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## **‘You’re looking for different parts in a jigsaw’: foetal MRI (magnetic resonance imaging) as an emerging technology in professional practice**

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**Abstract** Magnetic resonance imaging (MRI) was first introduced into clinical practice during the 1980s. Originally used as a diagnostic tool to take pictures of the brain, spine, and joints, it is now used to visualise a range of organs and soft tissue around the body. Developments in clinical applications of the technology are rapid and it is often viewed as the ‘gold standard’ in many areas of medicine. However, most existing sociological work on MRI tends to focus on the profession of radiology, little is known about the impact of MRI on a broader range of clinical practice. This article focuses on MRI use in pregnancy, a relatively new application of the technology. Drawing on empirical research with a range of health professionals (from radiologists to pathologists) in the North of England, this article asks: how do different types of health professionals engage with the technology and to what end? It will argue that MRI use in pregnancy offers an increasingly important piece of the diagnostic jigsaw, often acting as a bridging technology between medical specialties. The implications of this will be explored in the context of broader sociological debates on the ‘visualisation’ of medicine and its impact on professionals.

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**Keywords:** health technology/technology assessment, medical practice/medical work, obstetrics/obstetricians, antenatal care/testing, professions/professionalisation

### **Introduction**

Sociology of health and illness has long been preoccupied with the ability of technology to change or even redefine health, illness and medical practice (Webster 2002). The focus of sociological research on such technological intervention has been wide ranging, from exploring the use of scalpels to microscope and X-ray. However, despite rapid clinical applications of magnetic resonance imaging (MRI), little is known from a sociological perspective about its use in different types of professional practice. This article aims to address this gap by exploring a novel application of MRI technology, its use in the obstetric realm. Through this exploration the article seeks to offer an original contribution to cross-disciplinary debates on the fluid and contested role of technology in professional practice.

Sociological studies on the role of MRI in healthcare have emphasised the increasing popularity of the technology. As Joyce (2006) has articulated, in both medicine and popular culture

MRI is perceived as the 'gold standard' the epitome of what is possible in medical visualisation. This rise in popularity of MRI relates not just to the 'best technology' line of reasoning (diagnostic capability) but also to a successful strategy pursued by the profession of radiology during the 1970s and 1980s to assert professional authority and jurisdiction over the technology (Joyce 2006). According to Prasad (2014) this act of 'doing distinctions' contributed to the establishment of MRI as a diagnostic dream machine – ascribing it an iconic status within medicine. Imaging practices could therefore be viewed as practices of boundary work, aimed at gaining professional authority within the profession of radiology (Burri 2008). They can also signify a reproduction of traditional medical hierarchies between doctors (radiologists) and allied health professionals (radiographers) (Joyce 2006). Existing studies have examined the ways in which results from MRI scans inform clinical decision-making in a range of areas particularly those relating to the brain such as neuroscience and psychiatry (Dussauge 2008, Rapp 2011). However, much existing sociological work on MRI has been concentrated on its position in the sub-specialty of radiology. But as the clinical application of this technology rapidly expands to include more areas of the body and new domains of medicine such as obstetrics so too does the need to examine its impact on a broader range of professional practice.

Visual technology use in pregnancy has been a central concern of sociologists for several decades now, although they have tended to focus on the role of obstetric ultrasound. Studies emphasise three key roles for ultrasound in this context: it provides information and evidence for clinicians, it is linked with surveillance and the medical gaze, and it provides a tool through which a new myth is created – the foetus as image (Casper 1998, Zechmeister 2001: 392). Although not yet fully routinised in clinical practice, MRI is now often used as an adjunct to ultrasound during pregnancy, to back up or provide further information. It was used initially to identify and diagnose disorders of the brain and central nervous system. However the use of this technology has recently been extended to include anomalies in a range of other foetal organs (lungs, abdomen and kidneys) genetic disorders and problems with the placenta (Mailath-Pokorny *et al.* 2010).

Drawing on qualitative data from interviews with health specialists in a foetal medicine clinic in the north of England, this article will explore the emerging application of MRI technology in pregnancy. In doing so the article seeks to address the following questions: How has the technology been adopted and adapted in the obstetric realm? How do different professionals understand and interact with the foetal image? How does MRI fit into their existing professional practice and what are their future projections for the technology? Through addressing these questions the article seeks to extend existing sociological debates on visual technology use in pregnancy from ultrasound to MRI, and opens up to scrutiny the role of MRI in a diverse range of professional practice- from genetic counselling to dissection in autopsy.

