



Embracing neonatal MRI

A revolutionary neonatal MRI system is enabling hospitals to run more brain diagnostics on premature babies in intensive care units than ever. Elly Earls talks to **Uri Rapoport**, CEO of Aspect Imaging, about this game-changing new technology.

More than half of babies born before their due date by ten or more weeks suffer from brain damage. If an adult has suspected brain damage, they are immediately sent for an MRI scan, but the decision is not so easily made when the patient is a preterm infant.

For premature babies, the process of getting to the MRI machine, which may be on another floor or even in another building to the neonatal intensive care unit (NICU), is fraught with risks and complications, including germ exposure. And that's before they are subjected to

the cold environments that often surround conventional MRIs and the frightening sounds that they emit during a scan.

Because of this, ultrasound is the go-to technology for scanning newborns' brains. It may not be as sensitive as MRI, which can show a wider range of brain abnormalities in greater detail, but it's cheap, widely available and portable. Until recently, there was no MRI machine that came close to its level of convenience.

Radical improvements

Developed by Israeli company Aspect Imaging – which specialises in compact

MRI systems with performance that is comparable to that of large conventional MRIs – the Embrace Neonatal MRI System became the first FDA-cleared MRI device specifically for neonatal brain and head imaging in NICUs in July 2017.

Compact, quiet, self-shielded and able to accommodate a dedicated temperature-controlled incubator-like bed, the Embrace can be brought to the patient, removing the need for those perilous journeys to the MRI room.

“Preparing a baby for a conventional MRI and scanning requires anywhere

between three and six hours,” explains Uri Rapoport, founder, president and CEO of Aspect Imaging. “You have to extend the lengths of the tubes/pipes of any devices that are connected to the baby from around 1.5m to 4–6m, which is not a simple task.

“Then you have to take the baby out of the NICU into the MRI room downstairs in the basement [because conventional MRIs are acutely sensitive to vibration]. In the best-case scenario, this would be in the same building, but sometimes it isn’t. This journey presents major hazards such as the risk of contamination.”

Most importantly, though, keeping the baby in the NICU means it remains close to all the equipment essential to maintaining its life. “When we interviewed NICU managers,” Rapoport recalls, “their first request was always, ‘Please do not take the baby outside the NICU.’ They told us: ‘If something goes wrong, we don’t have the equipment downstairs, we don’t have the staff downstairs. We want to do it right here, in the safe environment of the NICU.’”

Unlike conventional MRI machines, the Embrace is fully enclosed with a negligible external magnetic field, which means that it can be used in a standard NICU, no matter what the surrounding equipment is made of.

“With superconducting technology as it is today, there are very strong magnetic fields outside conventional MRI machines, so all the equipment around them must be R-conditional,” Rapoport says. “But with the Embrace, you can have equipment around it, whether it’s made out of steel, iron, plastic or anything else. There are practically no restrictions.”

Doctors and nurses can also stay with the baby during the scan and, if necessary, pull the baby out in under 30 seconds, after which everything and everyone needed for treatment or resuscitation is on hand. If no problems arise, the whole process, from bed to bed, can take as little as 45 minutes, Rapoport explains.

Uri Rapoport

Aspect Imaging’s founder, president and CEO, Uri Rapoport is an expert in permanent magnet technology. He founded and led several Israeli and US companies in the fields of NMR and MRI, and holds multiple worldwide and US patents in the fields of NMR, MRI, and GPS.



Breakthrough technologies

The main technological features that set the Embrace apart from conventional MRIs are:

- **Magnet:** the Embrace system uses a 1T permanent magnet instead of a superconducting magnet, which would require cooling systems.
- **Self-shield:** the Embrace’s ‘5G line’ – the perimeter within which the levels of static magnetic field exposure are dangerous – is within the magnet covers. This means that NICU equipment can be placed near the system and no special MRI room is required.
- **Patient bed:** infants are placed in a custom-designed patient bed, complete with a customised swaddling accessory that

minimises movement and maximises comfort. The incubator-like environment is safe, temperature-controlled and enables continuous monitoring of the child’s vital signs.

