Improving C-arm Cone Beam CT: Protocol Optimization and Reducing Motion Artifacts for Preclinical Imaging

Purpose: In our institution, translational interventional research is performed in the VX2 rabbit liver tumor model using commercial C-arm systems (Allura FD20 with XperCT, Philips Healthcare, Best, Netherlands). Small physical size and rapid cardio-ventilatory motion in the rabbit poses a challenge in producing adequate imaging. We seek to improve cone beam CT (CBCT) image quality (IQ) by improving x-ray techniques, 3D reconstruction, and motion compensation.

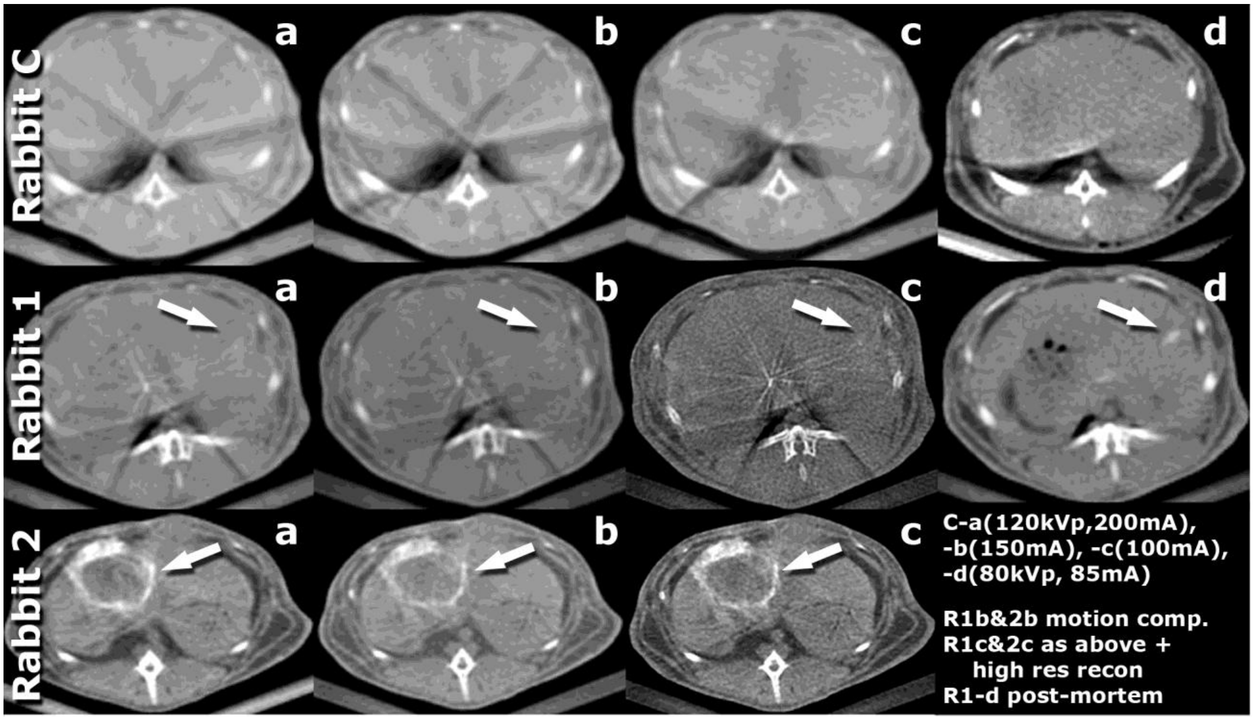
Materials and Methods: 3 adult male New Zealand white rabbits, one rabbit non-tumor bearing (C) and two experimental rabbits (R1) and (R2) had implanted tumors. Following commercially available x-ray techniques and image acquisition parameters were used to scan rabbit (C) at 120kVp to determine the best IQ: (1) 200mA, 5ms, 30 frames per second (fps), 10 sec scan time (st) (Fig C(a)), (2) 150mA, 5ms, 60 fps, 5 st (Fig C(c)), and (3) 100mA, 5ms, 60fps, 10st (Fig C(b)). IQ was assessed based on image contrast, artifacts, and tumor delineation.

R1 was imaged immediately after transarterial chemoembolization (TACE) and post-mortem using 120kVp, 150mA, 5ms, 60fps. R2 was imaged after TACE using a prototype x-ray technique (77kVp, 85mA, 5ms, 60fps, 5st; Fig C(d)). Images acquired from R1(a) and R2(a) were reconstructed: (1) using the commercially available filtered back projection kernel with prototype motion compensation (Fig R1&2 (b)), and (2) using a higher spatial resolution kernel with motion compensation (Fig R1&2 (c)). These images were compared to the post mortem images (R1(d)).

Results: The 120KVp, 150mA, 5ms, 60fps was the best among the commercially available protocols (R1(a)). The prototype x-ray technique and 3D reconstruction kernels showed even better IQ (Fig R2(a) and R1&2(c), respectively). Improvements to motion artifacts further improved IQ. Tumors were more clearly visualized after stages of improvement in image acquisition, 3D reconstruction, and motion compensation (Fig arrows).

Conclusion: Improvements in image acquisition protocol, 3D reconstruction, and motion compensation produced better IQ that allowed for better tumor delineation and characterization. This further enables use of clinical C-arm systems for translational, pre-clinical studies.

Clinical relevance: Optimization of imaging protocols in the rabbit liver tumor model will help to improve image quality in commercial machines.



Rabbit C
a
b
c
d
Rabbit 1
a
b
c
d
Rabbit 2
a
b
c
C-a(120kVp,200mA),
-b(150mA), -c(100mA),
-d(80kVp, 85mA)
R1b&2b motion comp.
R1c&2c as above +
high res recon
R1-d post-mortem