The article proceeds with an outline of the theoretical framework drawing on the 'technology- in- practice' approach as outlined by Timmermans and Berg (2003). Some background context to foetal MRI will also be provided along with a summary of the method used in the study. The main part of the article is concerned with the interview findings, presented in four sections which explore in turn: the role of MRI in clinical practice; the use of images versus the radiologist's written report; MRI as bridging technology and finally its future role in healthcare. This article will argue that MRI use in pregnancy offers one piece in an always incomplete clinical jigsaw (Prasad 2005). It can play a significant role in clinical decision-making and is often used by health professionals to assist them in the articulation of emotional labour. While professionals do sometimes differ in their engagement with the role of images and their views of the technology's projected future, most feel that it plays a key role as mediator between medical specialties. The article will conclude that MRI use in obstetrics

does not merely signify the reinforcement of inter and intra-professional boundaries, or facilitate a straightforward extension of the medical gaze. Rather MRI technology should be viewed as a multifaceted and unfolding technology-in-practice used by professionals to mediate parental experience and foster professional teamwork and planning. As the clinical application of technologies like MRI continue to expand to include new domains in medicine so too must our understanding of the implications of this expansion on a broader range of professional groups.

### **Conceptual framework: technology in professional practice**

Scholars of science and technology studies (STS), sociologists of health and illness, and sociologists of work and organisation have all contributed to our understanding of the role of technology in clinical professional practice. The wide range of disciplinary interest in this area has encouraged substantial diversity in theoretical approaches. Theoretical perspectives applied in this context also vary widely depending on whether technology is viewed as determining professional practice or conversely whether technological adoption and use are perceived as direct outcomes of social interaction and institutional organisation (Timmermans and Berg 2003). Some scholars have focused on the ways in which medical technology is used to extend the power of health professionals. Drawing on the work of Foucault, for example, sociologists have often argued that visual technology extends the medical gaze and medical surveillance through rendering the interior body visible (James and Hockey 2010). This argument has been made particularly in the context of imaging technology (Joyce 2006) and in pregnancy more specifically. Ultrasound is perceived to provide the medical profession with a window on the womb, leading to an objectification of women's bodies (Zechmeister 2001). Prasad (2005) extends this focus in his work on MRI. He argues that in contrast to ultrasound imaging, the gaze produced by MRI is not constituted by one act of seeing. Rather it produces diverse sets of images of the internal depths of the body offering an almost unlimited extension of the medical gaze (Prasad 2005).

While some sociologists have focused on the role technology plays in enhancing medical power, others have focused on the impact of organisational arrangements on the use and exploitation of technology (Dent 1990). In the UK this is often situated in debates on the modernisation of the NHS and the impact that this process has had on inter and intra-professional boundaries (Hunter and Segrott 2014, Martin *et al.* 2009). For example, there have been a number of studies on the role technology plays in various professionalisation projects (Tjora 2000). Other studies have focused on the ways in which technology can be used to reinforce traditional professional boundaries, hierarchies and jurisdictions in some contexts or facilitate inter-professional collaboration between different professionals and patients in others (Burri 2008, Heath *et al.* 2003). It has also been argued that the success of technology in different clinical contexts can be contingent on collaboration between different professionals (Dumit 2004), and also that technology itself is only one part of a much broader assemblage of materials used to inform clinical practice (Prasad 2005, Latimer 2013).

Drawing on this rich body of literature, this article seeks to explore the role of technology both within and across professional groups. It does not seek to focus explicitly on the role of MRI in establishing inter or intra-professional boundaries, autonomy or hierarchy. Nor does it seek to view this technological application purely through the lens of medical surveillance. Rather this article seeks to investigate the multifaceted nature of the technology itself, examining its unfolding influence on different types of professional practice. In order to do this the

article draws on Timmermans and Berg's (2003) technology- in- practice approach, a dynamic framework through which to study technology in a medical setting. The key to this approach is its emphasis on practice – a move away from a focus on exploring different perspectives on the body, or disease, towards a focus on 'doing' different perspectives (Mol 2002). As Mol articulates, this signals a move away from an emphasis on 'knowing' an object (epistemology) to 'practising' it (ontology). Three issues raised by this approach are crucial to the advancement of the argument in this article. First, the technology-in-practice approach does not reduce technology to any one given function but recognises that what technology does and for whom remains an open empirical question (Timmermans and Berg 2003: 104). As will be argued in this article, different aspects of MRI are used to inform different types of professional practice. Second, underlining this conceptual approach is the argument that 'technologies are embedded in relations of other tools, practices, groups, professionals, and patients, and it is through their location in these networks that treatment, or any other action, is possible in healthcare' (Timmermans and Berg 2003:104). As will be articulated in this article the use of MRI in this context is clearly interwoven with social relationships and other technologies. Third, Timmermans and Berg suggest that any exploration of technology in healthcare should include a focus on its potential role as a mediator in the production and reproduction of novel worlds – including professional and patient identity. MRI often acts as a bridging technology, a mediator between different types of professional practice and patient experience.

### **The role of visual technology in obstetrics**

Ultrasound imaging was originally applied to obstetric practice in the 1950s and 1960s but is now fully routinised in the UK (Draper 2002). Women are currently offered an initial scan at around 12 weeks to ascertain viability and gestational age of the foetus. They are offered a second scan at 20 weeks to locate a range of medical problems. The scan is conducted by a sonographer and any abnormal results reported to an obstetrician. Ultrasound is viewed as reliable and authoritative in the antenatal context, the objectivity of the foetus is 'provided by the visual evidence on the screen' (Nishizaka 2010: 22). However, although this technology is portrayed as accurate, it is not diagnostic. In the case of chromosomal anomalies for example it offers only a prediction of risk. Women therefore may also be offered further diagnostic testing such as an amniocentesis and in some cases now MRI (Reed 2012).

