Original Research

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Feed-and-sleep: a non-invasive and safe alternative to general anaesthesia when imaging very young children

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Abstract The successful image acquisition during a Magnetic Resonance Imaging (MRI) examination requires the subject to remain motionless. For very young children this requirement presents a challenge since reduced cooperation is to be expected with young patients. A general anaesthetic is often needed to immobilise the patient and satisfactorily complete the MRI. However, utilising a general anaesthetic involves costs in terms of staffing requirements, recovery time, pharmaceuticals and specialised equipment. A non-invasive method to ensure paediatric patient immobility during MRI may therefore be considered a better option. Evaluation of the success rate of completing paediatric MRI examinations at the Mater Private MRI Unit, Brisbane, by using food, comfort and an immobilisation device to induce sleep in infants has been undertaken. Over a period of 15 months a group of 36 infants were scanned without the aid of a general anaesthetic. The patients arrived in the department and were fed and nursed until they settled down. Once calm, the child would be taken into the scan room, accompanied by a parent or guardian and positioned in an immobilisation beanbag. The "feed-and-sleep" approach enabled the successful completion of scans in 89 per cent of patients in the study group. Using a feed-and-sleep method to complete a diagnostic imaging test offers a non-invasive option for the young paediatric patient. The advantage of the feed-and-sleep method is a reduction of cost and time associated with a general anaesthetic.

Keywords: Feed-and-sleep, general anaesthetics, non-invasive, MRI, paediatric patients.

Introduction

The aim of this investigation was to assess the feasibility of using a "feed-and-sleep" approach, with immobilisation devices, in an infant study population for MRI examinations instead of using a general anaesthetic.

The success of imaging the young patient depends on the cooperation of the child and his or her ability to lie still for the duration of the scan.[1] Newer parallel imaging techniques in MRI, such as the Array Spatial Sensitivity Encoding Technique (ASSET), have effectively reduced scan times. In addition, MRI acquisitions, like Periodically Rotated Overlapping Parallel Lines with Enhanced Reconstruction (PROPELLER), have rectified and compensated minor movement artefacts.[2,3]

Special consideration also needs to be taken when imaging the paediatric patient group. For example, infants cannot verbally communicate their needs so other forms of monitoring are necessary in the MRI suite. The acoustic noise and unfamiliar surrounds can frighten a child[4] and a general anaesthetic (GA) is therefore frequently used for imaging scenarios.[5] There are both benefits and risks of utilising GA when imaging paediatric patients. One of the risks associated with general anaesthetics for children is that their airways can become obstructed as a result of laryngospasm and this complication has been reported by other authors to be common in young patient groups.[5,6] MRI examination under GA in paediatric patients is time-consuming as it encompasses the preparation and safety screening of the patient, accompanying parents or guardians and staff, the scan itself, and finally the recovery after the anaesthesia where the patient is still in the MRI department.[7] Based on these factors, a non-GA setting for very young children having MRI examinations may prove to be a valid option, as this article set out to evaluate.

Method

The study was carried out as a retrospective study. To ensure patient confidentiality only de-identified data with patient age were recorded and used for the analysis. Ethics approval for the study was granted by the Queensland X-Ray Organisational Quality Committee.

Over a period of 15 months from January 2005 to April 2006 a number of young paediatric patients were scheduled to have MRI examinations without the use of a general anaesthetic at the Mater Private MRI Unit, Brisbane. The children were not anaesthetised upon arrival in the department, instead they were fed and nursed prior to the scan to induce sleep and they were then positioned in an immobilisation device and scanned. This approached is referred to as the "feed-and-sleep" method.

A total of 36 patients were assessed using the "feed-and-sleep" approach with an age group distribution ranging from three days to 39 weeks one day. The mean age of the patients was five weeks six days.

The workflow for a feed-and-sleep procedure in the department was: The patient was scheduled to arrive in the department half an hour prior to the scan and should have been fasting for four hours. After initial MRI safety screening of the child and any accompanying parent or guardian and hospital staff, the child would be fed until satisfied and then nursed by a family member or guardian to calm him or her down. Once fed and settled down, the child would be taken into the scan room escorted by a parent or guardian and positioned in a beanbag (VacFix Vacuum Cushion,

