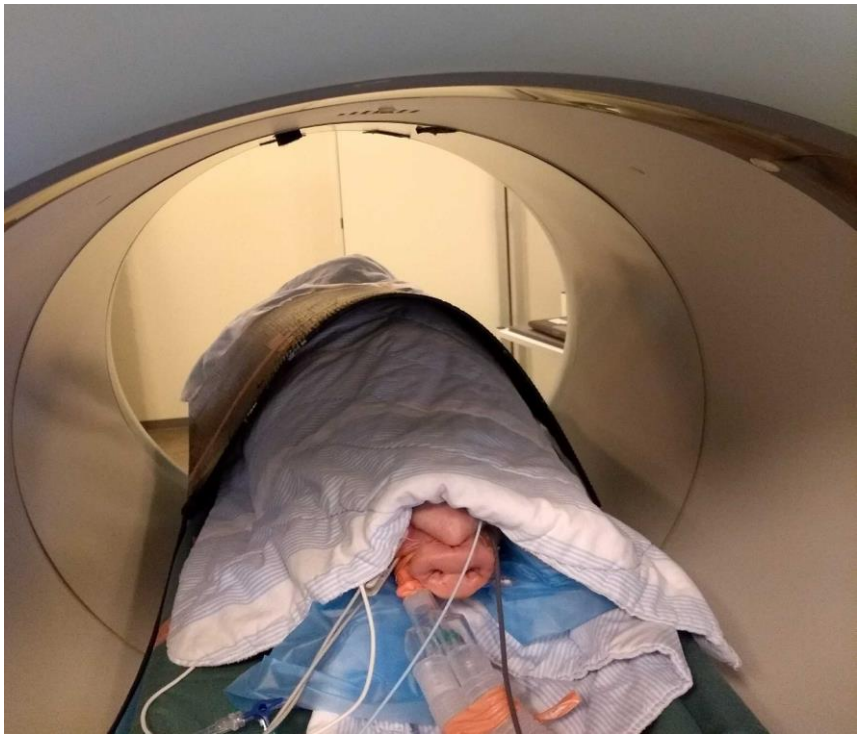
Ellegaard Göttingen Minipigs A/S
16 March 2021, webinar
10:00-10:40 AM



PET CENTER AARHUS
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Imaging techniques for Göttingen Minipigs with PET, MRI and CT

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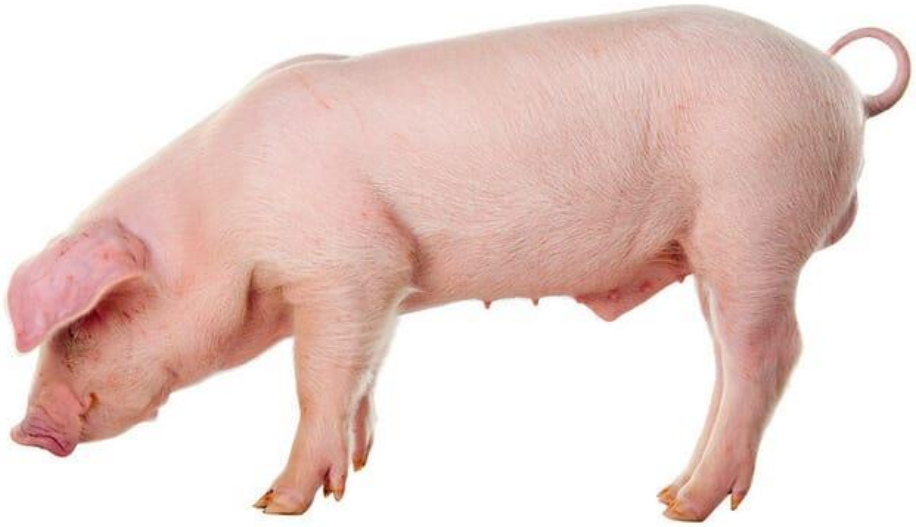
DVM, PhD, Aarhus University Hospital, Denmark

PET scanning of pigs since 2002

- brain
- liver
- bones
- kidney
- lungs
- heart

We are using both domestic and minipigs



Young domestic pigs
Non-recovery studies

Adult Göttingen minipigs
Recovery studies

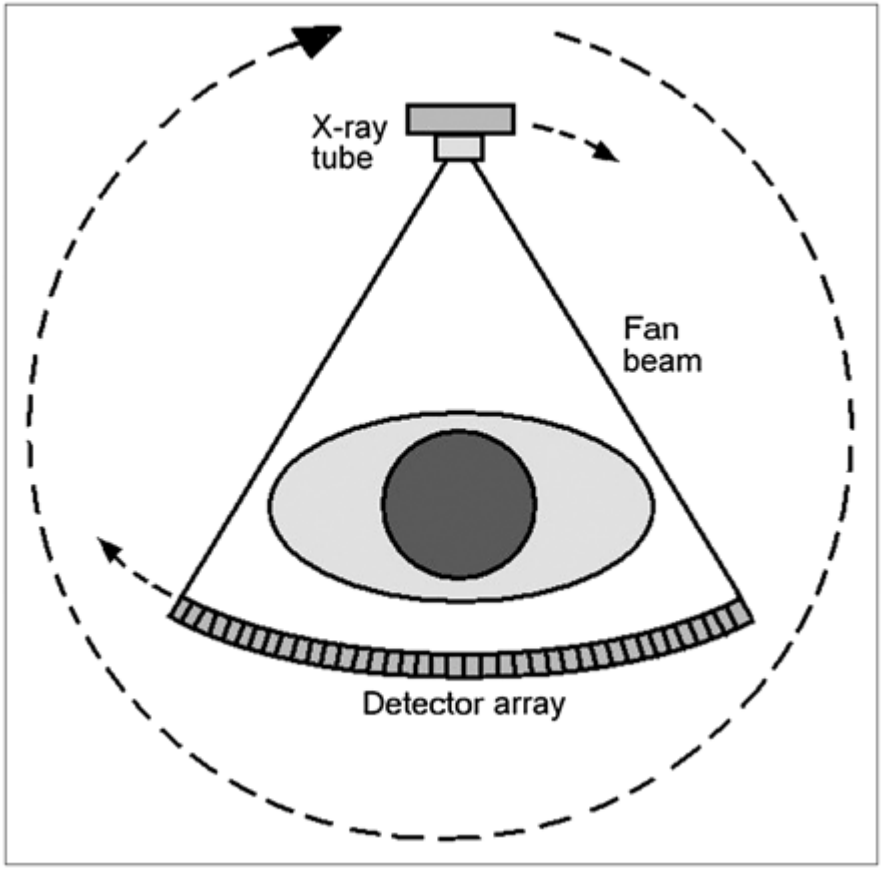
CT scanning

Rotating X-ray tube and detector

Takes few seconds

Dead or alive pigs

Anatomy (bones)



