When an image is reconstructed, as in Figure 2 B, the plane of the image does not contain enough data for reconstruction.

The data in that plane must be estimated by interpolation. Data interpolation is performed by a special computer program called an ***interpolation algorithm***.

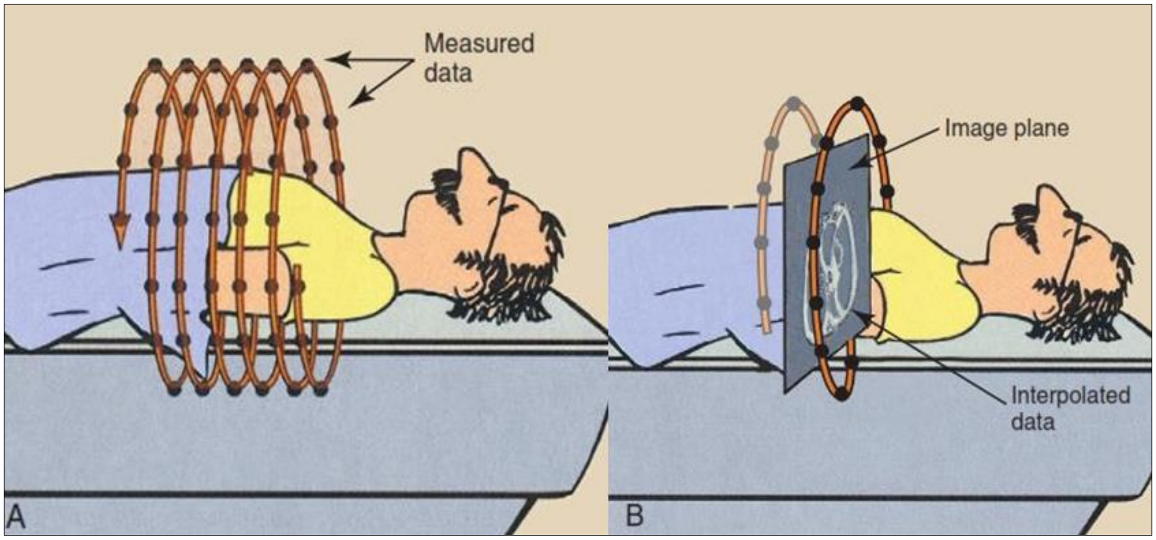
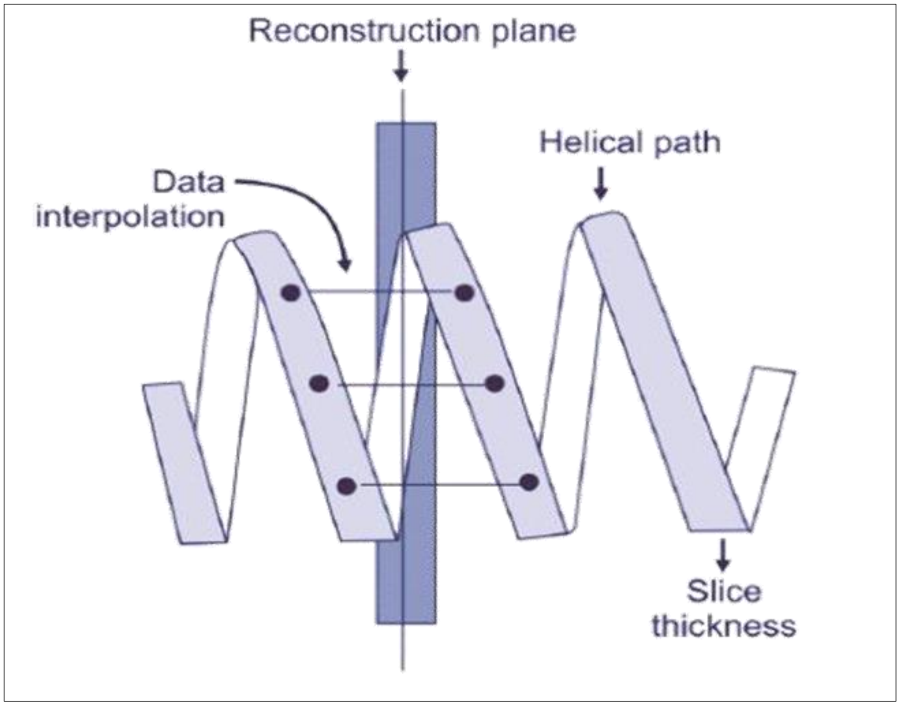


Fig. (2): A, During multislice helical computed tomography, image data are continuously sampled. B, Interpolation of data is performed to reconstruct the image in any transverse plane.

Image ***interpolation creates a number of new slices between known slices*** in order to obtain an isotropic volume image.

