SAFETY OF FETAL MRI: Neonatal And Development Outcome

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Background

- MRI is a popular and widespread imaging technique. In contrast to many other imaging techniques, MRI lacks use of ionizing radiation and has very high resolution

- Ionizing radiation is a know teratogen, Therefore, when imaging is needed on a pregnant individual, MRI is preferred, when applicable

Is MRI always safe ?

Potential harmful effects on the fetus

- **Acoustic noise**: sound pressure levels can reach 120 dB (equivalent to a jet engine at take-off)
- **Heating**: caused by absorption of radio waves
- **Teratogenic effects**: due to exposure to high power electromagnetic fields

Literature Review

Rats:

- "Mated Wistar rats were chronically exposed to a static magnetic field (MF) from day 1 to day 20 of pregnancy"

- "MF exposed pregnant rats showed a significant **decrease in the number of live fetuses**"

Effects of static and time-varying (50-Hz) magnetic fields on reproduction and fetal development in rats. Mevissen M, Buntenkötter S, Löscher W. Teratology. 1994 Sep;50(3):229-37.

Literature Review

Chickens:

"When embryos were sacrificed on the 6th day of incubation, exposed embryos from all developmental groups showed a trend toward **higher abnormality** and mortality rates than their controls"

Effects of MR exposure at 1.5 T on early embryonic development of the chick.
Yip YP, Capriotti C, Talagala SL, Yip JW. J Magn Reson Imaging. 1994 Sep-Oct;4(5):742-8.

Literature Review

Sheep:

"Intense exogenous noise penetrated the uterus of pregnant sheep and resulted in **elevations in auditory brain stem response thresholds** 2 to 3 weeks after exposure. In fetuses repeatedly exposed to noise, the middle and apical turns of the cochlea showed **greater hair cell damage** than found at the same locations in control cochlea"

Effects of intense noise exposure on fetal sheep auditory brain stem response and inner ear histology. Gerhardt KJ, Pierson LL, Huang X, Abrams RM, Rarey KE. Ear Hear. 1999 Feb;20(1):21-32.

Literature Review

Human:

"**pediatric assessment at 9 months of age** in infants exposed to echo planar MRI in utero from **20 weeks gestation** to term were investigated by performing a case controlled prospective observational study of **20 infants**"

"A small but significant **decrease in length** ($p = 0.047$). No other significant developmental or social differences were seen between the two groups. Infants at 9 months of age did not demonstrate any gross abnormality likely to be related to exposure to echo planar MRI in utero"

Infants exposed to MRI in utero have a normal paediatric assessment at 9 months of age. Clements H, Duncan KR, Fielding K, Gowland PA, Johnson IR, Baker PN.
Br J Radiol. 2000 Feb;73(866):190-4.

Literature Review

Human:

"**Thirty-five children** between 1 and 3 years of age, **and nine children** between 8 and 9 years of age, that were exposed to MR during the **third trimester** of pregnancy, were checked for possible adverse effects in a **follow-up study**. Data on pregnancy and birth, the results of a neurological examination at 3 months, their medical documentary with emphasis on eye and ear functioning, and a questionnaire answered by their mothers were collected and evaluated.

No harmful effects of prenatal MR exposure in the third trimester of pregnancy were detected in this study"

Absence of harmful effects of magnetic resonance exposure at 1.5 T in utero during the third trimesterof pregnancy: a follow-up study. Kok RD1, de Vries MM, Heerschap A, van den Berg PP. Magn Reson Imaging. 2004 Jul;22(6):851-4.

Literature Review

Recent study on humans, Feb 2015

Methods:

"a group of **751** neonates exposed to MR imaging in utero and a group of control subjects comprising **10,042** nonexposed neonates, both groups with no risk factors for hearing impairment at birth"

"Neonatal hearing screening was performed by means of otoacoustic emission testing and auditory brain stem response according to national guidelines"

Results:

- The rate of hearing impairment or deafness was found to be 0% (0 of 751) in the neonates in the exposed group
- There was no between-group difference in birth weight percentiles

Safety of MR Imaging at 1.5 T in Fetuses: A Retrospective Case-Control Study of Birth Weights and the Effects of Acoustic Noise. Strizek B1, Jani JC, Mucyo E, De Keyzer F, Pauwels I, Ziane S, Mansbach AL, Deltenre P, Cos T, Cannie MM. Radiology. 2015 Jan 7:141382

Literature Review

Weaknesses of this study:

- Most of the study cases were exposed to the MRI at the 3rd trimester, i.e. post organogenesis
- The study did not compare the outcome in different trimesters
- There was no follow-up in order to evaluate long term effects

And Now…

Our Study

Rationale

- Although research on animals demonstrates harmful effects of MRI on embryos, human studies do not support these claims, but do mention that due to scarce information, further research needs to be done.
- By gathering information and **follow-ups** about pregnant women that underwent MRI scans in different trimesters especially the **first and second** we can better evaluate the adverse effect of MRI if any

Methods

A retrospective study based on Sheba Medical Center's database and Telephone questionnaire

Methods

The first phase:

- Fetuses which were exposed to MRI during the pregnancy between 2011-2015 will be depicted from the Sheba's computerized database
- The study group will include about 150 fetuses that were exposed to MRI in different trimesters and from various indications: maternal, placental and fetal

Methods

The second phase:

Information will be collected about neonates short term outcome and childhood neurodevelopmental skills (who underwent MRI during pregnancy) from time of birth until neurodevelopmental assessment:

- Hospital database
- Telephone questionnaire (neurodevelopmental vineland score)

Inclusion Criteria :

