SHORT REPORT

Postmortem magnetic resonance imaging as an adjunct to perinatal autopsy for renal-tract abnormalities

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The aim of this study was to compare postmortem magnetic resonance imaging (MRI) of the renal system with autopsy in perinatal and fetal deaths. 37 deaths were studied and renal abnormalities were found in five of these cases. Postmortem MRI provided information of diagnostic utility comparable to that obtained by autopsy.

One percent of pregnancies are complicated by perinatal and fetal death. Establishing the cause of death is important for the bereavement process, genetic counselling and the optimal management of future pregnancies.¹ The diagnostic value of perinatal autopsy in postmortem examination is well established.² However, recent studies indicate that at least 30% of the reduction in autopsy rates is due to a combination of clinician and parental reluctance and misconceptions.³ Less invasive forms of postmortem examination are needed.

Several reports from the 1990s compare postmortem magnetic resonance imaging (MRI) with autopsy.^{4–5} The first such study, originating from our group, systematically compared

postmortem MRI with autopsy in 20 cases; in 90% of cases the two examinations were of similar importance.⁵

Recent studies have shown that postmortem MRI is particularly useful in diagnosing disorders of the central nervous system, where the practical difficulties with handling unfixed tissue make a non-invasive technique such as MRI most attractive.⁶ Other regions of the body have been less well studied. Our study aimed to evaluate the findings of post-mortem MRI of the renal-tract system and to compare these findings with those on autopsy.

METHODS

This study was approved by the local ethics committee. In all, 37 cases were examined by MRI immediately before autopsy. All cases were recruited from the Perinatal Pathology Unit, University College London, London, UK. Cases were eligible for inclusion in the study when parental consent for autopsy and its ancillary investigations was given.

MRI scans (Siemens Magnetom 63SP, 1.5T, Siemens, Erlangen, Germany) were obtained with a standard head coil. T2-weighted spin echo images (repetition time/echo time 3000/90 ms) were acquired in the coronal and sagittal planes.

Table 1 Clinical details, postmortem magnetic resonance imaging and autopsy findings of the six cases with renal abnormalities

Case	GA (weeks)	BW (g)	Antenatal findings	Outcome of pregnancy	Postmortem MRI findings (renal system)	Postmortem findings (renal system)
1	18	320	Thick bladder, ascites	Termination of pregnancy	Enlarged and thickened bladder wall (fig 1) suggesting a bladder outlet obstruction	Enlarged and thickened bladder wall, right dilated ureter. No definite obstruction of urethra was visualised. Contrast injected to the bladder showed that a smaller amount of contrast transversed the urethra than expected. These findings are most consistent with posterior urethral valves causing subtotal obstruction
2	31	NK	Bilateral hydronephrosis, thickened bladder wall	Preterm birth, died of respiratory failure due to lung hypoplasia	Thickened bladder wall, enlarged cystic kidneys, dilated ureters and dilated posterior urethra (fig 2A,B)	Numerous cysts with loss of cortico-medullary distinction, pelvi-calyceal system and ureters dilated. Hypertrophic bladder with urachal diverticulum, urethra stenose
3	38	4199	Oligohydramnios, hypoplastic lungs, polycystic kidneys	Term delivery, died from respiratory failure within hours after birth	Massively enlarged kidneys compressing heart and lungs. Reniform shape maintained (fig 3A,B)	*Skin markers placed under MRI guidance and tissue biopsies taken. Histological features in keeping with autosomal recessive polycystic kidney disease
4	24	580	Twin I, no abnormal findings	Preterm birth, died on day 8 from multiorgan failure due to sepsis and bilateral extensive IVH	Dysplastic right kidney (fig 4)	Right enlarged, dysplastic kidney
5	21	196	Body-wall defect	Termination of pregnancy	Horseshoe kidney (fig 5)	Horseshoe kidney
6	29	825	TTS, recipient, IVH	Died on day 1 from cardiac failure and extensive left-sided cerebral infarction	Bilateral hydronephrosis (fig 6)	Normal

GA, gestational age; BW, birth weight; IVH, intraventricular haemorrhage; MRI, magnetic resonance imaging; NK, not known; TTS, twin-to-twin transfusion

*Consent only for external examination and limited tissue biopsy.

Figure 1 (A) Whole-body magnetic resonance imaging of aborted fetus at 18 weeks of gestation: the bladder wall is thickened and prominent. (B) Postmortem magnetic resonance imaging (MRI) showing dilated posterior urethra in sagittal plane and enlarged, thickened bladder. (C) Postmortem MRI showing cystic kidneys.

Fetuses were prepared for scanning by immersion in 1 litre of sterile normal saline.

The MRI scans were systematically reviewed with reference to a checklist adapted from the guidelines of the Royal College of Pathologists (CESDI Postmortem guidelines, Royal College of Pathologists, London, UK (1993)). All autopsies were performed by a dedicated perinatal pathologist, who was blinded to the findings of the MRI scans at the time of the autopsies. The antenatal clinical records, including antenatal ultrasound findings, were available to both the pathologist and radiologist. The observations of the MRI and autopsy were compared for the diagnostic sensitivity and clinical significance of renal-tract abnormalities.