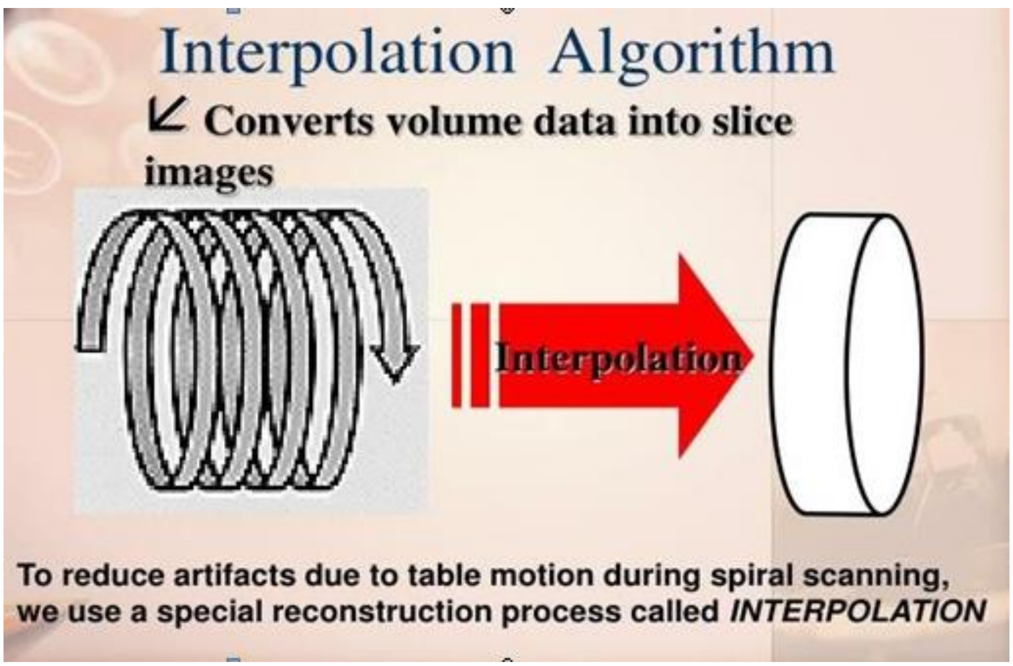
The problem with ***continuous tube and table motion*** was that ***projections precessed in a helical motion*** around the patient and ***did not lie in a single plane***. This meant that ***conventional reconstruction algorithms could not work***.

Helical CT scanning produces a data set in which the X-ray source has travelled in ***helical trajectory around the patient***, (the ***data are acquired in a helical path*** around the patient). Present day CT reconstruction algorithms assume that the X-ray source has ***negotiated a circular not a helical path*** around the patient. To compensate for these differences in the acquisition geometry, before the actual CT reconstruction ***the helical data set is interpolated into a series of planar image data sets*** (the reconstruction plane of interest). Interpolation is essentially a ***weighted average of the data from either side of the reconstruction plane***, with slightly different weighting factors used for each projection angle.



Figs.(3): Data interpolation

In summary: *Interpolation Algorithms are the mathematical process required to reconstruct axial images from the spiral volume data set.*



Pitch

During helical scans, the table motion causes ***displacement of the fan beam projections along the z axis***; the relative ***displacement is a function of the table speed and the beam width***. The r***atio of table displacement per 360° rotation to section thickness is termed pitch***.

Pitch is the table movement per rotation divided by beam width.

pitch = table travel / beam width

- pitch = 1 - coils of the helix are in contact
- pitch < 1 - coils of the helix overlap
- pitch > 1 - coils of the helix are separated

For example

- If beam width is 10cm, the table moves 10cm during one tube rotation, then pitch is 1, so, x-ray beam associated with consecutive helical loops are contiguous.
- If beam width is 10cm and table moves 15cm per tube rotation, then pitch is 1.5 So, a gap exists between the x-ray beam edge of consecutive loop.
- If beam width is 10cm and table moves 7.5cm then pitch is 0.75, so, beams and consecutive loops overlap by 2.5 (doubly irradiating the underlying tissues).

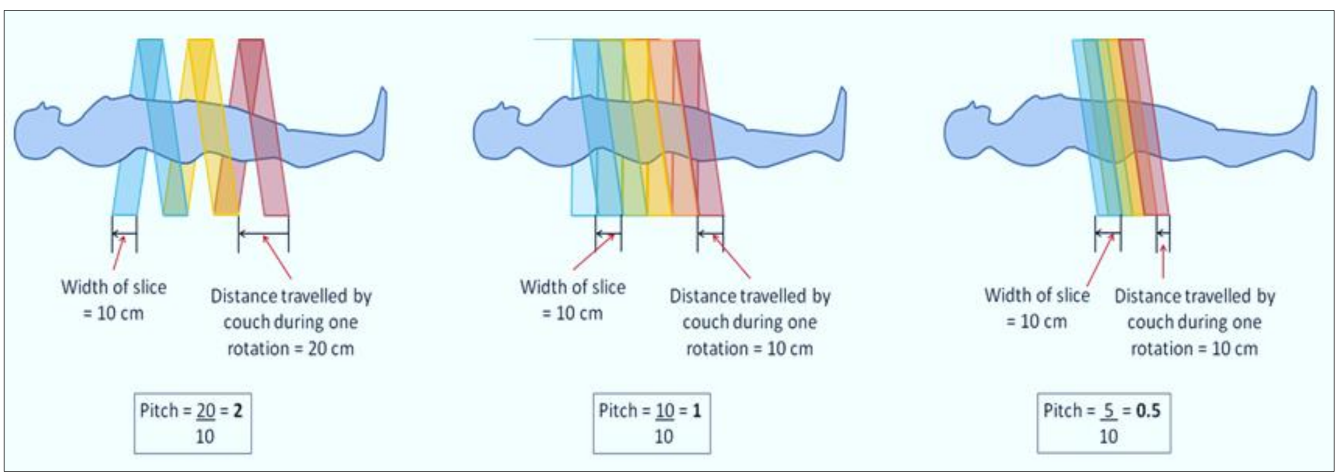


Fig (4): Illustration of pitch concepts

The relationship between ***the volume of tissue imaged and pitch*** is given as follows:

VOLUME IMAGING

$$\text{Tissue imaged} = \frac{\text{Beam width} \times \text{Pitch} \times \text{Imaging time}}{\text{Gantry rotation time}}$$

Advantages of helical CT scanner

1) Fast scan times and large volume of data collected.
2) Minimizes motion artifacts.
3) Less mis-registration between consecutive slices.
4) Reduced patient dose.
5) Improved spatial resolution.
6) Enhanced multiplaner or 3D renderings.
7) Improved temporal resolution