- **Coil:** the baby’s head is scanned using a transmit-receive head coil specifically designed for infants.
- **Acoustics:** the acoustic noise generated by the Embrace is drastically lower than that of a full body MRI system.

The system was developed over the course of seven years by Rapoport – who has worked in the permanent magnet industry for over 30 years – and his team. At present, the company has approximately 160 patents



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The Result of Aspect's Evolution - Today



Aspect Imaging has developed its magnet technology over the years, creating roughly 200 versions in order to continuously improve.

protecting the technology, with another 100 pending.

"It's the accumulation of knowledge – of daring to try, daring to test and daring to show what we can do," Rapoport says. "Over the years, we scaled up from small devices to large devices and we did it in a very efficient way. Over the last seven years, we have assembled about 200 versions of this technology magnet and all of them got to spec.

"We have the largest commercially available magnetiser in the world outside the US government and had to invent not only the technology itself, but also the ways in which to manufacture it commercially. We have developed fantastic simulation tools in-house, we didn't buy anything off the shelf. All this means that we can build systems cost-effectively and install them in places that were never feasible before," he adds.

Clinical drivers

So far, one Embrace system is currently in hospital use. Jerusalem's Shaare Zedek Medical Center delivers 22,000 infants every year, more than any other hospital in Israel, and in the first three months of using the Embrace, it ran around 20 scans.

The next machine is bound for a Harvard medical school affiliation hospital in Boston, which currently has more than 20 MRI machines at one campus, but carries out only one baby MRI scan per day due to the complexity of the process. With the Embrace, they anticipate

increasing this number to five to six.

Aspect Imaging is also in the process of manufacturing 12 other units, and has been in talks with organisations in the US, the EU, Hong Kong, China and Singapore.

MRI's sensitivity tops that of ultrasound for analysing brain injuries in premature/newborn babies, and these increased capabilities are spurring hospitals to invest in the Embrace system.

"There is no argument in the medical community that MRI is the ultimate tool for the full brain diagnostics," Rapoport says. "If you make MRI as simple as using a blood pressure gauge, there's no reason that everybody would not want to use it."

Multiple scientific studies back him up. For example, a study carried out in 2009 to compare the incidence and type of brain abnormality detected by MRI and ultrasound in a large cohort of premature babies with seizures found that the full extent of brain abnormalities were not well characterised by head ultrasounds in eight out of nine cases.

The research also stated that MRI can be performed safely in the newborn period and has increased sensitivity for brain injury compared with ultrasound, referencing several previous studies comparing the two technologies that found that ultrasound often fails to detect white matter injury.

The only downsides of MRI technology highlighted were its increased cost, and the specialised equipment and personnel that were needed to ensure safety during transportation and imaging.

Another paper, published in 2010, focused on the clinical and radiological aspects of 129 neonatal MRI examinations over a three-year period, and evaluated whether clinical management would change following information from an MRI. It found that MRI-based changes were initiated in 58% of cases, while in 57% of cases the initial ultrasound diagnosis was changed or further specified.

At present, there is no cure for brain damage in premature babies, and many who survive go on to develop lifelong problems such as cerebral palsy, epilepsy and learning disabilities.

Rapoport's hope is that the more hospitals use the Embrace system to detect problems early, and the more information that accumulates, the better the outcomes these patients will have in the long term.

"We want to completely change the management of premature and newborn babies in hospitals for good," he says. "In fact, my vision eventually is that every baby should have a brain MRI before they go home because many babies have problems that you can't see.

"If you detect problems early, hopefully, with the proper treatment, rehabilitation and physiotherapy, these children can grow to become functioning adults.

"Of course, there is no quick fix, and to penetrate with such new technology requires patience, know-how, time and money. But the interest we are generating is unbelievable. This is a game-changer," he concludes. ■