MRI was first introduced into the obstetric realm in the early 1980s. Initially the sequences used low field strength magnets that could take between 1 and 10 minutes to acquire images (Bekker and Von Vugt 2001). In order to avoid image blurring this acquisition time required the immobilisation of the foetus – achieved by sedating either the mother or the foetus via the umbilical cord (Pugash *et al.* 2008: 215). Financial cost and risks associated with sedation, constituted an argument for the continued use of more routine screening techniques at that time. However, the late twentieth and early twenty-first century saw the development of fast sequencing which meant sedation was no longer necessary leading to the increased use of foetal MRI. Currently women may be referred for an MRI scan by an obstetrician if anomalies show up on the 20 week ultrasound. Women are almost always offered MRI when problems with the foetal brain are shown, but are also referred for problems in other foetal or maternal organs where MRI can offer more detailed information and measurement. In clinical research MRI has been positioned as offering several advantages over ultrasound: the scan is less affected by maternal and foetal position, it is deemed safer for mother and baby than invasive

tests such as amniocentesis or tests involving exposure to ionised radiation (for example, CT). The images are dynamic enabling a depiction of the entire foetus or multiple contingent slices allowing for accurate measurement of foetal organs (Mailath-Pokorny *et al.* 2010). The use of greyscale in MR images is positioned by some radiologists as facilitating superior tissue contrast allowing for the interpretation of more subtle variations (D'Ercole *et al.* 1998). Finally, MRI produces complex stills which according to some, makes them less reliant on time and place for interpretation, opening up cases to a wider field of peer review and expertise (Pugash *et al.* 2008). The enhanced capability of MR imaging over routine ultrasound coupled with the limited safety concerns have contributed to the recent advance of MRI use in pregnancy (Bekker and Von Vugt 2001, Mailath-Pokorny *et al.* 2010). Some suggest that foetal MRI is in fact 'on its way to becoming an independent rather than an adjunct method in antenatal imaging' (Prayer 2006: 171).

While clinical studies on foetal MRI tend to extol the diagnostic virtues of the technology, we know little about the views of professionals whose clinical practice it informs. Women are referred for MRI through an obstetrician, but the scan can inform the work of a wider range of health professionals than those solely associated with ultrasound. This is because MRI often occurs in late pregnancy (late 2nd or 3rd trimester) when a maternal or foetal anomaly has already been detected and decisions may need to be made by parents and professionals about termination, delivery of the baby and neonatal care. This article therefore seeks to open up to scrutiny the influence of MRI on a wide range of professions working in the context of pregnancy and childbirth.

### **The study: foetal MRI in context**

This article is based on a sub-section of the findings from a study funded by the British Academy on the role of MRI in obstetrics. Ethical approval for this project was granted by the National Research Ethics Service in February 2013. The study included semi-structured interviews with 17 pregnant women who had undergone MRI and 14 health professionals (see Table 1). Respondents were recruited via an NHS foetal medicine unit in the North of England between March and August 2013. We also interviewed two representatives from two different manufacturers of MRI systems. We also collected around fifteen hours of observational data of MRI in practice during clinics, by observing the radiographers and radiologists at work. In a small number of cases we were also able to observe the radiologists' consultation with parents after the scan. The PI and RA also attended one of the monthly team meetings where all the professionals met to discuss individual cases. Fieldnotes were taken by hand during all observations which were typed up into fuller reports shortly afterwards. Due to the scope and focus of this article only data relating directly to professional interviews and observations will be explored here. Professional respondents were drawn from a range of specialities. The sample included male and female respondents and there was some variation across occupational categories and specialities (for example, consultants, allied health professionals and healthcare assistants). However, there were limitations to the diversity of the sample. For example, the study did not include any junior staff members.<sup>1</sup> Furthermore, we were unable to recruit from some occupations and specialities such as midwives and anaesthetists. This was a small-scale ethnographic study however focusing on exploring an emerging technological application as it unfolds. The article therefore does not seek to offer a representative account of occupational groups or sub-specialities.

Table 1 *Health professionals included in the study*

<i>Type of health professional</i>	<i>Number of respondents</i>	<i>Female</i>	<i>Male</i>
Foetal radiologist	1	1	0
Neonatologists	2	1	1
Paediatric surgeons	2	0	2
Surgical nurse	1	1	0
Genetics counsellor	1	1	0
Genetics consultant	1	0	1
Foetal medicine specialist (obstetrician)	1	0	1
Paediatric radiologist	1	0	1
Foetal and neonatal pathologists	2	1	1
Radiographer	1	1	0
Radiography assistant	1	1	0
Total	14	7	7

Professional interviews took place on the hospital site or in private places off hospital premises and were digitally recorded. Once conducted, all interviews and field-notes were transcribed, coded and organised into themes and categories. Themes emerging from professional accounts included: role of the radiologist, complexity of technology and professional practice, comparison with other technology, technology as mediator and future technological development. Identified themes were then used to reflect back on the literature and conceptual framework. Not all of the identified themes could be covered in-depth in this article (for example, technological comparison). Themes were selected according to their prominence in professional accounts.

