1. XVI GOLD ANCHOR SEED PROJECT

Ganesh Radhakrishna, M.D., S:t James´s Hospital, Leeds, UK, 2011

1.1. Introduction

X-ray volume imaging (XVI) facilities on the linac at LTH are particularly useful for confirming tumour position during radiotherapy fractions. Verifying pancreatic tumour position can be particularly difficult due to the limited contrast differentiation between the pancreas and other internal organs on the XVI images. A gold seed has been developed which can be permanently inserted into the pancreas to act as a marker on the XVI cone beam computed tomography (CBCT) images. The chain of gold anchor seeds, figure 1-1, is designed to fold to form a rigid structure within soft tissue.

Figure 1-1: Gold Anchor seeds.

An investigation was carried out to observe the gold anchor seeds on the XVI CT images and check that the seeds are clearly visible on the clinical XVI protocol or whether a new imaging protocol would be required in order to observe the markers.

1.2. Methods

Images were acquired using the XVI facilities on an Elekta linac. The seeds were placed within a tissue equivalent material inside a 4DCT respiratory motion phantom. The setup is shown in figure 1-2. A breathing rate of 15 breaths per minute (BPM) was set with an amplitude of 2.2cm in order to match that of the typical patient.

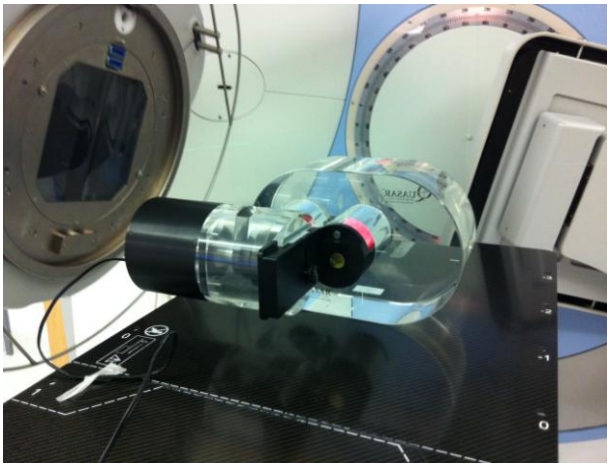

Figure 1-2: The setup of the respiratory phantom and the gold anchor seeds in the Elekta Linac.

The XVI images were acquired using an F1 'bow-tie' filter which attenuates the x-rays around the outside allowing more photons to pass through the centre of the field of view (FOV). The dynamic range of the XVI images is increased using the filter as the imaging panel does not reach the saturation limit as quickly. An M10 collimator was used which results in a 13.6x13.6cm field size at the isocentre and a reconstructed CT FOV of 41x41cm. The kV imaging panel was set to a medium FOV, corresponding to the M10 collimator used.

Images were acquired for the phantom using the clinical 3DCBCT and 4DCBCT XVI parameters. Variations of these parameters were also changed to increase the temporal and spatial resolution of the XVI images. The imaging parameters are shown below in table 1-1. 4DCBCT images were acquired using the same method as the 3DCBCT and then retrospective binning of the images into 10 phases was applied using an in-built software algorithm that assess the amplitude the respiratory motion.

Table 1-1: XVI parameters used to image the 4DCT respiratory phantom.

Protocol	Motion	Time (min)	N^{o} projections	Resolution
3DCBCT static	No	2	694	1mm (med)
3DCBCT clinical	Yes	2	694	1mm (med)
3DCBCT increase res	Yes	2	694	0.5mm (high)
4DCBCT clinical	Yes	3	1044	1mm (med)
4DCBCT increase time	Yes	4	1355	1mm (med)
4DCBCT off axis	Yes	3	1044	1mm (med)

1.3. Results

The images for each of the XVI protocols used are shown in figure 1-3. It can be seen that the seed markers are visible on all the images. The 3DCBCT images show the average seed position during acquisition. Using the XVI software a cine of the 4DCBCT was viewed however only one frame is shown in figure 1-3.

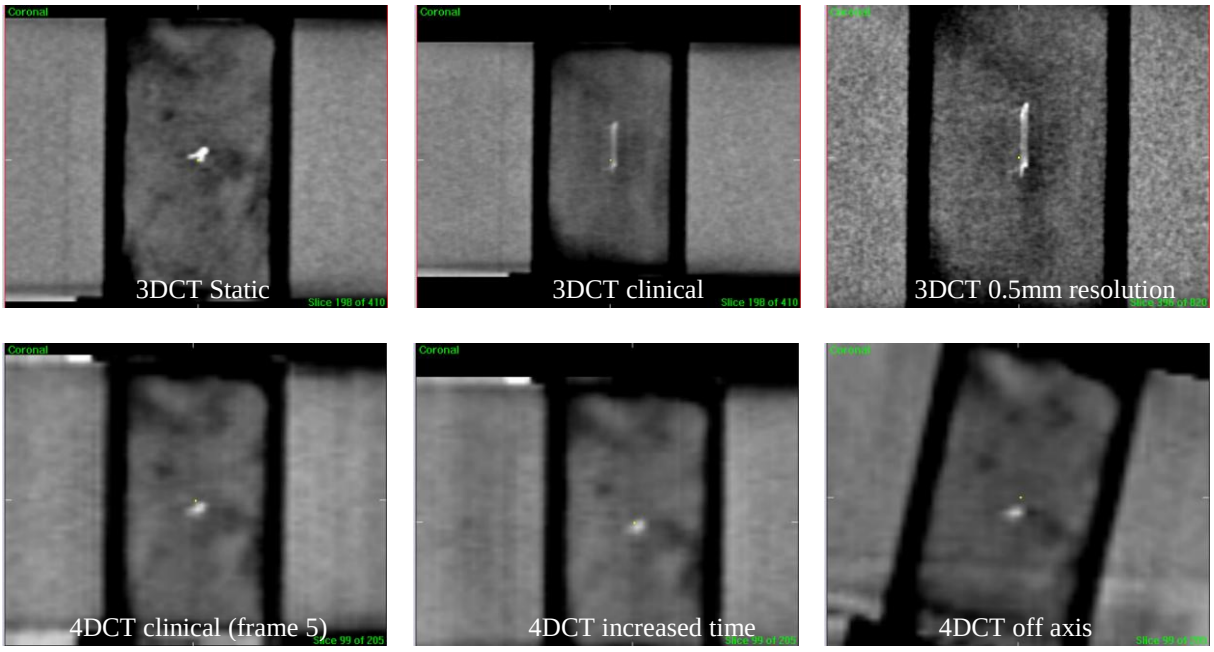

Figure 1-3: XVI reconstructed images acquired for the 3DCT and 4DCT parameters listed in table 1-1.

1.4. Conclusions

The gold seed markers can be seen clearly using the clinical 3DCBCT and 4DCBCT protocol which means the seeds can be used clinically to track the tumour position using XVI at the point of treatment delivery. The seed marker appears elongated on the 3DCBT images, figure 1-3, due to the motion of the respiratory motion. The benefits of the 4DCBCT is that the elongation due to motion is reduced, however this is at the compromise of poor image quality as less projections are been reconstructed per frame, compared to the 3DCBCT. The visibility of the seed markers using the standard clinical XVI parameters means that additional protocols are not required and that the current scan time and resolution parameters can be maintained. This has a clinical benefit as no additional time is added onto the treatment time, as XVI was already implemented to track tumour motion for pancreatic tumours.