NIHR | Great Ormond Street Hospital Biomedical Research Centre

What can PM imaging offer –

For the modern autopsy

Prof Owen Arthurs
Consultant Paediatric Radiologist
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UCL
INSTITUTE OF CHILD HEALTH

GOSH

GOSH workload

- PM work at GOSH

- 600 autopsies per year (7500 autopsies in UK)

- 1/4 fetal and perinatal deaths
- 1/4 terminations pregnancy
- 1/4 stillbirths
- 1/4 neonatal deaths / children

- 75% undergo C/S PM imaging

Perinatal post mortem imaging

- 1 What is the need ?
  - Decline in parental consent / agreement
  - What do parents consider acceptable?

- 2 What diseases am I looking for ?
  - Depends on age, country

- 3 What imaging modality should I use?
  - X-ray, CT, MRI or Ultrasound ?

- 4 What about minimally invasive autopsy?
  - Laparoscopy / INTACT

Perinatal Autopsy – the problem

I feel that my baby
has suffered enough

Loss of a baby is an
extremely traumatic
live-changing event

I don't want
her body cut

I don't know if
it will help me

Intrauterine Death
Miscarriage
Stillbirth
Termination of Pregnancy

Medical autopsy
can provide useful
information in 30 – 50%

BUT …

Invasive autopsy
is unacceptable
to parents

Lewis et al., Syst Review, BJOG, 2016

Historical background

- Gradual decline in parental acceptability of autopsy
  - Fear of body being disfigured
  - Dislike of head being opened
  - Fear that body will have incisions
  - Fear that organs will be removed / retained
  - Moral / religious reasons <10% overall cases

Cross sectional survey of parents' experience and views of the postmortem examination

Judith Rankin, Chris Wright, Tom Lind

Table 4 Reasons for respondents not consenting to a postmortem examination.* 27 out of 28 respondents gave reasons

Reason	No of responses (%)
I felt my baby had already "suffered enough"	22 (44)
I did not feel it would help me	13 (26)
I was concerned about the effects of the examination on my baby's appearance	5 (10)
I didn't want my baby cut	3 (6)
I was concerned it might delay funeral arrangements	2 (4)
For religious reasons	0
Other	5 (10)
Total	50

* More than one reason could be given.

TABLE 4 Factors associated with decision-making

	Not at all important (%)	Not very important (%)	Neither important nor unimportant (%)	Quite important (%)	Extremely important (%)
To understand why it happened	1.7	1.6	4.2	6.8	85.7
To understand if it might happen again	2.4	1.2	3.8	6.7	85.3
To prevent this from happening to others	1.8	3.1	10.5	21.4	63.1
To reassure me that it was not my fault	10.2	6.6	17.6	14.8	50.7
Feeling that my baby/child had 'suffered enough'	8.5	6.6	22.0	13.4	49.3
Not wanting my baby/child to be cut	7.3	9.6	19.8	14.1	49.1
To improve medical knowledge	6.4	6.6	16.9	21.2	48.7
Concern about the baby/child's appearance afterwards	8.6	9.0	19.4	20.0	42.9
Concern about what would happen to the tissue/organs afterwards	8.4	12.0	19.3	17.6	42.6
To help with the grieving process	13.1	7.5	20.1	18.3	40.9
The description of autopsy given by the health professional	17.7	10.2	21.8	16.1	34.1
Concern that my baby/child might be moved to another hospital	19.8	12.1	20.2	13.9	33.9
Concern about the length of time it may take to get the results	24.2	12.0	20.6	19.7	23.3
Feeling that I already knew what caused the loss of my baby/child	28.4	12.5	29.2	10.3	19.5
Feeling that it would add to my grief	30.7	13.6	25.3	16.7	13.5
The complexity and length of the consent form	43.3	12.9	20.8	9.9	12.9
Concern that it would delay funeral arrangements	46.3	13.3	18.6	10.3	11.4
My religion's views about autopsy	84.7	4.8	5.3	1.9	3.2

Note
Percentages may not total 100% due to rounding.

Lewis C et al., HTA 2019

Historical background

Pediatr Radiol (2010) 40:141–152
DOI 10.1007/s00247-009-1486-0

REVIEW

Current techniques in postmortem imaging with specific attention to paediatric applications

Tessa Sieswerda-Hoogendoorn · Rick R. van Rijn

	Initial autopsy rate (period)	Subsequent autopsy rate (period)
Australia	21.0% (1992–93)	12.0% (2002–03)
France	15.4% (1988)	3.7% (1997)
Hungary	100% (1938–51)	68.9% (1990–02)
Ireland	30.4% (1990)	18.4% (1999)
Jamaica	65.3% (1968)	39.3% (1997)
Sweden	81.0% (1984)	34.0% (1993)
UK	42.7% (1979)	15.3% (2001)
USA	26.67% (1967)	12.4% (1993)

Historical background

Table 18: Number of post-mortems offered and consented to by type of death (stillbirth, neonatal death, extended perinatal death): United Kingdom and Crown Dependencies, for births in 2014

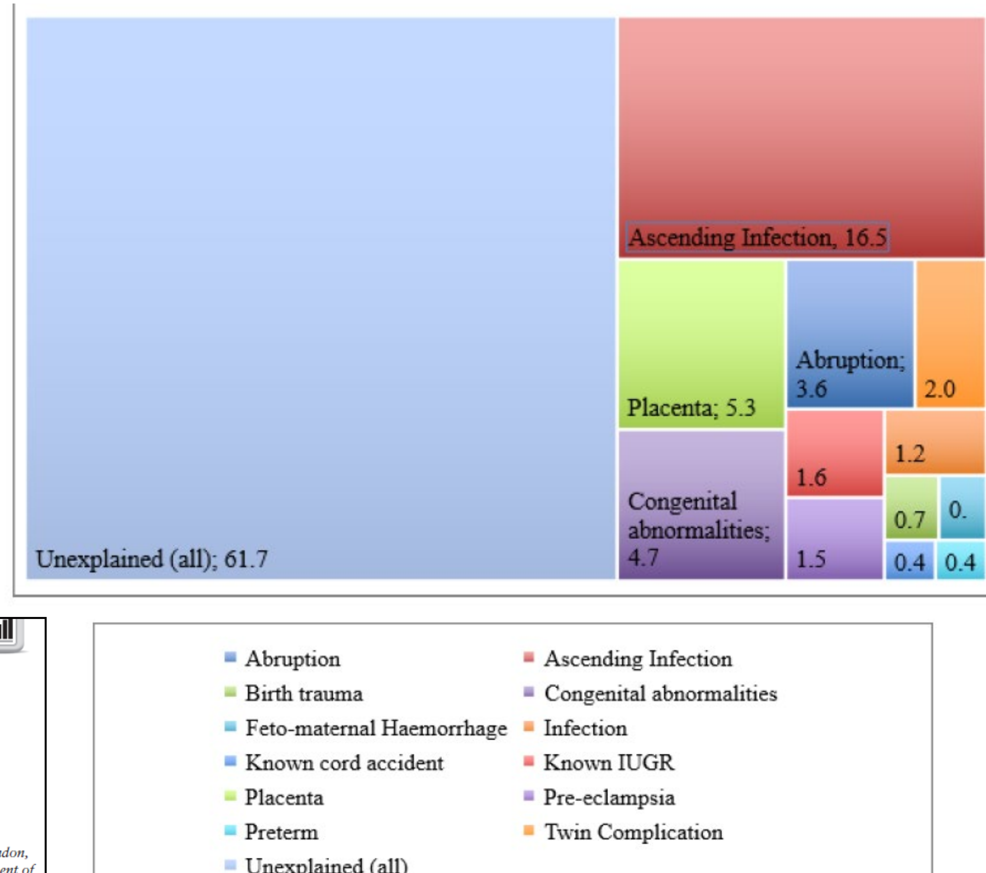
Post-mortem status	Stillbirths§		Neonatal deaths§		Extended perinatal deaths§	
	Number	(%)	Number	(%)	Number	(%)
Not offered	50	(1.6)	137	(10.0)	187	(4.1)
Not known if offered	67	(2.1)	155	(11.3)	222	(4.8)
Offered but no consent	1503	(46.6)	628	(45.7)	2131	(46.3)
Offered but unknown consent	83	(2.6)	54	(3.9)	137	(3.0)
Offered and limited consent	120	(3.7)	28	(2.0)	148	(3.2)
Offered and full consent	1402	(43.5)	372	(27.1)	1774	(38.6)

§ excluding terminations of pregnancy and births <24^{+0} weeks gestational age

Data sources: MBRRACE-UK

2016 MBRRACE-UK Perinatal Mortality Surveillance Report: UK Perinatal Deaths for Births from January to December 2014

Stillbirths



Ultrasound Obstet Gynecol 2016
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.16016

Stillbirth and intrauterine fetal death: factors affecting determination of cause of death at autopsy

J. MAN*†, J. C. HUTCHINSON*†, A. E. HEAZELL‡, M. ASHWORTH*, S. LEVINE§ and N. J. SEBIRE*†

**Department of Histopathology, Camelia Botnar Laboratories, Great Ormond Street Hospital, London, UK; †University College London, Institute of Child Health, London, UK; ‡Department of Obstetrics and Gynaecology, St Mary's Hospital, Manchester, UK; §Department of Histopathology, St George's Hospital, London, UK*

Stillbirths

Table 2 Categorization of results of macroscopic and histological examination of the lungs in cases of intrauterine death

	Macroscopic findings				*Histological findings*				*Histological findings when macroscopic findings normal*		
Category of finding	*Early IUFD*	*Late IUFD*	*Stillbirth*	*All*	*Early IUFD*	*Late IUFD*	*Stillbirth*	*All*	*Early IUFD*	*Late IUFD*	*Stillbirth*
Normal	235 (96)	159 (89)	448 (70)	842 (79)	198 (80)	100 (56)	198 (31)	496 (47)	196 (83)	96 (60)	172 (38)
Abn, not CoD	1 (< 1)	6 (3)	136 (21)	143 (13)	25 (10)	24 (13)	323 (51)	372 (35)	25 (11)	23 (14)	216 (48)
Abn, potential CoD	4 (2)	3 (2)	25 (4)	32 (3)	14 (6)	32 (18)	72 (11)	118 (11)	13 (6)	28 (18)	50 (11)
Abn, CoD	0 (0)	1 (< 1)	2 (< 1)	3 (< 1)	2 (< 1)	8 (4)	11 (2)	21 (2)	1 (< 1)	7 (4)	5 (1)
Not examined	5 (2)	10 (6)	28 (4)	43 (4)	5 (2)	11 (6)	32 (5)	48 (5)	0 (0)	2 (1)	2 (< 1)
Too autolyzed	1 (< 1)	0 (0)	0 (0)	1 (< 1)	2 (< 1)	4 (2)	3 (< 1)	9 (< 1)	0 (0)	3 (2)	3 (< 1)
Total	246	179	639	1064	246	179	639	1064	235	159	448

Data are given as *n* (%) or *n*. Early intrauterine fetal death (IUFD) was defined as intrauterine death < 20 weeks, late IUFD was death at 20–23 weeks and stillbirth was death ≥ 24 weeks. Abn, not CoD, abnormal but not cause of death; Abn, potential CoD, abnormal and potentially contributing to death; Abn, CoD, abnormal and definitive cause of death.

There was no case in which histological examination of macroscopically normal adrenals, spleen, thymus, intestines, pancreas or thyroid provided the cause of death.

Ultrasound Obstet Gynecol 2016
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.16020

Stillbirth and intrauterine fetal death: role of routine histological organ sampling to determine cause of death

J. MAN*†, J. C. HUTCHINSON*†, M. ASHWORTH*, L. JUDGE-KRONIS*, S. LEVINE‡ and N. J. SEBIRE*†

**Department of Histopathology, Camelia Botnar Laboratories, Great Ormond Street Hospital, London, UK; †University College London, Institute of Child Health, London, UK; ‡Department of Histopathology, St George's Hospital, London, UK*

Anatomy and Autopsy

Less invasive approaches

- FULL autopsy +/- imaging
  - Plain radiographs, CT in forensic cases

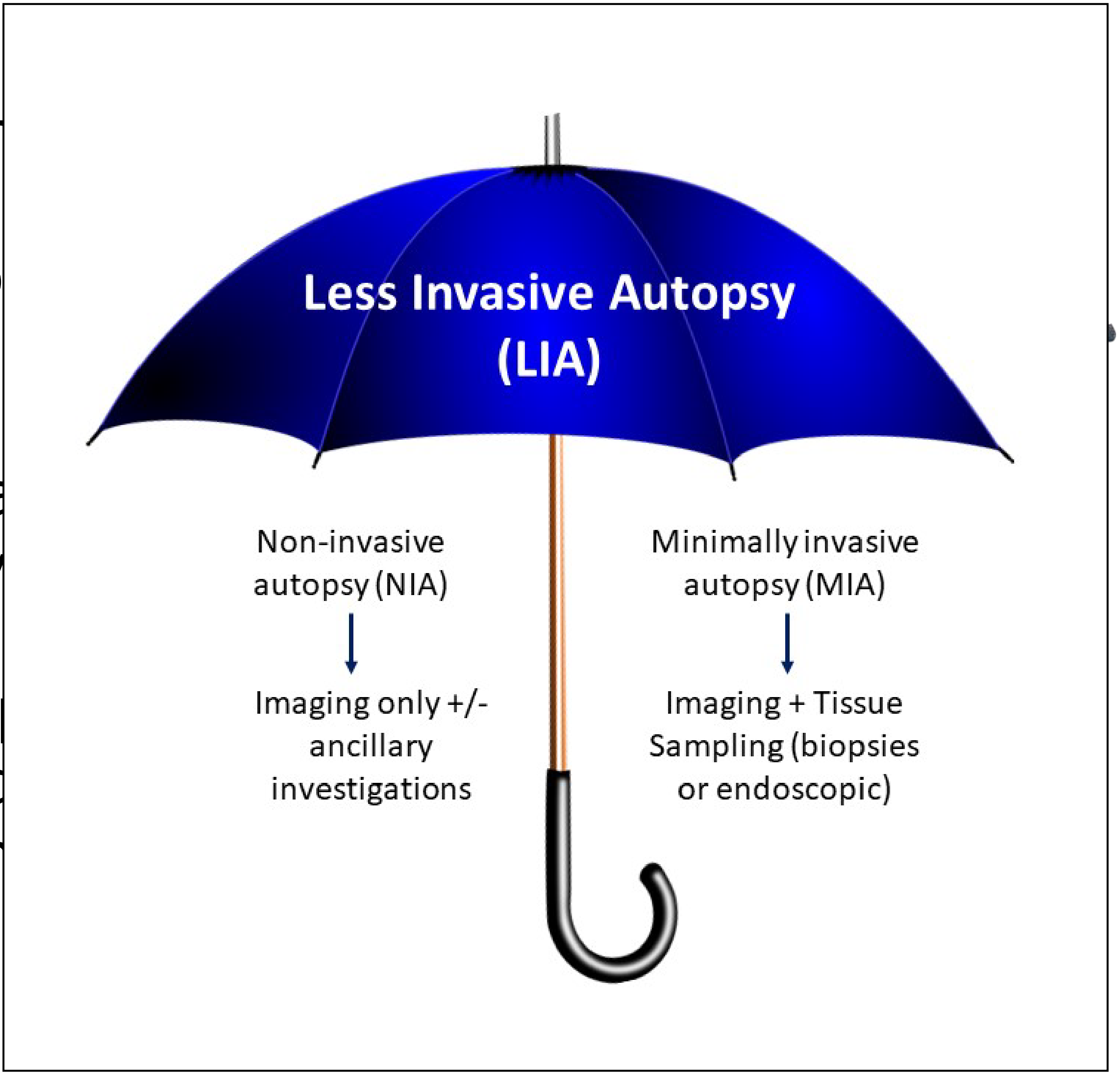
- Less invasive autopsy (LIA)

- Minimally-invasive autopsy (MIA)
  - pre autopsy imaging
  - Targeted biopsy or endoscopic approach

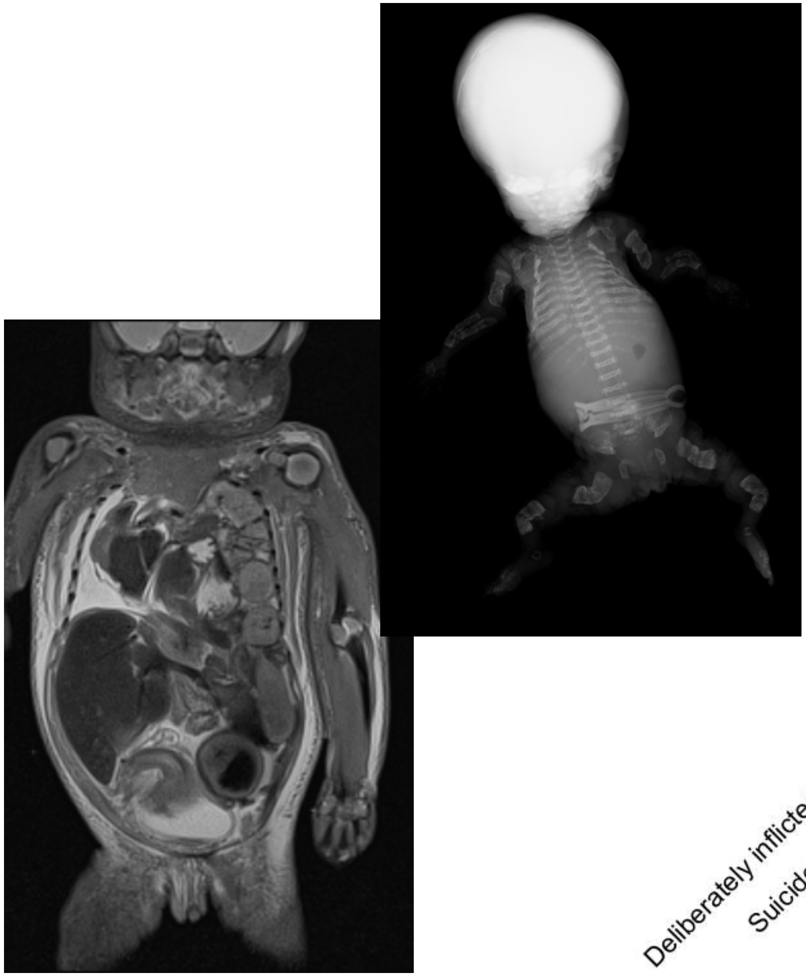
- Non-invasive autopsy (NIA)
  - Imaging instead of standard autopsy
  - External examination, Plain radiographs
  - Cross-sectional imaging to determine next steps