There are currently less than 20 foetal medicine centres performing MRI in the UK (NHS England 2013). This study took place in one such centre. Pregnant women were referred for an MRI scan mostly from the surrounding region. However, due to the limited number of services some women were referred from other parts of the UK. Through the fieldwork we were able to observe MRI use for a range of foetal and maternal conditions from tumours, to missing kidneys, to problems with the placenta. Some conditions involved changes to birthing plans, neonatal surgery or difficult decisions about late termination. However, MRI did not always lead to further medical intervention in pregnancy. It was also used as a reassurance tool for parents who had experienced problems in a previous pregnancy. Furthermore, in some cases it actually led to less intervention (for example, a potential tumour identified by ultrasound could turn out to be a harmless cyst on MRI). This article will not focus on a particular condition but will discuss various issues as they emerge in professional accounts.

During clinic, radiographers would conduct the scan but the radiologist was present and sat in the back room interpreting images on a computer. The radiologist would be in constant conversation with the radiographer asking for different images in order to hone in on the pathology. Once the scan was complete, the radiologist would take pregnant women (and their supporters) into a separate room and discuss the images with them. Images would be put up on the central hospital system so that other professionals could see them. The radiologist would also write a report based on her findings which would go directly to the obstetrician and other professionals to inform pregnancy and post-natal planning. Professionals therefore had direct access to the MRI images at different times depending on specialty and on the particular problem identified. The images were also used in monthly team meetings which all

professionals were invited to attend. These meetings were used to discuss specific cases and plan individual patient pathways. Having given some background context to the study this article will now turn to an exploration of the findings.

## Findings and discussion

### *Informing clinical practice*

Existing studies on scanning technologies such as MRI and PET<sup>2</sup> have shown that the actual scan is only one part of a broader diagnostic process. Closure of a diagnosis can only be reached by cross-referencing images produced by the scan with other sources of data (Dumit 2004, Prasad 2005). Professional accounts in this study re-affirmed this view. When asked about the role of MRI in clinical practice professionals often stated that it was 'one piece in the broader diagnostic jigsaw' and a technology that could help 'fine tune' a diagnosis. This was articulated in an account by a genetics counsellor, a specialist nurse with 20 years of patient experience. MRI could assist in the diagnosis of certain genetic disorders and be used to counsel parents. It was useful in family history cases, or where genetic problems had been identified in previous pregnancies. The genetic counsellor felt that MRI could give weight to a diagnosis:

If you're trying to make a syndrome diagnosis then you're looking for different parts in a jigsaw, so if you have an MRI result then that will either give weight to or not (to a diagnosis). (genetics counsellor)

Two specialist foetal and infant pathologists were interviewed as part of the study. Antenatal MRI was used to inform foetal or neonatal post-mortem. It was particularly useful in identifying problems with the brain and could directly inform dissection or provide information for parents who did not want to consent to traditional autopsy (Brookes and Hagmann 2006). As articulated by one of the pathologists below:

Interviewer: So does MRI inform what you do then, more generally, when you come to dissect?  
Pathologist 2: Yes, the more information we have the better. This is what we need. When we go to do a dissection, it's quite important to know if we should expect anything different or not . . . MRI is also useful when there is no consent for post-mortem then we can only rely on the images.

As well as highlighting the use of MRI in different types of routine clinical practice, all of the professionals in the study mentioned its exceptional use in EXIT surgery. This is a pioneering procedure where babies with serious airway problems (such as neck and facial tumours) are half-delivered via caesarean section. The baby is operated on while remaining attached to the mother via umbilical cord. This is a risky procedure as women can suffer a fatal bleed during surgery. EXIT surgery had been successfully conducted twice at the hospital where this study took place. Foetal MRI was used to inform the surgery in both cases. This is articulated by an experienced obstetrician (foetal medicine specialist) who had conducted the surgery:

It [MRI] was absolutely vital in making the decision to do the EXIT procedure because EXIT is potentially life threatening for the mother so if we don't have a hope in hell to save the baby you might as well not take the risk with the mother's health . . . Unless we have

documented evidence [through MRI] that the baby will not survive without EXIT we would not wish to do it (foetal medicine specialist).