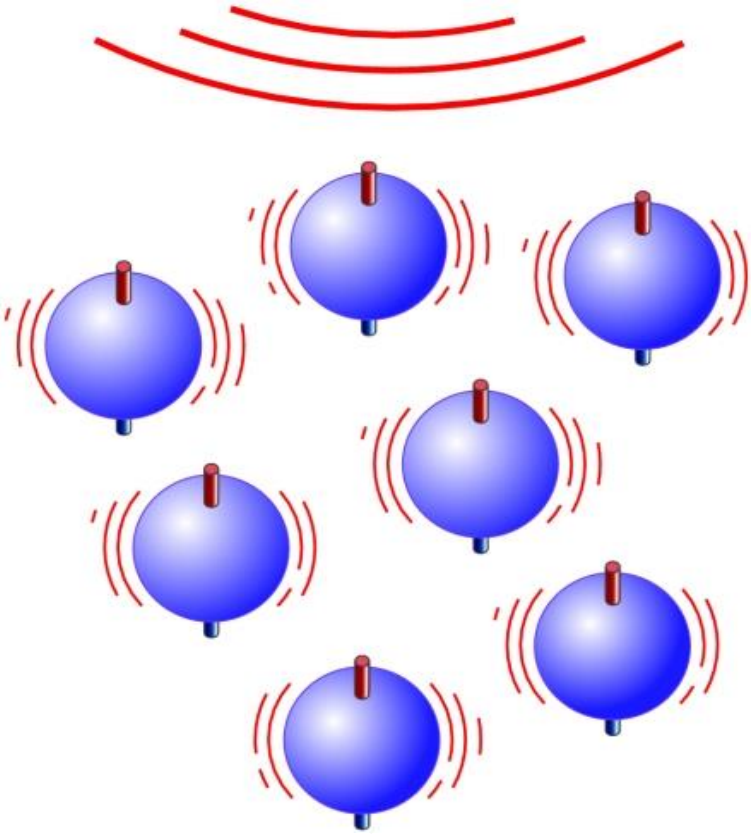
MRI scanning

Radiofrequency field

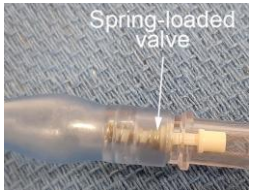
Takes some minutes

Dead or alive pigs

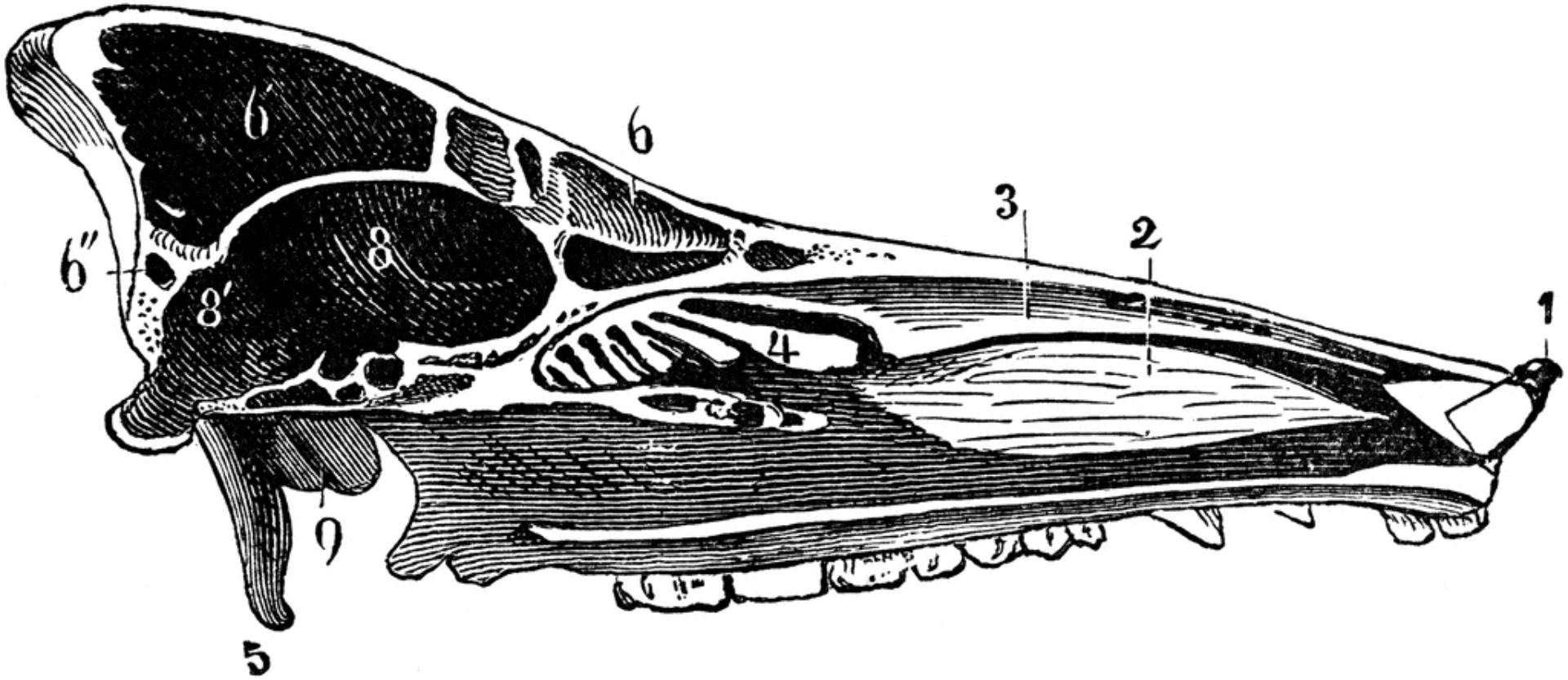
Anatomy (soft tissue)
Some functional



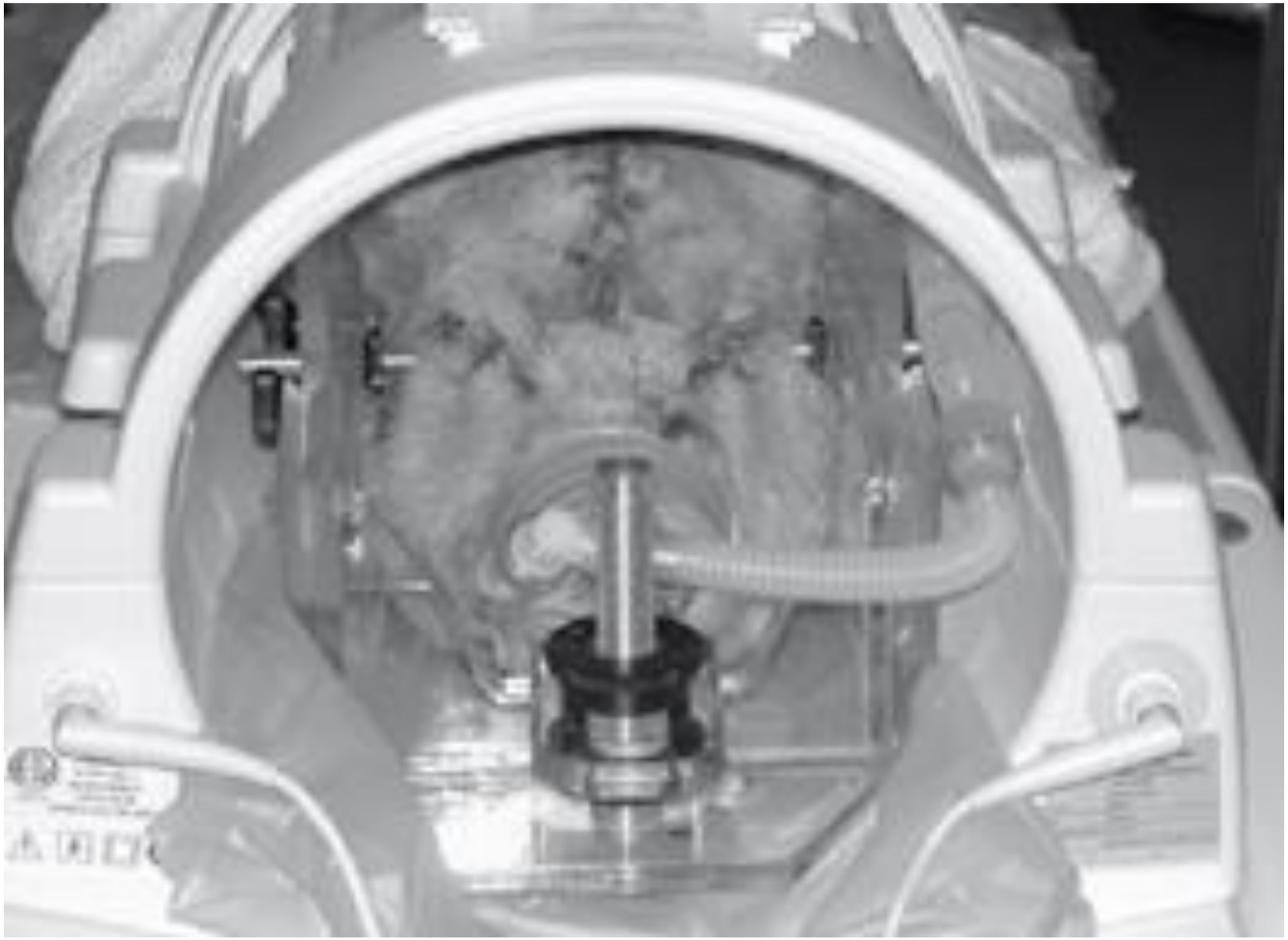
No metals



Reduced possibilities for functional MRI scans of the pig's brain



MRI with stereotactic frame used for brain surgery



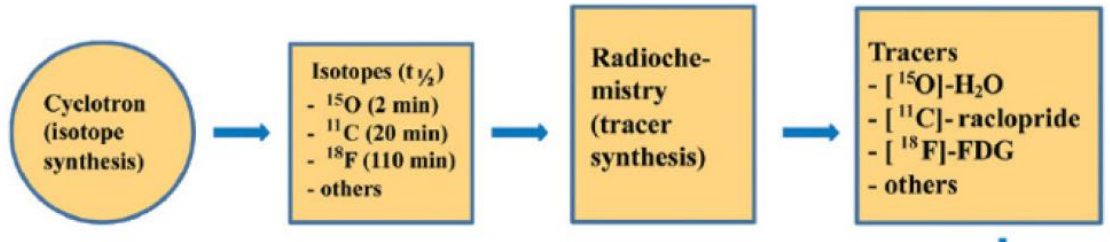
PET scanning

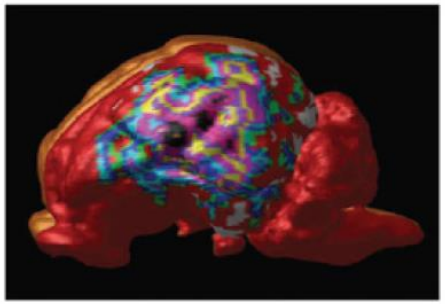
Radiotracers

Takes minutes to hours

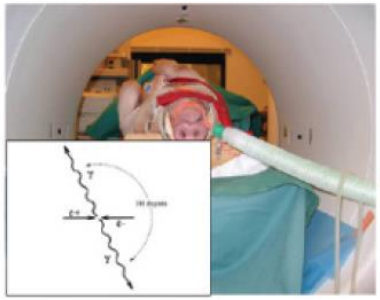
Only alive pigs

Functional imaging

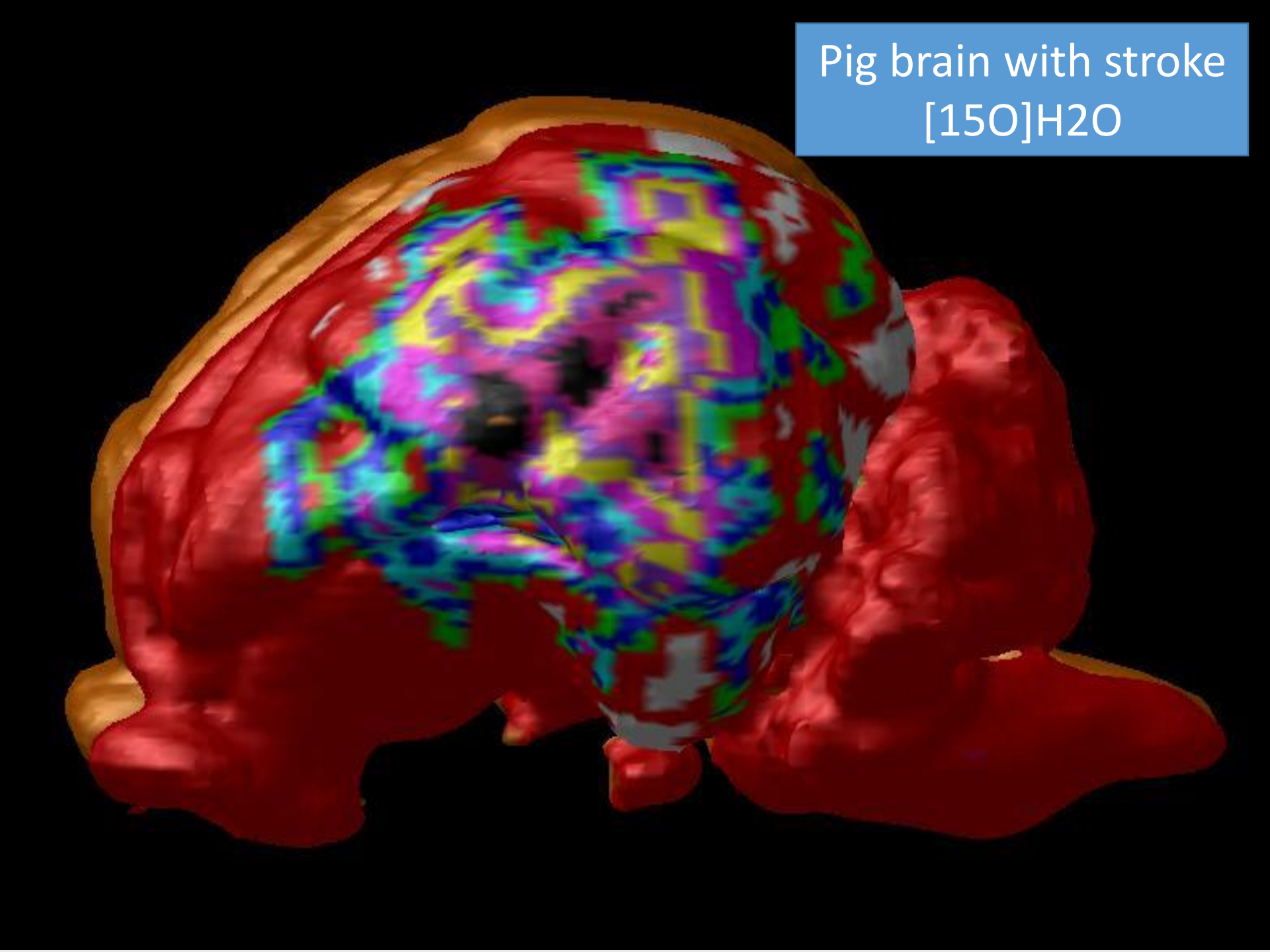




Reconstructed 3D map of Cerebral Blood Flow measured with [^{15}O]H_2O PET



Tracer injection and PET/CT scanning of anaesthetized pig. Tracer is detected by annihilation


Pig brain with stroke
[15O]H2O

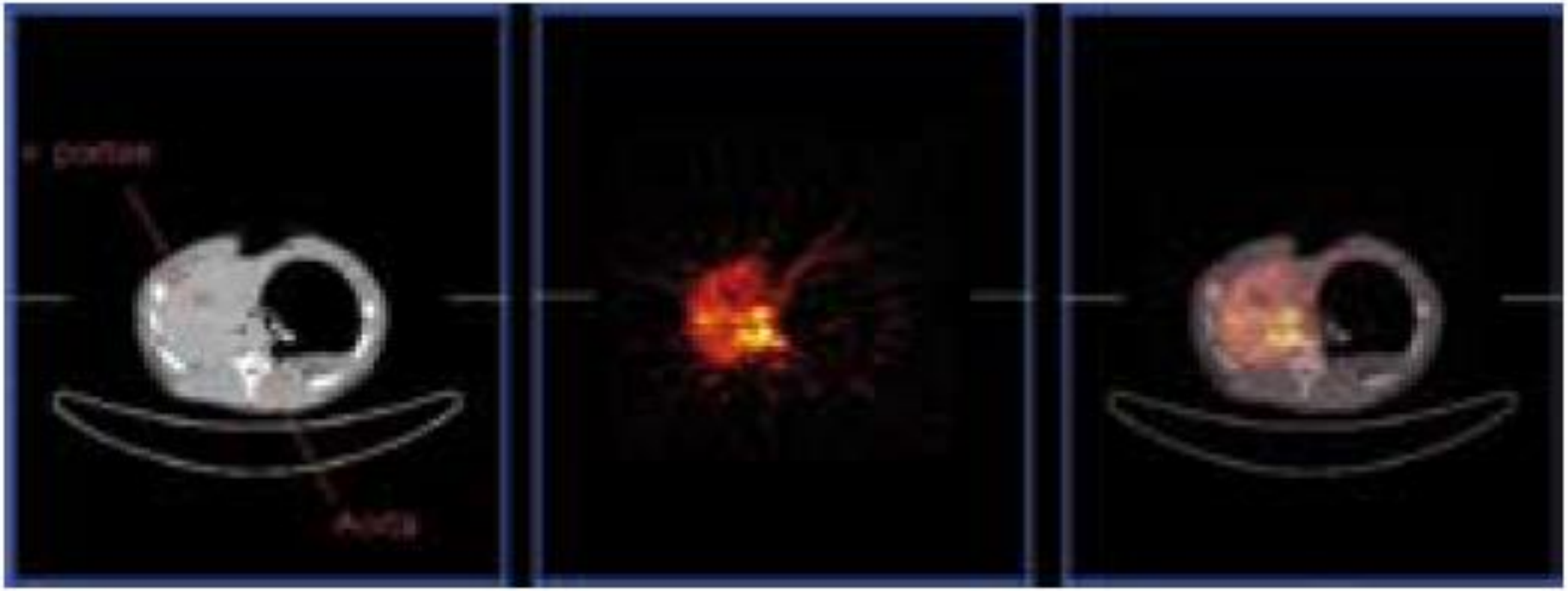
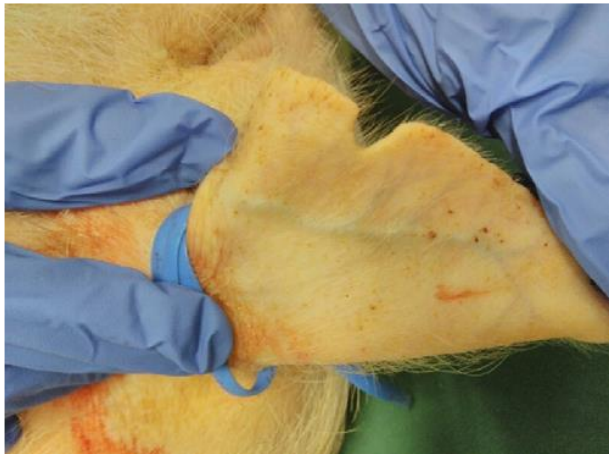


Figure 1. CT (left), $C^{15}O$-PET (middle), and fused PET/CT (right) images of the porcine liver region. Without the CT image it is difficult to localize the anatomy of the liver and its supplying vessels.

Procedures for PET/CT scanning

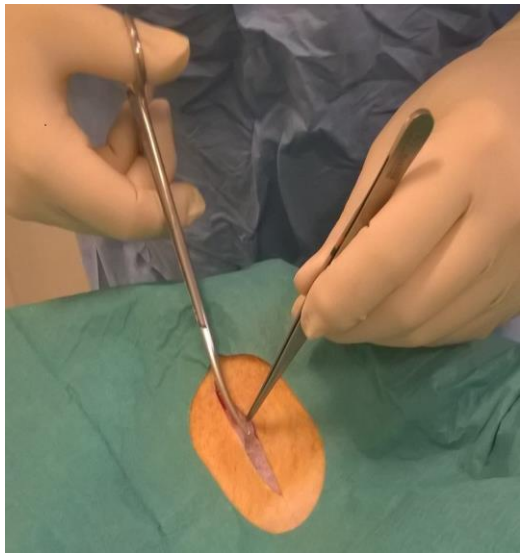


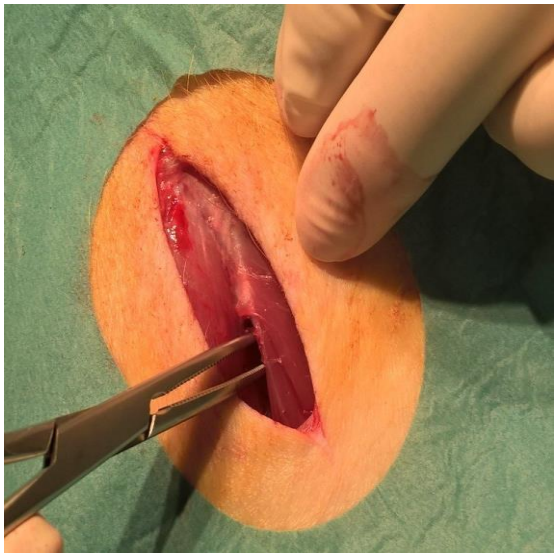
Midazolam + ketamin IM
Propofol IV (bolus)
Propofol IV (infusion) og isoflurane

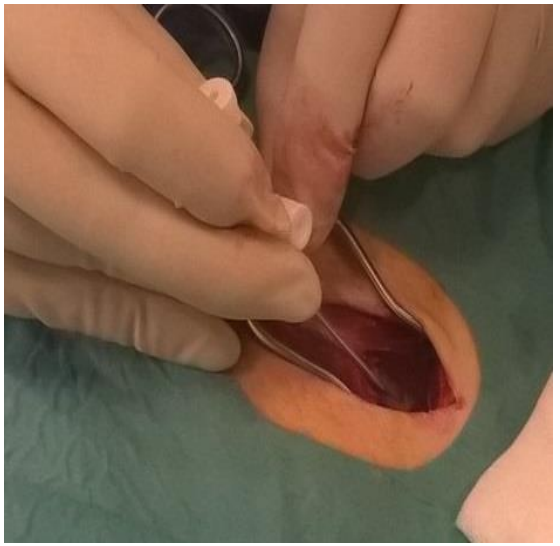
Temperature
SatO2+pulse
ETCO2

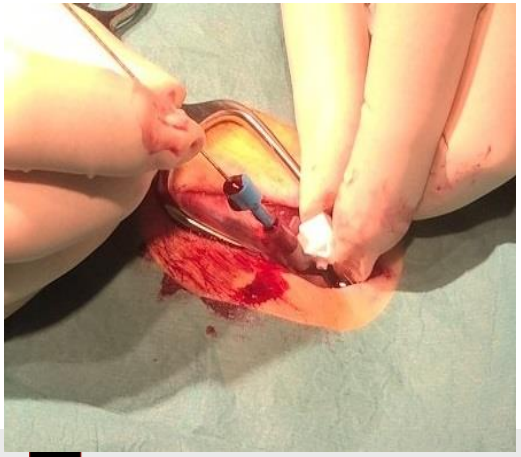
Procedures	Blood sampling			
	-		+	
Premedication, IM	Ketamine + midazolam		Ketamine + midazolam	
IV access	Ear vein catheter		Ear vein catheter	
Induction, IV	Ketamine midazo-lam	Propofol	Ketamine midazo-lam	Propofol
Intubation*+ventilation	Yes		Yes	
Maintain anaesthesia	Isoflurane	Propofol	Isoflurane	Propofol
Monitoring	Yes		Yes	
Capnography	Yes		Yes/no	
Blood storage and analysis	No		Yes	
Bladder catheters*	Mostly		Mostly	
Surgery, femoral A+V*	No		Yes	
Wrapping in plastic	Yes		Yes	
Placing in scanner	Yes (sternal recumbence)		Yes (dorsal recumbence)	
Tracer injection	Ear vein		Femoral vein	
Blood sampling	No		Yes, femoral artery	
Time of anaesthesia	1-6 hours (or more)		2-8 hours (or more)	
Transport between scanners	Yes	No	Yes	No
End of experiment	Mostly survival		Mostly euthanasia	

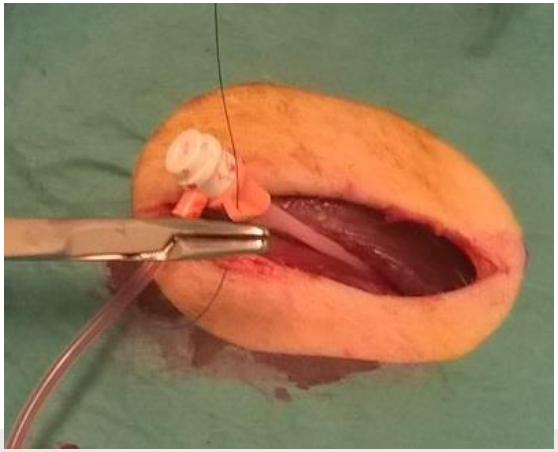
Placing of catheters in arteries and veins