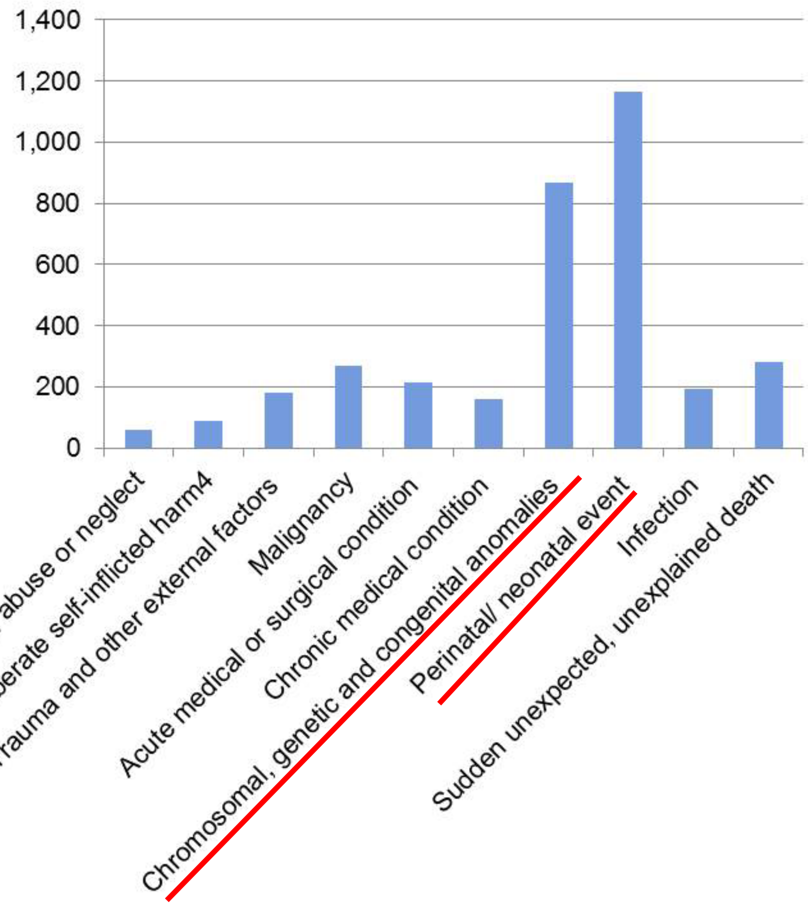
Less invasive approaches

- FULL autopsy +/-
  - Plain radiograph
- Less invasive auto
- Minimally-invasive
  - pre autopsy ima
  - Targeted biopsy
- Non-invasive auto
  - Imaging instead
  - External examin
  - Cross-sectional



Common causes death?

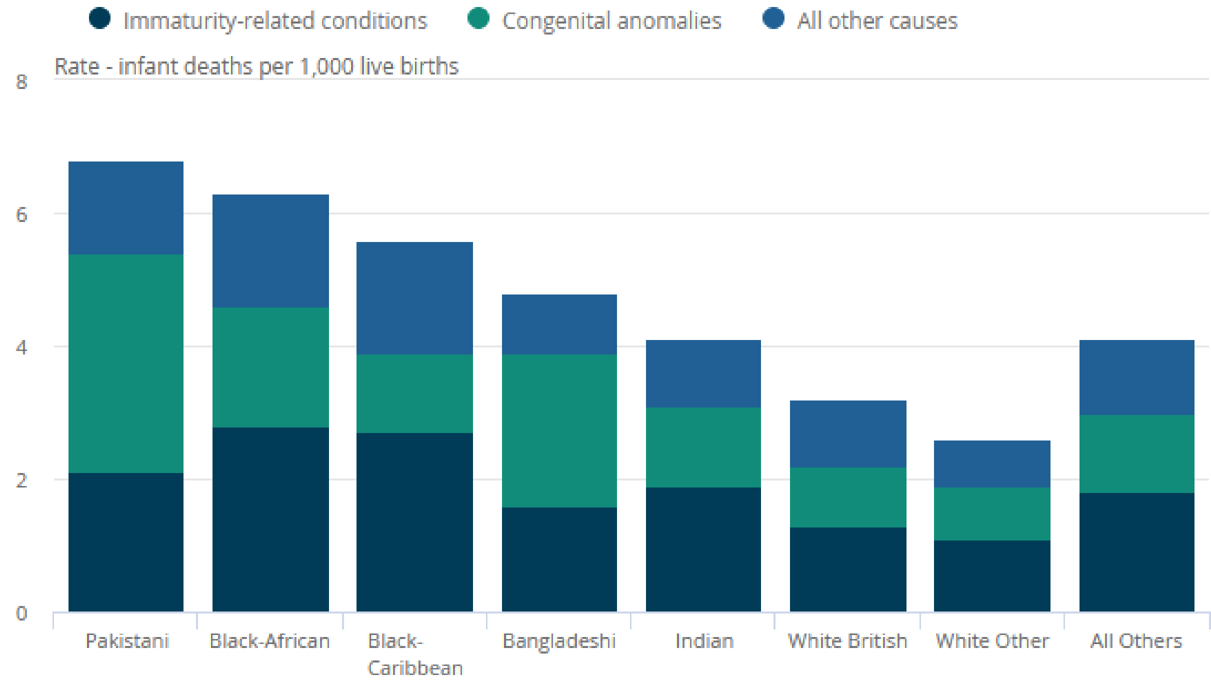




Death rates by Ethnicity

Figure 9: Congenital anomalies most common cause of infant deaths for Pakistani and Bangladeshi ethnic groups

Infant mortality rates by ethnicity and cause for babies born between 2015 and 2017 (three-year average), England and Wales



ONS Child & Infant Mortality 2018

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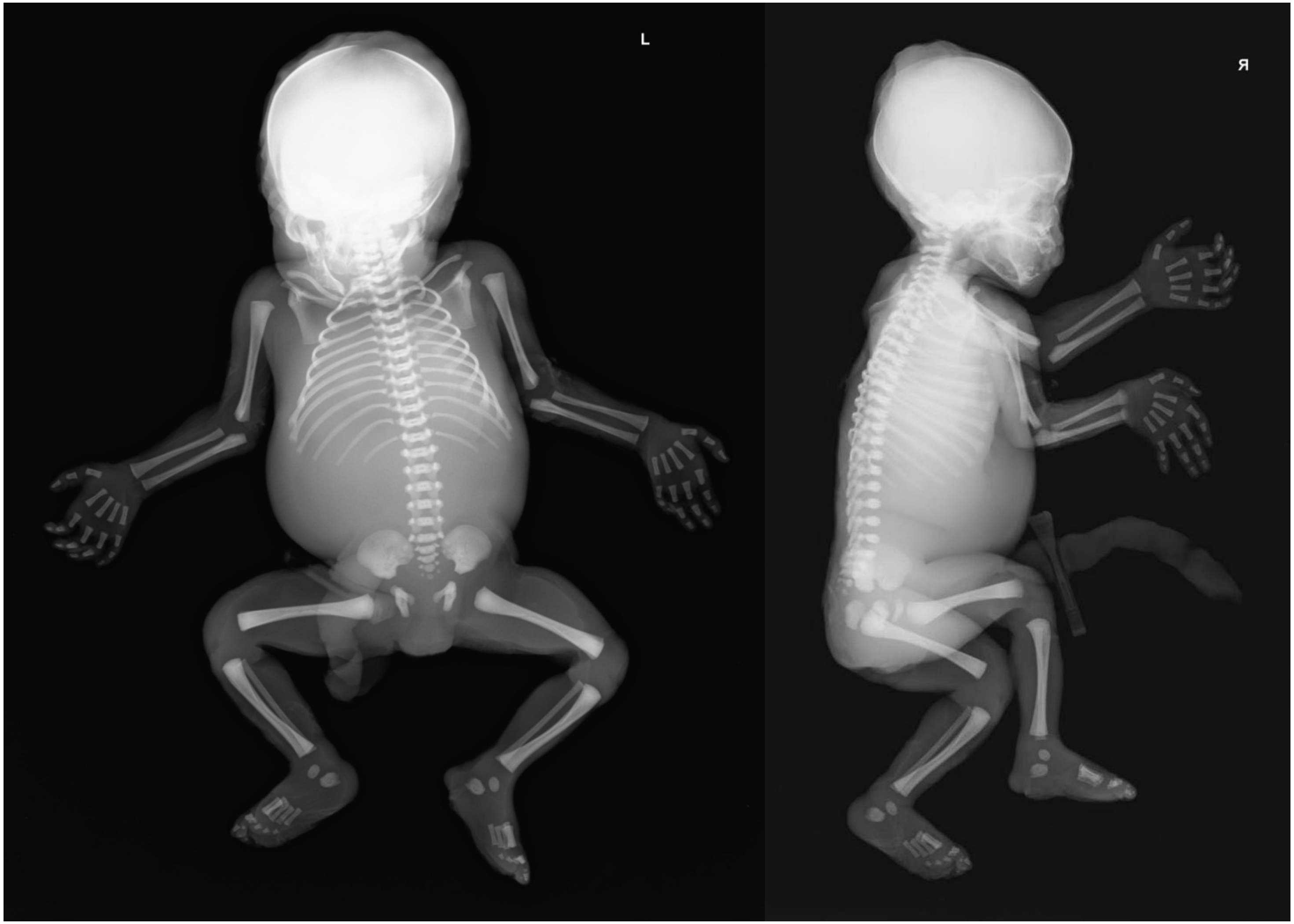
Babygrams

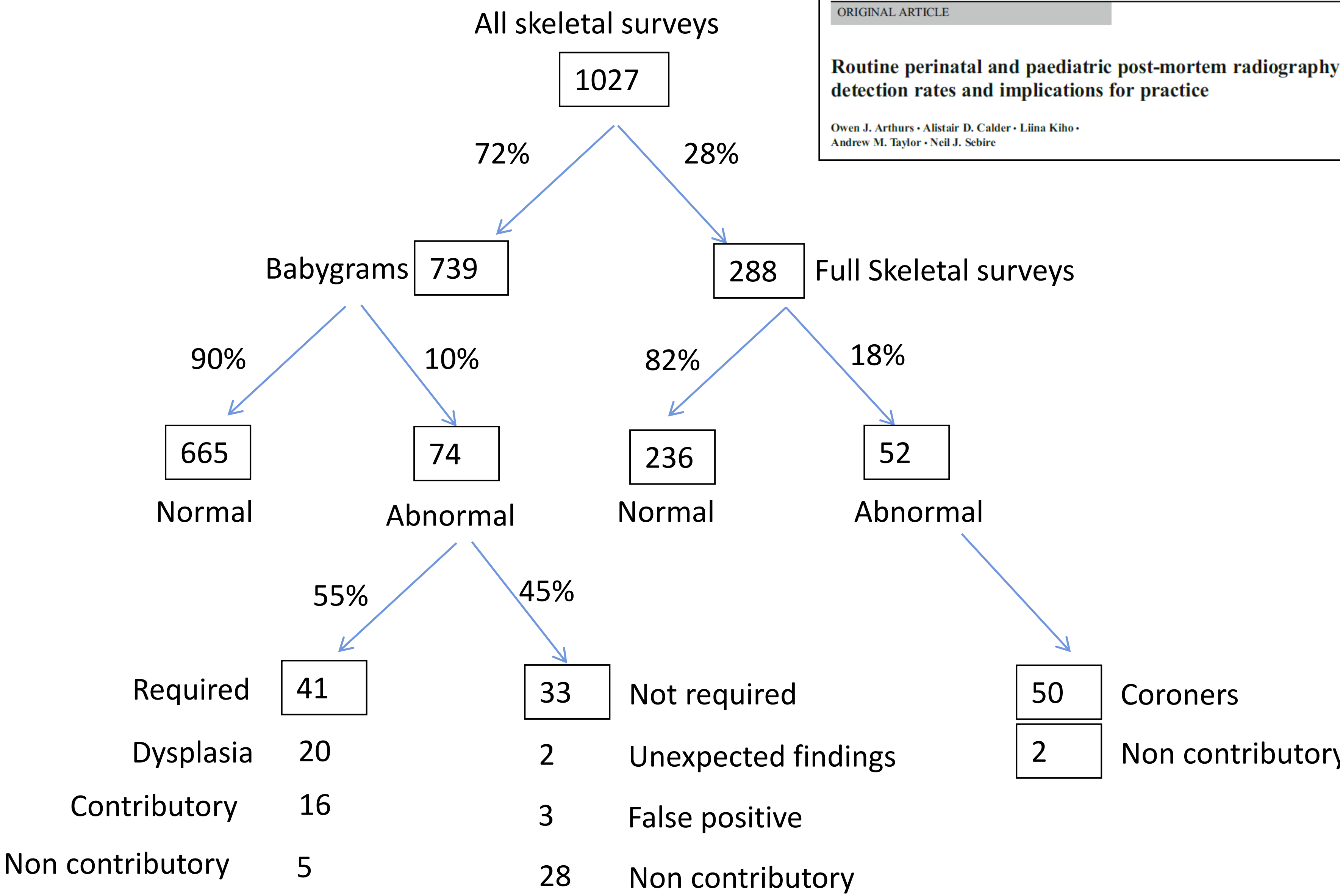


Pediatr Radiol (2014) 44:252–257
DOI 10.1007/s00247-013-2804-0

ORIGINAL ARTICLE

Routine perinatal and paediatric post-mortem radiography: detection rates and implications for practice

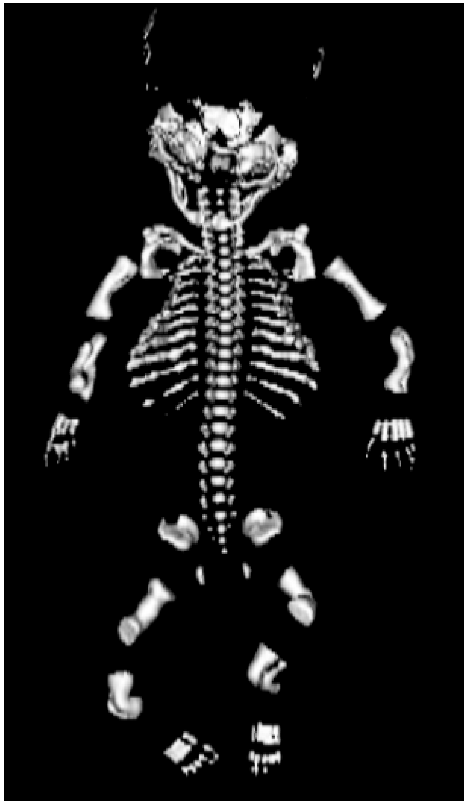
Owen J. Arthurs • Alistair D. Calder • Liina Kiho • Andrew M. Taylor • Neil J. Sebire



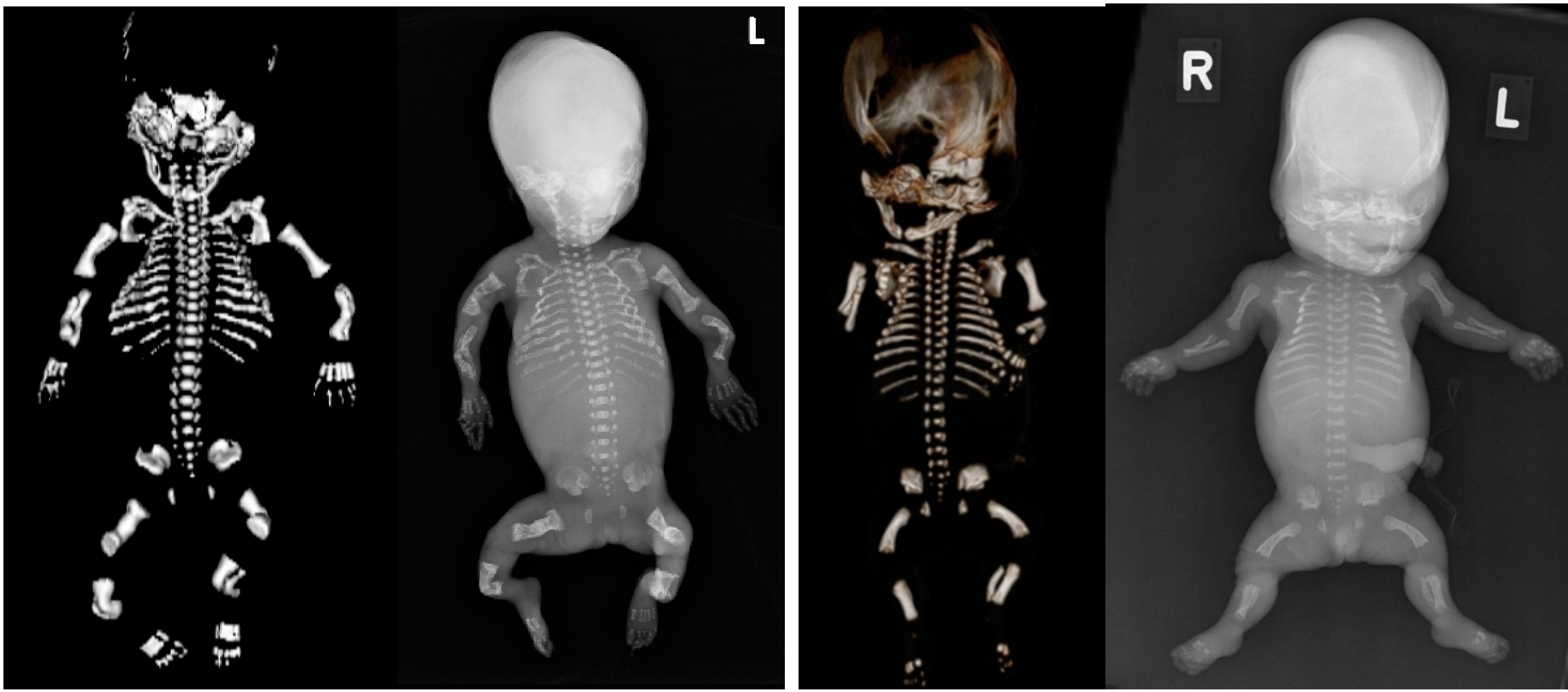
PM CT

- Used to show bone detail
- Usually needs IV contrast to define soft tissues
- PM CT now becoming popular in adults
- Children have different causes of death
    - Sepsis, trauma, sudden unexplained death