While most professionals clearly outlined the impact of MRI on clinical decision-making, they also felt it assisted them in emotional work such as parent counselling. For example, neonatologists were responsible for looking after babies who were seriously ill after birth. They accessed the antenatal MRI scan mostly via team meetings and often found these useful for parent counselling and postnatal planning. In one instance, a consultant neonatologist felt that the MRI scan during pregnancy had been central in preparing parents and professionals to plan a more emotionally supportive and less medicalised experience of birth. This was a case where MRI had been used to rule out the possibility of EXIT surgery:

I suppose a case I remember us being very strongly involved with was a baby who has got a very big facial tumour and the MRI was incredibly helpful in that situation because we knew that there was going to be nothing we could do for that baby, and that meant that when the baby was born the emphasis could be very different. I wrapped the baby up. I had Dad in the room with me. Dad held the baby. We took some photos; whereas if I hadn't known that, Dad would have been somewhere else, we would have been trying to resuscitate the baby. It would have been a very different experience for everybody (neonatologist 1).

The role of MRI in parent counselling was also highlighted in an account by a paediatric surgical nurse regarding a baby with a congenital diaphragmatic hernia (CDH). This is a condition where a hole in the baby's diaphragm means that contents of the abdomen can move into the chest cavity preventing adequate lung growth. MRI is often used to assess the severity of CDH, to examine lung capacity and plan for postnatal surgery. This nurse shows how the image and professional counselling worked together to provide a positive experience for parents, even when the baby's outlook might be poor:

There are huge risks with diaphragmatic hernias and sometimes you can tell by the MRI and the ultrasound that the lung tissue there is not sufficient or it's not very much so it's probably not going to be good – but this family, they had had the scans and then they had come for antenatal counselling, and they just said that, you know, even if their baby didn't survive (and he did survive and he went home and he did really, really well, really, really quickly) but they just felt that they were so grateful that they had had like the MRI pictures and the time given to them for their baby, and they said, you know, that they feel that when he's born he will have the best opportunity and if he doesn't survive then everyone's done their best for them. (surgical nurse)

In emphasising the value of MRI in this context, professionals often stressed the importance not just of the technology but also the radiologist and her ability to talk to parents about what she had found. This point is articulated by the genetic counsellor:

And, the radiologist is so good at talking to them, I mean if the person doing the MRIs was somebody who didn't talk to the patients and didn't explain things it would be a different situation. But, because she's so good the patients will go away understanding what she's found or not found. (genetic counsellor)

The potential of technology to depersonalise medicine has often been highlighted in existing research. However, as Heath *et al.* (2003) argue, communication and emotional labour in



clinical settings can often counter the potentially alienating characteristics of tools and artefacts. In this context, MRI was completely entwined with, and played an important role in mediating emotional labour in professional practice. However the role of the radiologist was cited as important in mediating both parent experience and other professional use of the technology. This lends support to the technology-in-practice approach because it emphasises the importance of a complex interaction between social context, interpersonal relationships and technological application. It also reinforces the view made by others that technologies such as MRI form one part of broader assemblage of techniques used to inform specific aspects of clinical work (Latimer 2013). As will be explored next, the technology itself was also complex and differential aspects of it also informed different types of professional practice.

### *The image versus the written word*

When computer assisted technologies such as CT and MRI first emerged in the 1970s many argued that a new visual regime was created in medicine (Prasad 2014). At first glance MR images may look similar to X-ray however they do not involve 'seeing' in the traditional sense because they are not based on the reflection or absorption of light or other electromagnetic waves (Prasad 2005). Diverse sets of MR images are produced by converting physical data such as relaxation times into spatial maps of internal parts of the body with the help of computers (Joyce 2006, Prasad 2005). MRI images are made intelligible by radiologists through comparison with other anatomical 'facts' – statistics on disease, and comparison with brain and body atlases (Dussauge 2008). The radiologist then produces a written report translating the content of images into words. This report is circulated to all relevant professionals involved in an individual patients' healthcare pathway. In this study, professional respondents tended to distinguish between the images produced by MRI and the radiologist's report and their different roles each played in clinical practice. Images played a central role in counselling parents as articulated by a surgical nurse:

I think it's really important for parents, especially if there's something wrong with your baby, it's very important that they have, you know, things like pictures and that; it just helps them really. (surgical nurse)

While most professionals felt images were central to parent counselling several relied on the radiologists report for diagnosis. MRI images have no straightforward relationships to the way the body looks to the untrained eye, and demand considerable interpretative skill from radiologists before they can be reliably used for clinical purposes (Prasad 2005). This is reflected by a neonatologist who relied on the radiologists report for diagnostic information:

I would say more from the report. Looking at the images, I find really difficult to look at if you're not an expert, because the orientation is completely different because the baby . . . if you or I had a scan we'd go in the scanner lying as we are. The babies can be upside down, diagonal, backwards, so that's quite difficult to look at. (neonatologist 1)

In contrast perhaps to other professionals, one of the paediatric surgeons felt that visual technology including MRI informed every aspect of his clinical practice, from counselling parents to conducting surgery as articulated below:

I use a lot of videos, video of surgeries, so I use still and video images from when I'm operating with keyhole surgery. I'll use them to show parents after surgery, so then you can have your [antenatal] MRI, followed up by your telescopic image and that creates a whole image for the patients. (paediatric surgeon 1)