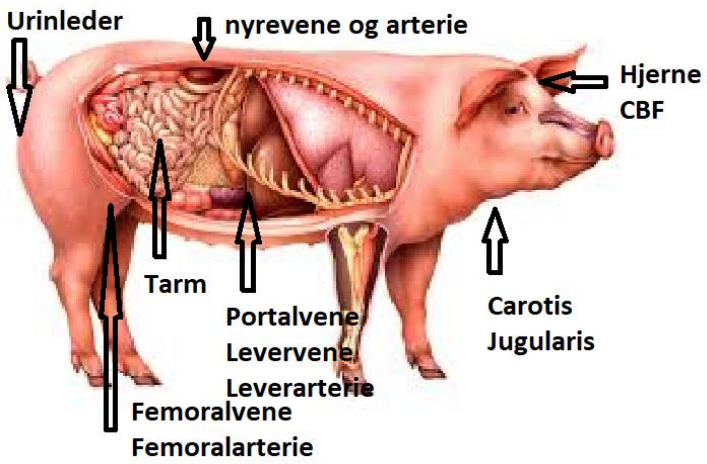




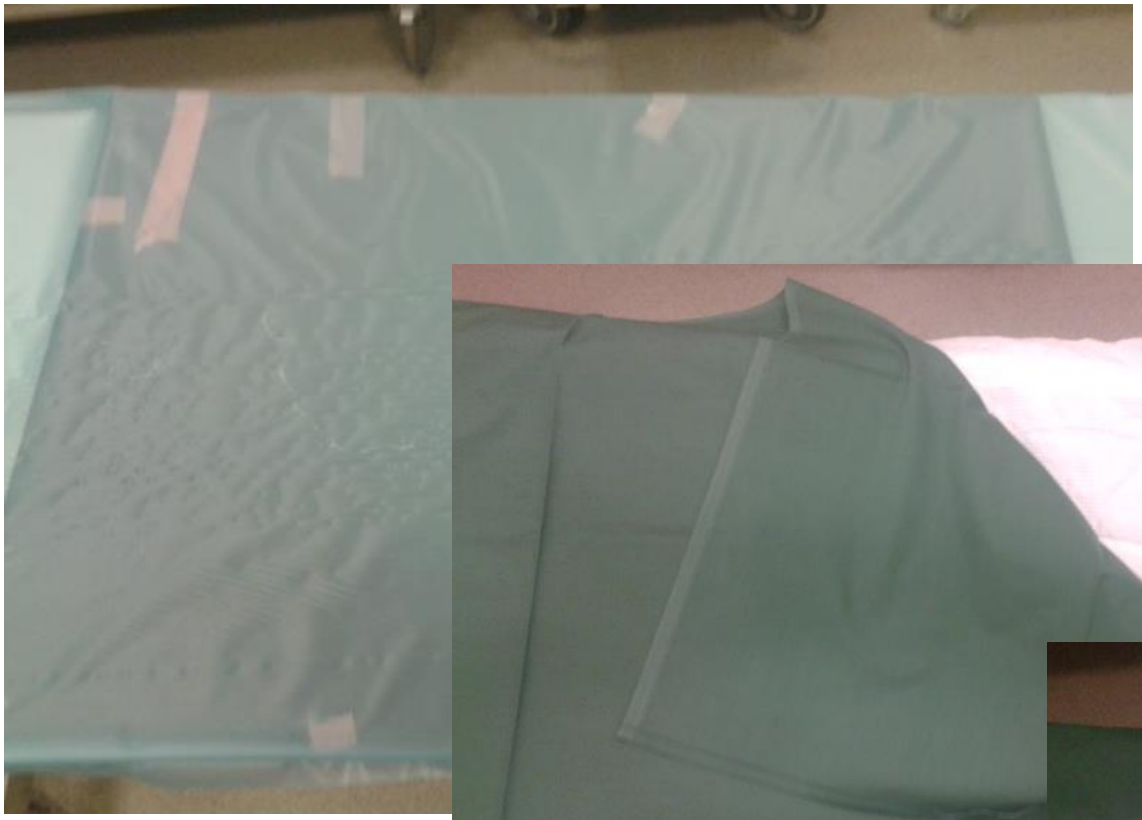


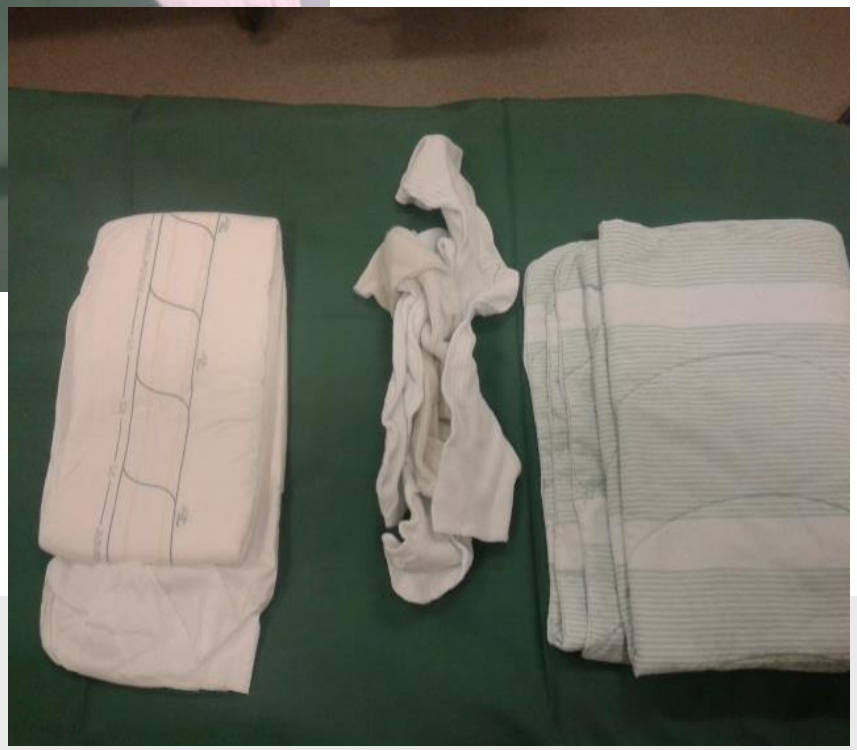


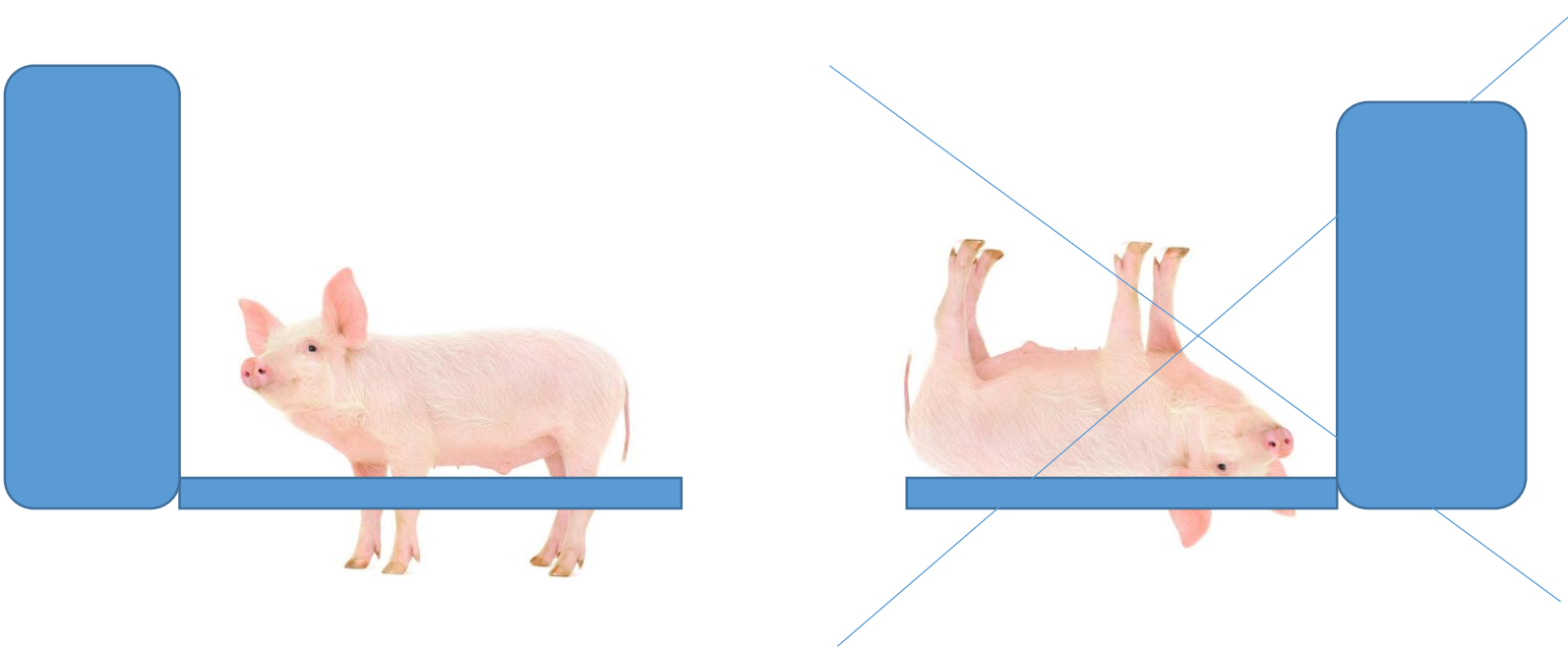




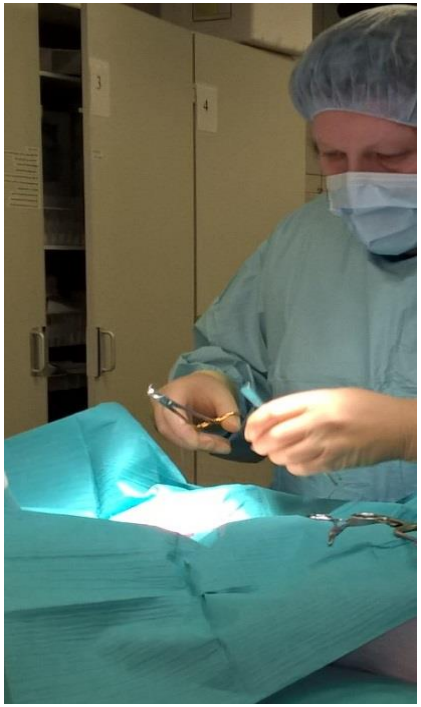
Ettrup K, AN Glud,D Orlowski,LM Fitting, K Meier, JC Soerensen, CR Bjarkam & AKO Alstrup: Basic Surgical Techniques in the Göttingen Minipig: Intubation, Bladder Catheterization, Femoral Vessel Catheterization, and Transcardial Perfusion. J Vis Exp. 2011; (52): 2652.





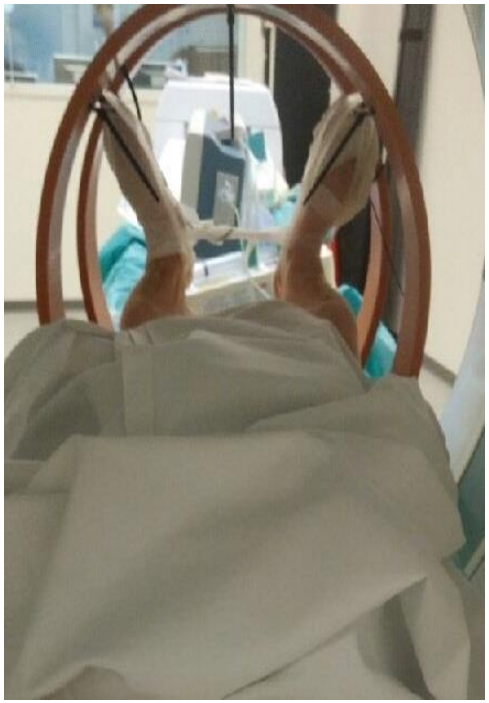


Pig model of osteomyelitis

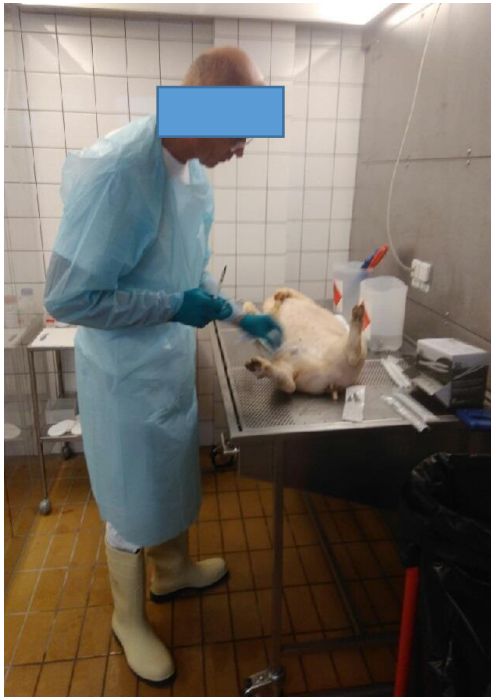


Inokulation in femoral artery with *Stafylococcus aureus*

7 days Painkillers



CT, PET and SPECT Monitorering

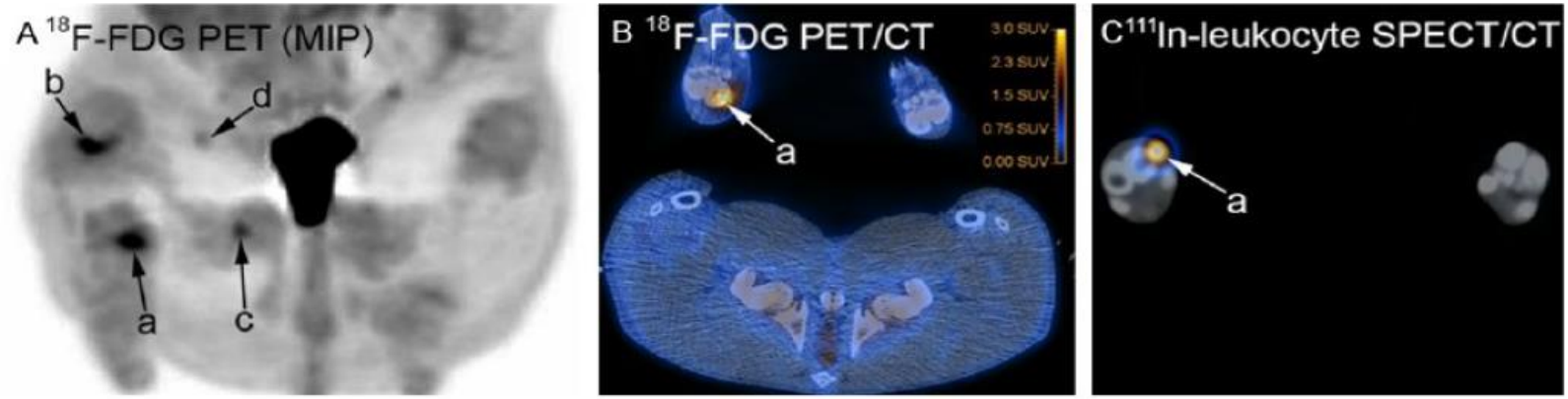


Necropsy & grafting

Table 3. Number of gross pathology and/or CT lesions identified by the individual tracers

Lesion	Total number	Tracers				
		^{18}F-FDG	^{68}Ga-citrate	^{11}C-methionine	^{11}C-PK11195	^{111}In-leukocytes
Osteomyelitis	5	4	1	2	0	4[A]
Soft tissue abscess	5	5	3	4	1	4
Arthritis	3	0	0	0	0	0
Enlarged lymph node	5	3	2	2	1	0[B]

[A]In one of these four lesions, the patella, the ^{111}In-leukocytes had only accumulated in the cortical part of the bone. [B]Only two lymph nodes were scanned.



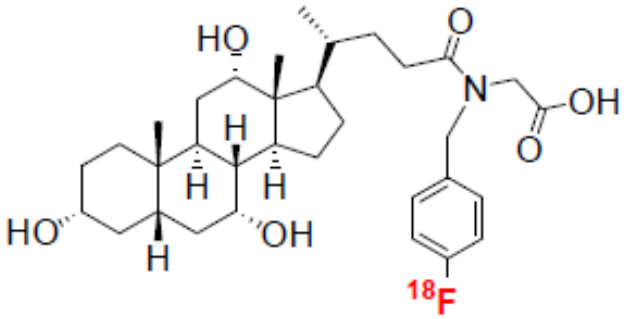
Nielsen OL, P Afzelius, D Bender, HC Schønheyder, PS Leifsson, KM Nielsen, JO Larsen, SB Jensen & AK Alstrup: Comparison of autologous (111)In-leukocytes, (18)F-FDG, (11)C-methionine, (11)C-PK11195 and (68)Ga-citrate for diagnostic nuclear imaging in a juvenile porcine haematogenous staphylococcus aureus osteomyelitis model. J. Nucl. Med. Mol. Imaging. 2015, 5, 169-182.

	Tracers lesion	Total number	^{11}C-methionine	^{11}C-donepecil	^{99m}Tc-DPD	^{111}In-leukocytes	^{18}F-FDG
Pig A	Osteomyelitis	3	2	1	0	1	3
	Contiguous periosseous abscess	0	-	-	-	-	-
	Hematoma/Abscess at inoculation site	0	-	-	-	-	-
	Lymph node enlargement	0	-	-	-	-	-
Pig B	Osteomyelitis	5	5	5	0	5	5
	Contiguous periosseous abscess	0	-	-	-	-	-
	Hematoma/Abscess at inoculation site	1	1	1	0	(1)	(1)
	Lymph node enlargement	1	1	1	0	0	0
Pig C	Osteomyelitis	6	4	3	0[A]	4[A]	NT[B]
	Contiguous periosseous abscess	1	(1)	1	0[A]	(1)[A]	NT[B]
	Hematoma/Abscess at inoculation site	0	-	-	-[A]	-[A]	NT[B]
	Lymph node enlargement	2	2	1	0[A]	(1)[A]	NT[B]
Pig D	Osteomyelitis	4	4	2	0	4	4
	Contiguous periosseous abscess	1	1	(1)	0	1	1
	Hematoma/Abscess at inoculation site	0	-	-	-	-	-
	Lymph node enlargement	3	3	2	0	(1)	1
Pig E	Osteomyelitis	6	4	3	0	5	6
	Contiguous periosseous abscess	2	2	2	0	2	2
	Hematoma/Abscess at inoculation site	1	0	0	0	0	0
	Lymph node enlargement	2	2	2	0	1	2
Total	Osteomyelitis	24	19/24	14/24	0/24	19/24	18/18
	Contiguous periosseous abscess	4	4/4	4/4	0/4	4/4	3/3
	Hematoma/Abscess at inoculation site	2	0	0	0/8	0	0
	Lymph node enlargement	8	8/8	6/8	0/8	3/8	3/6

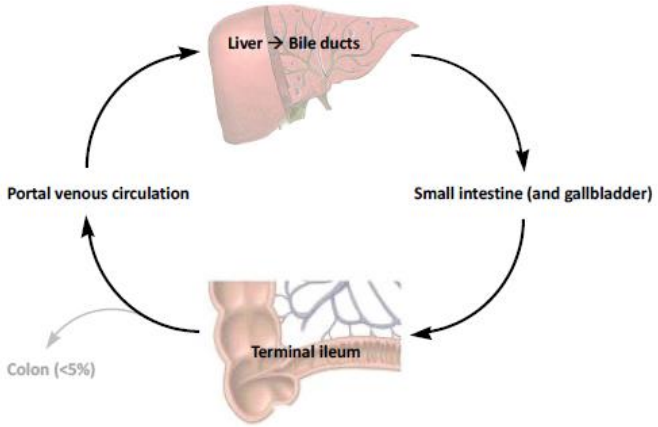
A: Scans performed on dead pig. B: NT, not tested, as the pig had died.

