Bruker microCT

Rodent hindlimb positioning for *in-vivo* microCT bone imaging

Method note

MCT-026

1.   Introduction

The limb must be held in a tube

When microCT-scanning the hindlimb of a rodent, whether the knee or foot or other site on the femur and tibia, it is essential that the hindlimb is held apart from the torso and abdomen in a suitable tube (figure 1). The same is true if the forelimb is scanned. It is unacceptable and highly disadvantageous to scan the leg alongside the pelvic abdominal region, i.e. in the rodent's natural posture whether lying on its back (prone) or on its ventral side. This is for following reasons:

1.   The **crossectional area** of a scanned object strongly affects the tomographic signal to noise ratio – a wide object requires a longer scan than a narrow object (of the same material) to achieve a certain signal to noise ratio. Or – put another way – with the same scan parameters the reconstructed crossection of the wide object will be much noisier than that of the corresponding narrow object. A crossection including both hindlimbs and the rear torso / abdomen presents a vastly greater area and x-ray beam path length than the hindlimb held separately in a tube. Thus a single limb in a tube can be scanned to an acceptable image quality in much shorter a time.

2.   Holding the leg close to the **midline axis** of the scan field of view (FOV) improves image quality and allows shorter scanning (since larger rotation step can be used). This is achieved by holding the leg in plastic or foam tubes (figure 2) as shown in this document.

3.   Scanning both hindlimbs with the rodent in the prone position (figure 2a) results in **radiation dose** to both limbs and to more radiosensitive rear abdominal and pelvic region tissue. By contrast scanning a single hindlimb in

a tube irradiates the hindlimb only with minimal dose elsewhere.

(a)   (b)
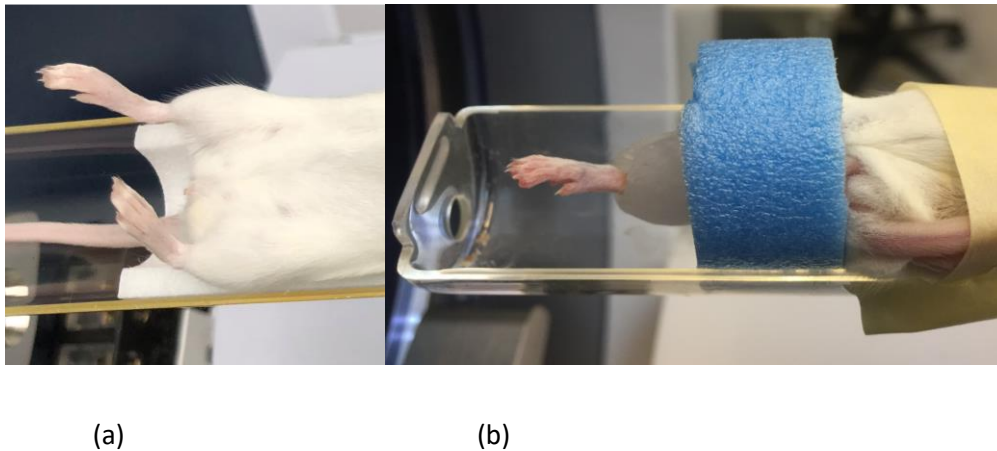
Figure 1. For microCT imaging of the rodent hindlimb, do not perform the scan with the legs in the natural prone position (a) – this will irradiate an unnecessarily large amount of abdominal and pelvic tissue, increasing noise in the image and the limbs will be positioned away from the scan midline, compromising image quality. Instead the hindlimb should be held in a tube as shown (b). Soft dental wax is used to hold the protruding foot in place.


Figure 2. Tubes of different diameters, made from both expanded polystyrene and polypropylene foam, allow flexible solutions for mounting the limbs of mice, rats and rabbits, as well as other samples for scanning. Note that the smaller tubes with 3cm outer diameter fit inside larger tubes with 3cm inner diameter. Tubes can be cut to short sections as necessary.

2.   Method

2.1.   The leg of the rodent is first pushed through an appropriate tube, as shown in figures 3-5. If the tubes of polystyrene or polypropylene foam are used, then take care while inserting the leg not to catch the claws of the foot on the tube inside edge.

2.2.   Pull the foot out of the end of the tube as far as possible without putting undue pressure or distortion on the animal's leg. Then clamp the protruding foot and leg in place with a piece of a soft grade of wax such as orthodontic tray wax[1].

2.3.   In the case of a rat hindlimb then one of the moulded plastic tubes shown in figure 3a can be used instead of a foam tube. When these end-of-bed moulded plastic tubes are used for the rat leg, then the bed must be moved rearwards on its mounting by 10-15 cm as shown in figure 3b, to allow space for manipulating and securing the rat's leg in the tube.

2.4.   Once the leg is firmly held as just described, the other, non-scanned leg together with the tail should be folded toward the animal's head and held alongside the animal using paper-based tape (see figure 4 a, b, c).

