

Pediatric MRI without anesthesia: The effect of application-supported communication to prepare the child.

Abstract

The purpose of this study was to assess whether using an educational video application to prepare children undergoing Magnetic Resonance Imaging (MRI) decrease the number of MRI scans in general anesthesia (GA) in children aged four to nine years, and to evaluate parents' perceptions of children's confidence using an educational video application to educate about the scan.

During a three-month period 52 children aged four to nine were included in this study after the parents had given consent. Eleven of these children were scheduled for MRI scan with GA. Each child received thirty minutes of preparation before their MRI scan. The radiographer used an educational video application called 'HC And' with animated characters demonstrating the MRI scan procedure. After the scan, the parents answered a questionnaire to assess whether they thought the educational video application helped their child in being calm and able to cooperate during the MRI scan. All parents who participated in the study completed the questionnaire.

All children, including the eleven children originally scheduled for GA, completed the MRI scan without GA. The parents rated the video application either overall good or very good, and felt that their child was better educated about the upcoming scan using the app. Also, parent responses indicated that their child was more confident before and during the scan using the educational video application. The percentage of MRI scans in GA in 2015 was 42% versus 24% in 2017 ($p=0.02$).

The results suggest that the number of children that are able to complete MRI scan without GA is increased when preparation using video application supported communication is implemented in the daily routine. Furthermore, the children's confidence as mediated by parents' perception may increase by the use of the custom-designed educational video application.

Keywords:

Anesthesia, pediatric, MRI, preparation

Introduction

Pediatric Magnetic Resonance Imaging (MRI) can be challenging because the child must lie completely still for 20-60 minutes. In general, undergoing MRI is anxiogenic to some patients [1] and children in particular may feel discomfort and fear of the examination [2]. The child cannot always see the parents and at the same time the scanner makes unfamiliar loud noise.

When children were taken directly from the waiting area to the scanner room where the necessary information and preparation was provided, the radiographers often found it challenging to provide the necessary information because the scanner easily took focus and made it difficult to create a good relationship with the child. They experienced that many children seemed poorly informed and had no knowledge about the scan procedure and the demands to the child. In a study by Gaardling et al [3] parents of children undergoing MRI stated that if the preparation before the scan was insufficient, children would feel anxious about failing. Conversely, positive attitudes and good preparation had the opposite effect.

Unfortunately, many children at Radiology Department were routinely put into general anesthesia (GA), but GA is associated with risk [4, 5] and may provoke anxiety for both parents and the child. Furthermore, some children who undergo treatment or with chronic disease may be referred for repeated examinations. Different approaches to reduce anxiety have been proposed such as the use

of audio-visual systems, [6, 7] and recently preparation using MRI simulators [8] and age-appropriate preparation [9] have resulted in decreased number of children needing GA.

For the above mentioned reasons and to decrease the number of children needing GA to complete MRI, Radiology Department implemented a thirty minute preparation using video application supported communication before each MRI scan in children aged four to nine. This age was chosen based on the children's cognitive level and their ability to use the educational video application. Children referred for MRI scan with GA were routinely offered to be scanned without GA if there were no obvious reason for the scan to be done with GA (such as children referred for MRI scan via the Oncology Department and undergoing cancer treatment, children with involuntary movements etc.). If the preparation regime successfully reduced the number of children scanned under GA, consequently the risk of GA was reduced and other radiology departments may implement similar procedures.

The purpose of this retrospective cross-sectional study was to assess whether using an educational video application for preparation of children undergoing MRI, may reduce the number of MRI scans under GA in children aged four to nine years. The secondary purpose was to evaluate parents' perceptions of their child's confidence using the educational video application to educate about the scan.

Methods

Inclusion for this study took place during a three-month period from May to June 2017.

Recruitment and eligibility criteria

Outpatient children aged four to nine years were asked to arrive thirty minutes before their scheduled MRI scan, to be prepared with the educational video application. Fifty-two children were included in the study after the parents had given consent.

Children scheduled for MRI scan under GA without obvious reasons for GA such as involuntary movements, were offered a scan without GA before the scheduled time.

We excluded children referred for MRI scan via the Oncology Department and undergoing cancer treatment. This is a particularly vulnerable patient group, and their examinations must be performed on schedule and the children must lie absolutely still in order to achieve reliable tumour status. Thus, for both ethical and practical reasons, we decided to exclude them from this study.