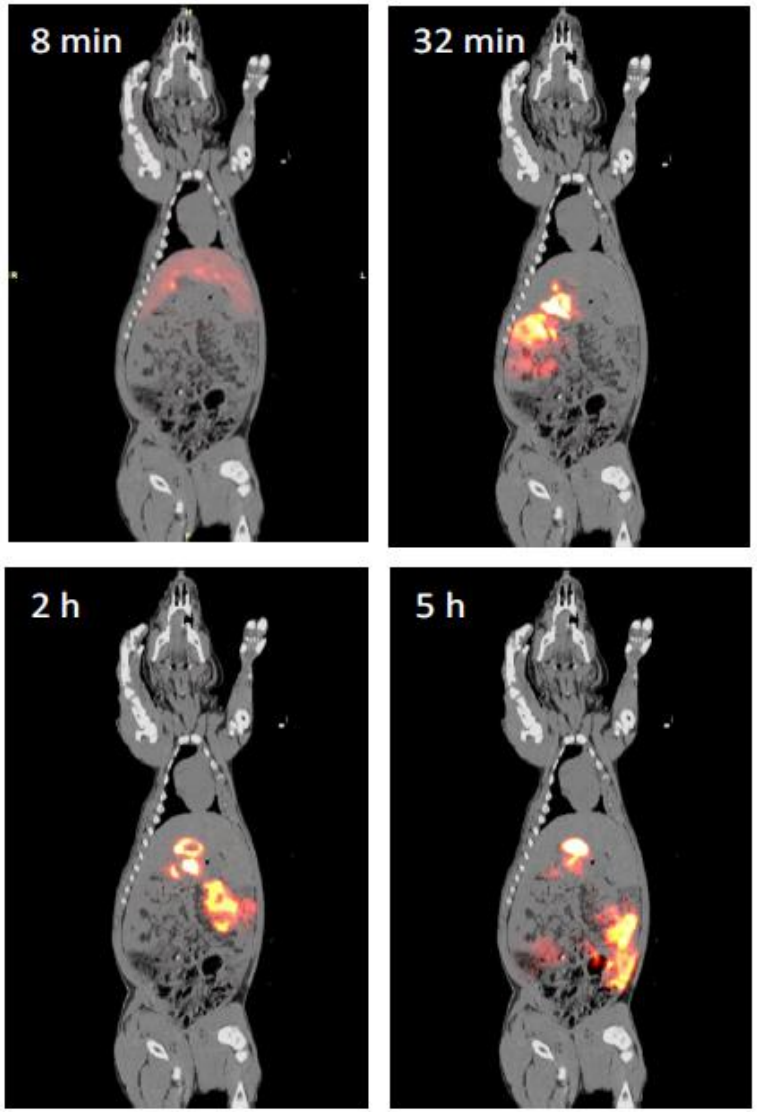
Afzelius P, AKO Alstrup, HC Schønheyder, P Borghammer, SB Jensen, D Bender & OL Nielsen: Utility of 11C-methionine and 11C-donepezil for imaging of Staphylococcus aureus induced osteomyelitis in a juvenile porcine model: comparison to autologous 111In-labelled leukocytes, 99m Tc-DPD, and 18F-FDG.
Am. J. Nucl. Med. Mol. Imaging 2016, 30, 6, 286-300.

Bile tracers

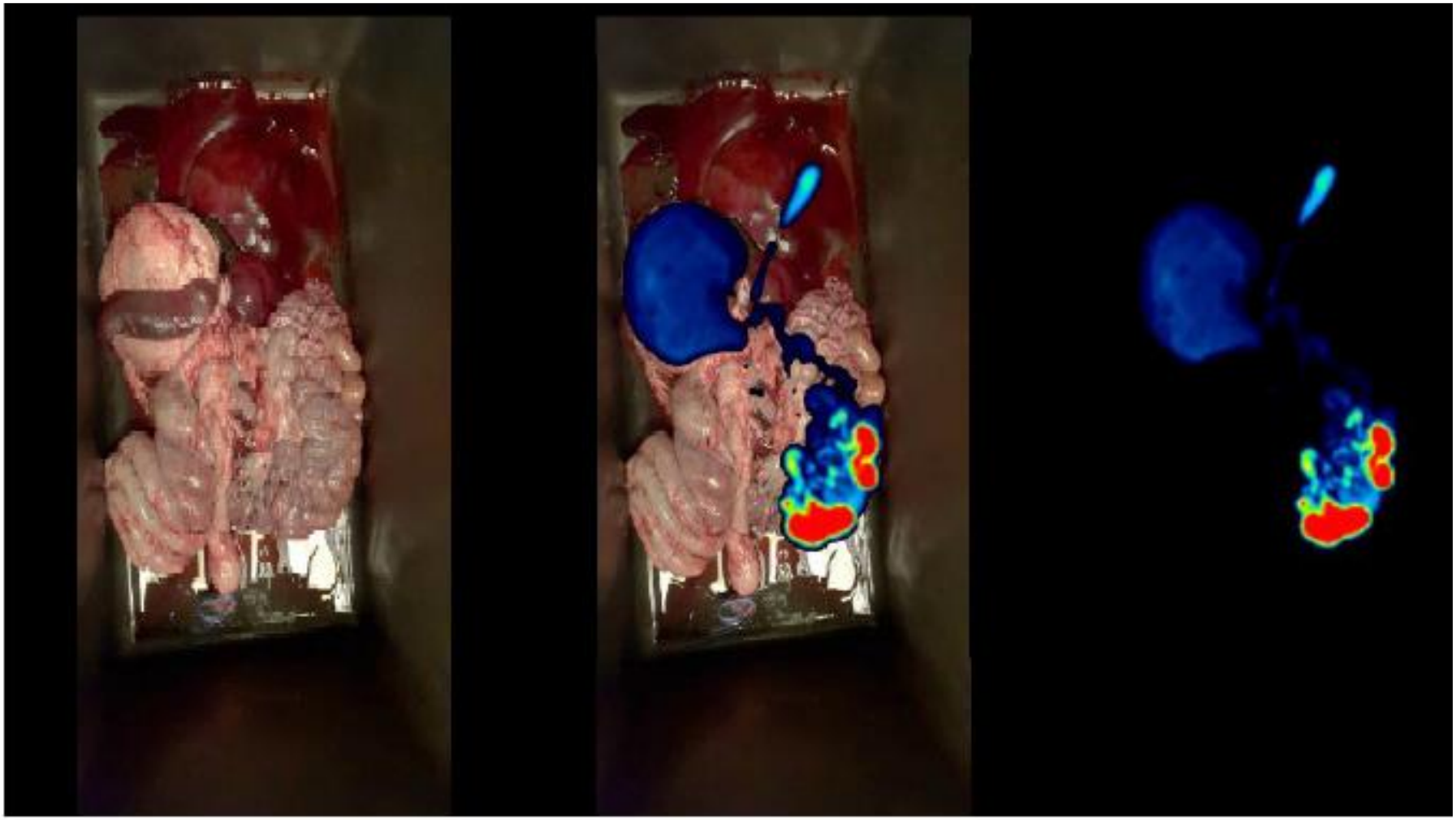


N-(4-[^{18}F]fluorobenzyl)-cholylglycine ([^{18}F]FBCGly)

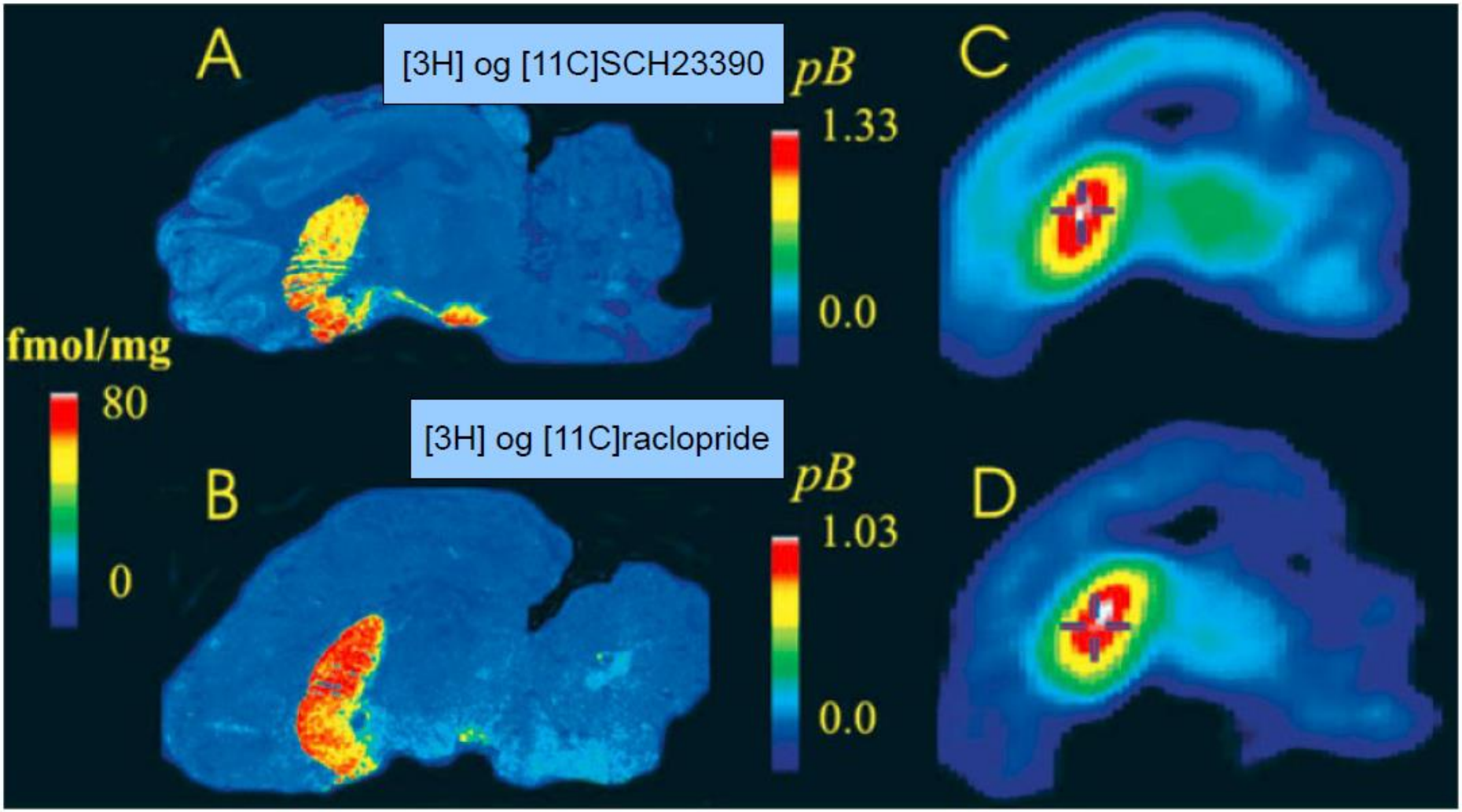




Post mortem: PET scans

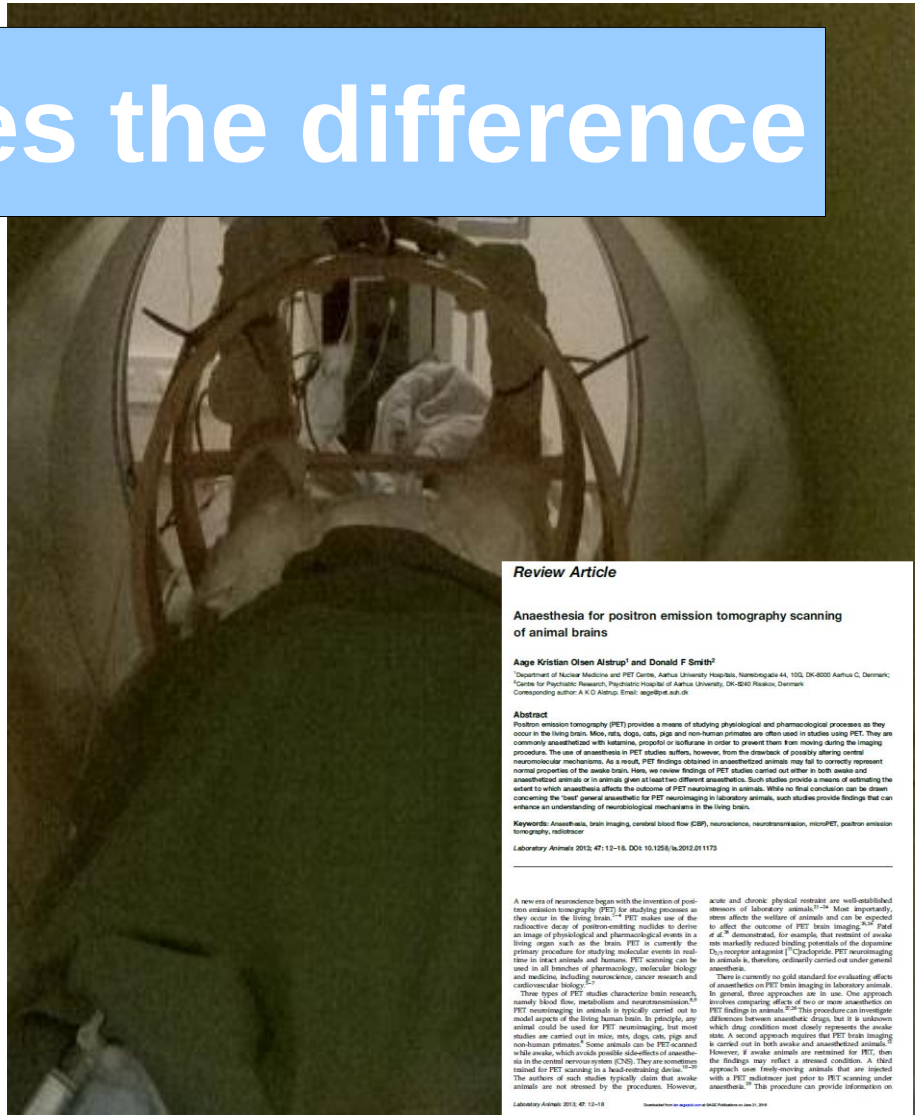


Post mortem: autoradiography



Minuzzi L, AKO Alstrup, D Bender, S Arnfred, R Grant, EH Danielsen & P Cumming: Quantitative autoradiography of ligands for dopamine receptors and transporters in brain of Göttingen minipigs: comparison with results in vivo. Synapse 2006, 59, 211-219.

Anaesthesia makes the difference



Review Article

Anaesthesia for positron emission tomography scanning of animal brains

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Corresponding author: A K O Alstrup. Email: aage@pet.auh.dk

Abstract

Positron emission tomography (PET) provides a means of studying physiological and pharmacological processes as they occur in the living brain. Mice, rats, dogs, cats, pigs and non-human primates are often used in studies using PET. They are commonly anaesthetized with ketamine, propofol or isoflurane in order to prevent them from moving during the imaging procedure. The use of anaesthesia in PET studies suffers, however, from the drawback of possibly altering central neuromolecular mechanisms. As a result, PET findings obtained in anaesthetized animals may fail to correctly represent normal properties of the awake brain. Here, we review findings of PET studies carried out either in both awake and anaesthetized animals or in animals given at least two different anaesthetics. Such studies provide a means of estimating the extent to which anaesthesia affects the outcome of PET neuroimaging in animals. While no final conclusion can be drawn concerning the 'best' general anaesthetic for PET neuroimaging in laboratory animals, such studies provide findings that can enhance an understanding of neurobiological mechanisms in the living brain.