This perhaps relates to the anatomical underpinning of MRI. In her work on MRI in radiology and psychiatry in Sweden for example, Dussauge (2008) argues that anatomy provides an underlying frame for the exploration and reproduction of MRI visions. Anatomy also forms a central role in both surgical teaching and training (Turney 2007). As the numbers and scope of this study are modest, it is impossible to generalise about this specialty. However, the paediatric radiologist felt that MRI fitted in well with the practice of surgery. He related this to the anatomical nature of MRI and the way in which MRI images on different planes could be reconfigured digitally even after the scan. This is in contrast to ultrasound which is captured through a live-feed and although stored digitally on the PACs system, cannot be reconstructed afterwards:

With MR, it's like getting a sausage and putting it through a slicing machine. The slices come out the same way with every sausage. They're exactly the same. And the surgeons get very used to looking at it, because it's far more anatomical compared with ultrasound, which isn't. To understand ultrasound, you really have to be there watching the screen when it's done. With MR you don't need to. You can just look at the stack of the slices and reconstruct the sausage. So the surgeons like it because they can understand it. (paediatric radiologist)

Sociological studies on obstetric ultrasound have often focused on the production of an image and its role in the articulation of the medical gaze (Draper 2002, Zechmeister 2001). By drawing attention to the ways in which MR images are built and worked on through different types of practice the data here suggests a more complex picture. While most professionals used images for parent counselling, the data emphasise diversity in terms of how different specialties engage with the technology for diagnostics and treatment. Data reinforce the point made by others that MRI is a complex technology that cannot be reduced to the straightforward production and use of an image (Joyce 2006). MRI produces diverse sets of data allowing for different configurations and multiple ways of 'seeing' the body (Prasad 2005). This section again reinforces the technology- in- practice approach by emphasising not only the complex nature of the technology and professional engagement with it, but also by stressing the role of the radiologist in disciplining the image through interpretation work thereby mediating technological output. In the next section we will explore the role of MRI as a mediator between specialties.

#### *A technological bridge between specialties*

STS scholars have shown how material artefacts integrate and stabilise social interests (Latour 1987). Burri (2008) argues that the same holds true for the placement of artefacts that are difficult to transfer from one site to another. MRI machines are large and costly and once installed cannot be moved. She argues that this physical positioning is often used to reinforce professional boundaries and professional ownership. In this study, while the scanner was fixed in one hospital location the actual image (once uploaded onto the hospital system) was mobile and could be used across both time and space. MRI appeared to act in this context as a boundary object – while it held different meanings for professionals working in different specialties, it also acted as a means of translation between them (Star and Griesemer 1989). As articulated by the surgical nurse, the images were often used in team meetings (along with other information) to discuss particular patient cases:

The radiologist shows them (MR images) at the MDT (monthly team) meeting and they (different specialists) discuss it. I think it is useful because then, especially if I'm there with the paed surgeon . . . and then you discuss a (pregnant) lady, you see the ultrasound, you see the MRI, and then you have the antenatal counselling and you sort of say, oh, I

remember this as the lady that had X, Y, Z, and then that does help in doing the counselling because you've got a bit more information to deliver to the parents. (surgical nurse)

MRI can and does lead to professional conflict at different times and in different contexts. For example, Prasad (2014) argues that during the development of MRI inter-professional conflict arose as a result of media debates over safety issues. In this particular context however MRI appeared to enhance cooperation between different types of professionals. It was not simply used to ensure the imposition of the radiological vision onto others rather it acted as a bridge between different specialties and viewpoints (Star and Griesemer 1989). This is articulated in the quote from the paediatric surgeon below:

The obstetricians form an opinion we form our opinion and it (MRI) kind of acts as a bridge between the two as well. (paediatric surgeon 1)

As well as acting as a bridging technology, this surgeon felt that MRI would lead to the development of new combined specialities within paediatric medicine. He articulated this with reference to the development of interventional radiology:

The imaging technology is marrying with the interventional technologies so that you now get this interface area of specialism which is modern interventional radiology, they're not surgeons, nor just film critics. They're actually recognising the problem, creating an image and intervening with putting wires or tubes up through arteries and veins and stereotactic surgery in the brain, for instance, what they do over the road (in another local hospital) is absolutely amazing. (paediatric surgeon 1)

Galison (1997) developed the term 'trading zone' in order to explain how physicists from different paradigms collaborated with each other. He argued that cooperative trading between groups is necessary for most scientific work to move forward. In this study MRI was part of this cooperative trading between different medical specialities. Successful developments in surgical and radiological techniques using MRI required cooperation and team work beyond individual career aspirations, as articulated below:

Paediatric surgeon 1: It's not just about cornering your little market or having your niche. It is fun, it's exciting to be in a new area.

Interviewer: Something that's going forward.

Paediatric surgeon1: So necessarily you are part of a much bigger team when you're in those interface areas.