Data collection instruments

After the examination the parents answered a questionnaire to assess their general perception of the educational video application, and how they perceived their child's level of information and confidence.

The questionnaire consisted of two parts. The first part was answered by the radiographer and contained background questions about the child such as sex, age and what anatomy that was scanned. This information was used for the grouping of data. The second part was answered by the parents and contained a combination of three 5-point Likert-type scale questions and two open-ended questions. The 5-point Likert-type scale questions were constructed with response options

ranging from 'strongly agree' to 'strongly disagree' or 'excellent' to 'very poor'. One of the questions also gave the respondent the opportunity to answer, 'no opinion'.

In the open-ended questions the parents were asked to state and elaborate any advantages and disadvantages about the application-mediated communication.

The number of children who underwent MRI with or without GA was recorded from the department Radiology Information System.

Preparation for MRI

The radiographer met each child in the waiting area and sought to establish a good relationship with the child in order to provide the necessary information before the MRI scan according to the department standard procedure, i.e. 30 minutes were allocated for preparation of the child and the radiographer used open body language, eye-level communication and no use of technical terms. The radiographer used a tablet to show the custom designed in-house developed educational video application called 'HC And'¹ with animated characters showing how MRI and other examinations are performed (Fig. 1). The application was developed in order to prepare children for different contacts with the hospital, such as blood samples, surgery, radiology procedures etc. The radiographer who prepared the child for the MRI scan also conducted the examination. Due to the age of the children, the parents were present both during the preparation and the MRI scan (Fig. 2).

The educational video application is designed for children, and it is produced in a collaboration between the local Danish company "10:30 Visuel Kommunikation" and the pediatric department at

¹ The name of the application 'HC And' is a pun in Danish as the abbreviation refers to the fairy tale writer Hans Christian Andersen after whom the Pediatric Department is named and to the Danish word for 'duck' – the main character throughout the animations.

Odense University Hospital. The video application is free and generally available in Danish and Swedish in Google Play and App Store.

The children were scanned in one of five different rooms using Philips Ingenia dStream or Philips Achieva dStream (1.5 or 3T) MRI scanners (Philips Healthcare, Amsterdam, NL).

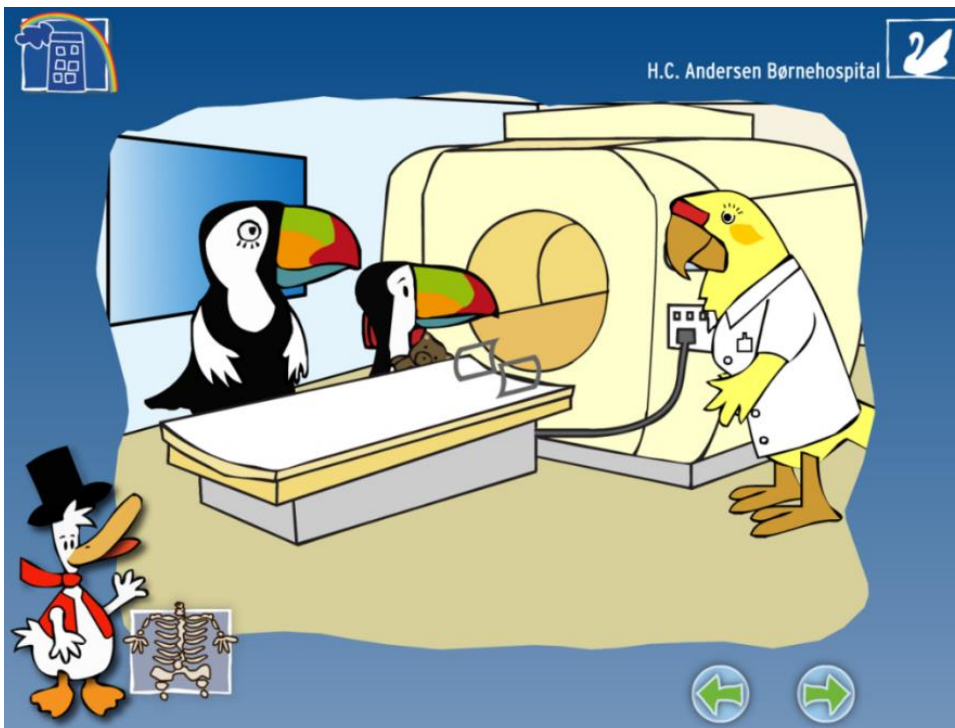


Fig. 1. Animated scene in the app used for the preparation of children referred for MRI.