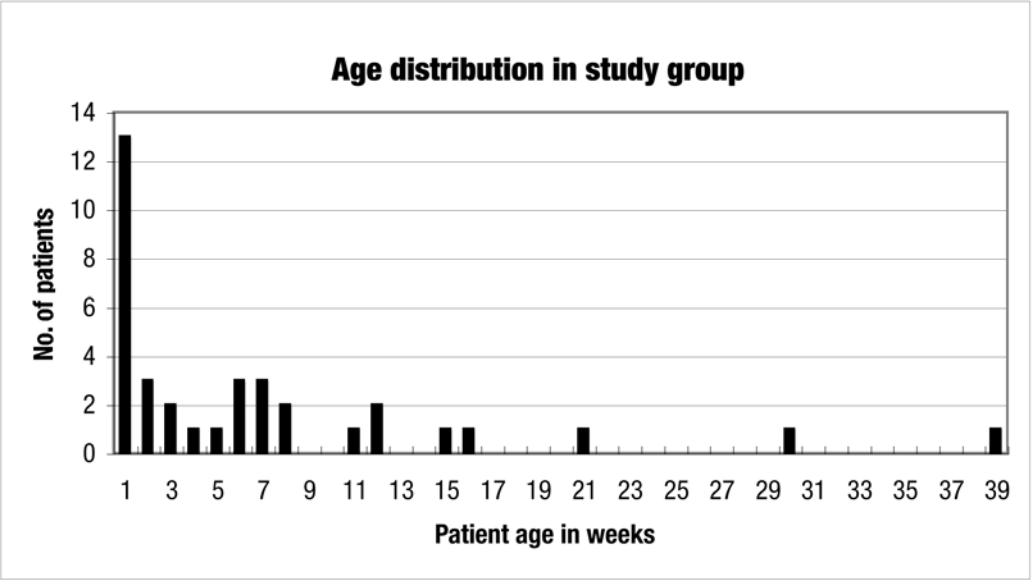

Figure 1: Age distribution in the feed-and-sleep study cohort.

PAR Scientific A/S, Sivlandvænget, Denmark). The beanbag was soft and could easily be moulded to fit in the MRI coil of choice. Once the patient was properly positioned, the air was sucked out of the beanbag which made it shape to the child's body and this maintained good immobilisation. The family member or guardian would stay in the scan room for the duration of the examination to reassure and monitor the infant. The MRI examinations were performed on a General Electric (Milwaukee, Wisconsin, USA) 1.5 Tesla Signa TwinSpeed Magnetic Resonance System.

The anatomical region most frequently scanned during the 15 months period was the brain. For head imaging PROPELLER acquisitions were employed when possible to reduce the risk of motion blur during the scan. Examination times varied depending on clinical indications but were typically less than 15 minutes.

Information was recorded for each patient in the study cohort presenting for an MRI examination and included:

- The child's age in weeks and days.
- Whether adequate patient preparation i.e. timely arrival in the department and appropriate fasting status had been completed according to accompanying guardian or nursing staff.
- The patient's condition upon completion of feeding when being positioned in the beanbag was recorded and was categorised as either "relaxed" or "alert".

The relaxed state was noted when the child was either sleeping or very drowsy. In the alert state the infant would be awake and respond to visual and auditory stimuli.

- Any use of sedation prior to scan was also registered.
- Image quality was assessed using three categories; good, diagnostic or unsuccessful. The quality was considered good when there were no motion artefacts present.
- For the diagnostic category, slight motion artefacts were seen but the radiologist was still able to answer the referring clinician's questions based on the acquired images.
- An examination would be deemed unsuccessful if there were substantial movement artefacts on the images or if the child could not be settled and immobilised in the beanbag.
- Finally, if the examination had to be cancelled due to lack of patient immobility then an opinion was expressed as to whether a general anaesthetic was required to successfully complete the scan. This was based on the radiographer's observation in consultation with the radiologist.

Results

In the study group, the examination of 32 out of 36 paediatric patients was successfully completed with a good or diagnostic image quality using the feed-and-sleep approach. This non-invasive method proved useful for 89% of the participants in the cohort. Of the 32 patients who accomplished their scans, 11 children were recorded as being relaxed while the other 21 were active. In the relaxed group, eight patients achieved good quality images and three patients obtained diagnostic quality. For the active cohort 14 children had good images while seven children were in the diagnostic category.

Only one child, an eight-day-old inpatient had been given sedation in the form of chloral hydrate in the ward prior to the MRI.

The age distribution in the study group ranged from three days to 39 weeks one day with the greater number of children being in the one-week age category (Figure 1).

All children under the age of 12 weeks accomplished good or diagnostic image quality. Table 1 demonstrates the state of the children in the 3 days to 11 weeks age group and the obtained image quality.

Of the four patients who did not complete their scan, three infants did not settle after feeding and nursing despite several attempts and one child was physically too big to fit into the immobilisation device.

Discussion

The use of a general anaesthetic provides an immobilised patient with the advantage of a successful examination and good image quality.[8] However, when weighing the risks and time-frame associated with the procedure, if a non-invasive method such as the feed-and-sleep approach is available this may provide a better alternative.

A painless imaging scenario[9] is undoubtedly preferable to procedures involving general anaesthesia from both a risk and cost management point of view. A number of the children undergoing MRI at the Mater Private MRI Unit can be quite ill and here general anaesthesia adds another stress factor to an already frail

Table 1: The patients' state (relaxed *vs.* alert) and the corresponding image quality in the under 12 weeks group.

