

Computed tomography in University Hospitals of Morecambe Bay

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Thirty years ago a fundraising campaign to install Lancaster's computed tomography (CT) scanner was nearing completion. The Morecambe Bay Medical Journal featured an article describing this new modality and outlining its clinical use.



Figure 1: A picture of a new machine.

I am grateful to the editor for asking me to revisit this topic and write a review of CT in the trust now. I am particularly grateful to Dr Mike Flanagan for writing such a strong original article in 1989, which made revisiting this topic so much easier.¹

Reading his article my overwhelming sense is one of 'plus ça change plus c'est la même chose' (the more things change the more they stay the same).² (p. 278)

Some things have clearly evolved; the planned service outlined then was based around one yet-to-be acquired

scanner and to run 9 to 5, Monday to Friday, scanning a modest number of mostly elective patients. Since then the configuration of the Trust has expanded to include Furness General Hospital and Westmorland General Hospital, as well as the Royal Lancaster Infirmary. The scope of CT imaging has also expanded to four scanners, split between two acute sites, which between them provide a 24 hour a day, seven day a week service, scanning around 30,000 patients per annum.

Now as then, 'it is hoped that this will provide a 'same day' service for [in] patients. Naturally this is a flexible framework which can be changed in line with clinical priorities.'¹ (p. 17)

Fundamentally the concept of CT as a three dimensional X-ray has not changed but the method of acquisition has. With the first generations of CT scanners, images would be acquired slice by slice and the orientation of the slice might be altered to show certain anatomy to best effect. For instance, direct coronal imaging of the bony sinuses of the face saw patients lying prone with their neck extended to bring their face into line with the intended position.

Scanners then became 'multi-slice' and as the name suggests several parallel slices of images would be acquired simultaneously. Just as we are familiar with two dimensional pixels on a screen or a single slice of a CT, the whole study consists of many three-dimensional voxels with potentially different dimensions in x, y and z axes.

Over time, scanners have evolved to acquire a volume of data, often isotropic (the same size of voxel in each plane), by moving the patient through the scanner at the same time as images are being taken. Spiral (strictly