Fig. 2. Child and parent watching the educational video application on a tablet (model photo).

Data analysis

The total number of children aged four to nine years who completed the MRI scan without GA in April to June 2017 were compared with the same period in 2015. Year 2016 was not included as the communicative procedure was implemented during that year. Therefore, learning curve issues and different skills between staff members would have resulted in an invalid baseline for comparison and consequently, unreliable results.

The results were analyzed using descriptive statistics, i.e. means, medians, percentage, ranges and the difference in total percentage of children in GA between the years was assessed using Chi square test. Each age group was assessed individually using Fisher's exact test. P-values <0.05 were considered statistically significant.

Ethics

As no biomedical intervention took place, The Regional Committee on Health Research Ethics for Southern Denmark (Journal No. 20202000-100) stated that ethical approval was not required according to Danish legislation.

Results

Eighty-six children were referred for MRI scan in the inclusion period, of which 18 were referred from oncology department and therefore excluded.

Twenty-seven children were referred for MRI under GA, but in 11 children there were no obvious reasons for them to be scanned under GA, and according to department procedure, they were therefore offered a scan without GA. The remaining 16 children who had obvious reasons for MRI under GA were excluded from the study. Thus, 52 children (25 female/27 male, median age 7 years, range 4 to 9) were included in this study (Fig. 3). All parents consented to the offer and answered the questionnaire.