While the professionals involved in the study all found MRI useful, some of them did suggest that there were other professionals who felt threatened by the technology and did not engage directly with it. One pathologist felt that the technology would increasingly be used to inform post-mortem practice and professionals had to decide either to work with it or compete with it and risk becoming side-lined:

I know that there are pathologists that would not be supportive of MRI, of competing with MRI in the post-mortem field, but my view is that rather than competing, I have to get them to work with me. (pathologist 1)

In this study MRI images appeared to facilitate cooperation between different types of professionals. Such cooperation was sought to ensure the best patient pathways were established and

also to move clinical developments in the field forward (Dumit 2004, Galison 1997). This cooperation between specialties was established largely through monthly team meetings where cases were discussed and care plans established. Images played a central role in this process. Not all professionals were able to attend every meeting, and there was some evidence of resentment towards MRI. However, most saw MRI as a technological bridge between specialties – a medium of translation between different professional worlds (Star and Griesemer 1989). This reinforces another aspect of the technology-in-practice approach by emphasising the potential of technology to act as mediator in the construction and reproduction of different types of professional practice (Timmermans and Berg 2003). According to some the use of foetal MRI could lead to the development of new medical specialties. The article now turns to a focus on its potential future use.

### *Is the future magnetic?*

Joyce predicted in 2006 that MRI could be used in the future for foetal and breast imaging. MRI in the UK is now beginning to be applied in both areas. Professional respondents in this study were invited to give their views on the potential future of obstetric MRI. During the development of MRI in the 1970s and 80s the fact that it did not use nuclear radiation was perceived to be a key advantage of the technology over CT (Prasad 2014). This focus on safety featured heavily in professional accounts on its projected future use in obstetrics and paediatrics:

I think it's (MRI) probably going to be used more . . . and I think it's better from a radiation point of view isn't it? . . . Yes, because a CT scan is, I don't know exactly but it's something like several hundred x-rays, which isn't good is it really? But then I think the CT scans, they're getting different images aren't they so I suppose it depends what the problem is, what's the information you want, but I think for antenatal MRI is probably much better. (surgical nurse)

Some professionals focused more directly on MRI's future diagnostic potential and the impact that this could potentially have on certain specialties. One of the pathologists for example spoke of the rise of a 'super technology' involving MRI which would eventually lead to a totally new and non-invasive approach to autopsy:

I'm sure that it is going to evolve so much that you will get this microscope embedded into the 3D and MRI and CT and we will be able to do a PM (post-mortem) without opening the bodies, perhaps. (pathologist 1)

While most professionals were positive about the likely increased use of MRI, some raised concerns. The consultant geneticist for example felt that MRI would increasingly show us more changes in the body of which we don't know the consequence. This would be a case of technological potential outstripping our knowledge of the body as articulated below:

And, I think the new technology, which is called Next Generation Sequencing, the anxiety on our side is that we're going to see more and more changes (in the brain and body) of which we're uncertain of their significance. (consultant geneticist)

The foetal medicine consultant felt that the technology was simply too large and expensive to ever become fully routinised in clinical practice and would therefore continue to remain an adjunct to ultrasound. The paediatric radiologist who had been involved in the original

development of MRI felt that while it would continue to expand, this expansion however, would slow down and stop at some point:

I don't think it'll disappear, because it is a very useful tool. I've lived through the development of MRI, when MRI started off as a scientific concept, and when, in the UK, there were three scans in the whole of the UK. [*mobile phone ringing*] So when, you know, people said, well, MR, it'll never catch on, it'll never be any use. Now every hospital has got an MR scanner, 20 odd, 30 years down the line. I can't see that happening in obstetrics. I can't see every woman having an MRI scan – I may be wrong. I suspect, like most imaging, once you have the facility available, initially it was only used for a certain number of conditions, and as you learn and get used to it, it gradually expands, and then I think it will stop at some stage. (paediatric radiologist)

MRI is one of several important technologies currently used in the obstetric realm. As the technology develops it is likely to be able to 'show' us more, and will probably be used more widely. The threshold for visualisation could become lower due to fear of litigation. We may even find ourselves in a similar situation to those in the US where the combination of a commercialisation of health along with the power of the visual have led to MRI scanners being placed in shopping malls (Joyce 2006). However, due to size and cost it may never become fully routinised in antenatal care in the same way that ultrasound has been. Furthermore, the constant pressure on using visualisation as reassurance may have profound impacts on clinical practice. There are concerns that as the technology develops there may be a growing discrepancy between what we 'see' and what we 'know'. The concluding section will now reflect on the role of this technology in professional practice.

## Conclusion

This article has sought to extend the focus of existing studies on MRI from radiology, neuroscience and psychiatry to the obstetric realm, and also offers a fresh angle to existing sociological discussion on the role of visual technology in obstetrics. However, the article is based on a small-scale ethnographic study of one foetal medicine clinic at one point in time, and therefore does not claim to be representative. The article will now conclude by evaluating the role of MRI in professional practice, reflecting on the conceptual framework and, situating this technology in the broader context of debates on visual technology in health.