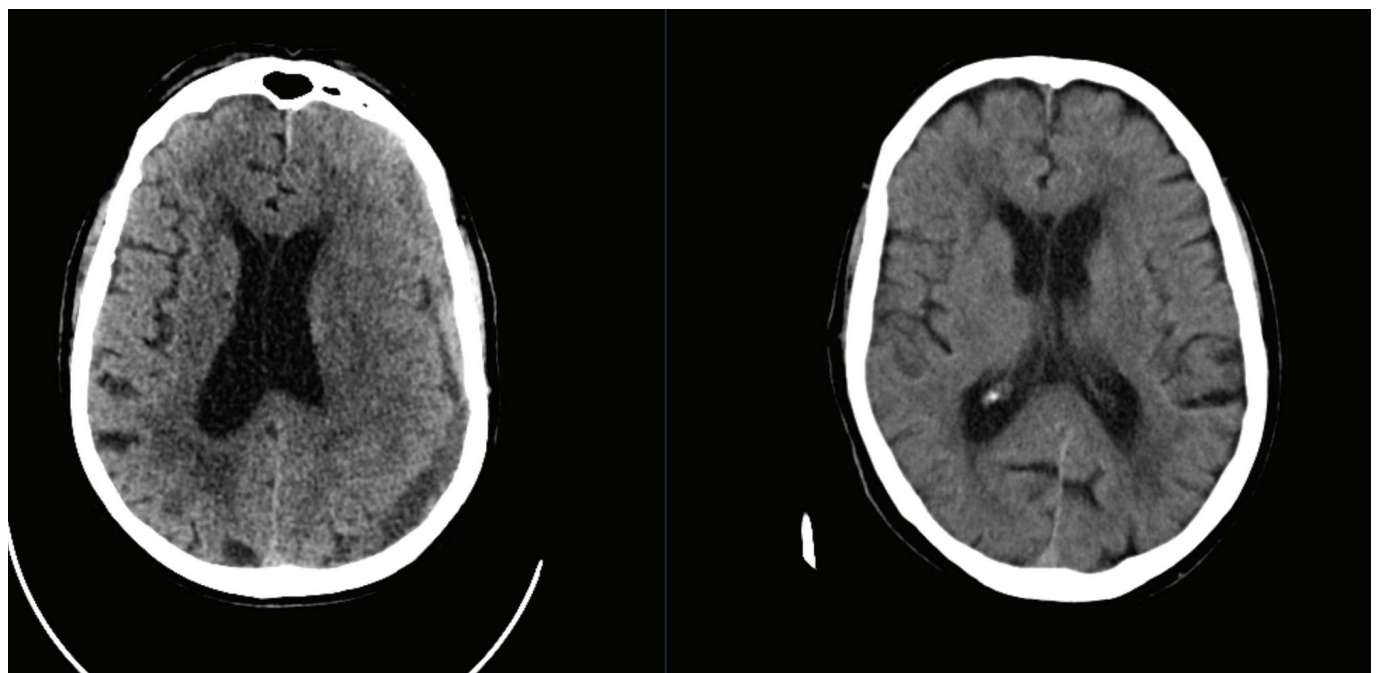


Figure 2: Then and now picture of something in the old article that's not changed much – maybe a subdural haemorrhage (old fig 5).