Techniques: XR vs CT



Techniques: XR vs CT

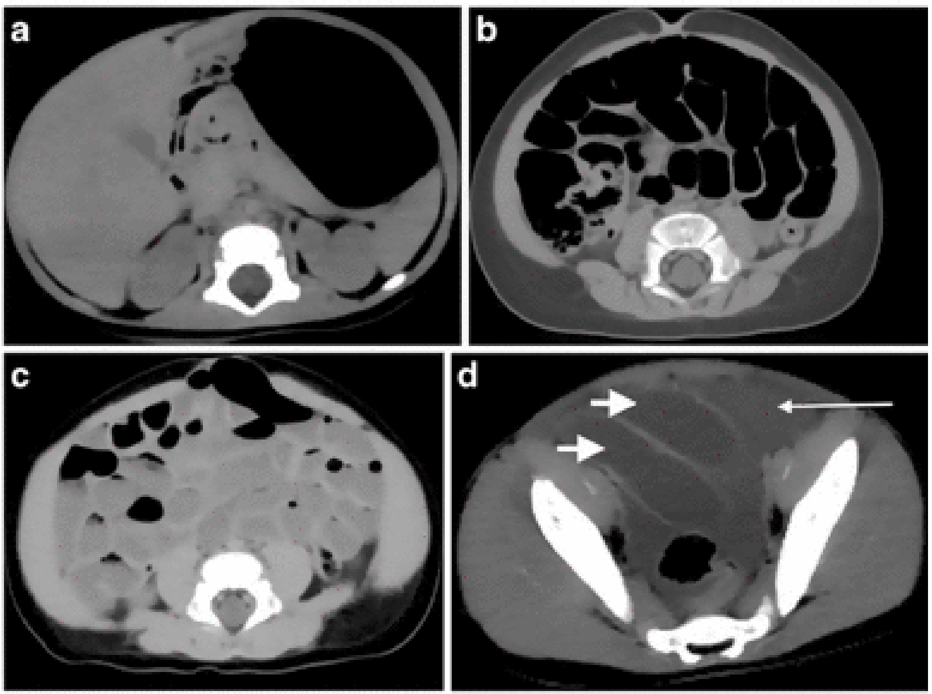


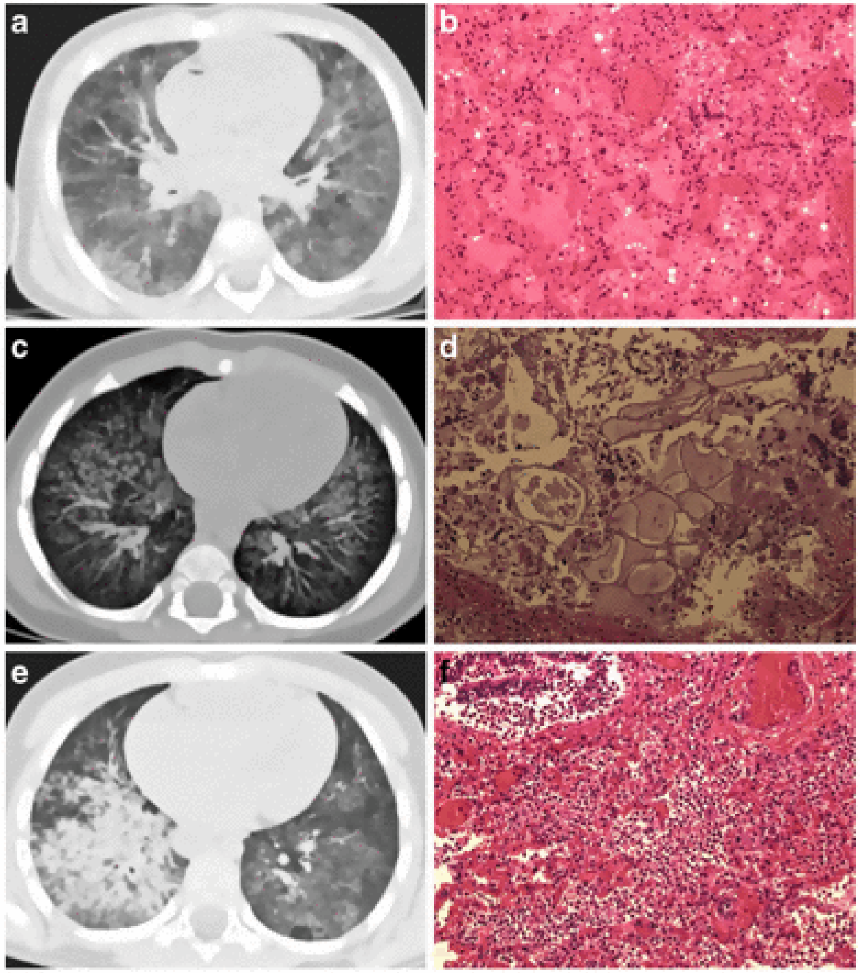
Un-enhanced PMCT

European Radiology
June 2013, Volume 23, Issue 6, pp 1711-1719

Whole-body post-mortem computed tomography compared with autopsy in the investigation of unexpected death in infants and children

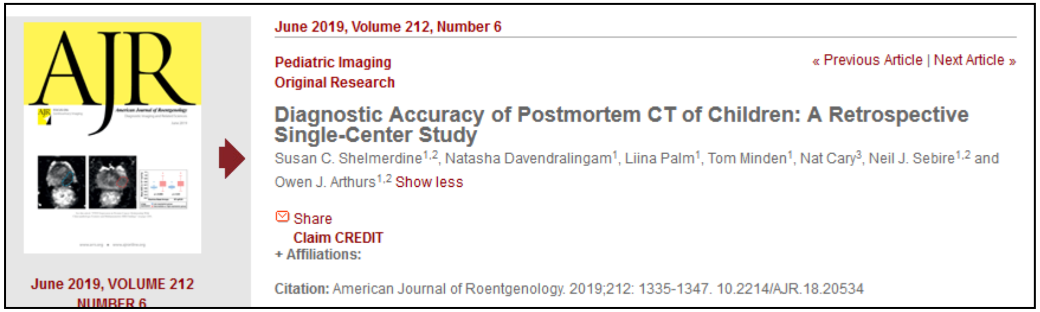
Maïa Proisy, Antoine Jérôme Marchand, Philippe Loget, Renaud Bouvet, Michel Roussey, Fabienne Pelé, Céline Rozel, Catherine Treguier, Pierre Darnault, Bertrand Bruneau





PMCT – systematic evaln

- 136 PMCT children aged 1 – 16, mean age 2.1 years, 2016 - 2017
- PMCT gave <u>agreement</u> in 103 / 136 (75.7%)
- … <u>cause of death</u> only found in 77, i.e. 56%
- But PMCT gave a correct cause of death in only 55 / 136 (40%)



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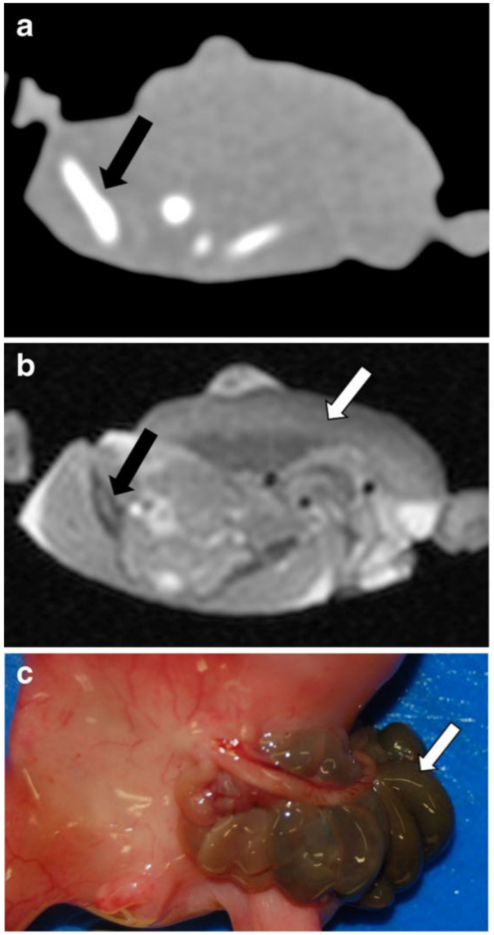
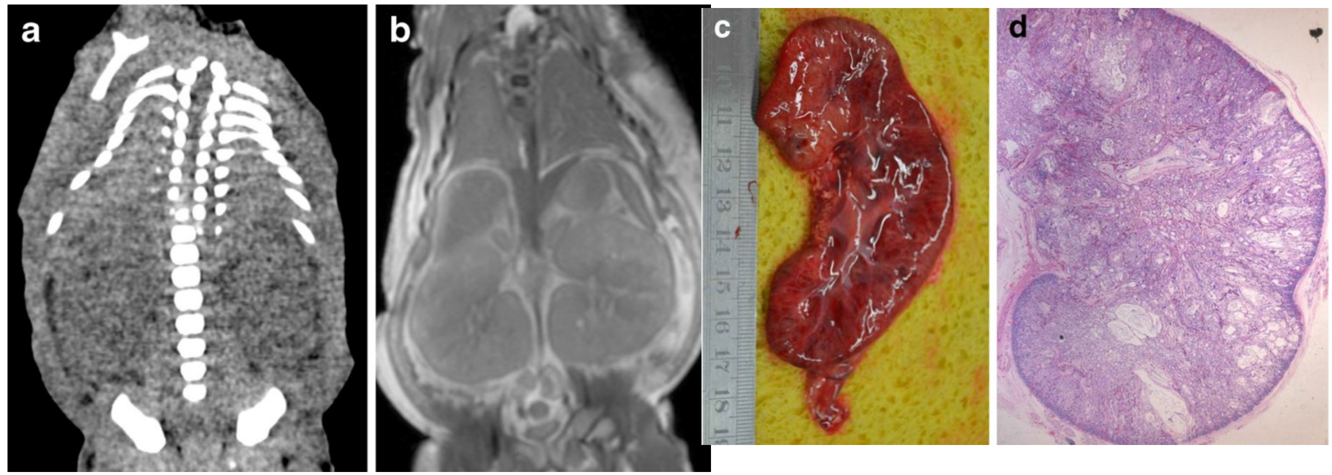
Perinatal PMCT





Eur Radiol
DOI 10.1007/s00330-015-4057-9

PAEDIATRIC

Comparison of diagnostic performance for perinatal and paediatric post-mortem imaging: CT versus MRI

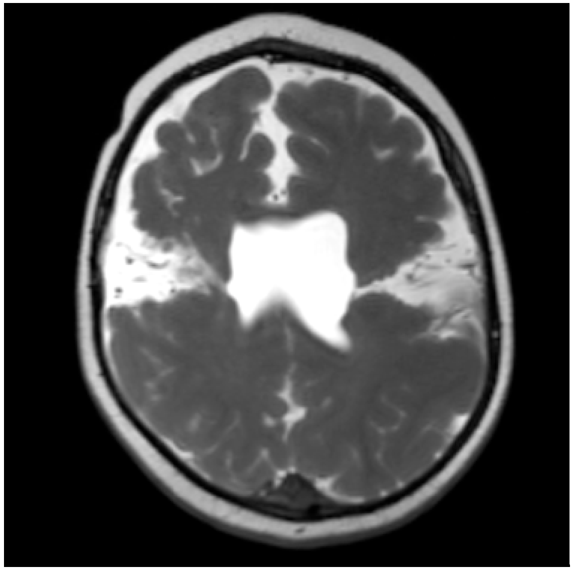
Owen J. Arthurs[1,2] · Anna Guy[1] · Sudhin Thayyil[3] · Angie Wade[4] · Rod Jones[5,6] · Wendy Norman[5,6] · Rosemary Scott[7] · Nicola J. Robertson[8] · Thomas S. Jacques[1,2] · W. K. 'Kling' Chong[1] · Roxanna Gunny[1] · Dawn Saunders[1] · Oystein E. Olsen[1] · Catherine M. Owens[1,5,6] · Amaka C. Offiah[9,10] · Lyn S. Chitty[1,7,11] · Andrew M. Taylor[5,6] · Neil J. Sebire[1,2] · for the Magnetic Resonance Imaging Autopsy Study (MaRIAS) Collaborative Group

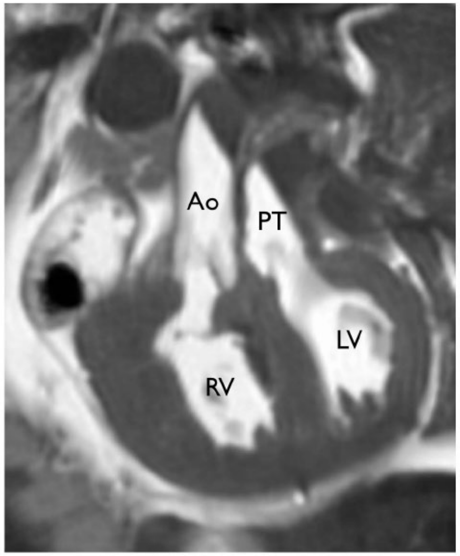
PM CT vs PM MR

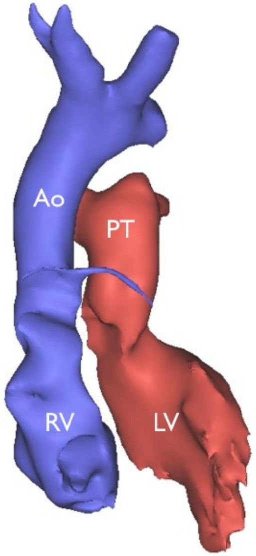
- PMMR very good at neuro, cardiac, MSK
- PMCT for fractures, …

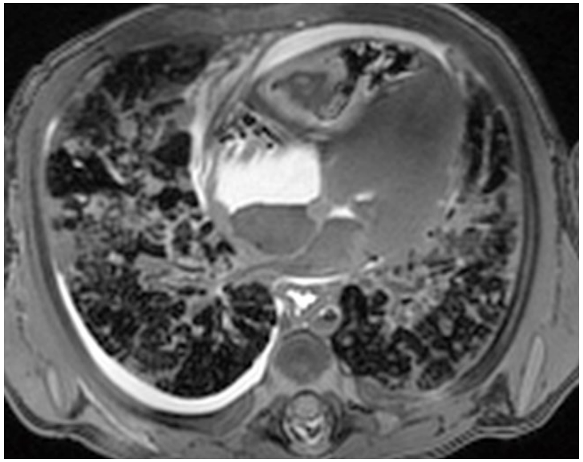
	PMCT Children	N=136				PMMR Fetuses	N=201			
	TP / FP	FN / TN	Sens (%)	Spec (%)	Agree (%)	TP / FP	FN / TN	Sens (%)	Spec (%)	Agree (%)
Neuro	31 /3	10 / 88	75.6 [60.7, 86.2]	96.7 [90.8, 98.9]	90.2 [83.9, 94.2]	63 / 9	4 / 90	**94.0% [85.6 , 97.7]**	**90.9% [83.6 , 95.1]**	**92.2% [87.1 , 95.4]**
Cardiac	5 / 5	11 / 115	31.3 [14.2, 55.6]	95.8 [90.6, 98.2]	88.2 [81.7, 92.6]	12 / 5	8 / 155	**60.0% [38.7 , 78.1]**	**96.9% [92.9, 98.7]**	**92.8% [88.0 , 95.7]**
Thoracic	33 / 15	18 / 70	64.7 [51.0, 76.4]	82.4 [72.9, 89.0]	75.7 [67.9, 82.2]	18 / 8	4 / 161	**81.8% [61.5 , 92.7]**	**95.3% [90.9, 97.6]**	**93.7% [89.3 , 96.4]**
Abdominal	6 / 14	7 / 108	46.2 [23.2, 70.0]	88.5 [81.7, 93.0]	84.4 [77.4, 89.6]	34 / 16	4 / 134	**89.5% [75.9 , 95.8]**	**89.3% [83.4 , 93.3]**	**89.4% [84.1 , 93.0]**
MSK	61 / 6	1 / 67	**98.4 ** [91.4, 99.7]**	**91.8 ** [83.2, 96.2]**	**94.8 ** [89.7, 97.5]**	33 / 1	16 / 142	67.3% [53.4 , 78.0]	99.3% [96.1 , 99.9]	91.1% [86.3 , 94.4]
Total	138 / 43	45 / 448	75.4 [68.7, 81.1]	91.2 [88.4, 93.4]	86.9 [84.2, 89.3]	160 / 39	36 / 682	81.6% [75.6 , 86.4]	94.6% [92.7, 96.0]	91.8% [89.9 , 93.4]
Overall	55 / 11	22 / 48	71.4 [60.5, 80.3]	81.4 [69.6, 89.3]	75.7 [67.9, 82.2]	123 / 8	11 / 40	**91.8% ** [85.9 , 95.4]**	83.3% [70.4 , 91.4]	**89.6% ** [84.3 , 93.2]**