Keywords: Anaesthesia, brain imaging, cerebral blood flow (CBF), neuroscience, neurotransmission, microPET, positron emission tomography, radiotracer

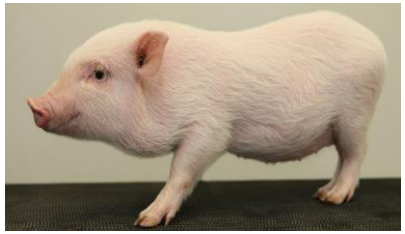
Laboratory Animals 2013; 47: 12–16. DOI: 10.1258/la.2012.011173

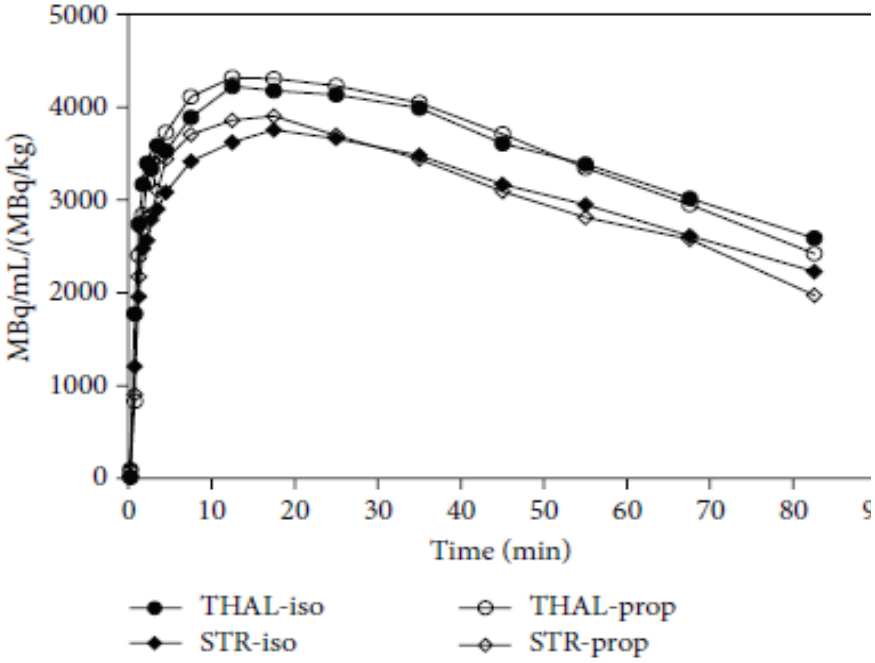
A new era of neuroscience began with the invention of positron emission tomography (PET) for studying processes as they occur in the living brain.[1–4] PET makes use of the radioactive decay of positron-emitting nuclides to derive an image of physiological and pharmacological events in a living organ such as the brain. PET is currently the primary procedure for studying molecular events in real-time in intact animals and humans. PET scanning can be used in all branches of pharmacology, molecular biology and medicine, including neuroscience, cancer research and cardiovascular biology.[5–7]

Three types of PET studies characterize brain research, namely blood flow, metabolism and neurotransmission.[8,9] PET neuroimaging in animals is typically carried out to model aspects of the living human brain. In principle, any animal could be used for PET neuroimaging, but most studies are carried out in mice, rats, dogs, cats, pigs and non-human primates.[4] Some animals can be PET-scanned while awake, which avoids possible side-effects of anaesthesia in the central nervous system (CNS). They are sometimes trained for PET scanning in a head-restraining device.[10–20] The authors of such studies typically claim that awake animals are not stressed by the procedures. However, acute and chronic physical restraint are well-established stressors of laboratory animals.[21–24] Most importantly, stress affects the welfare of animals and can be expected to affect the outcome of PET brain imaging.[8,24] Patel *et al.*[25] demonstrated, for example, that restraint of awake rats markedly reduced binding potentials of the dopamine $D_{2/3}$ receptor antagonist [^{11}C]raclopride. PET neuroimaging in animals is, therefore, ordinarily carried out under general anaesthesia.

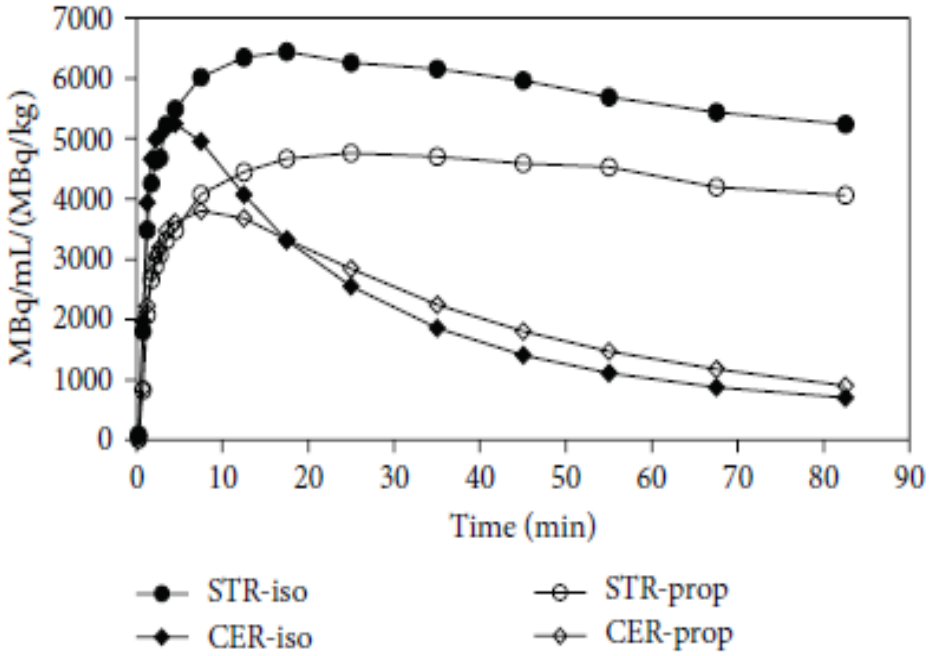
There is currently no gold standard for evaluating effects of anaesthetics on PET brain imaging in laboratory animals. In general, three approaches are in use. One approach involves comparing effects of two or more anaesthetics on PET findings in animals.[8,26] This procedure can investigate differences between anaesthetic drugs, but it is unknown which drug condition most closely represents the awake state. A second approach requires that PET brain imaging is carried out in both awake and anaesthetized animals.[8] However, if awake animals are restrained for PET, then the findings may reflect a stressed condition. A third approach uses freely-moving animals that are injected with a PET radiotracer just prior to PET scanning under anesthesia.[20] This procedure can provide information on

Isoflurane versus propofol i minipigs



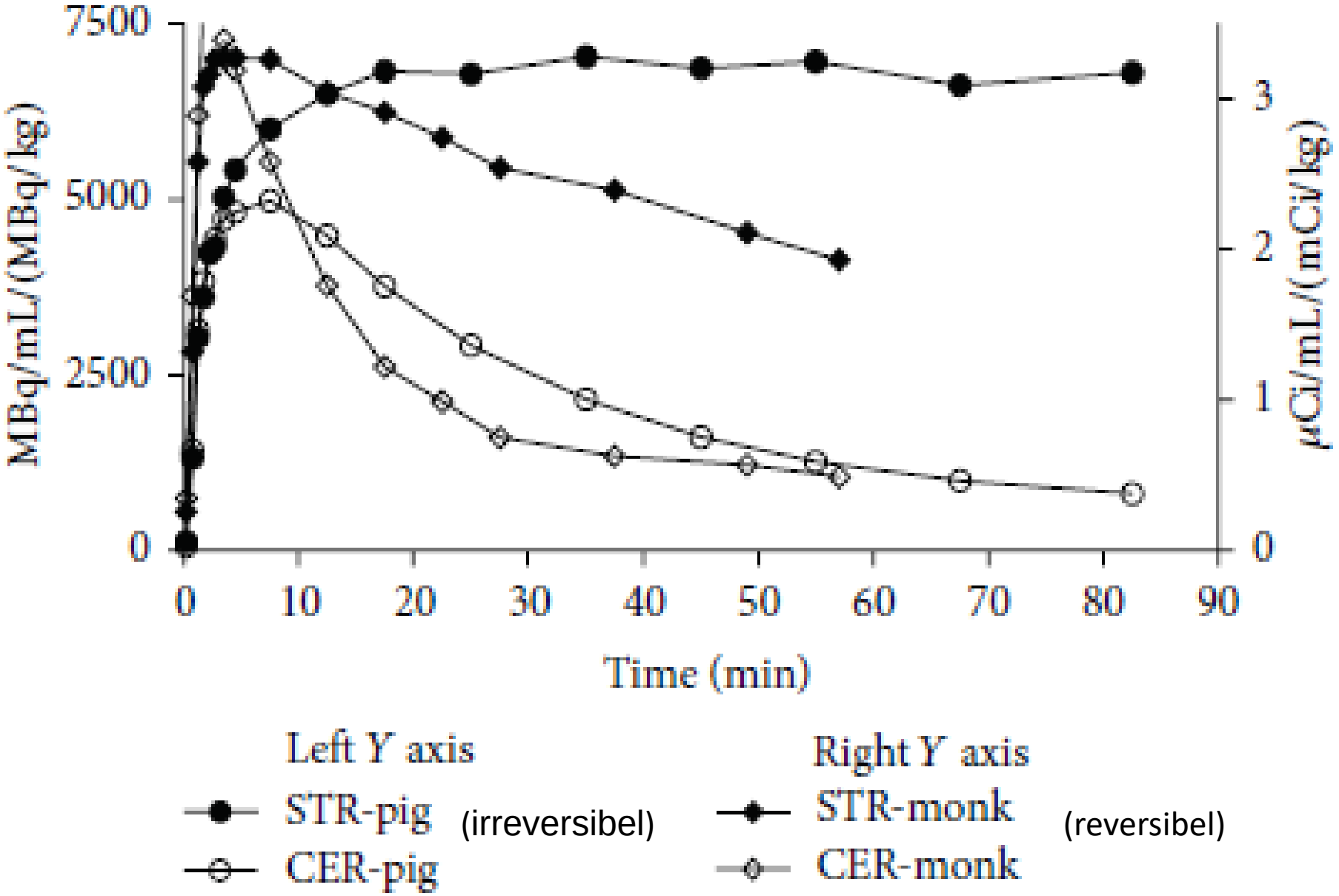


[^{11}C]yohimbin (reversibel)
Noradrenalin-receptor

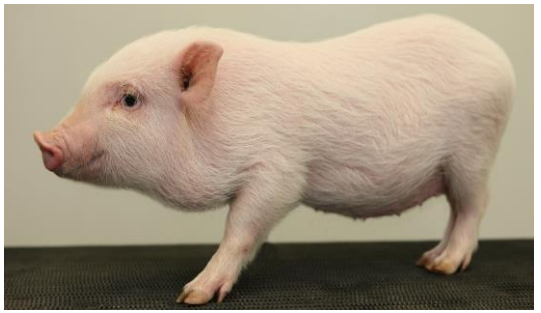


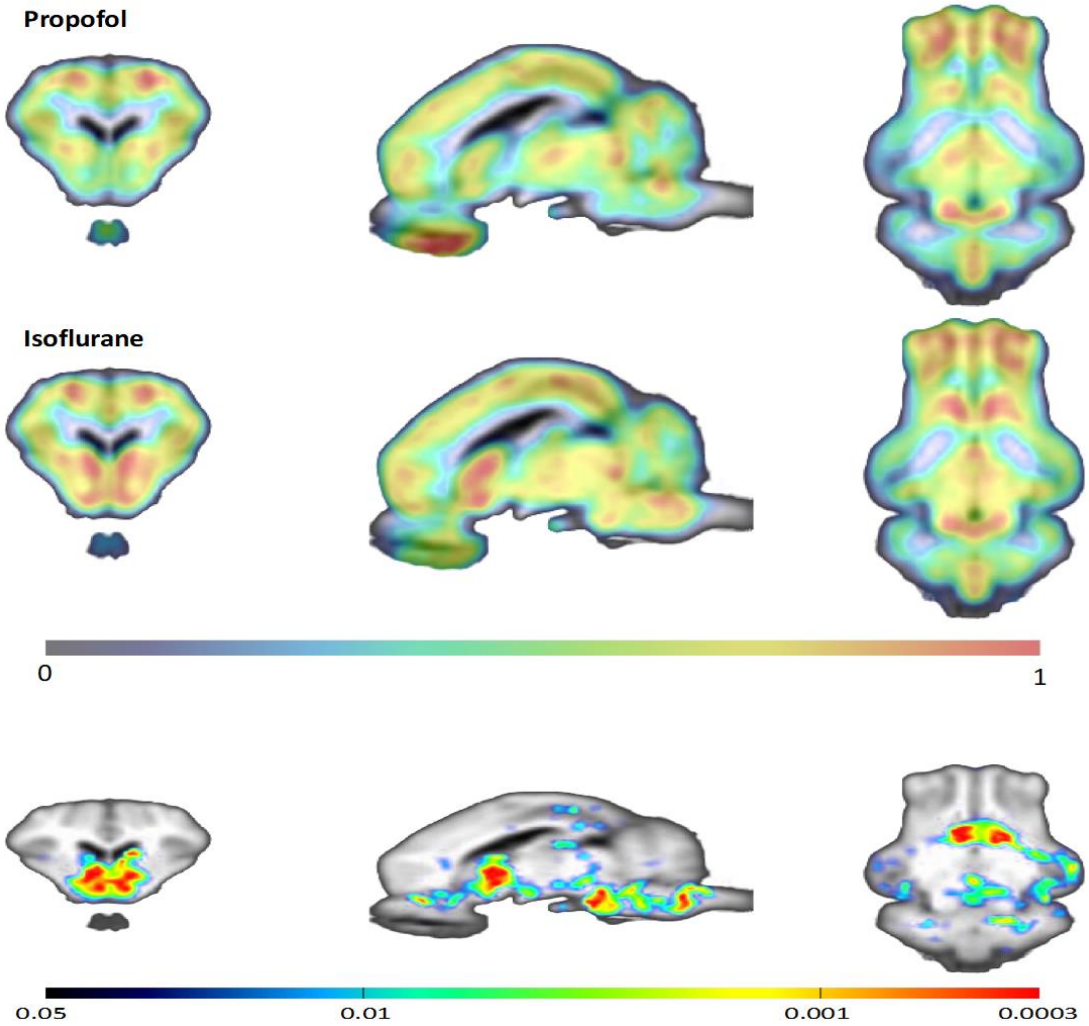
[^{11}C]SCH23390 (irreversibel)
Dopamin D_1-receptor

Minipig versus non-human primate (isoflurane)



[^{11}C]MDL100907 ($5HT_{2A}$-receptors)





[^{11}C]MDL100907 (5HT$_{2A}$-receptors)

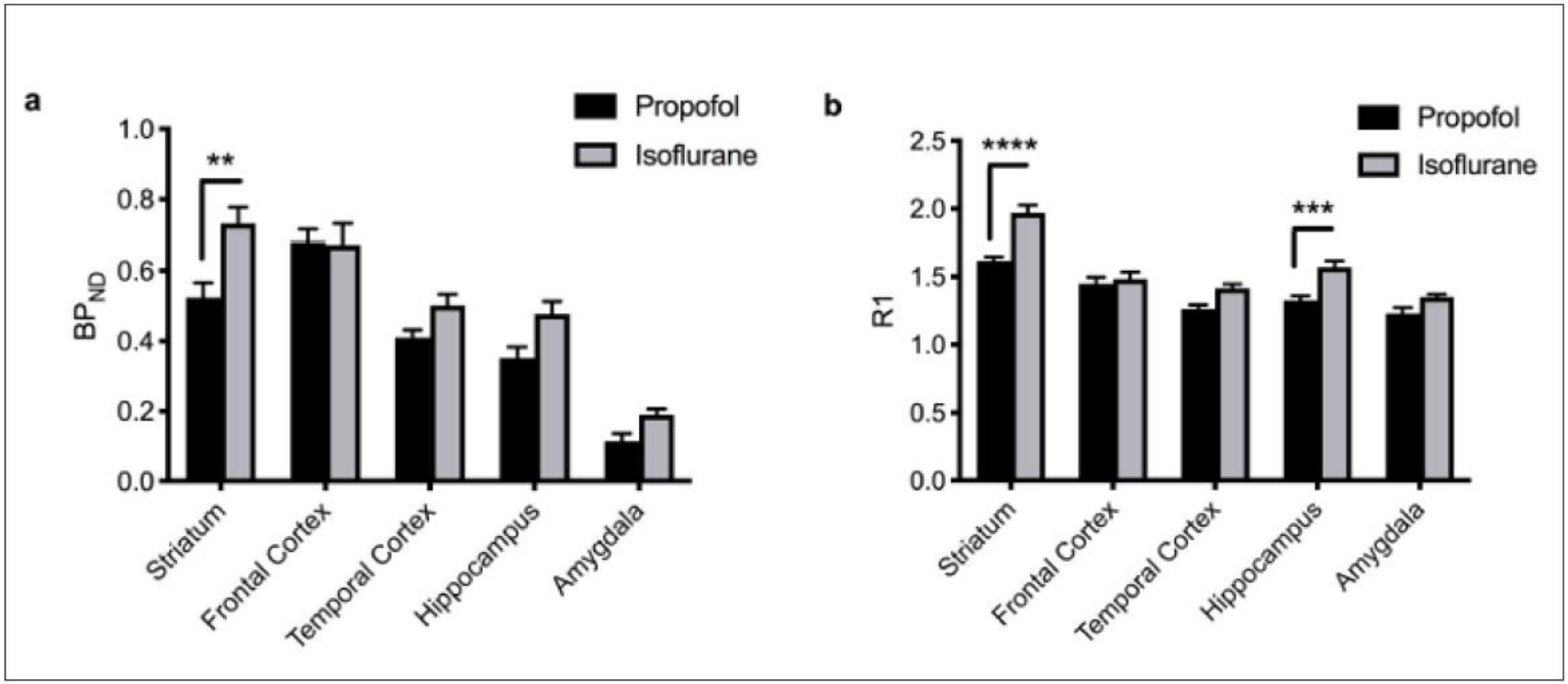


Figure 5: Binding potential (BP$_{ND}$) of [^{11}C]MDL100,907 (**A**) and R1 blood flow surrogate marker (**B**) in five brain regions during propofol and isoflurane anaesthesia in Göttingen minipigs Two-way ANOVA shows effects of both anaesthesia and region for (**A**) and (**B**). Bonferroni post-hoc testing of anaesthesia effects: **: P<0.01, ***: P<0.001 and ****: P<0.0001 (Figure **2** in paper **P-XI**).