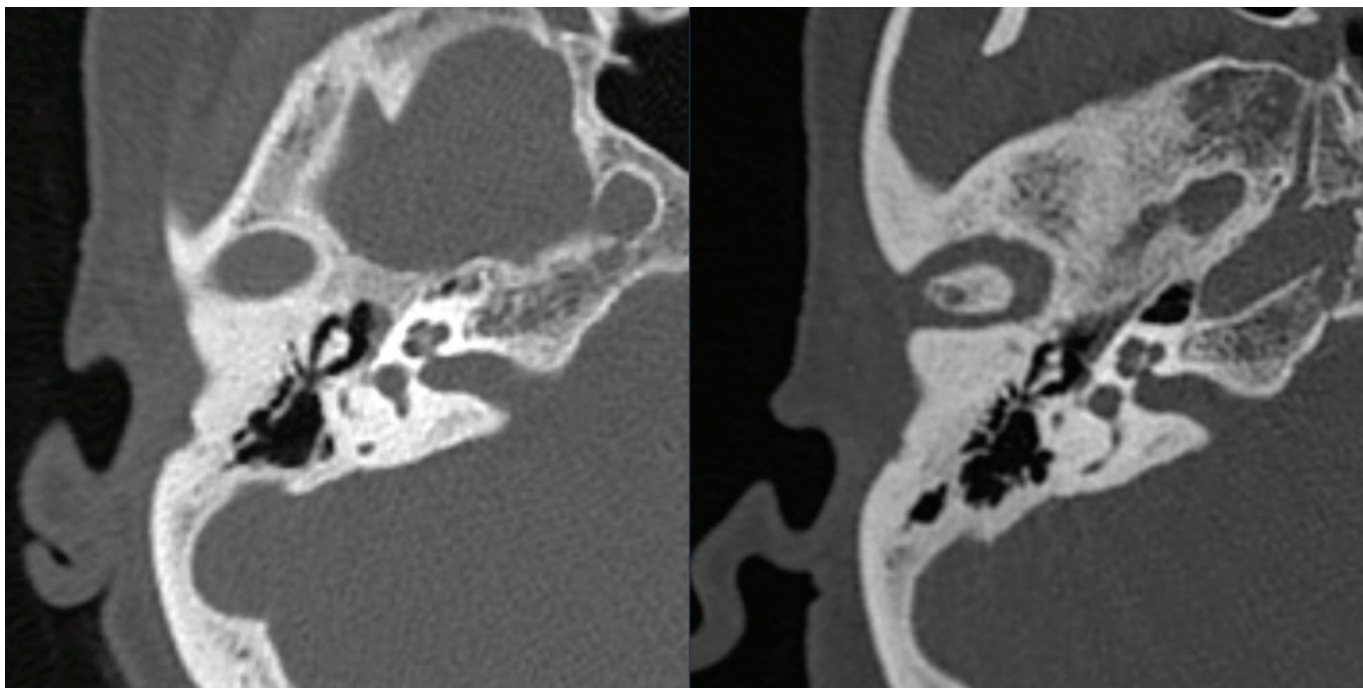


Figure 3: High resolution scans currently allows to visually much finer detail of intrinsic bony anatomy in the inner ear like the bones which resemble ice cream cone on the left are much better appreciated than on the left.