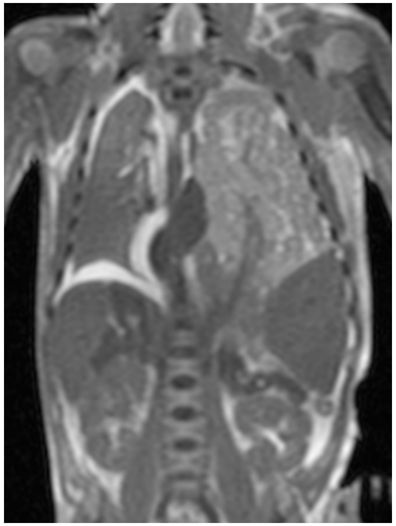
PM MR

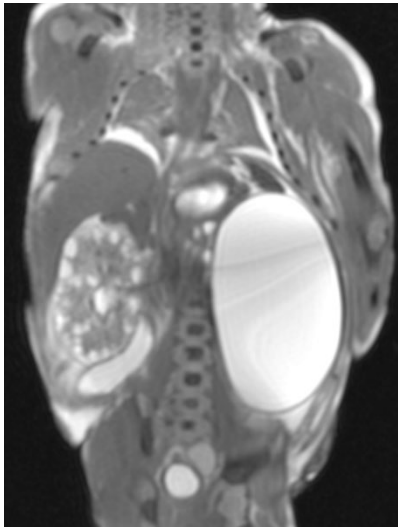


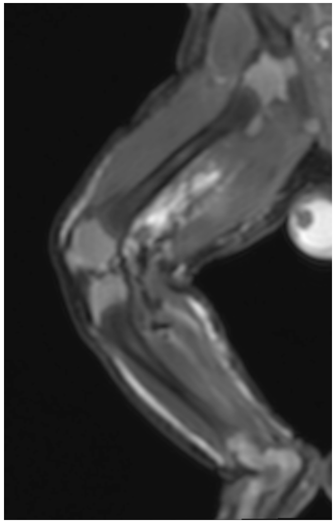




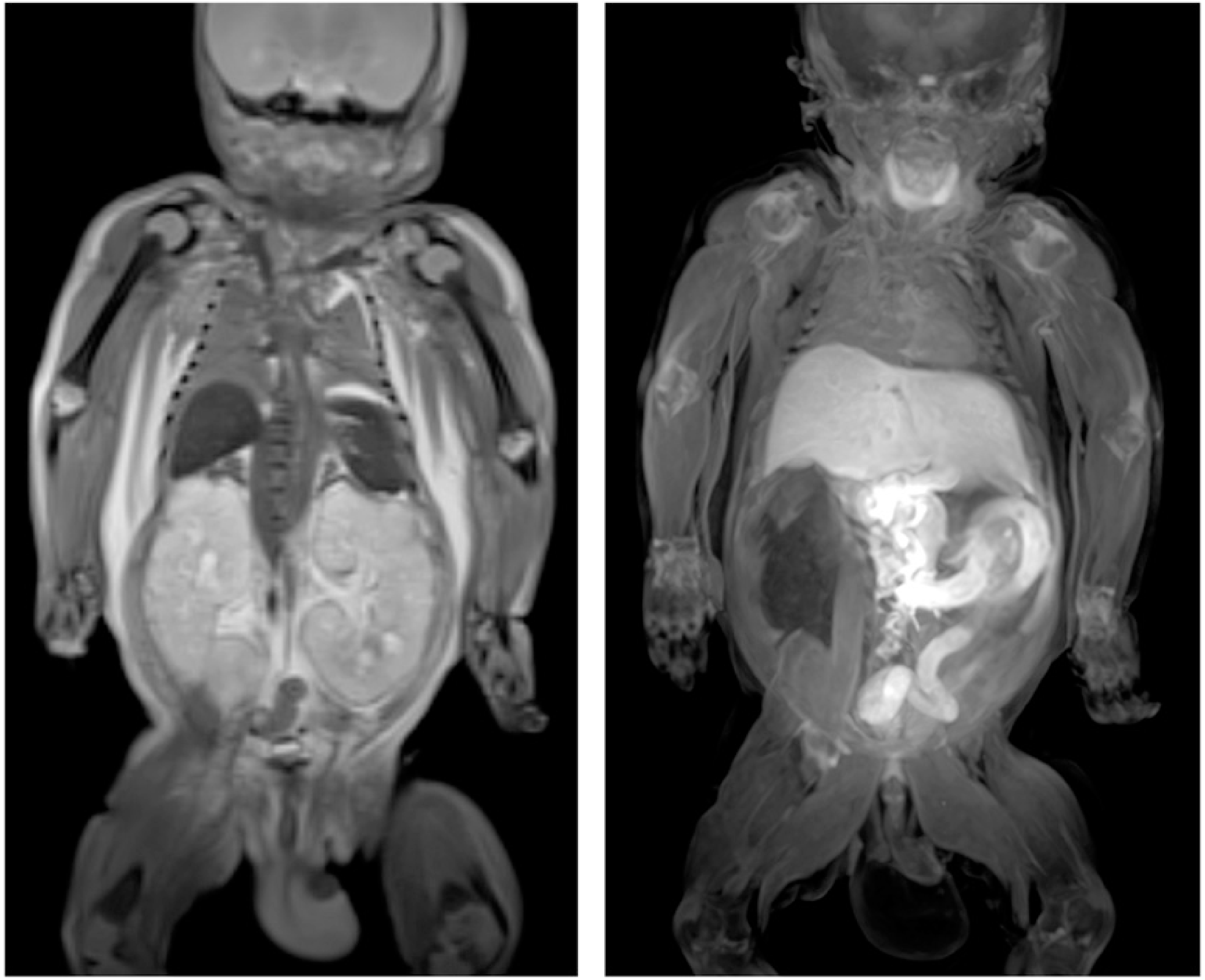






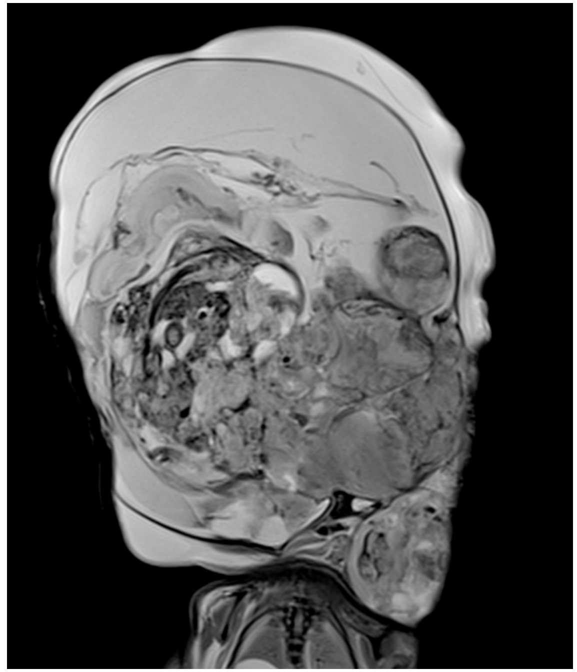


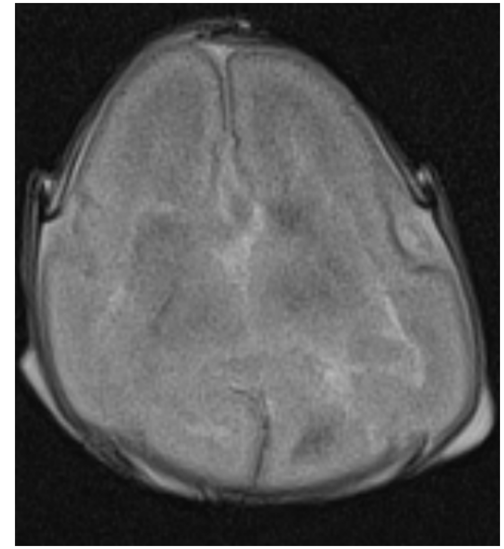
PM MR

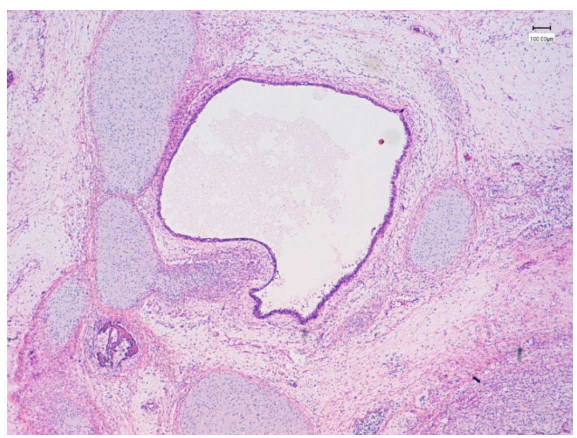


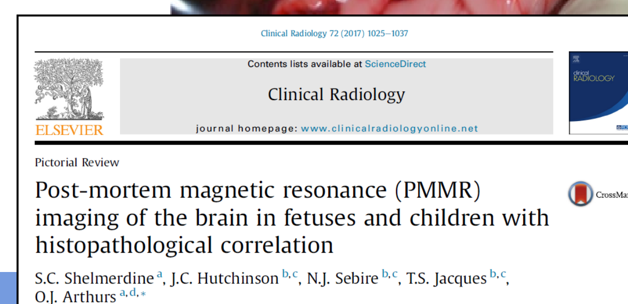
(a) (b)

Neuro PMMR








Clinical Radiology 72 (2017) 1025–1037

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.clinicalradiologyonline.net

ELSEVIER

Pictorial Review

Post-mortem magnetic resonance (PMMR) imaging of the brain in fetuses and children with histopathological correlation

S.C. Shelmerdine [a], J.C. Hutchinson [b,c], N.J. Sebire [b,c], T.S. Jacques [b,c], O.J. Arthurs [a,d,*]

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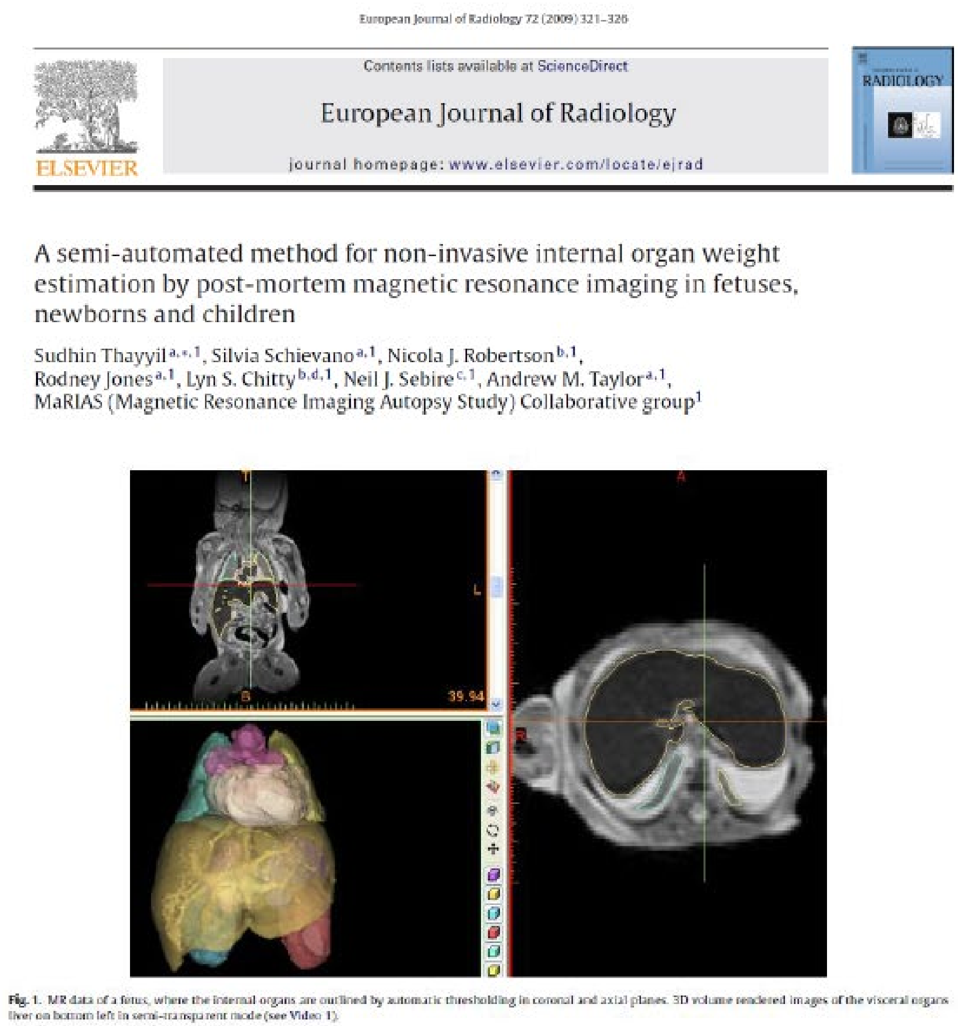
Organ weights


European Journal of Radiology 72 (2009) 321–326

Contents lists available at ScienceDirect

European Journal of Radiology

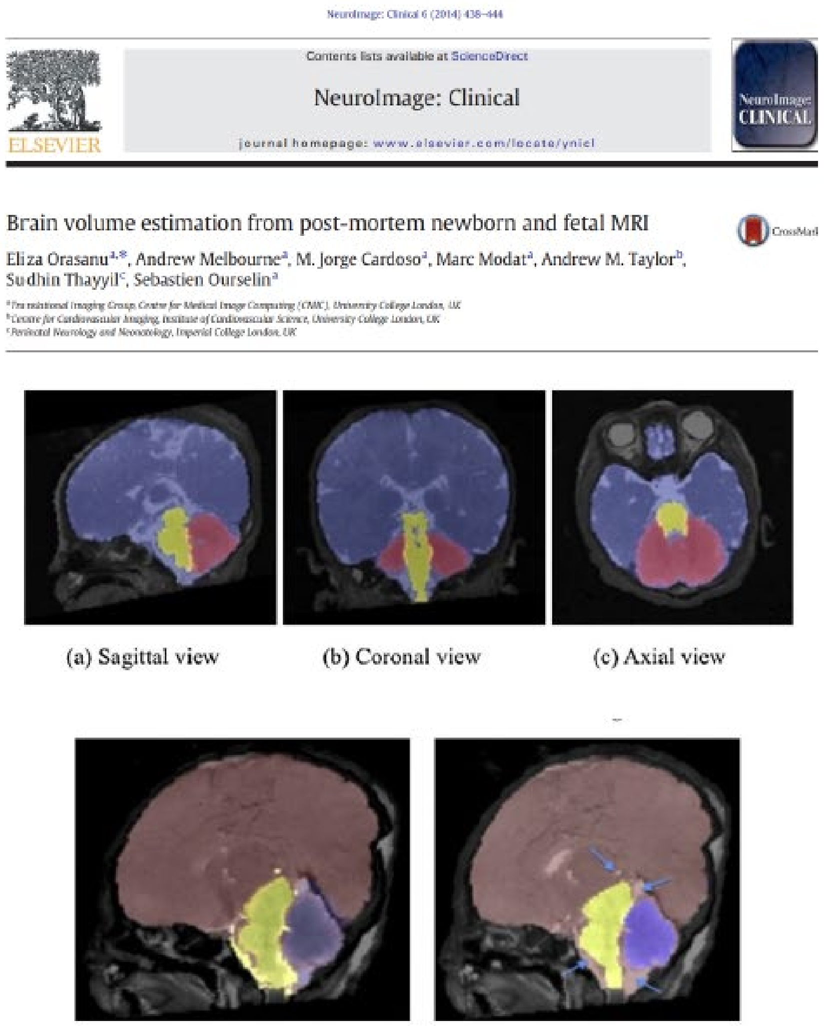
journal homepage: www.elsevier.com/locate/ejrad

ELSEVIER

A semi-automated method for non-invasive internal organ weight estimation by post-mortem magnetic resonance imaging in fetuses, newborns and children

Sudhin Thayyil[a,*,1], Silvia Schievano[a,1], Nicola J. Robertson[b,1], Rodney Jones[a,1], Lyn S. Chitty[b,d,1], Neil J. Sebire[c,1], Andrew M. Taylor[a,1], MaRIAS (Magnetic Resonance Imaging Autopsy Study) Collaborative group[1]

Fig. 1. MR data of a fetus, where the internal organs are outlined by automatic thresholding in coronal and axial planes. 3D volume rendered images of the visceral organs liver on bottom left in semi-transparent mode (see Video 1).


NeuroImage: Clinical 6 (2014) 438–444

Contents lists available at ScienceDirect

NeuroImage: Clinical

journal homepage: www.elsevier.com/locate/ynicl

ELSEVIER

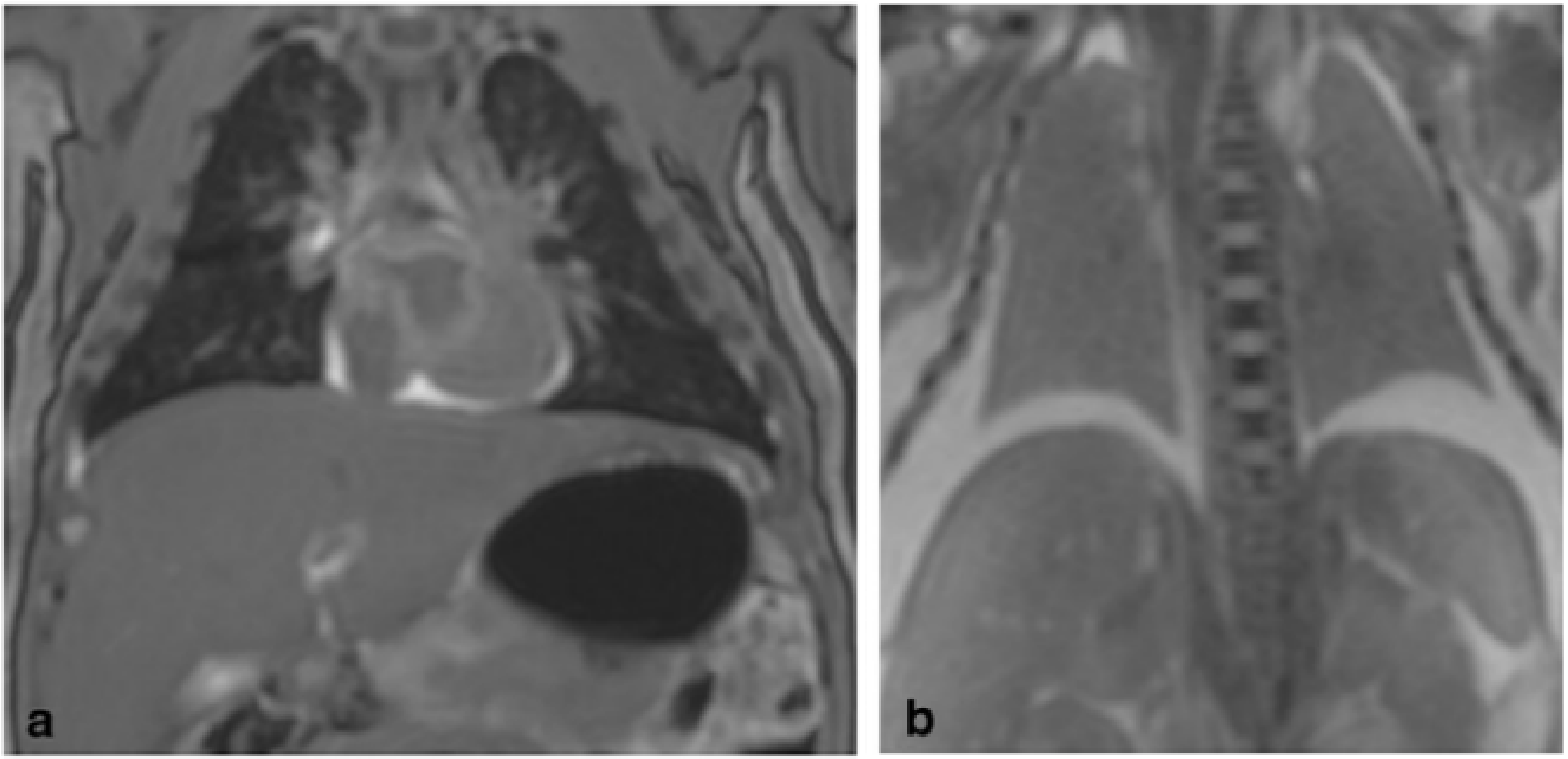
Brain volume estimation from post-mortem newborn and fetal MRI