Data from the study highlighted some differences in professional interaction with MRI technology. This is reflected in different specialities' interests. For example, neonatologists felt MRI assisted them in the development of postnatal care plans, MRI images assisted pathologists in the process of dissection. While MRI informed the practices of all the professionals in this study, there were clearly other professionals who avoided engaging with the technology. However, as one pathologist indicated, such professionals could risk becoming side-lined as the technology continues to expand. Mol (2002) in her study on atherosclerosis (a disease of the arteries) suggests there is not one singular reading of the body or implementation of technology, rather there are multiple forms of reality as constructed through different types of practice. This was something reflected through professional data in this study. Despite some diversity in professional accounts, however, for the participants in this study, MRI tended to play two key roles. It gave clinicians more diagnostic information to assist in clinical decision-making and intervention strategies. It also assisted clinicians in parent counselling and in the articulation of emotional labour. The image in particular was used to counsel parents, plan for a less medicalised birth and

often became a keepsake for parents who may go on to experience neonatal loss. MRI use in obstetrics could therefore be viewed as one piece of the jigsaw, an important part of a broader assemblage of materials used to inform different types of professional practice (Latimer 2013).

In support of the technology-in-practice approach, social context and in particular social relationships were pivotal in informing professional perceptions and employment of the technology. For example, the foetal radiologist played a central role in mediating both parent and professional experience of MRI. Professional trust in her clinical ability, her written report and ability to convey news to parents was reflected in some-way across all professional accounts. This leads onto a related point, the role of the technology (and radiologist) as mediator across specialties. Fox (1992) argued that all medical specialties seek to possess the authority to heal, and will use discursive strategies to demonstrate their 'truth' as being the one that others should follow. Sociologists often suggest that technologies such as MRI are part of the discursive strategy employed by radiology to assert 'truth' and reinforce disciplinary boundaries (Burri 2008). However, in this context MRI was not used to assert the status of the radiologist rather it acted as a boundary object, a bridge between different types of professional practice (Star and Griesemer 1989). Its use in MDT meetings appeared to facilitate professional teamwork and planning over particular patient pathways. Furthermore, collaboration through MRI helped to push clinical developments forward in this field. MRI use in this context is perhaps indicative of broader changes in clinical work brought about by the scientific turn in medicine. As Rabeharisoa and Bourret (2009) argue clinical work no longer consists of the physician examining a patient and formulating a diagnosis. Clinical work is increasingly distributed in and between what they call 'bioclinical collectives'. These collectives bring together researchers and clinicians from different disciplines and specialties, and strongly interconnect the clinic and research. This process of collaboration as shown in this study plays a key role in driving new developments in medicine forward (Galison 1997)

Sociological studies on imaging in obstetrics have often focused on the production of an ultrasound image and its role in the articulation of the medical gaze (Draper 2002, Zechmeister 2001). In contrast, STS studies have highlighted the complex nature of technologies such as MRI- focusing on its use in radiology and various brain related specialties. Prasad (2005) for example, has argued that MRI visuality is complicated and is not constituted by one act of 'seeing'. Rather MRI produces diverse sets of images which are then made intelligible by radiologists through comparison with other anatomical 'facts' such as brain atlases (Dussauge 2008). The development of MR technology allows for the production of the body according to Prasad (2005) facilitating an almost unlimited extension of the medical gaze. The findings of this study on obstetric MRI reinforce the argument made by STS scholars that MRI is a complex technology that goes beyond the production of an image. MR images in the obstetric realm are disciplined by the radiologist who translates their content into words, and mediates this information to relevant professionals. These images are however also built and reconfigured through different types of professional practice in a range of medical specialties. In this study therefore MRI did not appear to produce a mono or bifocal medical gaze (the obstetric or radiological gaze) as such, but rather multiple and contingent versions depending on medical training and speciality. This reinforces the need for future research on obstetric imaging to acknowledge the diversity and complexity of visual technologies themselves, going beyond the role of the actual image in clinical practice.

This article has shown how MRI is one part of a broader assemblage of technologies currently being applied in the obstetric realm. How this technological application will evolve remains unclear. Joyce (2006: 6) argued that the 'cultural ideologies that link sight and knowledge contribute to how we find meaning in pictures of the body'. However, what happens when there is a growing disjuncture between what we 'see' through the MR image and what

we 'know' about changes in the body? Furthermore, despite its continued expansion MRI has not always produced the medical certainty that was initially hoped (e.g. its limited success in the diagnosis of schizophrenia, autism and ADHD) (Joyce 2010). Such ambiguity adds a cautionary note to the projected future growth of this emerging 'technology-in-professional practice' in obstetrics. Building on the conceptual framework developed by Timmermans and Berg, the present case emphasises the need for future sociological work to explore the complex intersection of technology and professional practice.

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## Notes

- 1 Doctors were all consultants. The allied health professionals were all over 15 years post-qualification. The health care assistant (RA) had been in her role for 13 years.
- 2 Positron emission tomography (PET) scans involve injecting radioactive isotopes into the body and then imaging radioactivity through time. They are used to produce detailed 3D images of inside the body (Dumit 2008).

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