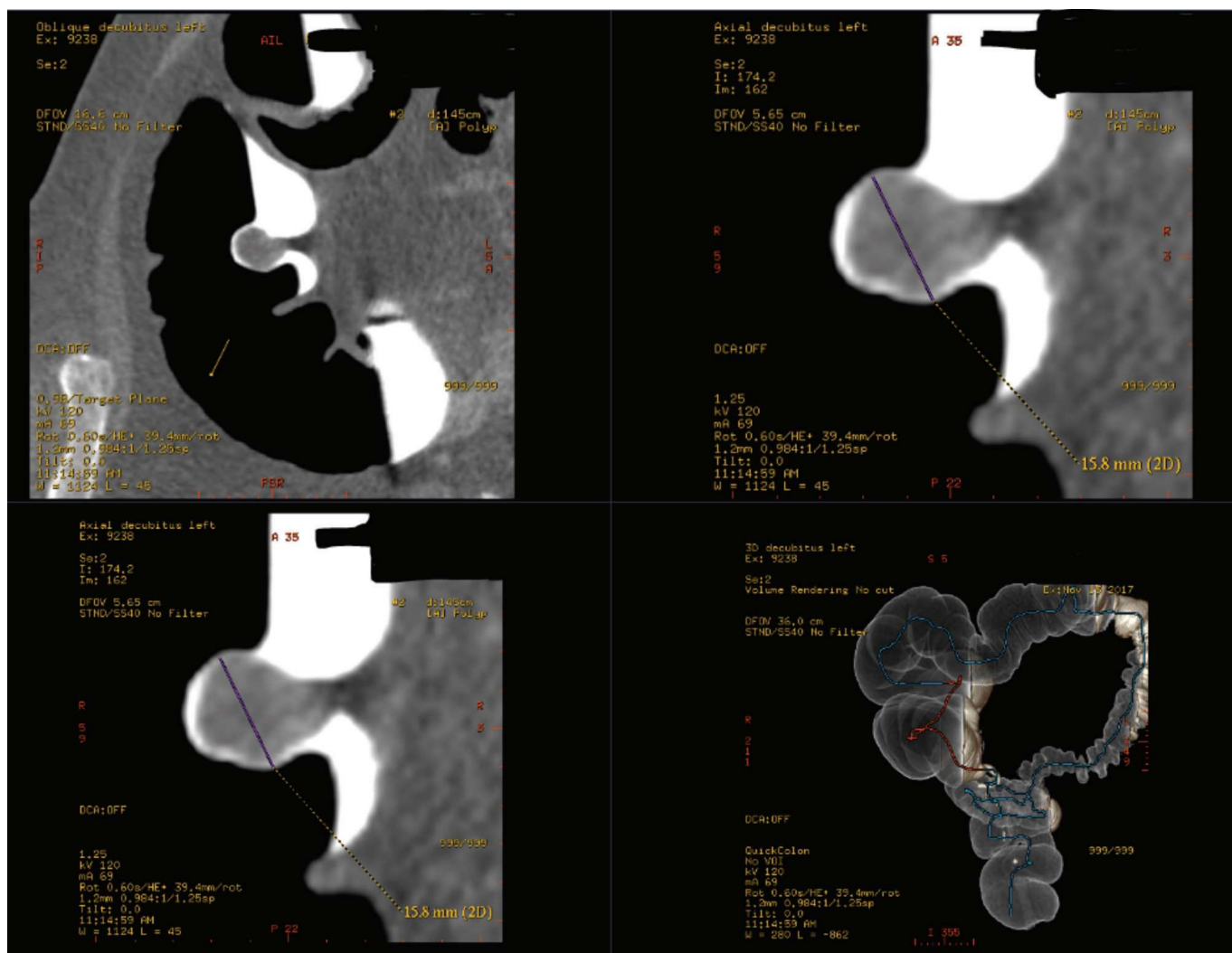


Figure 4: Pictures of things that were impossible 30 years ago like CT colon.

speaking helical) acquisition is normal and the output is now a volume of data which can be processed into any plane and with multiple additional options to produce rendered pictures or perform further analysis.

The technology has evolved, although the terminology was becoming fixed by the time of the prior article and much terminology which has technically been superseded remain is common parlance. Just as we talk about acquiring ‘films’ (plain X- rays) more than a decade after we went film-less and moved to digital imaging, we also talk about ‘slices’ in CT at a time when the images are now a volume of data in three dimensions which can be displayed and manipulated in any plane.

CT continues to require radiation to acquire images and certainly historically far more than for an X-ray of the same body part, but the dose has reduced since the early days of the modality. With more recent increases in computing power, a number of additional techniques have become available to further reduce the radiation by more complex reconstructions of the acquired data, such as iterative processing. In some situations this has led to CT being possible for the same dose as would historically have been required for a regular X-ray.

Just as the spatial resolution of scanners has improved

and is now typically <1mm, the temporal resolution has also changed, making scanning moving body parts more accessible. For instance, cardiac CT has been established in the trust within the past 10 years and remains a growth area and a driving force in the requirements for future scanners.

Like any radiographic image, CT depends on X-rays being attenuated differently in different tissues – i.e. that it is harder for them to pass through some parts of the body than others – and this leads to the contrast within the images which are produced. In CT, fat is useful up to a point as fat between organs helps separate them and helps in interpreting which organ is the source of any abnormality. Consequently the increase in size of the population over the past 30 years has helped and the weight limit on scanners has also increased.

Colloquially, ‘contrast’ has come to mean intravenous contrast and this has also evolved. While not entirely inert, modern iso-osmolar contrast is much less allergenic than older contrast media and other than a transient warm flush and a transient metallic taste, it is generally very well tolerated. It is now routinely delivered by pressure injectors running at several mls per second to make sure the contrast remains in a tight bolus (i.e. it goes where it