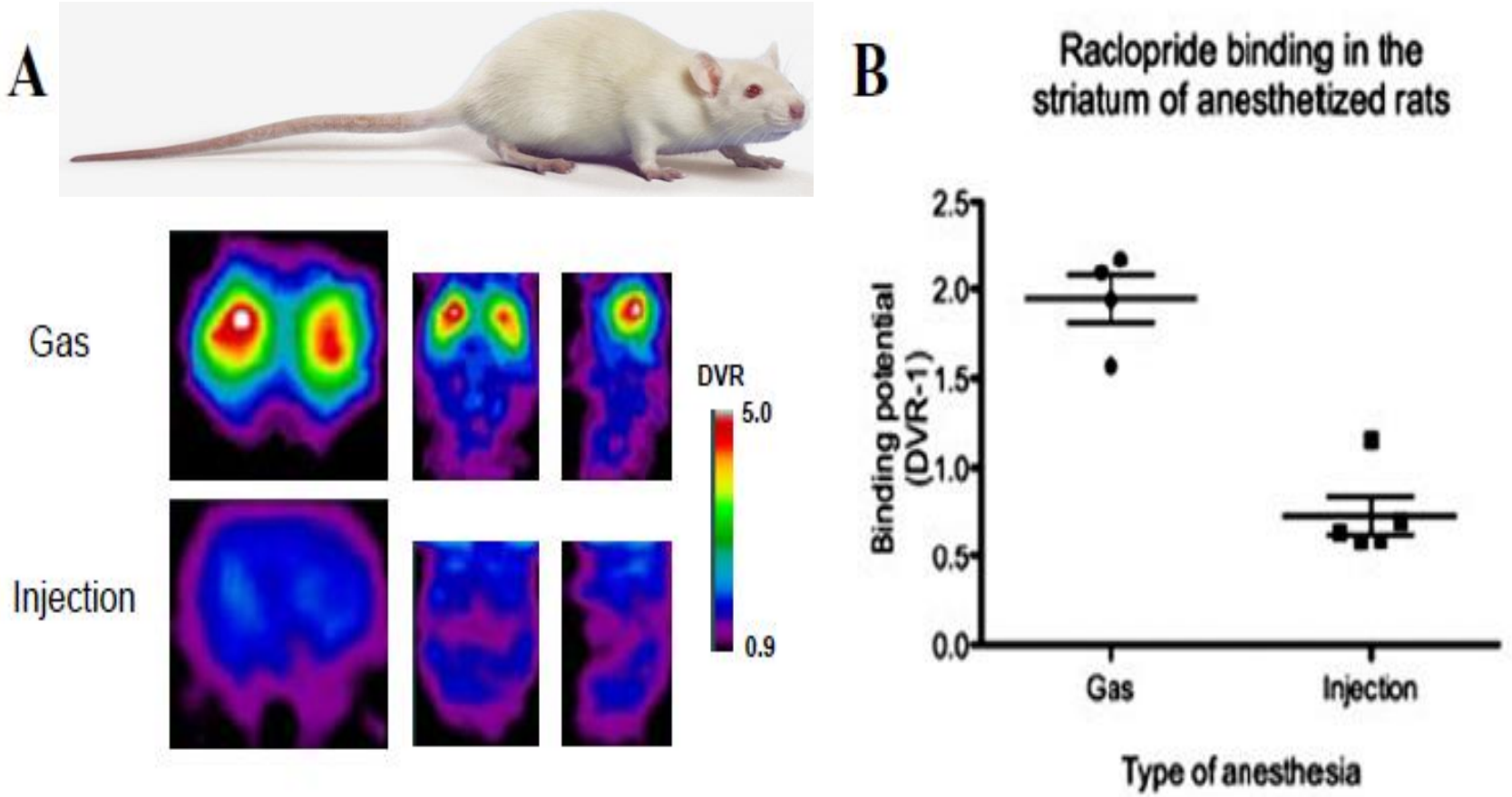


Figure 1. Isoflurane treated rats have significantly higher striatal [^{11}C]raclopride binding potential than fentanyl-fluanisone-midazolam treated rats. *(A) PET images are shown for [^{11}C]raclopride binding in one representative rat in each group. (B) Binding potential values for [^{11}C]raclopride are shown for each rat in the experiment, determined by subtracting 1 from the distribution volume ratio (DVR). Circles represent rats treated with isoflurane (N=4) and squares represent rats treated with fentanyl-fluanisone-midazolam (N=5). Binding potential was significantly greater in rats treated with isoflurane (2-tailed student t-test *P<0.001).*

Monitoring

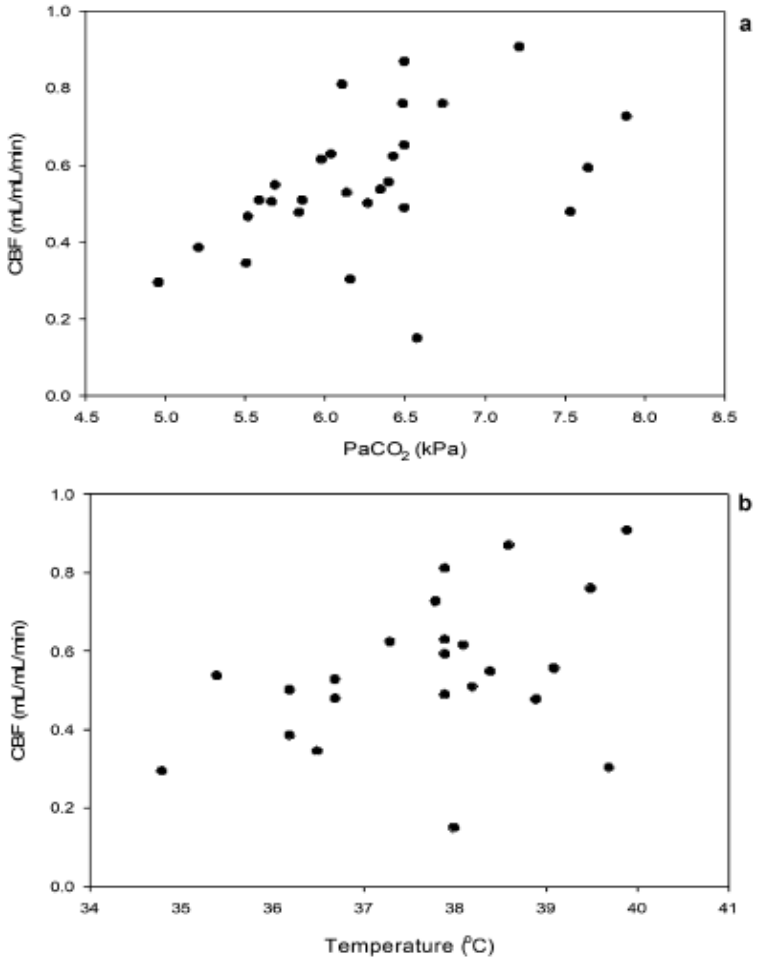
Long-term scannings:
- Animal welfare
- Influence on results

Monitoring and CBF ($[^{15}O]H_2O$)

Table 1 Estimated cerebral blood flow and measured physiological variables expressed both as mean and median

	Mean	Std dev	Median	Range	N
CBF (mL/mL/min)	0.54	0.16	0.51	0.15–0.91	37
pH	7.44	0.04	7.44	7.35–7.52	28
$PaCO_2$ (kPa)	6.3	0.7	6.2	5.0–7.9	28
PaO_2 (kPa)	18	5	16	10.7–29.0	27
HCT (%)	30	3	30	24.3–35.9	26
HR (min^{-1})	115	25	116	53–160	21
SBP (mmHg)	114	14	110	86–142	23
DBP (mmHg)	76	17	70	51–118	23
GLC (mmol/L)	4.9	1.4	4.8	2.3–8.1	26
TEMP (°C)	37.7	1.3	37.9	34.8–39.9	23
TIME (min)	115	68	127	79–314	37

CBF cerebral blood flow, *$PaCO_2$* arterial carbondioxide tension, *PaO_2* arterial oxygen tension, *HCT* haematocrit, *HR* heart rate, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *GLC* blood glucose, *TEMP* body temperature, *TIME* duration of anaesthesia, *N* number of observations



	pH	$PaCO_2$	PaO_2	HCT	HR	SBP	DBP	TEMP	GLC	TIME
CBF	−0.35 0.064 28	0.45 0.016 28	−0.22 0.28 27	0.22 0.29 26	0.49 0.024 21	0.06 0.80 23	−0.07 0.76 23	0.41 0.052 23	0.13 0.53 26	0.26 0.11 37
pH	–	−0.82 0.000 28	0.065 0.75 27	−0.014 0.95 26	−0.16 0.48 21	−0.043 0.85 23	−0.089 0.69 23	−0.23 0.29 23	0.13 0.54 24	0.01 0.96 28
$PaCO_2$	–	–	−0.11 0.59 27	0.30 0.14 26	0.24 0.31 21	0.27 0.21 23	0.21 0.33 23	0.34 0.12 23	−0.13 0.56 24	0.10 0.62 28
PaO_2	–	–	–	−0.23 0.28 25	−0.60 0.004 21	0.40 0.059 23	0.26 0.23 23	0.035 0.87 23	−0.24 0.27 23	**−0.46** **0.015*** **27**
HCT	–	–	–	–	0.45 0.046 20	0.18 0.43 22	0.18 0.43 22	0.22 0.33 22	0.21 0.34 22	0.27 0.18 26
HR	–	–	–	–	–	0.022 0.92 21	0.039 0.87 21	0.33 0.14 21	0.21 0.40 18	**0.73** **0.000*** **21**
SBP	–	–	–	–	–	–	0.58 0.004 23	0.27 0.22 23	0.25 0.28 20	0.048 0.83 23
DBP	–	–	–	–	–	–	–	0.019 0.93 23	0.094 0.69 20	−0.23 0.28 23
TEMP	–	–	–	–	–	–	–	–	0.19 0.42 20	**0.53** **0.010*** **23**
GLC	–	–	–	–	–	–	–	–	–	0.44 0.02 26

$PaCO_2$ and CBF ($[^{15}O]H_2O$)

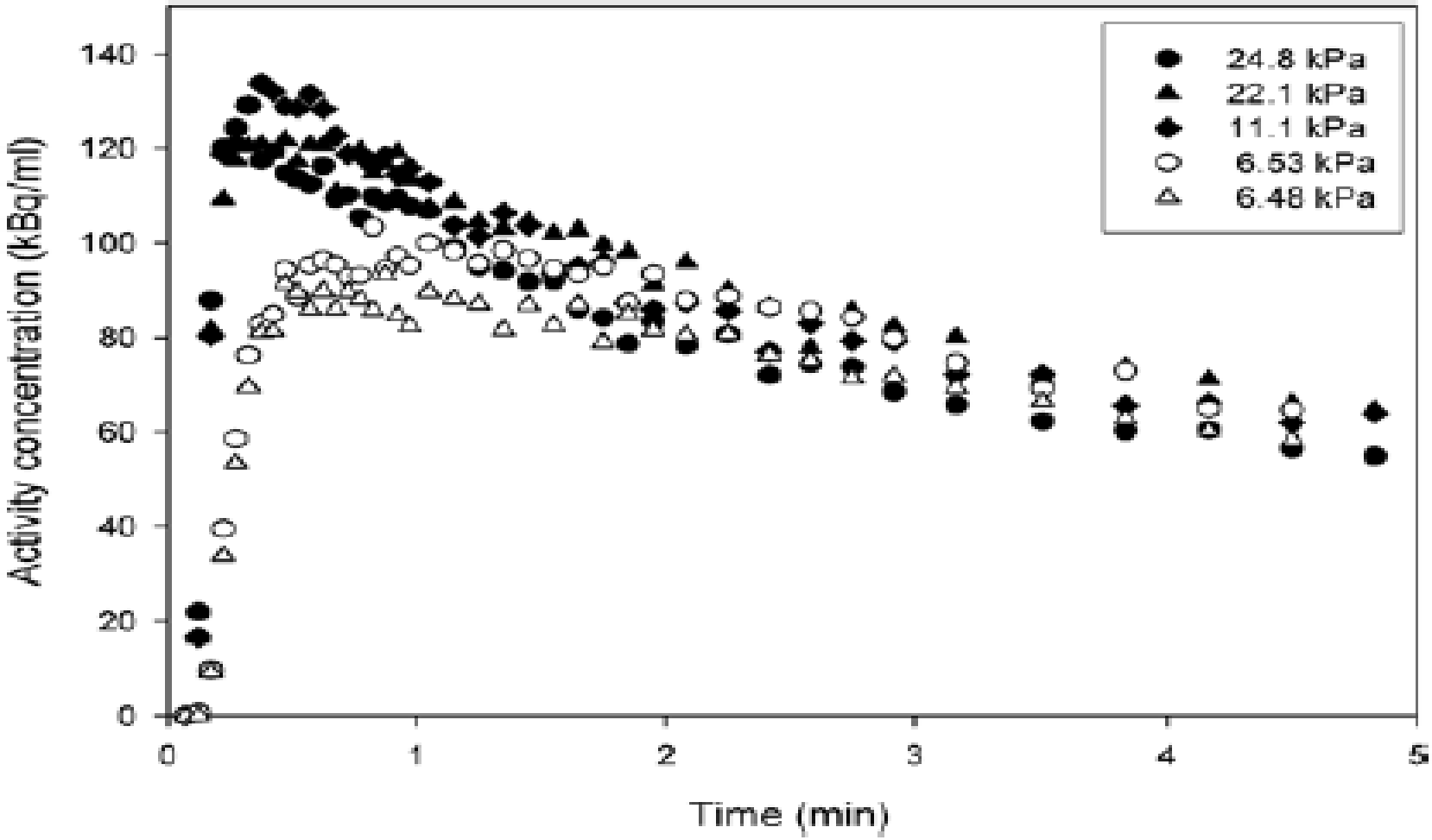
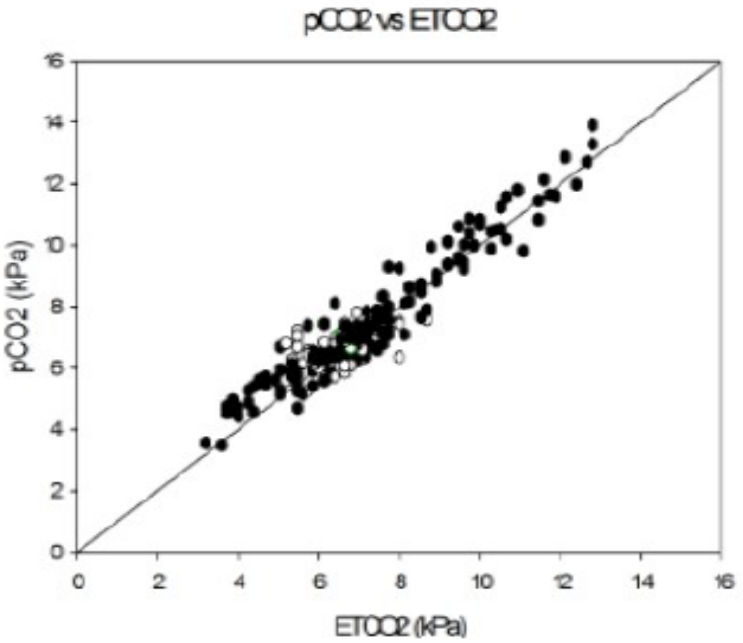


Figure 1. Time–activity curves after five $H_2{}^{15}O$ injections in Pig 4. The shape of the activity concentrations as function of time clearly varies depending on whether the pig is normocapnic (white symbols) or hypercapnic (black symbols).