2.5.   The forelimb and tail can also be similarly mounted in tubes for *in-vivo* scanning (figure 4 d, e).

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[1] Orthodontic tray wax can be obtained from Kerr Inc. Their website http://www.kerrdental.eu/contact/ gives contact and ordering details.

(a)   (b)
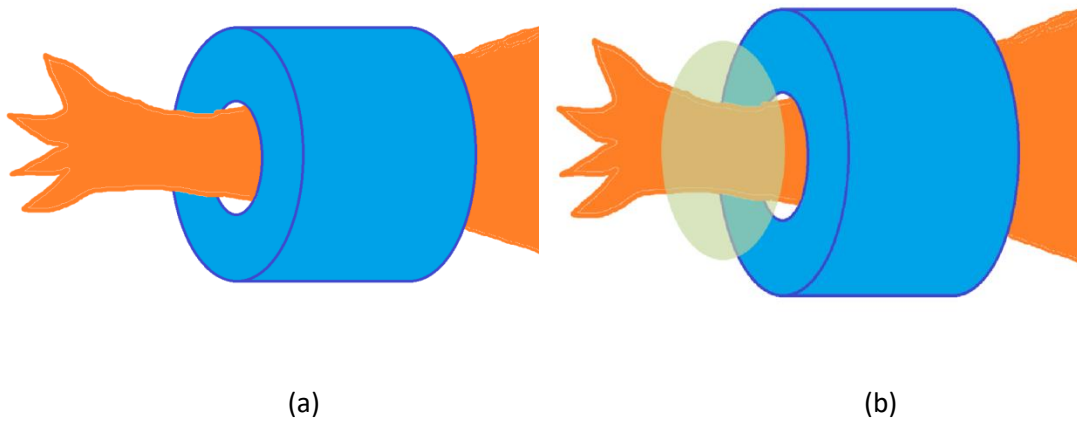
Figure 3. The mouse or rat hindlimb is pushed through a tube of polystyrene or polypropylene (a), taking care not to catch the claws on the sides. To keep the leg secure from slipping, the protruding foot is held with a soft grade of wax such as orthodontic tray wax (b).

Figure 4a. For imaging the rat hindlimb in the SkyScan1176, a plastic tube is available which fits into the mounting ring at the end of the 60mm (rat) bed. There are three tube end diameters available for rats of different sizes, 17, 21 and 25 mm.
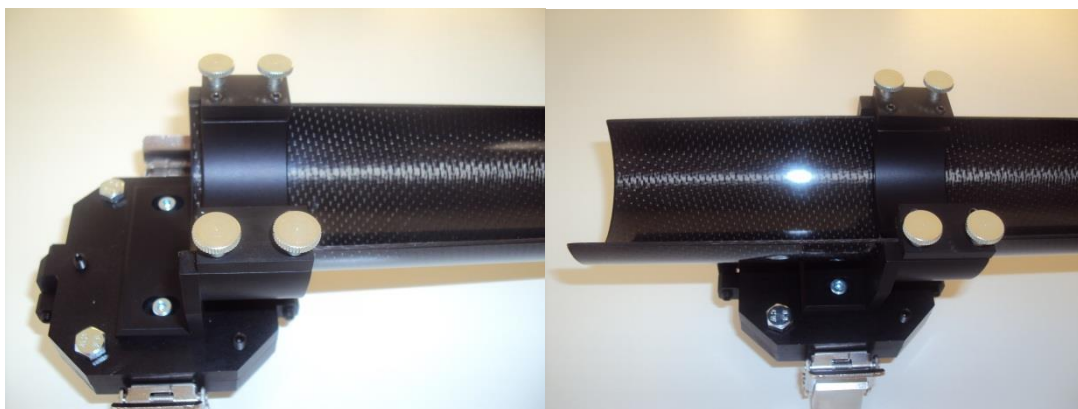

Figure 4b. When the end-of-bed plastic leg tubes shown in figure 4a are used for the rat leg, then the 60mm rat bed must be displaced rear-wards on its mounting as shown, by about 10-15cm, to allow space in front of the scan chamber entrance for manipulation of the rat leg in the tube.

(a)

(b)

(c)

(d)