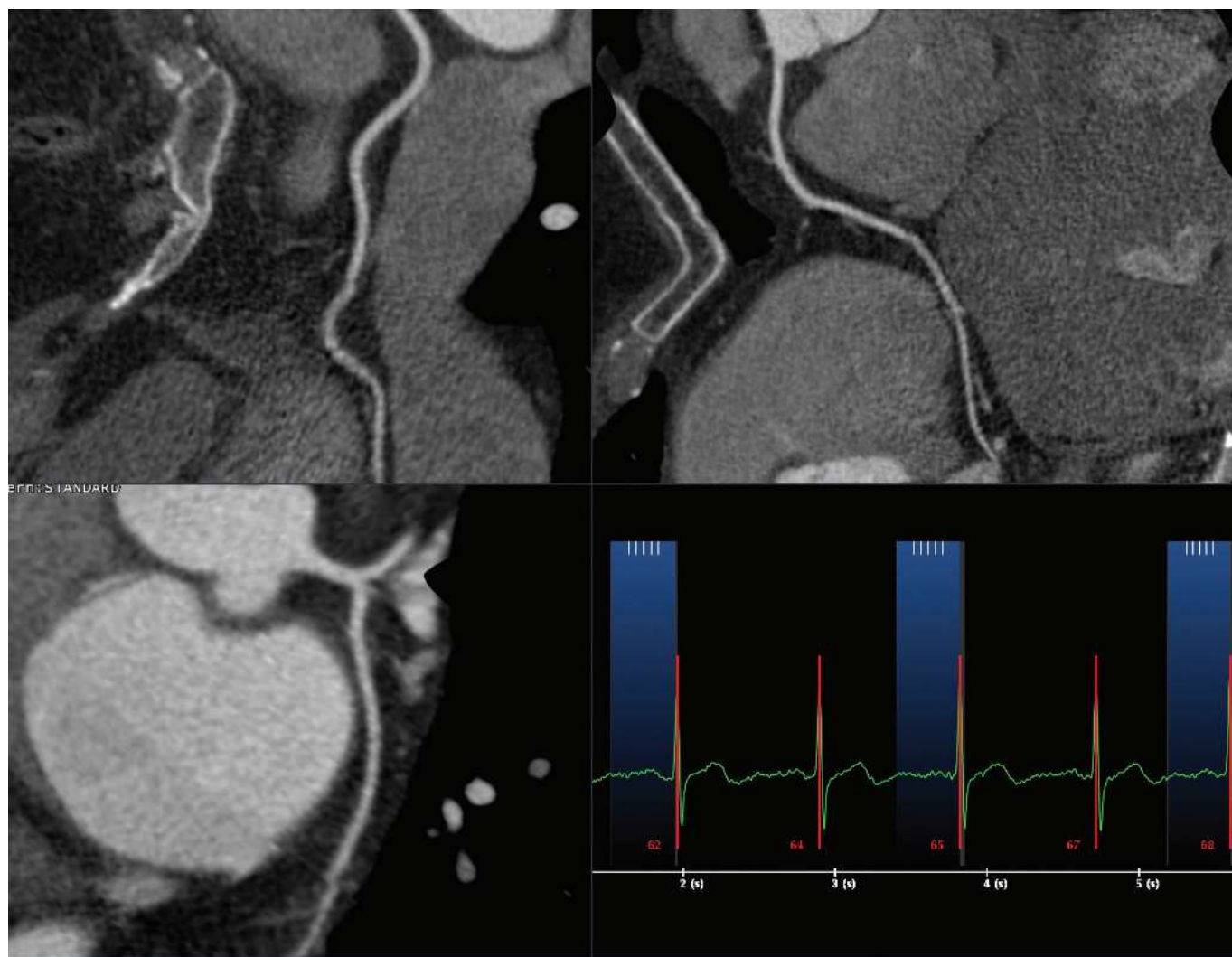


Figure 5: Pictures of things that were impossible 30 years ago like CT colon or cardiac CT.

is intended when it is intended) to give high-quality CT pulmonary angiograms and other studies.

The increase in comorbidities and the increased survival of people with many conditions, with ongoing changes remaining visible have, however, more than made up for these technical changes and although the images are sharper, interpreting them is no quicker and requires no less expertise than it ever did. Add to this the change in society towards increased moral absolutism, doctors being more risk averse and patients more keen to pursue investigation, it is easy to understand why there is a massive increase in demand for radiology services and CT's valuable part in this.

Looking to the future, the nature of CT continues to evolve, for instance with a current fundraising campaign to purchase a cone beam CT, and the complexity of CT imaging continuing to increase. Dual source CT has been available for a number of years (more than one energy of X-ray) and can help identify certain tissue types. Artificial intelligence (AI) has been the next big thing for several years and machine learning is leading to greater appreciation of additional findings in CT data sets that are not directly observable by a human, such as textural analysis. It seems reasonable to believe that radiologists

who use AI will replace those who don't, but it will be many years, if ever, that the machines are doing all the diagnosis for us.

Finally, one factor that has not changed is, as Sir William Osler wrote, that 'medicine is a science of uncertainty and an art of probability'.³ (p. 125) The pre-test probability is critical in selecting the most useful test and framing the result in a useful way. Put less elegantly and as Osler certainly didn't say 'garbage in, garbage out'.

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Service Development