Eliza Orasanu[a,*], Andrew Melbourne[a], M. Jorge Cardoso[a], Marc Modat[a], Andrew M. Taylor[b], Sudhin Thayyil[c], Sebastien Ourselin[a]

[a] Translational Imaging Group, Centre for Medical Image Computing (CMIC), University College London, UK
[b] Centre for Cardiovascular Imaging, Institute of Cardiovascular Science, University College London, UK
[c] Perinatal Neurology and Neonatology, Imperial College London, UK

(a) Sagittal view (b) Coronal view (c) Axial view

Stillbirth vs live birth



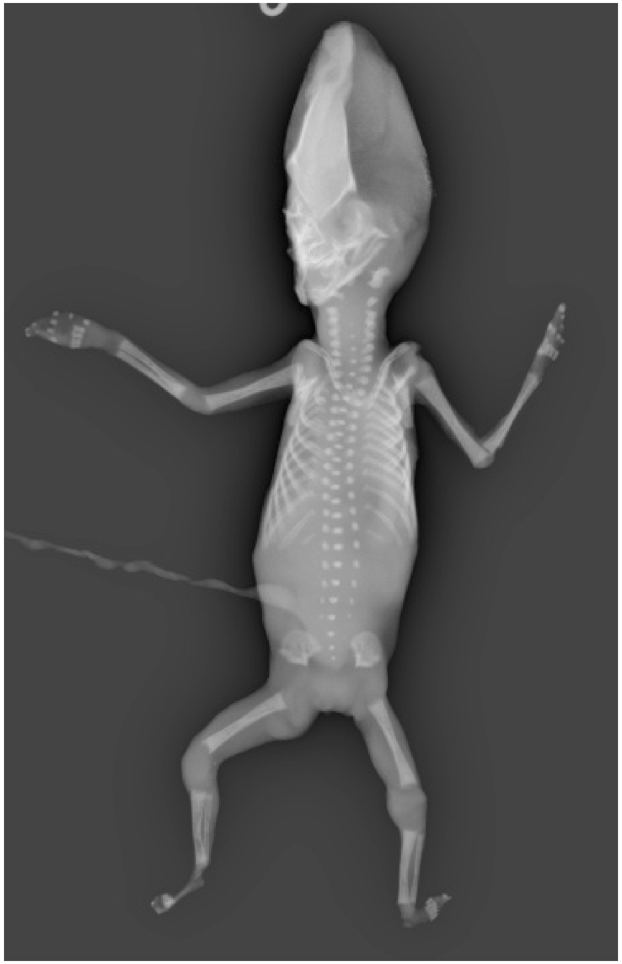
Int J Legal Med (2015) 129:531–536
DOI 10.1007/s00414-014-1125-7

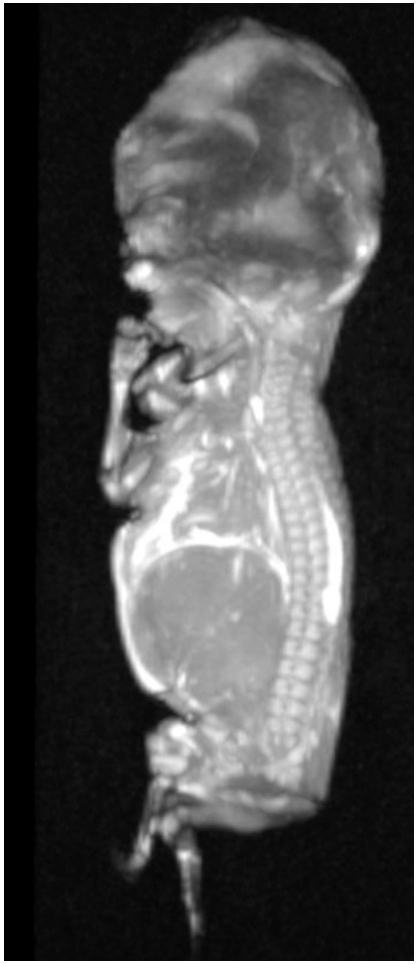
ORIGINAL ARTICLE

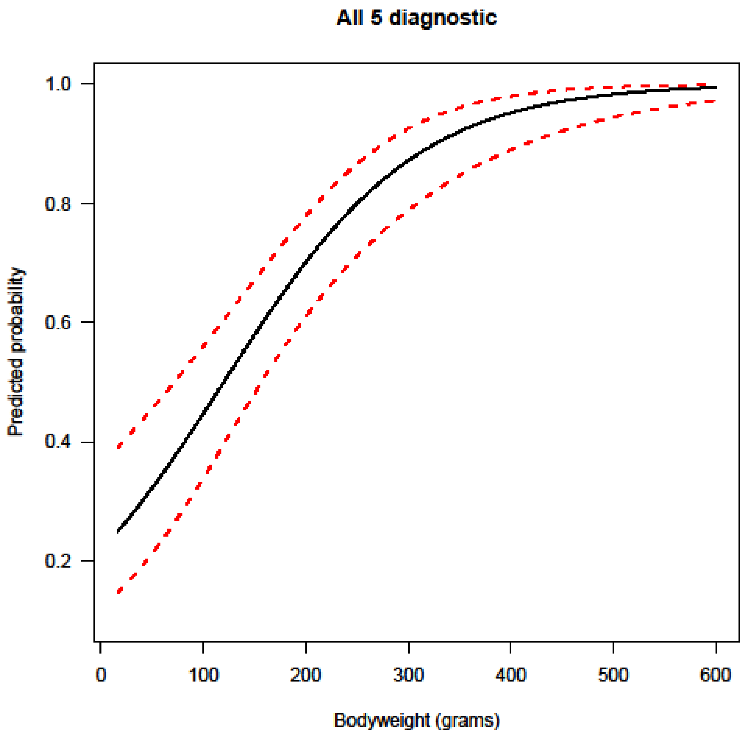
Lung aeration on post-mortem magnetic resonance imaging is a useful marker of live birth versus stillbirth

Joy L. Barber • Neil J. Sebire • Lyn S. Chitty • Andrew M. Taylor • Owen J. Arthurs

Small fetuses



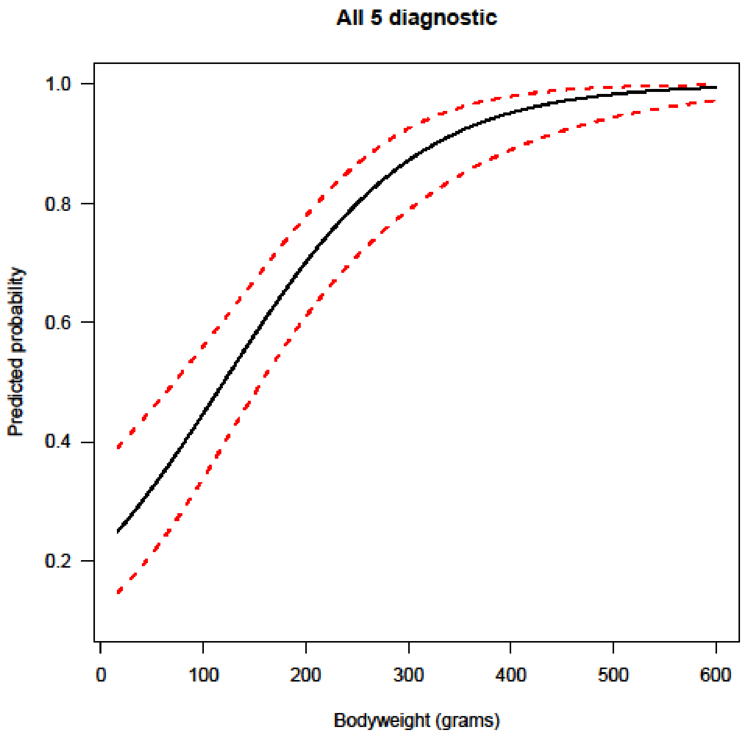




Jawad N et al., 2015

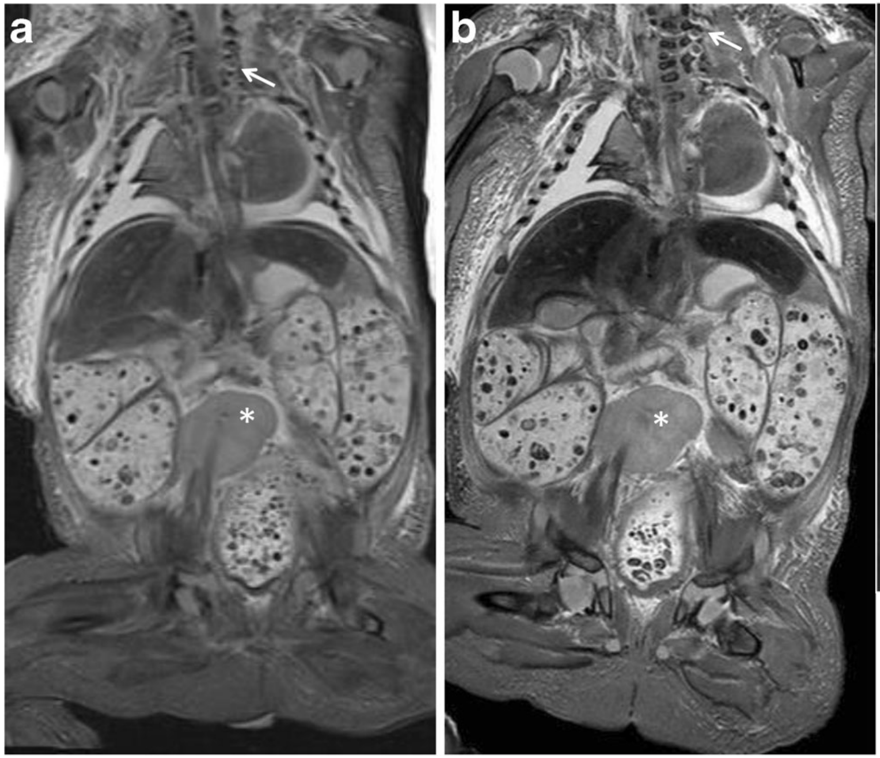
Small fetuses

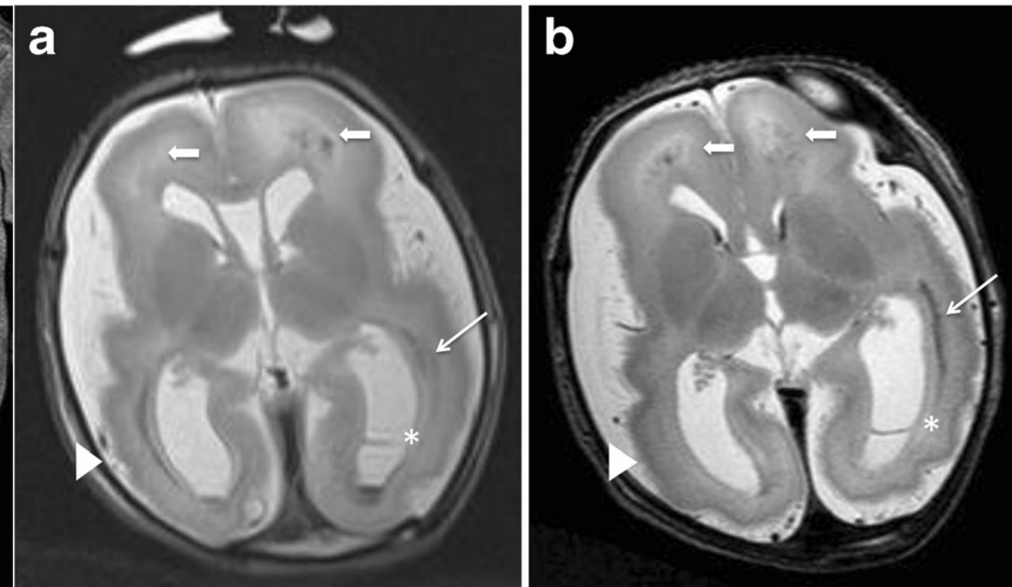
Organ system	Percentage of PMMR diagnostic		
	50%	**80%**	**90%**
Cardiovascular	84g (22,125)	269g (198, 358)	429g (298, 571)
Neurological	90g (53,119)	210g (155, 267)	301g (209, 419)
Abdominal	63g (16,90)	173g (117, 226)	267g (161, 398)
Thoracic	53g (16,89)	190g (133, 251)	318g (217, 478)
Musculoskeletal	Not estimable	96g (31, 150)	219g (130, 344)
All 5 areas	**156g (122,190)**	**309g (245, 384)**	**415g (317, 535)**



Jawad N et al., 2015

1.5 vs 3T





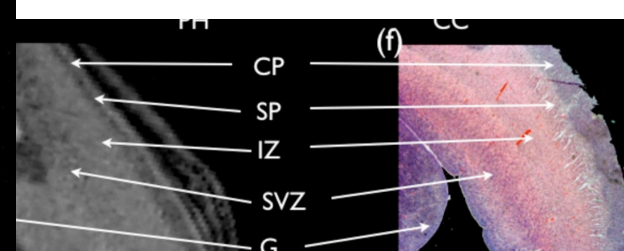
Eur Radiol
DOI 10.1007/s00330-016-4725-4

MAGNETIC RESONANCE

Post-mortem whole-body magnetic resonance imaging of human fetuses: a comparison of 3-T vs. 1.5-T MR imaging with classical autopsy

Xin Kang[1] · Mieke M. Cannie[2,3] · Owen J. Arthurs[4,5] · Valerie Segers[6] · Catherine Fourneau[6] · Elisa Bevilacqua[1] · Teresa Cos Sanchez[1] · Neil J. Sebire[4,5] · Jacques C. Jani[1]