(e)
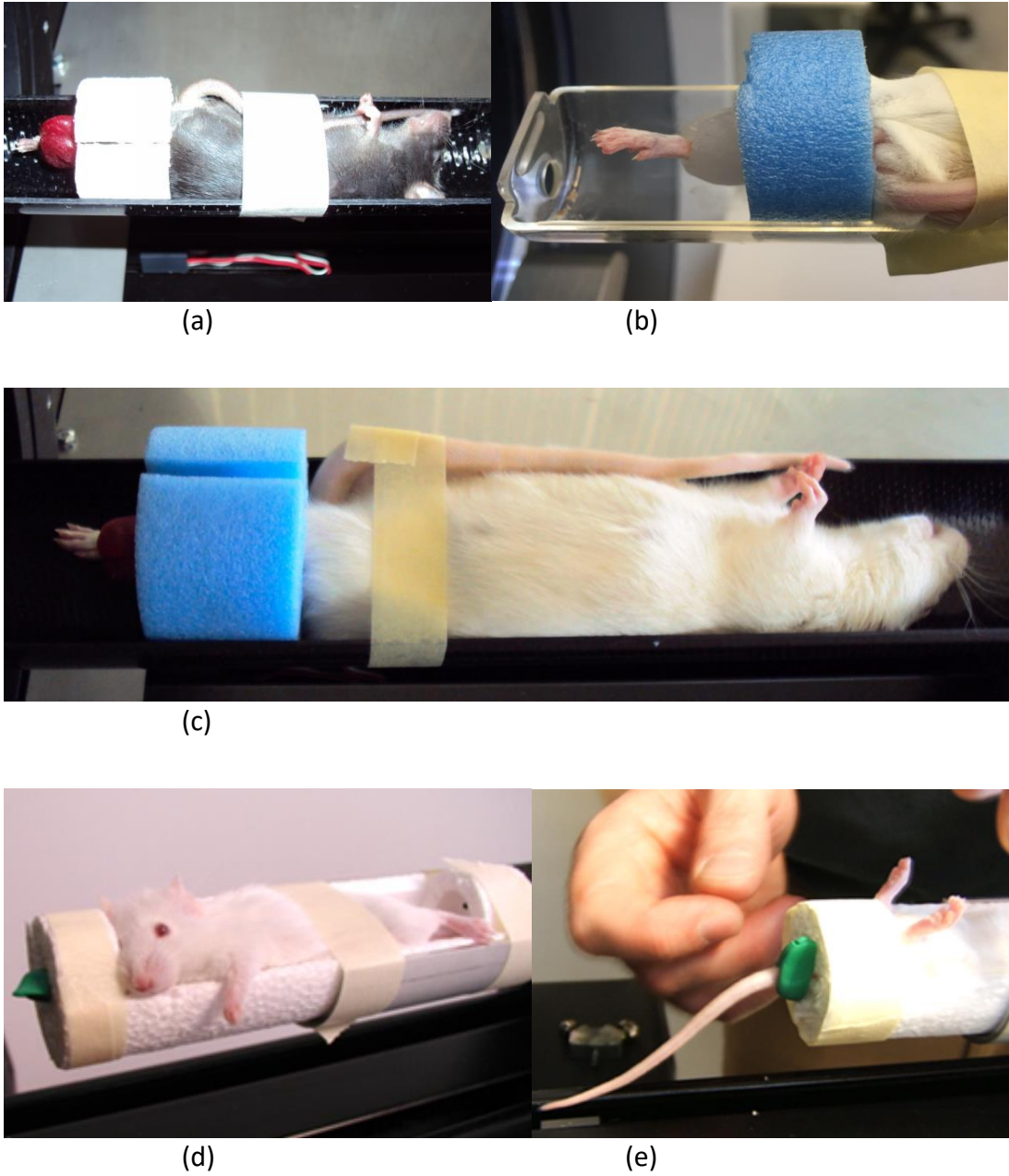
Figure 5. Examples of mice (a, b) and rats (c) with hindlimbs mounted for scanning. Also a mouse with the forelimb (d) and the tail mounted (e).

Figure 6. The x-ray source in the SkyScan1176 is collimated such that there is very little irradiation beyond the length (axially) of the camera field of view. Thus when the leg is positioned for scanning as described above, the rest of the animal outside the field of view, including the non-scanned leg, receive very little x-ray dose.
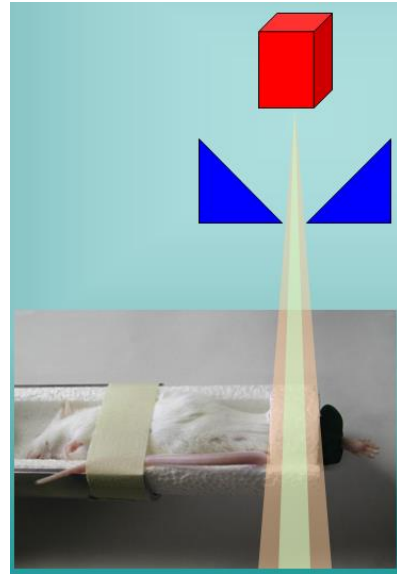
X-ray source collimation

The x-ray beam from the source is collimated as shown in figure 6. This means that only the field of view (FOV) is irradiated, and the x-ray dose outside of the FOV is very small.

X-ray dosimetry of in-vivo microCT

Please refer to the dosimetry report for scanners such as the SkyScan 1176 for measured values of absorbed dose rates for different sites in the rat and mouse, and effective dose equivalent values using human tissue quality factors (ICRP 60)

3.   References

International Commission on Radiological Protection (1991) Publication 60, *1990 Recommendations of the ICRP.* Ann. ICRP Vol. 21 No. 1/3, Pergamon Press, Oxford, UK.