$ETCO_2$ versus $PaCO_2$



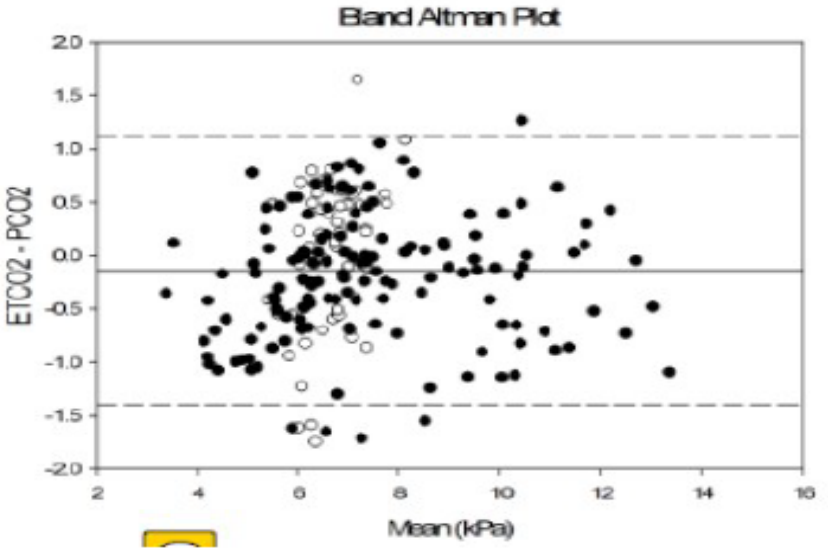


***Figure 8**: The relationship between end-tidal carbon dioxide ($ETCO_2$) and partial pressure carbon dioxide ($PaCO_2$) in 40 kg female domestic pigs (N=9) during anaesthesia. Data was recorded both during normocapnia (o) and hypo- and hypercapnia (•). The left figure shows a plot of $PaCO_2$ measurements as a function of $ETCO_2$ measurements. The right figure is a Bland-Altman plot of the same data.*

Blood lactate in pigs

- Marker for hypoxia

***Table 14**: Blood lactate levels (mmol/l; mean ± SD) in pigs.*

Pig breed	N	Anaesthesia	Weight	Surgery	Blood Lactate	*p*
Göttingen minipigs	19	Isoflurane	35 kg	Minor	2.53 ± 1.10	***
Domestic pigs	16	Isoflurane	40 kg	Minor	0.68 ± 0.48	NS
Domestic pigs	16	Propofol	40 kg	Minor	0.77 ± 0.34	NS
Domestic pigs	22	Propofol	40 kg	Major	0.88 ± 0.65	NS
Domestic pigs	08	Propofol	70 kg	Minor	0.71 ± 0.39	NS

****: Significant (P<0.001) differences between Göttingen and domestic pigs. N: number of pigs.*

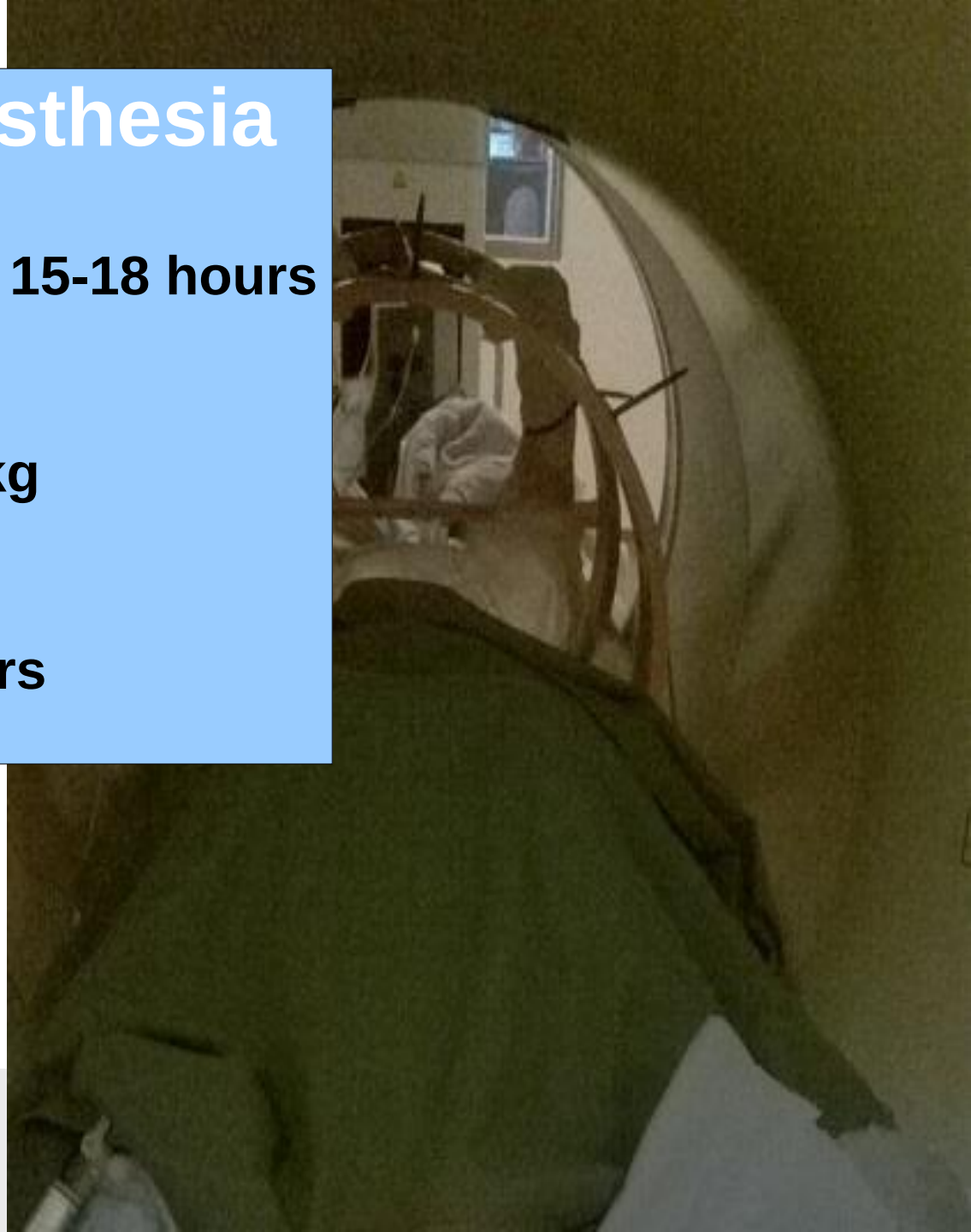
*NS: not significant. Data from Table **1** in paper **P-VI**.*

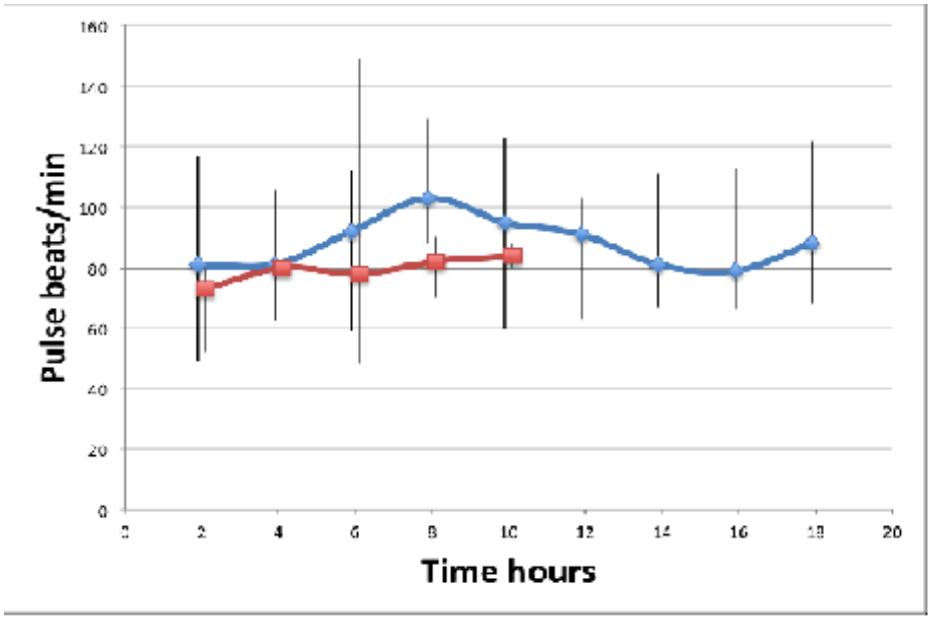
Long-term anaesthesia

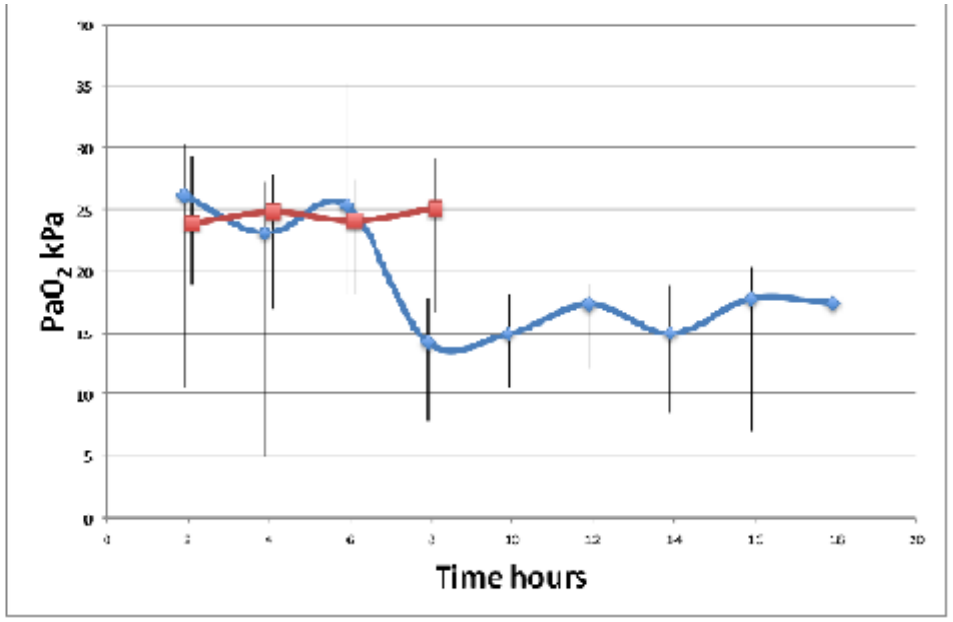
Long-term anaesthesia: 15-18 hours
- versus 8-14 hours

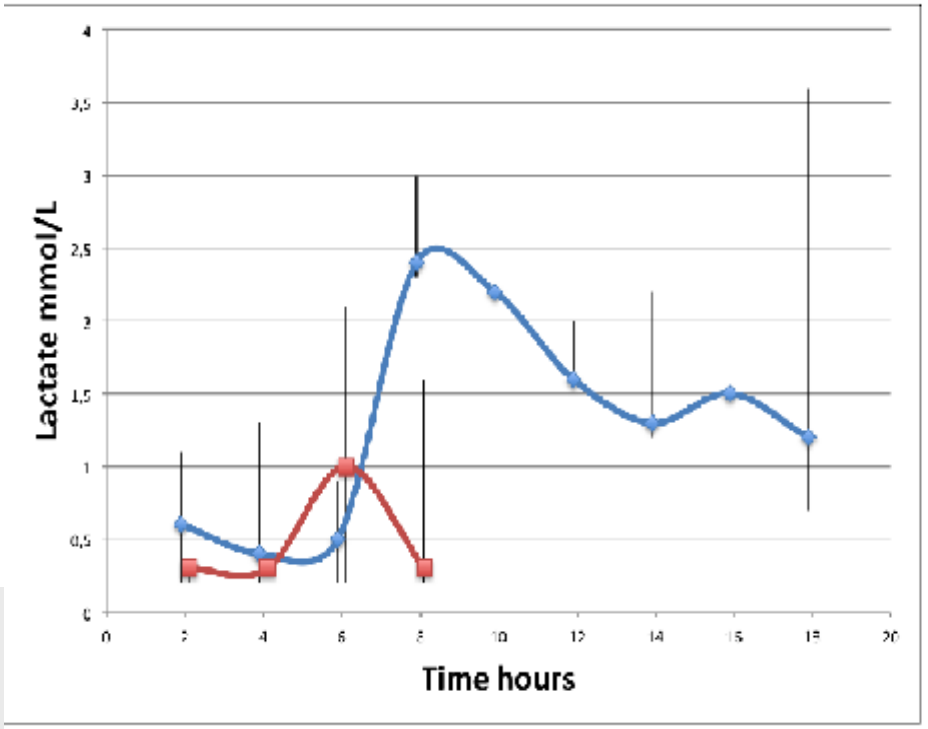
Blood sampling: 20 ml/kg
- versus 14 ml/kg

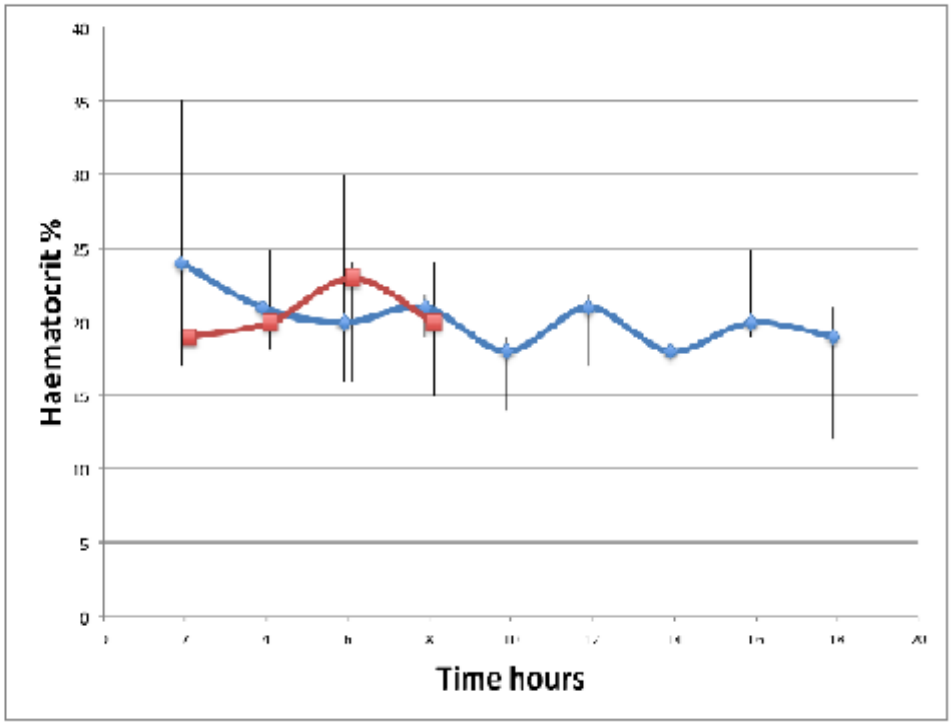
Road transport: 1½ hours
- versus no transport