RESULTS

Renal-tract abnormalities were detected in 5 (of which one has been previously reported⁵) of the 37 cases. Table 1 shows the clinical details and the findings on autopsy and postmortem MRI. The MRI report was falsely positive in one case (case 6).

DISCUSSION

In this study, MRI of the postmortem fetus or neonate provided information on renal-tract abnormalities of comparable diagnostic utility to that obtained by autopsy. The cases represent a spectrum of congenital renal-tract abnormalities, and the data suggest that the structure and morphology of the kidney on postmortem MRI may be of sufficient resolution to make specific diagnoses. Indeed, in a previous study, the

morphological appearance on MRI alone allowed classification of renal cystic diseases.⁷ In our study, in the case of cystic renal disease, we also performed an image-directed biopsy (case 3). Skin markers were placed over both kidneys under MRI guidance, and tissue biopsies were taken. This allowed a precise diagnosis to be made and appropriate counselling to be performed. The changes on histology were diagnostic of autosomal recessive polycystic kidney disease. This case illustrates the powerful combination of MRI, which provided structural and macroscopic information, and a tissue biopsy, which allowed histological analysis. Image-directed biopsy falls into the category of minimally invasive autopsy, and is an approach that may become more and more common as MRI becomes accepted as having a major role in postmortem examination.^{8,9}

In case 6, the initial radiology review reported bilateral hydronephrosis. However, normal renal anatomy was seen on autopsy. With these discrepant findings, the authors reviewed the literature on in utero fetal and postmortem MRIs of the kidney. In the light of more recent literature, we realised that the initial magnetic resonance report was falsely positive. This case shows the importance of ongoing research into postmortem MRI, its utility and its limitations.

The current standard perinatal postmortem examination includes external examination of the baby, examination of the internal organs, examination of the placenta and cord, imaging (radiography) and supplementary laboratory investigations such as microbiology and cytogenetics.¹⁰ In the past

Figure 3 (A) Whole-body postmortem MRI at 38 weeks of gestation: oblique coronal view showing the diaphragm raised by renal masses that compress the heart and lungs. (B) Postmortem magnetic resonance imaging (MRI). Axial view of kidneys shows that they are grossly enlarged, yet maintain a reniform shape.

decade, the rates of perinatal autopsy have been falling.³ Kumar *et al*¹¹ reported a marked decline in neonatal autopsy rates over 10 years, from 71.2% (1984–8) to 47.7% (1989–93). Such figures may result from a combination of factors including a decline in healthcare professionals' understanding of the value an autopsy can bring.¹² This directly leads to a situation where parents believe they are not fully informed and therefore do not give consent.¹² In 2000, on the background of low autopsy rates and after wide consultation, the UK's Chief Medical Officer recommended the assessment of less invasive forms of postmortem examination.¹³ The document "Less invasive autopsy: the place of magnetic resonance imaging" was produced in 2004 by Parker¹⁴; it concluded that fully funded trials should be set up to compare postmortem MRI with autopsy, assessing adults and the fetus/neonates in separate trials.¹⁴

Although it has previously been suggested that postmortem MRI cannot function as a substitute for standard autopsy,¹⁰ there seems to be a place for investigating the potential role of less invasive forms of postmortem examinations. One disadvantage of postmortem MRI as an alternative to autopsy is the lack of histological information; however, this can be overcome by combining imaging with needle biopsies, as shown in case 3. In the present environment, if parental consent is not given for autopsy, alternatives such as

Figure 4 Postmortem magnetic resonance imaging at 24 weeks of gestation. Sagittal view showing the right cystic dysplastic kidney. Intraventricular haemorrhage is also evident.

postmortem MRI alone or combined with needle biopsies must be considered^{5 8 9 15} and discussed with the parents.

In conclusion, this small series of cases with perinatal renal abnormalities demonstrate that postmortem MRI can provide information concerning renal-tract abnormalities, which is of comparable diagnostic utility to that obtained by autopsy. As experience grows, in particular in defining the limits of normality at varying gestational ages, postmortem MRI will probably provide an important clinical resource. Combining MRI with image-guided biopsies and umbilical cord blood sampling for genetic and metabolic analyses may provide valuable, non-invasive alternatives to autopsy. Further investigation of the utility of postmortem MRI is important; a project funded by the Department of Health will start in 2006 to assess whether MRI can provide a minimally invasive approach for postmortem assessment of the fetus, infant and child, with similar detection rates for anomalies and determination of the cause of death.

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Figure 5 Horseshoe kidney seen on postmortem magnetic resonance imaging in the coronal plane.

Figure 6 Initially reported as bilateral hydronephrosis. On review of recent literature, however, these were seen to be normal.

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