High field MR imaging

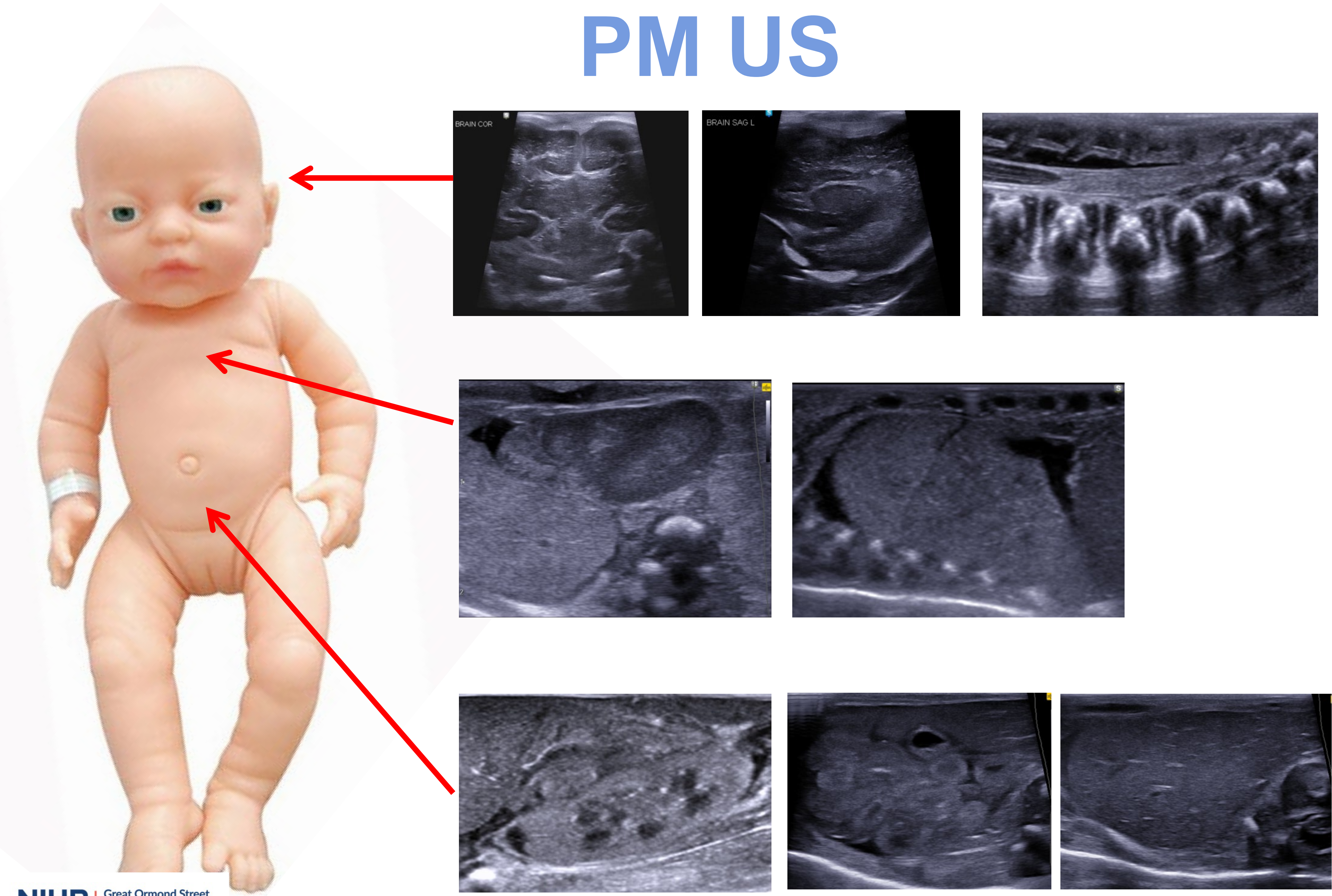


Thayyil S et al., Lancet 2009

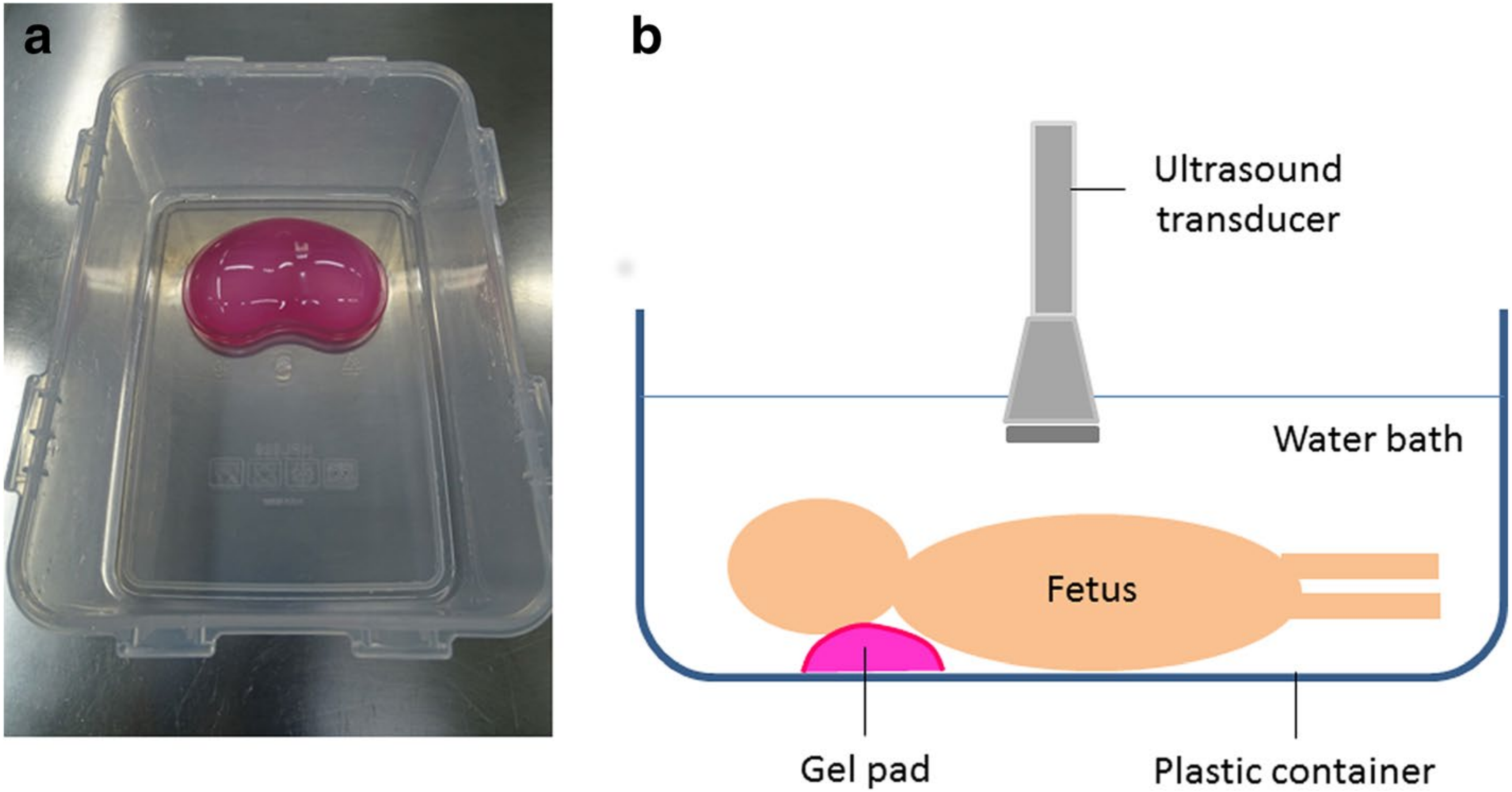
Post mortem US

- Cheap, accessible
- Portable,
- Easily translatable to PM imaging
- Pediatric Radiology, fetal medicine, obstetrician experience
- May be used to guide tissue biopsy

PM US



PM US

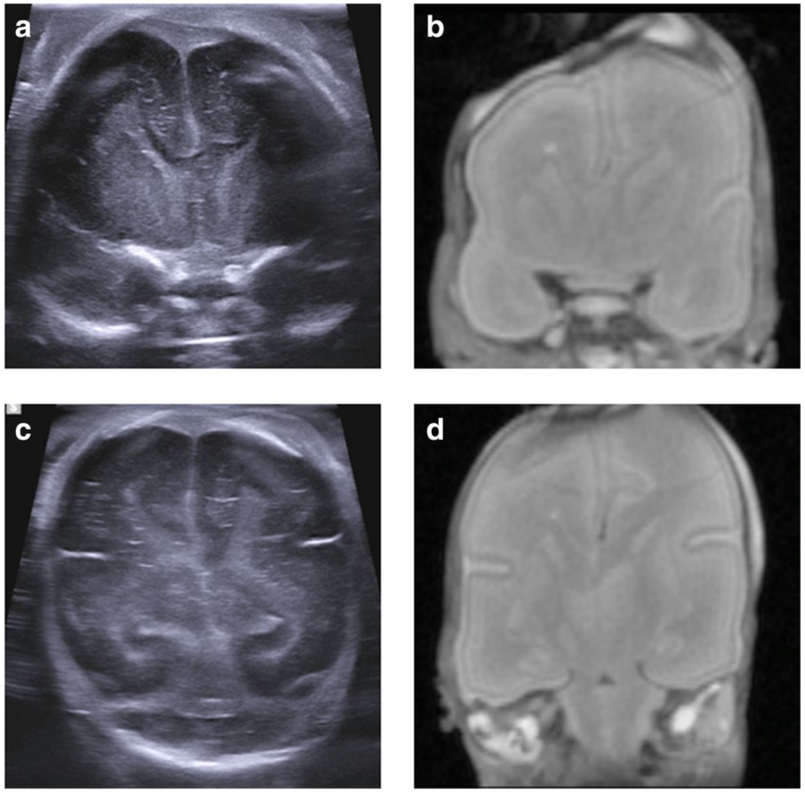


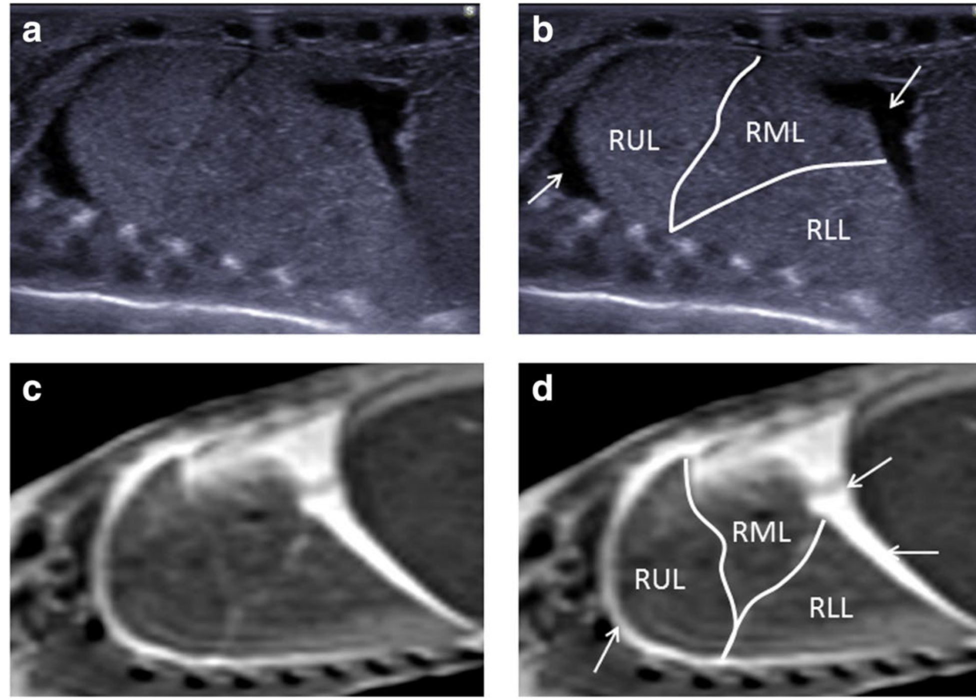
EDUCATIONAL REVIEW Open Access

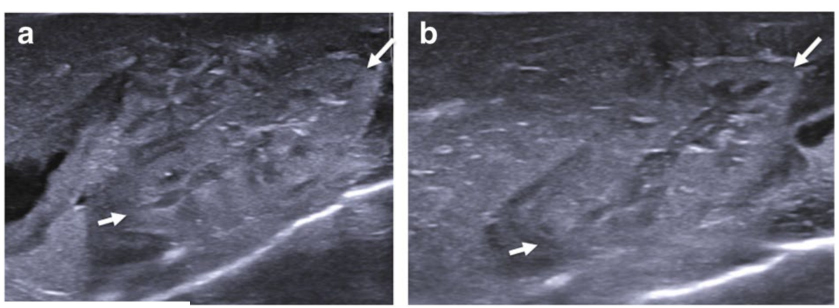
Perinatal post mortem ultrasound (PMUS): a practical approach

Susan C. Shelmerdine[1,2*], Neil J. Sebire[1,2] and Owen J. Arthurs[1,2]

PM US







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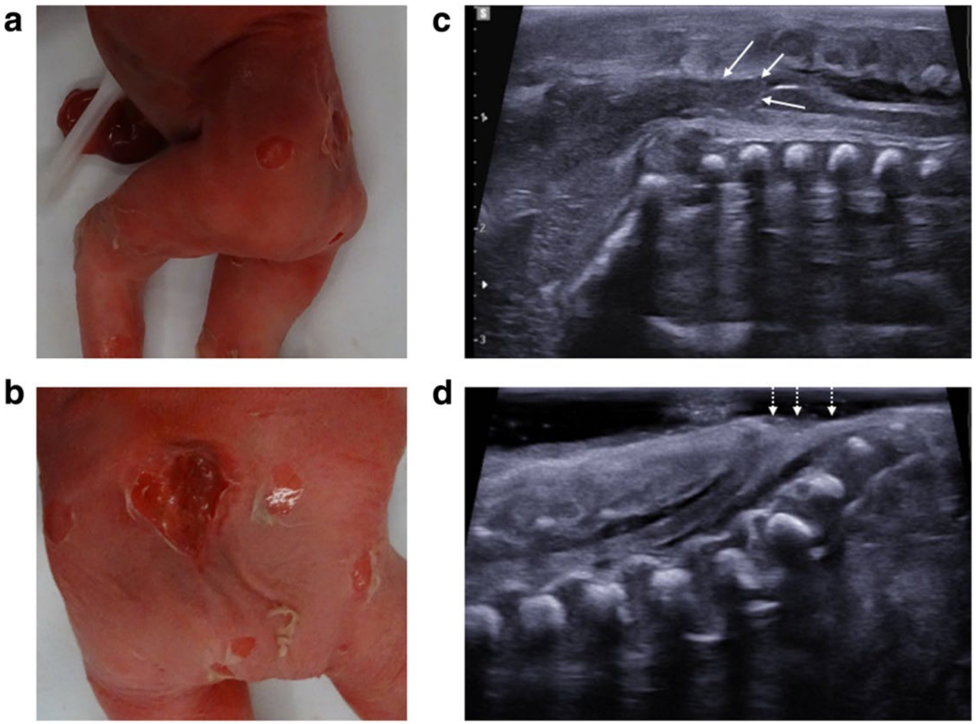
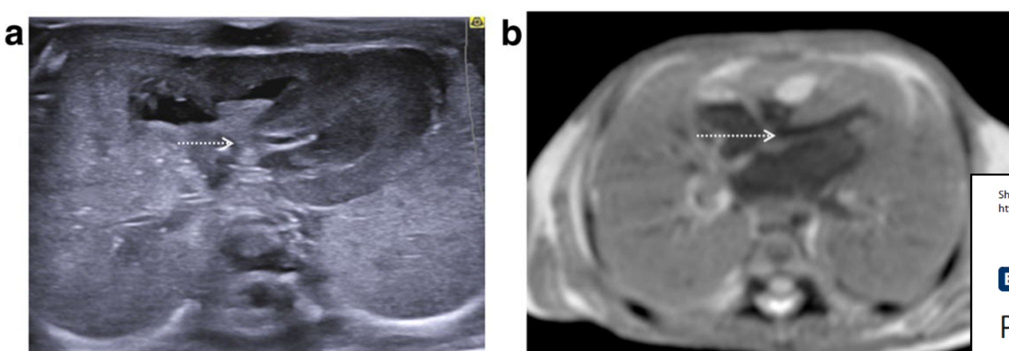
Perinatal post mortem ultrasound (PMUS): a practical approach

Susan C. Shelmerdine[1,2*], Neil J. Sebire[1,2] and Owen J. Arthurs[1,2]

PM US





Shelmerdine *et al. Insights into Imaging* (2019) 10:81
https://doi.org/10.1186/s13244-019-0762-2

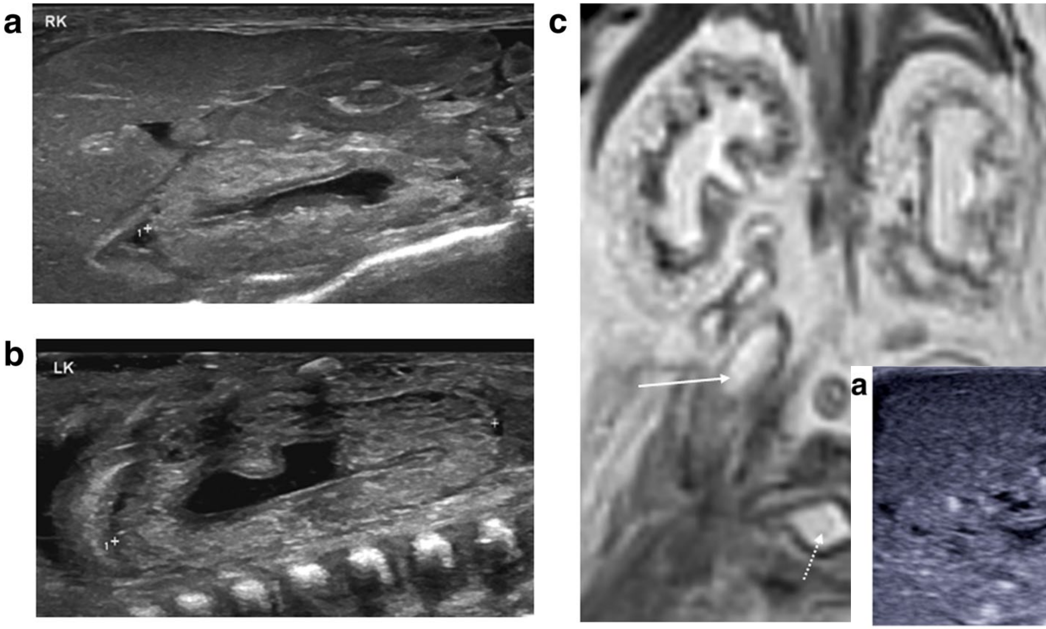
Insights into Imaging

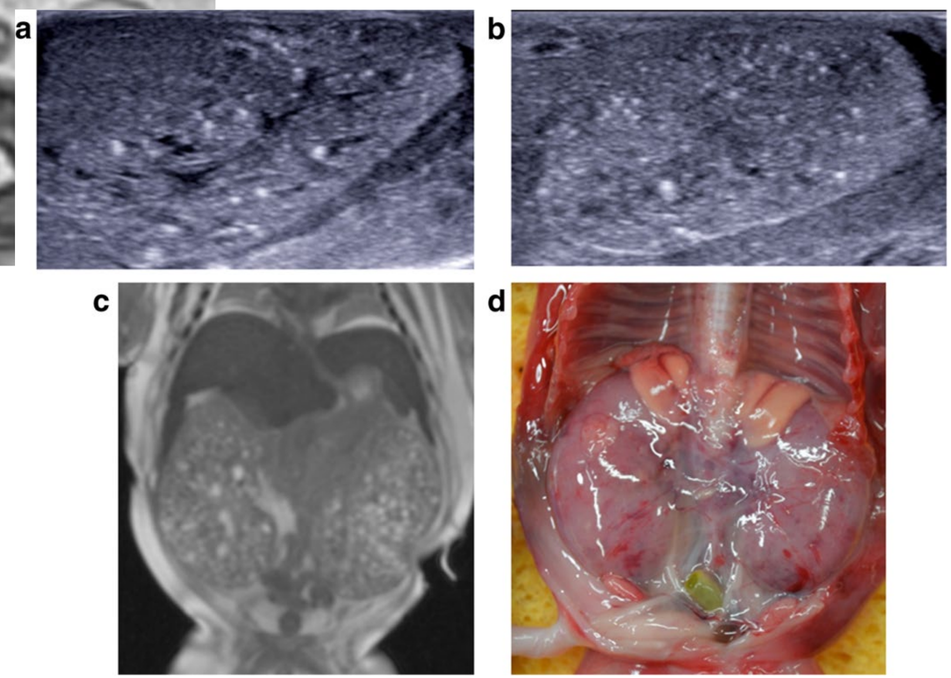
EDUCATIONAL REVIEW Open Access

Perinatal post-mortem ultrasound (PMUS): radiological-pathological correlation

Susan C. Shelmerdine[1,2*], Neil J. Sebire[1,2] and Owen J. Arthurs[1,2]

PM US





Shelmerdine *et al. Insights into Imaging* (2019) 10:81
https://doi.org/10.1186/s13244-019-0762-2

Insights into Imaging

EDUCATIONAL REVIEW **Open Access**

Perinatal post-mortem ultrasound (PMUS): radiological-pathological correlation

Susan C. Shelmerdine[1,2*], Neil J. Sebire[1,2] and Owen J. Arthurs[1,2]

Accuracy rates

Table 3 Analysis of accuracy of postmortem ultrasound examination (US), using invasive autopsy as gold standard ($n = 123$)