- MRI performed due to non-serious indication and without or subtle findings
- Singleton
- Childbirth in Sheba medical center
- Existence of newborn's medical information

Exclusion Criteria:

- Significant findings in the MRI results
- Birth complications
- Pregnancy complications
- CMV infection during pregnancy
- Multifetal pregnancy

Data

Mother:

- Age
- Background disease
- Medications
- Previous pregnancies and their progression
- Conception method
- Findings on Routine fetal organ Scan
- Amniocentesis
- Pregnancy diseases (such as diabetes, hypertension…)
- Infection such as CMV

Data

Birth data:

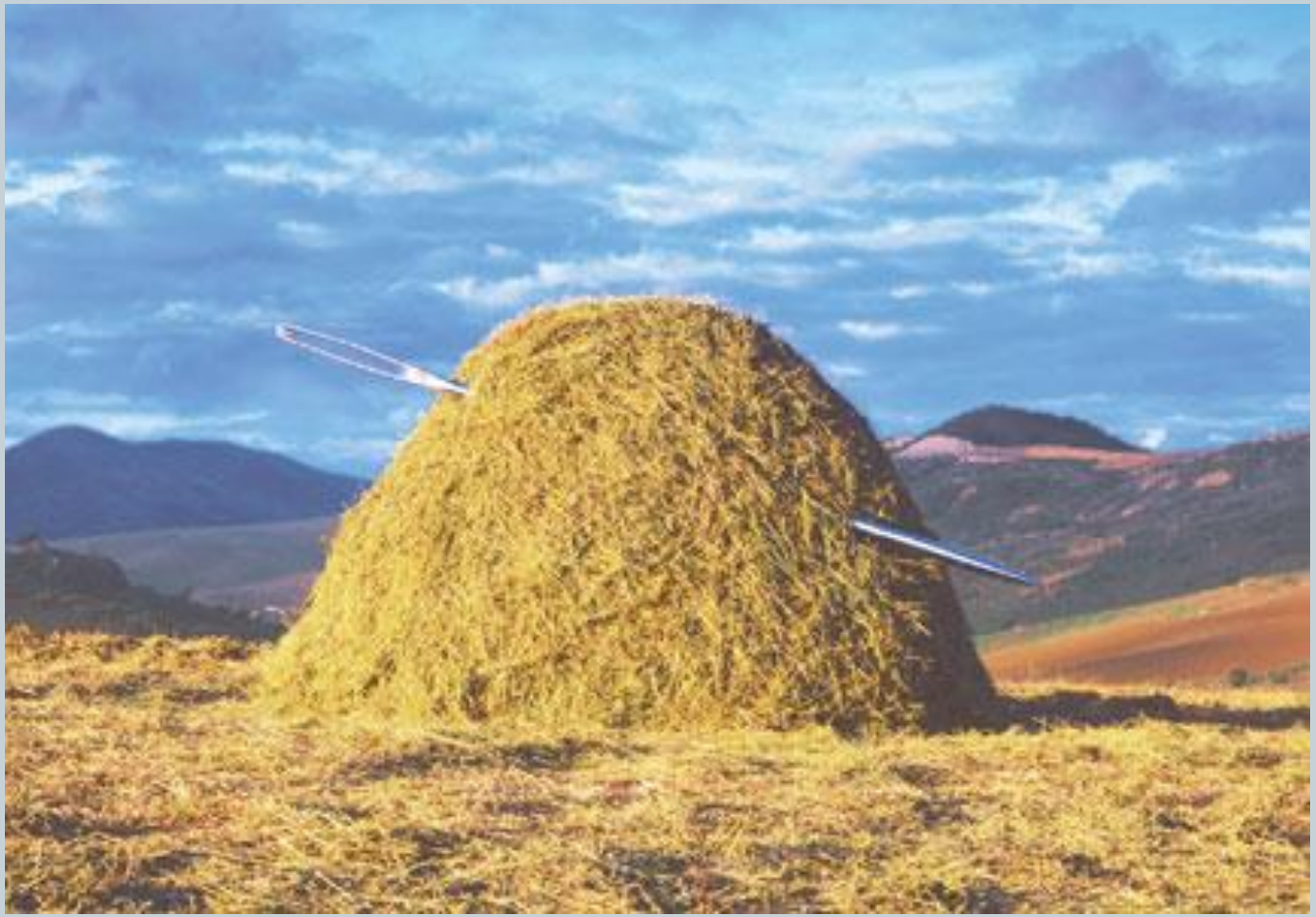
- Week at birth
- Hour of birth
- Fetal sex
- Weight
- Mode of delivery
- Complications

Data

Newborn Data:

- Apgar score
- Cord blood pH
- Duration of hospitalization
- Abnormal findings on physical examination
- Abnormal findings on laboratory examination
- Hearing examination
- Neurological examination
- Developmental milestones (vineland score)

Where are we now?



Study Progress

- We examined over 2,500 files and selected 153 suitable candidates on which we started collecting data
- Our biggest challenge has turned out to be finding fetuses that were exposed during the first trimester (out of 2,500 only 8 cases were found)
- We expanded our search to all indications to MRI during pregnancy (Maternal, Fetal, Placental)

Study group

First trimester- 8 subjects

Second trimester-36 subjects

Third trimester- 109 subjects

Indication for the MRI scan

Maternal : 63 subjects

- Appendicitis
- Back\abdominal pain
- Headaches

Fetal: 85 subjects

- Asymmetric lateral ventricle
- Low head circumference
- brain Cyst
- Lack of Amniotic fluid

Others:

For example: abnormalities in previous pregnancies


thank you!