Patient	Patient state	Image quality	Age
A	Relaxed	Good	4 days
B	Relaxed	Good	6 days
C	Relaxed	Good	1 week
D	Relaxed	Good	1 week
E	Relaxed	Good	1 week 3 days
F	Relaxed	Good	1 week 5 days
G	Relaxed	Good	4 weeks
H	Relaxed	Diagnostic	5 days
I	Relaxed	Diagnostic	6 days
J	Relaxed	Diagnostic	7 weeks
K	Alert	Good	3 days
L	Alert	Good	1 week
M	Alert	Good	1 week 4 days
N	Alert	Good	1 week 5 days
O	Alert	Good	2 weeks 5 days
P	Alert	Good	3 weeks
Q	Alert	Good	6 weeks
R	Alert	Good	6 weeks 2 days
S	Alert	Good	7 weeks
T	Alert	Good	7 weeks
U	Alert	Good	8 weeks
V	Alert	Good	8 weeks 3 days
W	Alert	Good	11 weeks
X	Alert	Diagnostic	5 days
Y	Alert	Diagnostic	1 week
Z	Alert	Diagnostic	1 week 1 day
AA	Alert	Diagnostic	1 week 2 days
BB	Alert	Diagnostic	5 weeks
CC	Alert	Diagnostic	6 weeks

patient. The patient's age may also play a part in the decision of whether a GA is necessary. Some of the visiting anaesthetists in the department will not perform GAs on children under the age of six months or even one year.

The psychological effect on parents when their child needs sedation also has to be considered. Both parents and child will undoubtedly perceive a GA as a disturbing event,[10] with the most distressing experience for parents being the induction of anaesthesia and watching their child falling asleep; in addition is the intravenous cannulation of the child.[11] Many parents will opt for the least anxiety-causing or invasive method if there is a choice.[12]

Finally, the costs in terms of both manpower, equipment and anaesthetic drugs are substantial.[13,14] Having a multidisciplinary team, including anaesthetists, anaesthetic technicians, nurses, radiographers and radiologists, present for an MRI under GA is far more expensive than if only two health care professionals, i.e. a nurse to monitor the well-being of the patient and a radiographer to perform the scan, are required.[15]

The overall success rate using the feed-and-sleep method for children under the age of 40 weeks at the institution was 89 per cent. It was also found that the achievement of a good or diagnostic scan did not correlate to the condition of the child, i.e. both patients in the relaxed and alert group were found to have good as well as diagnostic image quality.

The feed-and-sleep approach worked well for the greater number of patients during the study period. The completion of a satisfactory examination nevertheless depends on the size of the patient. One patient in the group (20 weeks five days old) had gone through the preparation steps in a satisfactory manner and was relaxed and fed prior to the commencement of the scan. However, when the child was positioned for the examination it was found that the patient was too large to fit properly into the bean bag. Even the most calm and relaxed infant cannot be expected to stay still for the duration of an MRI examination without some kind of immobilisation device; hence the patient's scan was not successful.

In this data collection, an emphasis was put on the patient's age, although in the article from Lawson in 2000, the author mentioned a study where candidates were selected on their body weight.[16] This selection criterion may well be supported by the above findings but needs further investigation.

Sury, *et al*. in 2005 estimated that approximately 75 per cent of infants under the age of three months at their institution could have a successful MRI scan for a duration of up to 45 minutes.[9] All the children who were scanned at our facility during the 15-month data collection period had significantly shorter scan times than this. The majority of MRI examinations performed were of the brain and a scan would typically take about 15 minutes. The shorter scan times may explain why the success rate was higher in this study.

The data collection also revealed that the vast majority of the children completed their MRI examination without pharmaceutical aids. Only one patient in the study group had chloral hydrate as a sedative for the scan. Several authors have suggested this as an appropriate method of sedation for paediatric patients.[5,6,16] However giving sedation to children for MRI requires specially trained staff to both administer the drugs and monitor the patient. Because the above-mentioned patient was an inpatient, adequate staffing requirements for the oral sedation had been allocated.

Conclusion

Based on the findings of this data collection, it was found that the feed-and-sleep approach is feasible for infants up to 11 weeks. In the study, all patients under the age of 12 weeks completed their examination with a satisfactory image quality. The recommendation following this investigation would therefore be to use the feed-and-sleep method for young children under the age of 12 weeks. This age criterion is in keeping with other authors[9] who found the age limit to be under three months. However, it would still be useful to attempt a non-GA approach for older children keeping in mind that a 39 weeks one day old patient was successfully scanned in the department.

The condition of the child (relaxed *vs*. active) could not be used as an indicator for whether the image quality would be good or diagnostic, or whether the MRI examination could be completed satisfactory.

Although the initial preparation for a feed-and-sleep method may take longer than the preparation for a general anaesthetic, the fact that the child can leave the department immediately the scan is completed and that a multidisciplinary team on site is not required makes this an attractive option when imaging very young children. The well-being of the child must take precedence over any other consideration when imaging the paediatric patient. This is especially so for seriously ill, very young children where a non-

invasive method seems a good alternative. Finally, if the option is available many parents will probably choose a non-GA setting for their infants from both a safety and cost aspect.

Future investigation into a non-GA scenario for infant patients and medical imaging examination may look at both patient age and weight.

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