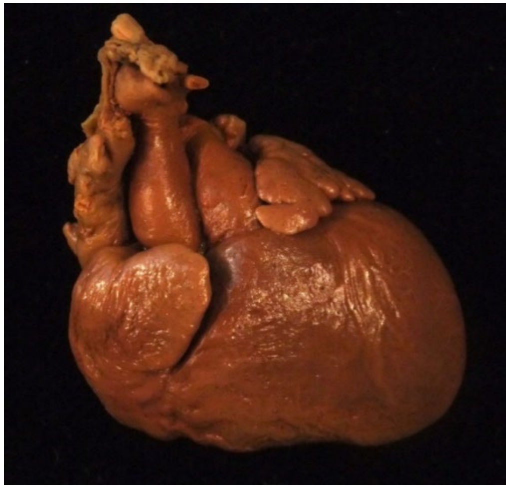
	Overall (n = *123*)	*GA < 20 weeks* (n = *37*)	*GA ≥ 20 weeks* (n = *86*)
Full postmortem US			
Sensitivity	74.7 (56/75) (64.8–84.5)	66.7 (12/18) (41.0–86.7)	77.2 (44/57) (66.3–88.1)
Specificity	83.3 (40/48) (70.0–92.5)	73.7 (14/19) (48.8–90.9)	89.7 (26/29) (72.7–97.8)
Concordance rate	78.0 (96/123) (70.7–85.4)	70.3 (26/37) (55.5–85.0)	81.4 (70/86) (73.2–89.6)
Discordance rate	6.5 (8/123) (3.3–12.3)	5.4 (2/37) (0.7–18.2)	7.0 (6/86) (3.2–14.4)
Non-diagnostic	15.5 (19/123) (9.9–23.1)	24.3 (9/37) (10.5–38.1)	11.6 (10/86) (4.8–18.4)
Brain*			
Sensitivity	61.9 (13/21) (40.9–79.3)	0 (0/0)	61.9 (13/21) (40.9–79.3)
Specificity	77.6 (38/49) (65.9–89.2)	83.3 (15/18) (58.6–96.4)	74.2 (23/31) (55.4–88.1)
Concordance rate	72.9 (51/70) (62.4–83.3)	83.3 (15/18) (58.6–96.4)	69.2 (36/52) (56.7–81.8)
Discordance rate	8.6 (6/70) (4.0–17.5)	0 (0/18)	11.5 (6/52) (5.4–23.0)
Non-diagnostic	18.6 (13/70) (10.3–29.7)	16.7 (3/18) (1.0–33.9)	19.2 (10/52) (8.5–29.9)
Thorax excluding heart*			
Sensitivity	26.3 (5/19) (9.2–51.2)	0 (0/2)	29.4 (5/17) (10.3–56.0)
Specificity	80.8 (84/104) (73.2–88.3)	68.6 (24/35) (53.2–84.0)	87.0 (60/69) (76.7–93.9)
Concordance rate	72.4 (89/123) (64.5–80.3)	64.9 (24/37) (49.5–80.3)	75.6 (65/86) (66.5–84.7)
Discordance rate	10.6 (13/123) (5.1–16.0)	2.7 (1/37) (0.1–14.2)	14.0 (12/86) (6.6–21.3)
Non-diagnostic	17.1 (21/123) (10.9–24.9)	32.4 (12/37) (17.3–47.5)	10.5 (9/86) (4.0–16.9)
Heart*			
Sensitivity	50.0 (13/26) (30.8–69.2)	0 (0/6)	65.0 (13/20) (43.3–81.9)
Specificity	81.3 (78/96) (73.4–89.1)	77.4 (24/31) (58.9–90.4)	83.1 (54/65) (74.0–92.2)
Concordance rate	74.6 (91/122) (66.9–82.3)	64.9 (24/37) (49.5–80.3)	78.8 (67/85) (70.1–87.5)
Discordance rate	5.7 (7/122) (2.8–11.4)	8.1 (3/37) (1.7–21.9)	4.7 (4/85) (1.9–11.5)
Non-diagnostic	19.7 (24/122) (13.0–27.8)	27.0 (10/37) (12.7–41.3)	16.5 (14/85) (9.3–26.1)
Abdomen*			
Sensitivity	60.7 (17/28) (42.6–78.8)	71.4 (5/7) (29.1–96.3)	57.1 (12/21) (34.0–78.2)
Specificity	75.8 (72/95) (67.2–84.4)	73.3 (22/30) (54.1–87.7)	76.9 (50/65) (66.7–87.2)
Concordance rate	72.4 (89/123) (64.5–80.3)	73.0 (27/37) (58.7–87.3)	72.1 (62/86) (62.6–81.6)
Discordance rate	12.2 (15/123) (6.4–18.0)	8.1 (3/37) (1.7–21.9)	14.0 (12/86) (6.6–21.3)
Non-diagnostic	15.4 (19/123) (9.6–23.1)	18.9 (7/37) (6.3–31.5)	14.0 (12/86) (7.4–23.1)

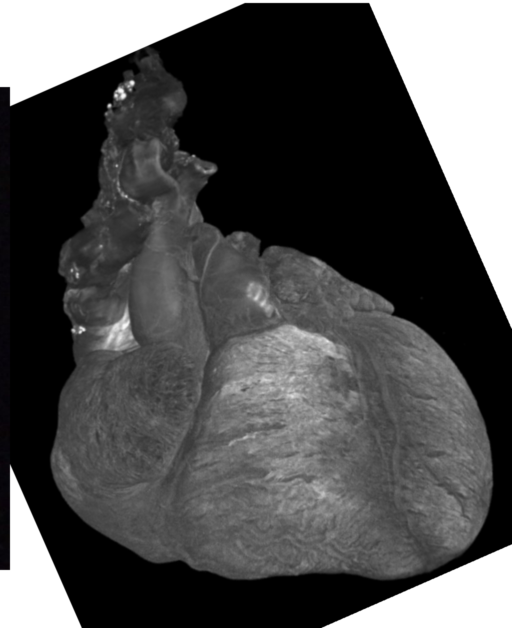
Data are given as % (n/N) (95% CI of %) or % (n/N). *Numbers diagnostic at conventional autopsy: brain, $n = 70$; thorax excluding heart, $n = 122$; heart, $n = 122$; abdomen, $n = 123$. GA, gestational age.

Kang, Shelmerdine et al., UOG 2019

Micro CT

Micro CT



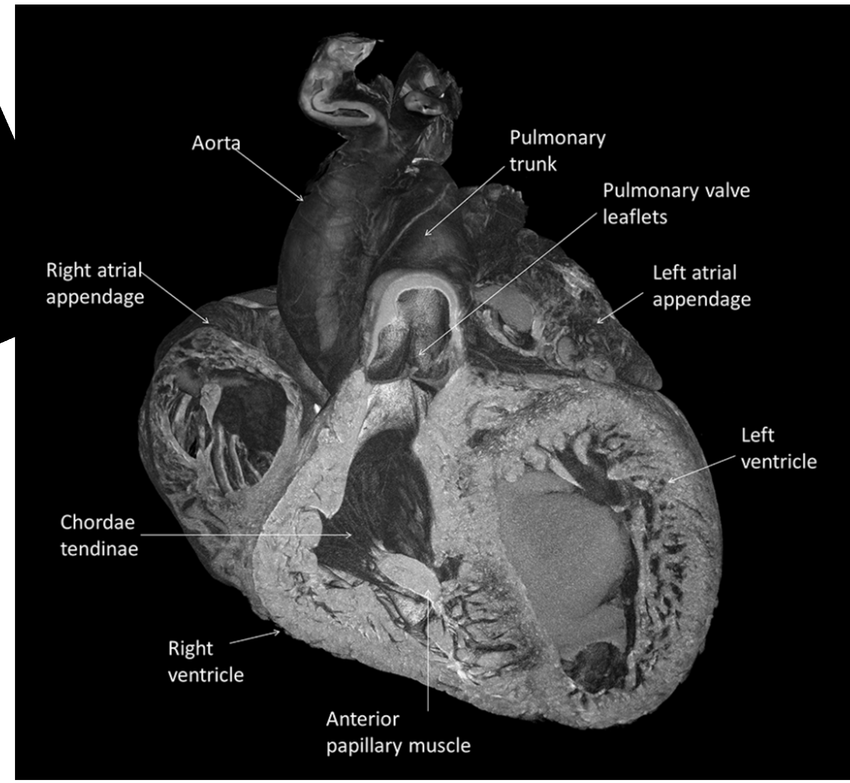


Ultrasound Obstet Gynecol 2016; **47**: 58–64
Published online 2 December 2015 in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.15764

Clinical utility of postmortem microcomputed tomography of the fetal heart: diagnostic imaging *vs* macroscopic dissection

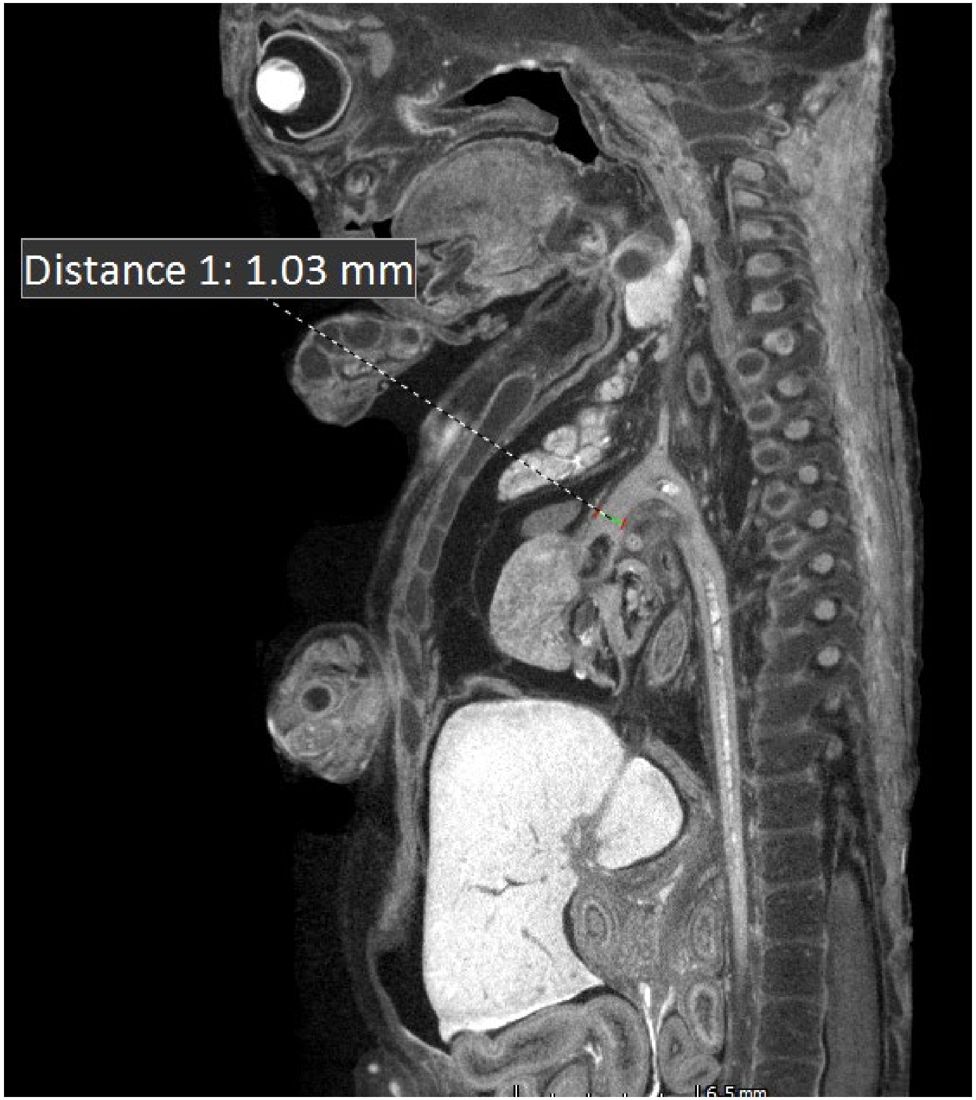
J. C. HUTCHINSON*†, O. J. ARTHURS*‡, M. T. ASHWORTH†, A. T. RAMSEY§, W. MIFSUD*†, C. M. LOMBARDI¶ and N. J. SEBIRE*†

**Institute of Child Health, UCL, London, UK; †Department of Histopathology, UCL Institute of Child Health & Great Ormond Street Hospital for Children, London, UK; ‡Paediatric Radiology, Great Ormond Street Hospital for Children NHS Trust, London, UK; §Nikon Metrology, Tring, UK; ¶Department of Radiology, Studio Diagnostico Eco, Vimercate, Milan, Italy*



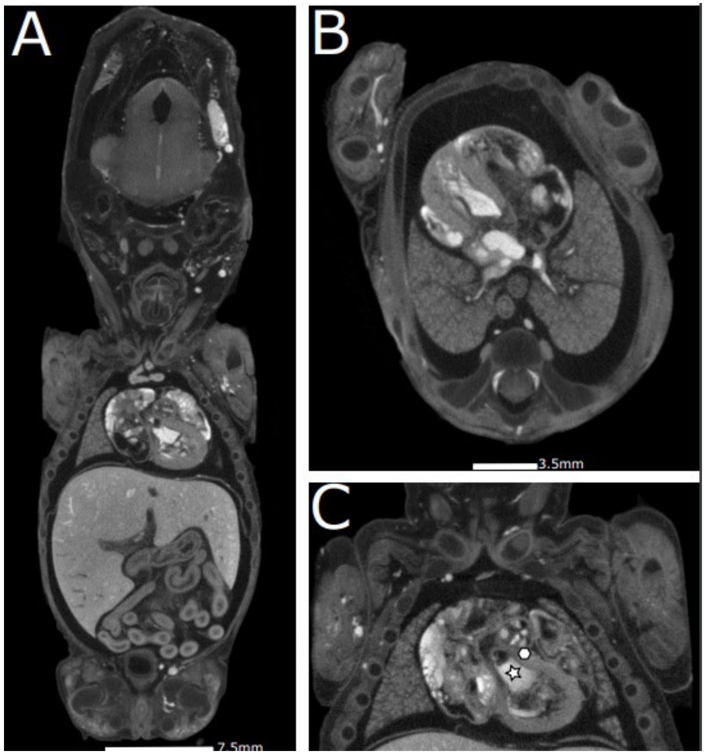
NIHR | Great Ormond Street Hospital Biomedical Research Centre

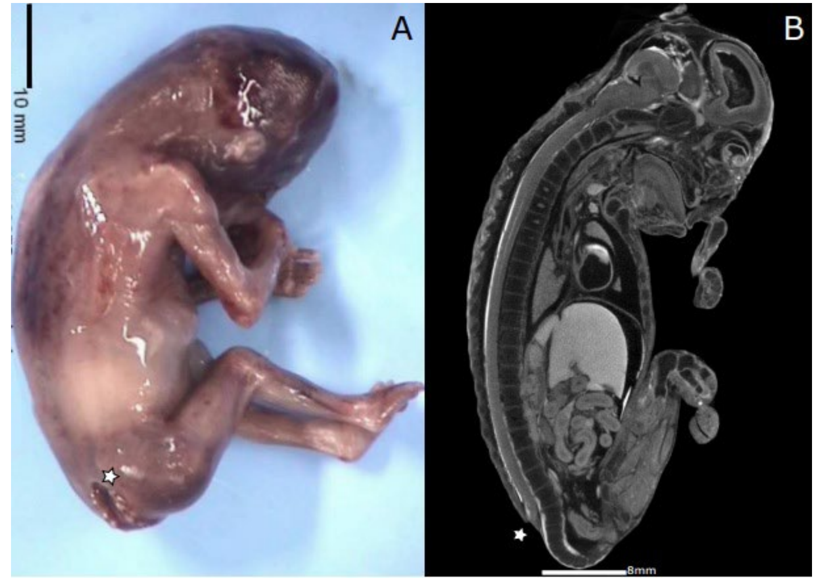
Micro CT

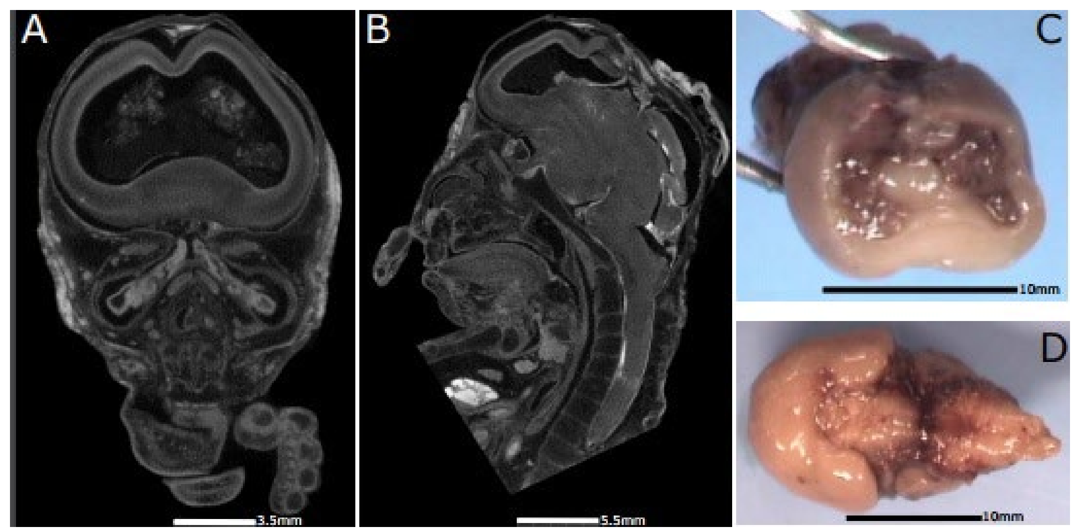


Hutchinson JC et al,. 2018

Micro CT







OBSTETRICS

Postmortem microfocus computed tomography for early gestation fetuses: a validation study against conventional autopsy

Check for updates

John C. Hutchinson, MBBS; Xin Kang, MD; Susan Cheng Shelmerdine, MBBS; Valerie Segers, MD; Claudio M. Lombardi, MD; Mieke M. Cannie, MD, PhD; Neil J. Sebire, MD, PhD; Jacques C. Jani, MD, PhD; Owen J. Arthurs, MD, PhD