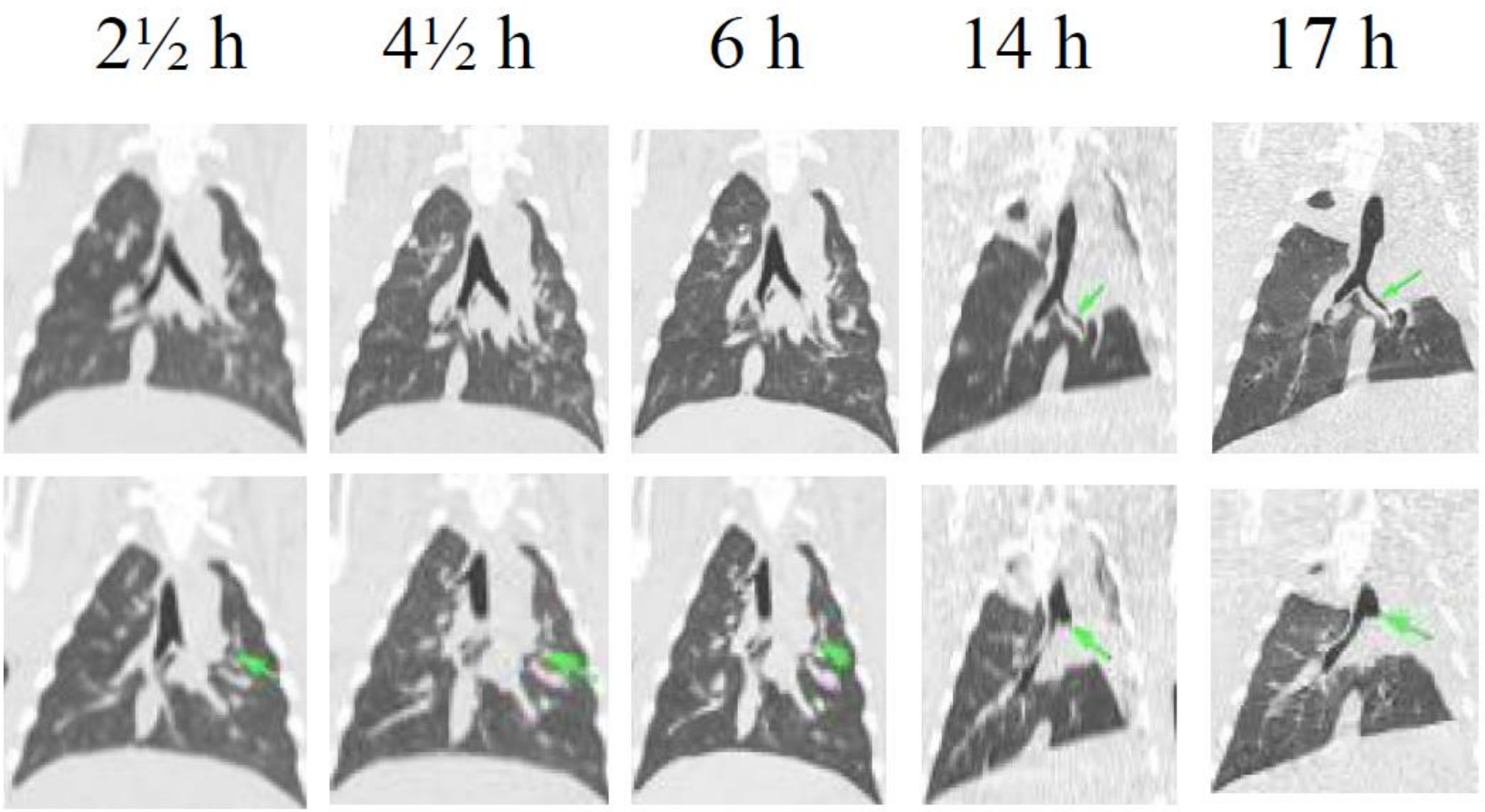

Pulse beats/min
Time hours


PaO2 kPa
Time hours


Lactate mmol/L
Time hours


Haematocrit %
Time hours

Atelectasis after long-term anaesthesia

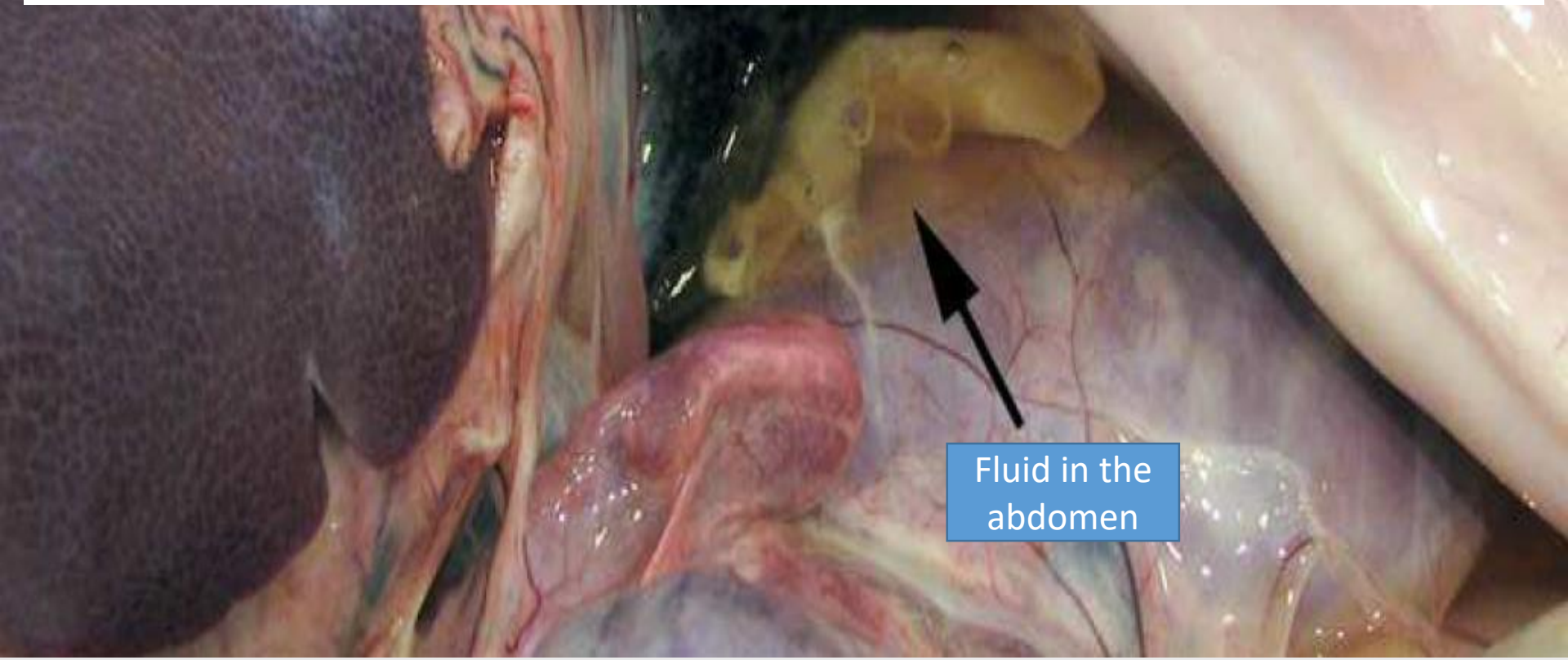


No effects of long-term anaesthesia on brain

Table 17: *Brain necropsy, histology, Fluoro-Jade-B and median (min-max) FDG uptake.*

Pigs	Necropsy	Histology	Fluoro-Jade-Color	SUV [^{18}F]FDG
I-IX	No findings (N=9)	No findings (N=9)	All negative (N=9)	1.8 g/ml (1.5-2.6) (N=9)
X-XVIII	No findings (N=9)	No findings (N=9)	All negative (N=8)	1.9 g/ml (1.4-3.0) (N=9)

SUV: standardized uptake values. FDG: fluorodeoxyglucose. N: number. Data from paper ***P-X****.*



Short scans and animal welfare

CT before and after 2 hours of PET scanning
- No pathology

14 day periods post-scanning without blood sampling
- 95 procent without any notes

14 day periods post-scanning with blood sampling
- 50 procent without any notes (most small bleedings)

14 days periods (controls)
- 98 procent without any notes

Alstrup et al (2021) PET imaging sessions do not cause detectable organ pathology in Göttingen minipigs. In prep.

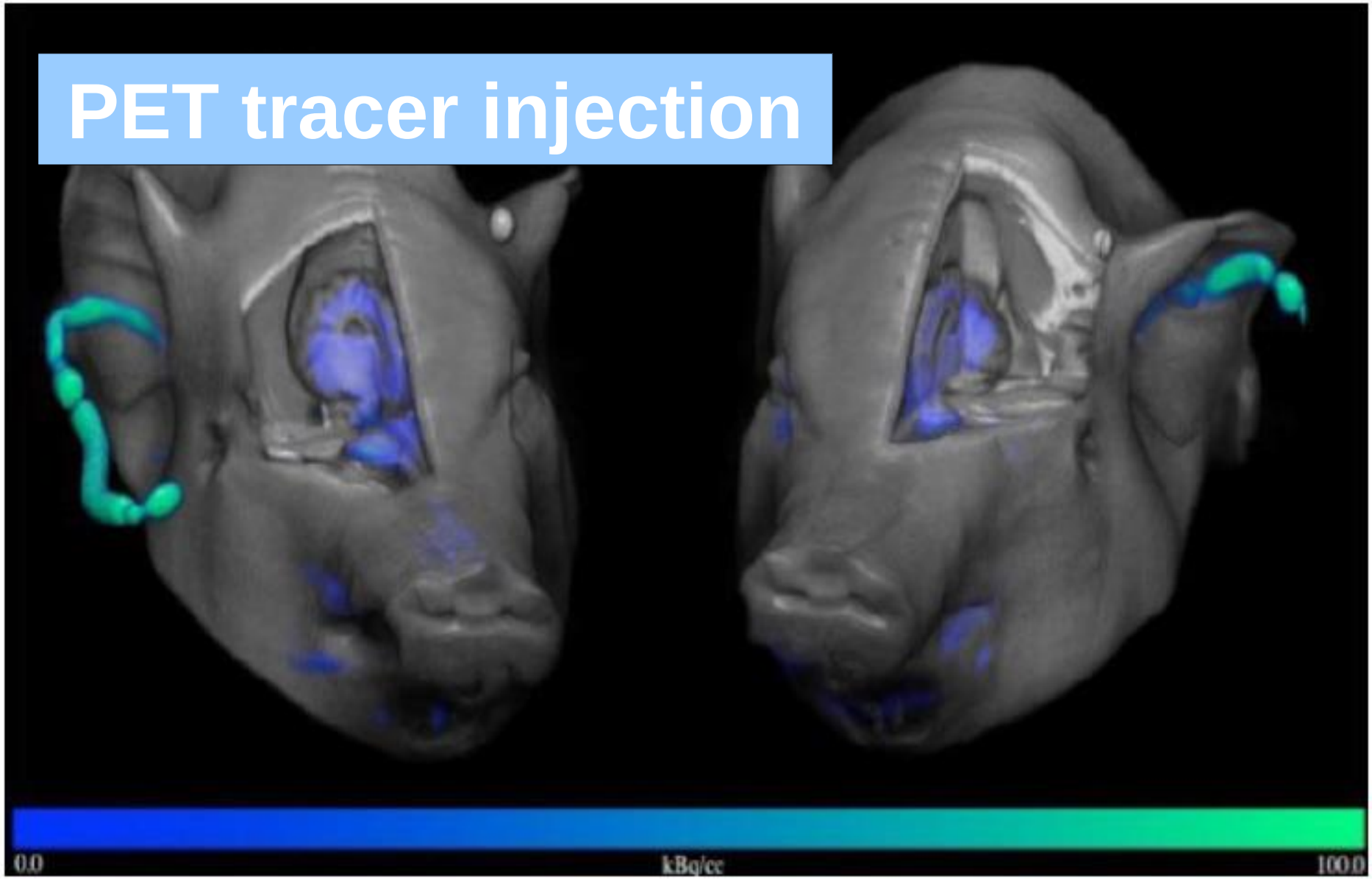
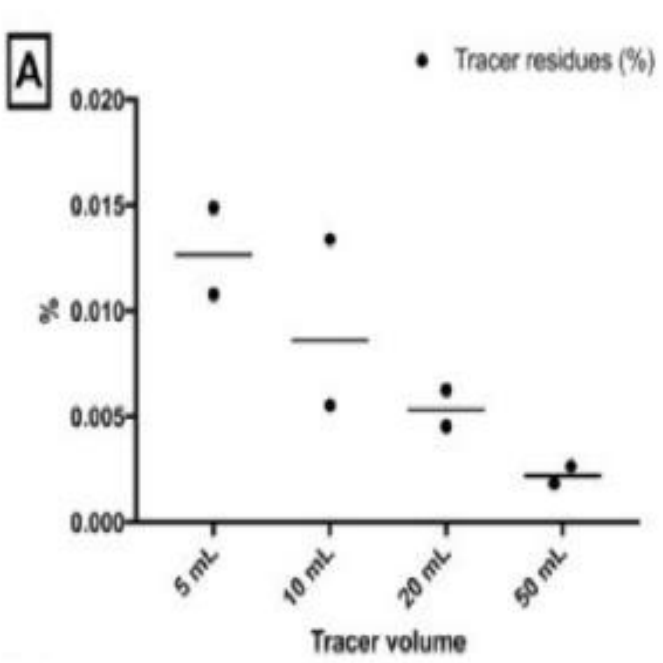


Figure 5**: PET images showing tracer residues in ear catheters from [^{11}C]PK11195 in 6 Göttingen minipigs after injection of 300-400 MBq tracer in a volume of 10 ml. The catheters were flushed with 10 ml saline after tracer injection. Figure **1** in Paper **X



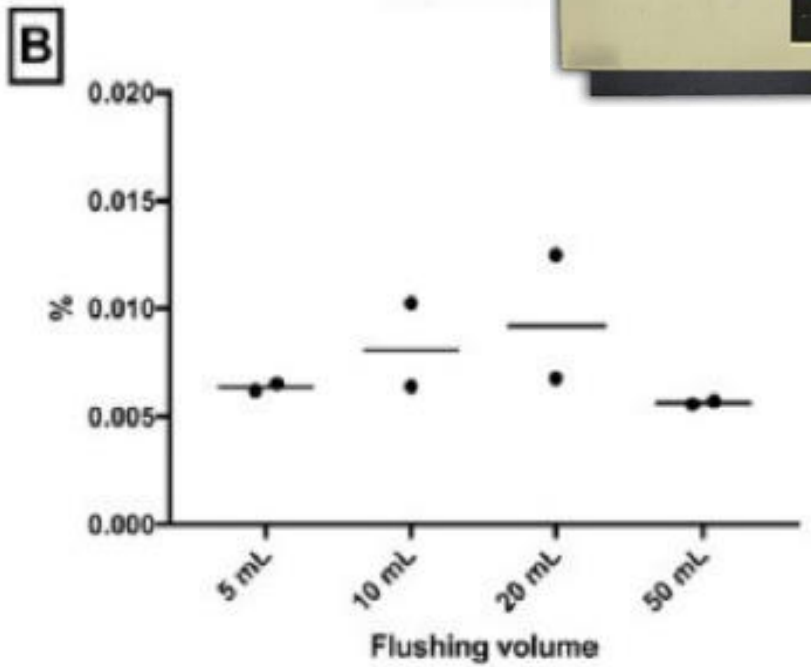


***Figure 6**: Results of in vitro study with the tracer [^{18}F]FDOPA with different tracer volumes (5-50 ml) (A) and flushing volumes (5-50 ml) (B). The residues of the tracer are shown as % of the injected tracer dose. The study was performed twice.*

Thanks for listening

ELLEGAARD
GÖTTINGEN MINIPIGS

Göttingen Minipigs MR and CT Imaging Atlas

A comprehensive imaging atlas presenting detailed information about the physiology of Göttingen Minipigs has been made available for anyone interested in the anatomical evolution of Göttingen Minipigs. This documentation enables a unique opportunity to follow the development of all organs over time and obtain new data.

The images are made from high-resolution CT- and MRI-scans and the atlas covers a wide range of information based on the scans (see page 2). With these, a user-friendly virtual minipig can be created using freely available software, and organ development analyses can be performed.

Why the imaging atlas is important

The imaging atlas fully supports all three parametres of the 3R principles, which contribute with important steps in the development of safer and more effective medicines:

- *Replacement*; as the access to and use of the imaging atlas can fully replace the use of new animals in similar studies
- *Reduction*; as the use of the imaging atlas can fully or partly reduce the number of animals used to obtain the same amount of scientific information
- *Refinement*; as reducing animal distress is a direct result of a reduced need for operational studies, since knowledge can be obtained through the images, which also supports the definition of age and development-stage

Access to the images

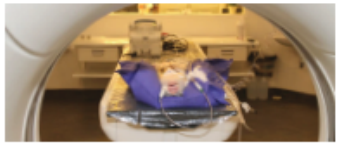
You can gain access to the database with CT- and MRI-scan files free of charge after signing an MTA. The files may be used for non-commercial, internal and/or knowledge building purposes within your organization.

Are you interested?
Contact us on ellegaard@minipigs.dk

Background and usability

A total of 12 Göttingen Minipigs were scanned at different ages to follow the anatomical development from the age of 2 to 24 months:

- Four females were scanned repeatedly, at the ages 2-3 months, 4-5 months, 6-7 months and 12-13 months
- Two females and two males at the age of 1 year
- Four females at the age of 2 years



Picture 2
Setup at CT scanner with anaesthetized göttingen minipigs connected to ventilator and monitor.

"Throughout the years, we have received many diverse requests from researchers planning experiments with Göttingen Minipigs, e.g. the size of the eyeballs at different ages, the development of the teeth, the size and location of certain organs, arteries, and veins.

This atlas makes it possible to study the anatomy and the development of growing organs, the vascular system and bone structures, and makes it easier to choose the right model for each research set-up. Likewise, pre-study considerations, such as age, growth during study period, equipment and probe sizes etc., can be solved beforehand and thereby reduces the use of pilot animals in compliance with the 3R principles.

Sigríður Olga Magnúsdóttir
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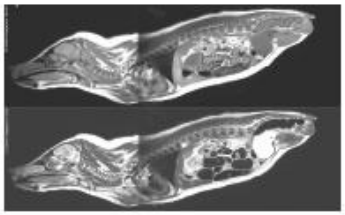
The value of MRI-scans

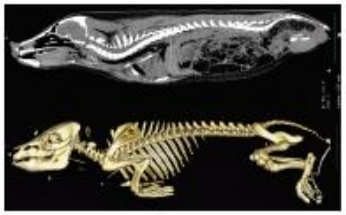
MRI-scans illustrate higher detail in soft tissues and has the ability to change the contrast of the images, which highlight different types of tissue. For example, the signal intensity for fluids is low in T1 weighted images, but high in T2 weighted images. Based on this, most soft tissue structures can be differentiated through either inherent contrast or comparison between the two. The high resolution images depict and enable most organs for segmentation, and sequential scan sets enable a time-evolution curve of all organs.

The value of CT-scans

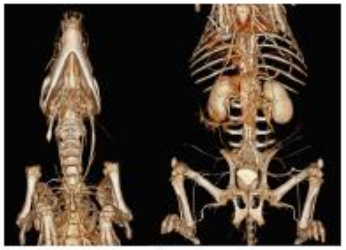
CT-scans are great for imaging the bone structure, good for soft tissue differentiation (particularly with intravenous contrast), and generally provides higher imaging resolution with less motion artifact. The x-ray based CT-scans outline high dense materials very clearly, when segmenting bone structures based on the CT-scans. The cardiovascular system becomes visible through contrast agent administration, and can be segmented with great results.



Picture 3
MRI-scans showing sagittal T1 weighted (top) and sagittal T2 weighted (bottom).



Picture 4
Full body CT scan of göttingen minipigs and CT scan of göttingen minipigs showing segmented bone structure.



Picture 5
CT scan showing frontal and distal segmentation of bone structure and cardiovascular system.

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Olsen AK et al.: Effect of pre-analytical handling on haematological variables in minipigs. Laboratory Animals 2001, 35, 147-152.

Olsen AK: Short-term effects of storage time and temperature on pH, pCO2, and pO2 in porcine arterial blood. Scandinavia Journal of Laboratory Animal Science 2003, 4, 30, 197-201.

Olsen AK et al.: Effect of hypercapnia on cerebral blood flow and blood volume in pigs studied by positron emission tomography. Comparative Medicine 2006, 56, 5, 416-420.

Alstrup AKO et al.: Type of anesthesia influences positron emission tomography measurements of dopamine D2/3 receptor binding in the rat brain. Scandinavia Journal of Laboratory Animal Science 2011, 38, 3, 195-200.

Alstrup AKO et al.: Effects of anesthesia and species on the uptake or binding of radioligands in vivo in the Göttingen minipig. BioMed Research International 2013, 808713.

Alstrup AKO: Blood lactate concentrations in Göttingen minipigs compared with domestic pigs. Journal of the American Association for Laboratory Animal Science 2016, 55, 1, 18-20.

Alstrup AKO: End-tidal carbon dioxide (ETCO2) can replace methods for measuring partial pressure of carbon dioxide (PCO2) in pigs. Laboratory Animal Science Professional 2017, 12, 33-34.

Alstrup AKO et al: PET radioligand injection for pig neuroimaging. Scandinavia Journal of Laboratory Animal Science 2018, 44, 2, 1-5.

Alstrup AKO et al.: Monitoring variables affecting positron emission tomography measurements of cerebral blood flow in anaesthetized pigs. Acta Veterinaria Scandinavica 2018, 60, 17, 1-7.

Alstrup AKO et al.: Effects of long-term anaesthesia, blood sampling, transportation, and infection status on hearts and brains in Staphylococcus aureus inoculated pigs used for imaging studies. 2019. Submittet til et forsøgsdyrstidsskrift.