Micro CT

TABLE 2
Diagnostic performance of micro-CT vs autopsy by areas of the body

Area of the body	NE autopsy	ND autopsy	ND imaging	TP/FP	FN/TN	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Concordance
Nervous system	22	4	8	1/0	0/6	100 (20.7–100)	100 (61.0–100)	100 (20.7–100)	100 (61.0–100)	100 (64.6–100)
Chest	0	0	0	2/0	0/25	100 (34.2–100)	100 (86.7–100)	100 (34.2–100)	100 (86.7–100)	100 (87.5–100)
Cardiovascular system	2	0	0	2/2	1/22	66.7 (20.8–93.9)	91.7 (74.2–97.7)	50.0 (15.0–85.0)	95.7 (79.0–99.2)	88.9 (71.9–96.1)
Abdomen (non-GU)	5	1	0	3/0	0/20	100 (43.9–100)	100 (83.9–100)	100 (43.9 –100)	100 (83.9–100)	100 (85.7–100)
Abdomen (GU)	5	0	0	4/0	0/23	100 (51.0–100)	100 (85.7–100)	100 (51.0–100)	100 (85.7–100)	100 (87.5–100)
Total systems	34	5	8	12/2	1/96	92.3 (66.7–98.6)	98.0 (92.9–99.4)	85.7 (60.1–96.0)	99.0 (94.4–99.8)	97.3 (92.4–99.1)
Overall diagnosis	0	0	0	9/2	0/18	100 (70.1–100)	90.0 (69.9–97.2)	81.8 (52.3–94.9)	100 (82.4–100)	93.1 (78.0–98.1)

Nondiagnostic autopsy cases were excluded from calculations. For the 8 cases in which neuropathology examination of the brain could be performed, 7 were of diagnostic quality for comment on micro-CT imaging (in 1 case, brain imaging was too autolyzed for

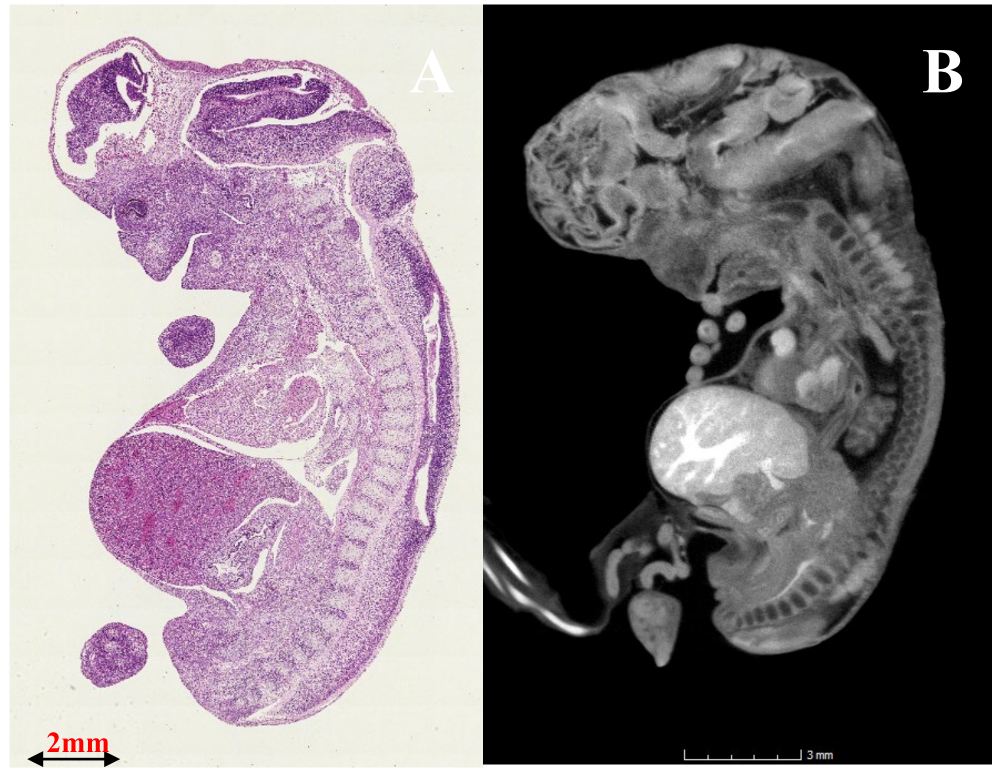
OBSTETRICS

Postmortem microfocus computed tomography for noninvasive autopsies: experience in >250 human fetuses

Susan C. Shelmerdine, FRCR; Ian C. Simcock, MSc; John Ciaran Hutchinson, FRCPath; Anna Guy, MSc; Michael T. Ashworth, FRCPath; Neil J. Sebire, MD; Owen J. Arthurs, PhD

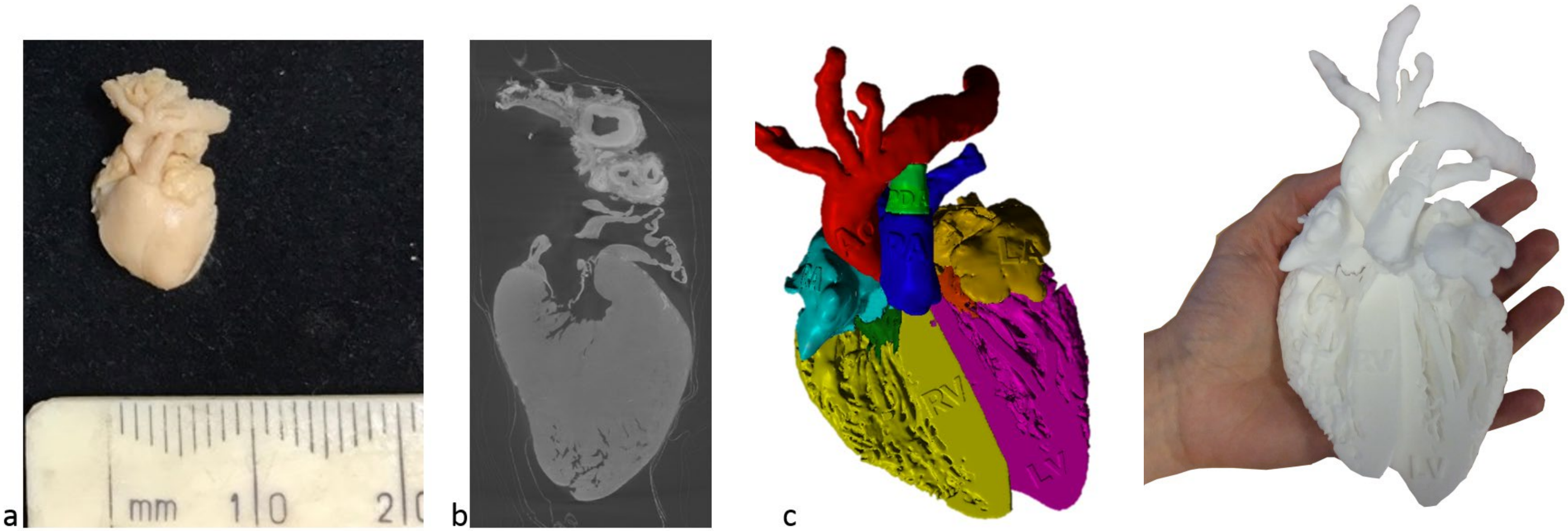
Micro CT – embryo stage

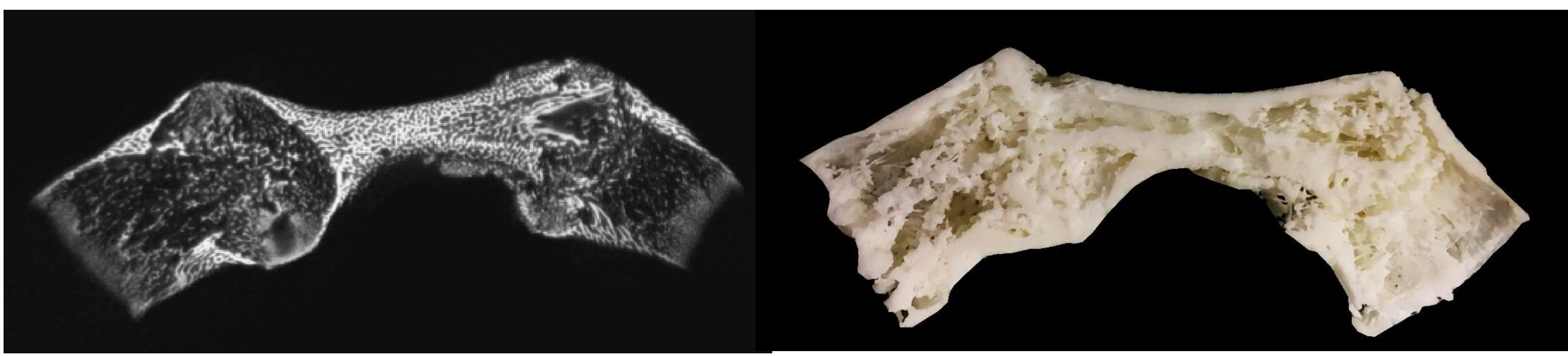
50d Embryo
CRL 16 mm



Shelmerdine SC et al,. 2018

Rapid prototyping





Shelmerdine SC et al,. BJR 2018

Parents' perspective

- Factors: dislike of invasiveness, practicalities procedure, organ retention issues, protective parenting

- Facilitation: desire for information, contributing to research, coping and well-being, minimally invasive options

BMJ Editorial (Arthurs et al., 2015),
Systematic review (Lewis et al,. BJOG 2018).

- Health Professionals Views
- Ethnic minority views
- Muslim / Jewish opinions

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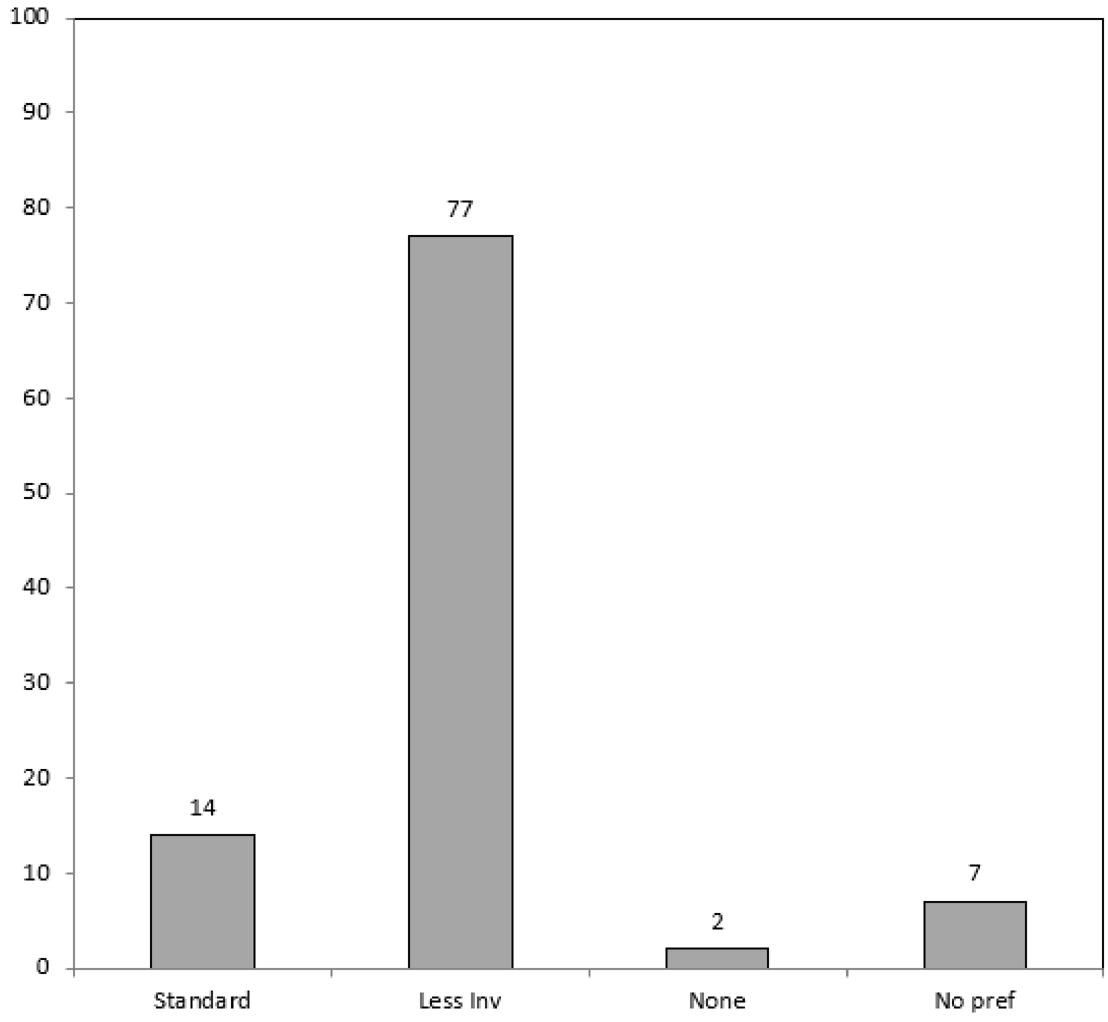
Health Technology Assessment
Volume 23 • Issue 46 • August 2019
ISSN 1366-5278

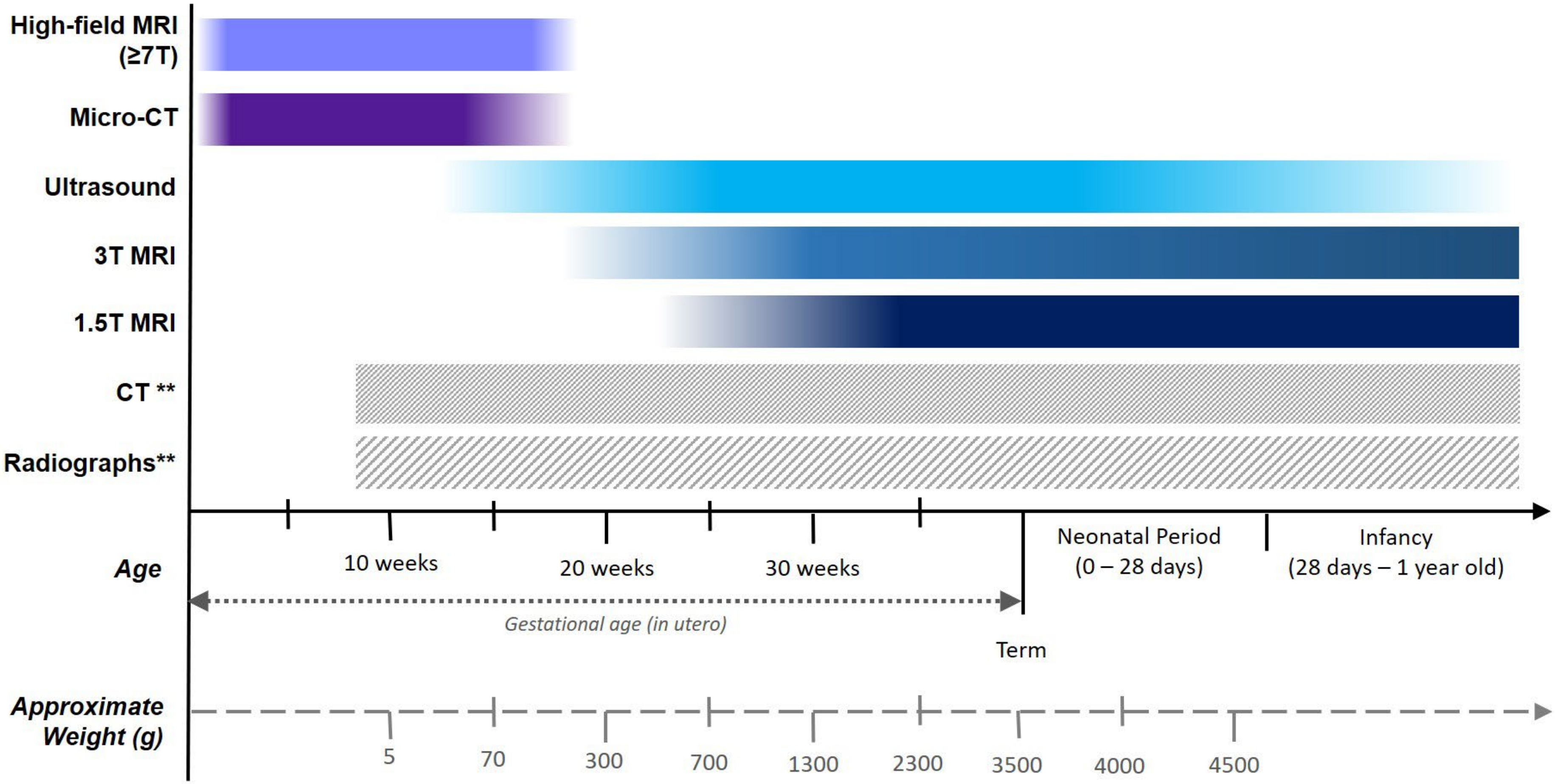
Minimally invasive autopsy for fetuses and children based on a combination of post-mortem MRI and endoscopic examination: a feasibility study

Celine Lewis, John C Hutchinson, Megan Riddington, Melissa Hill, Owen J Arthurs, Jane Fisher, Angie Wade, Caroline J Doré, Lyn S Chitty and Neil J Sebire

Parents' prefer – UK 2018



PM Imaging by AGE



Perinatal post mortem imaging

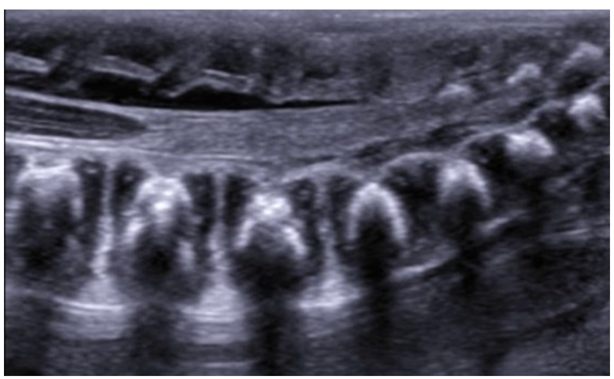
- 1 What is the need ?
  - Decline in parental consent / agreement
  - What do parents consider acceptable?

- 2 What diseases am I looking for ?
  - Depends on age, country

- 3 What imaging modality should I use?
  - X-ray, CT, MRI or Ultrasound ?

- 4 What about minimally invasive autopsy?
  - Laparoscopy / INTACT

Anatomy – 1632 – 2022?



<u>UCL ICH GOS MIA team:</u> Neil Sebire, Andrew Taylor, Susan Shelmerdine, Jade Parmenter, Celine Lewis, Anna Guy, Lakeisha Ward, Hannah McGarrick, Wendy Norman, Rod Jones, Owen Arthurs, Toby Hunt, Ciaran Hutchinson, Ian Simcock, Alistair Calder, Michael Ashworth, Tom Jacques

Summary

THAN K YOU

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