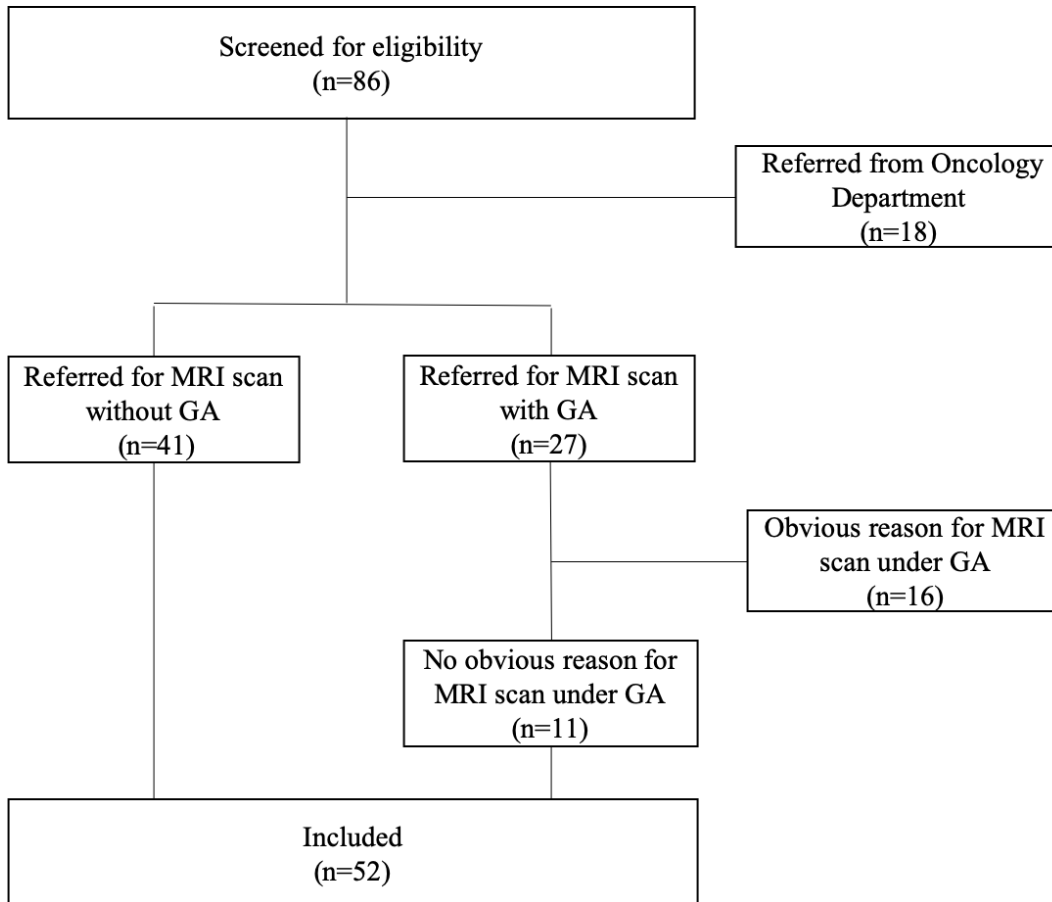


Fig. 3. Eligibility Algorithm

The children were referred for different MRI examinations, but MRI of the brain was predominant (63%). The distribution of included examinations and referrals for GA are shown in Table 1. The mean scheduled scan time was 26 minutes (range 20 to 60).

Eleven children (median age 6 years, range 4 to 8) were scheduled for MRI under GA because the referring physician had assessed that GA was necessary for the MRI procedure to be successfully completed. Nevertheless, all 52 children completed their MRI scan without GA - including the 11 children originally scheduled for GA. The percentage of MRI scans in GA in 2015 was 42% versus 24% in 2017 ($p=0.02$) (Table 2).

In the questionnaire all 52 parents rated the educational video application ‘Good’ (n=16) or ‘Excellent’ (n=36) (Table 3a). The remaining answers are listed in Table 3b. The open-ended questions were answered by 35 parents and 34 stated that the use of the application was mostly advantageous, i.e. the use of animated characters and a narrator with a child’s voice were comforting for the children. Furthermore, the application enhanced the child’s knowledge about the MRI examination because the animation took place in an MRI room. A few parents mentioned that the animation could be improved technically and that the application was best suited for younger children.

Examination	Scanned (n=52)	Referred for GA (n=11)
Brain	33	9
Spine	6	1
Abdomen	2	0
Orthopedics	9	0
Full Body	2	1

Table 1. The distribution of included examinations and referrals for general anesthesia.

Age	2015		2017		p-value
	years	n	GA (%)	n	
4	10	8 (80)	8	5 (63)	0.41
5	11	9 (82)	8	5 (63)	0.35
6	12	5 (42)	13	3 (23)	0.32
7	12	3 (25)	13	1 (8)	0.24
8	9	2 (22)	15	1 (7)	0.27
9	18	3 (17)	11	1 (9)	0.57
Total	72	30 (42)	68	16 (24)	0.02

Table 2. Age and number of children scanned under GA before (2015) and after implementation of thirty minutes of preparation (2017).

Question	Excellent	Good	Average	Poor	Very	No opinion
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	Poor					
What is your overall evaluation of the app?	36	16	0	0	0	0

Table 3a. The distribution of answers in the questionnaire. N=52

Question	Strongly agree	Agree	To some degree	Disagree	Strongly disagree
To what extent do you agree that your child got more information about the scan using the app?	28	18	6	0	0
To what extent do you agree that the app made your child more confident before and during the scan?	26	17	9	0	0

Table 3b. The distribution of answers in the questionnaire. N=52

Discussion

In this study, we assessed whether the number of MRI scans under GA in children aged four to nine years would decrease after the introduction of thirty minute preparation using application-supported communication at their cognitive level. We also evaluated the parents' perceptions of the children's confidence.

The results are in line with the findings of Walker et al (2018) who found that the majority of parents perceived MRI without GA as an acceptable procedure [10] and Gaardling et al (2017) who found age-appropriate preparation feasible [9]. Furthermore, Runge et al. demonstrated that a similar setup was cost-effective [7]

The study is strengthened by the prospective design and that the children represented many different diagnoses and symptoms. Most of the children in the study were scanned as elective patients, but some of the examinations were based on acute referrals.

Limitations

The study has some limitations. The questionnaire was answered by the parents and not the children. Thus, we rely on the parents' capability of assessing their children's level of confidence. Furthermore, some parents may not have had previous experience with MRI for comparison. Therefore, the questionnaire only provided information about the parents' perceptions at the given time and no information about the children examined in 2015 could be provided.

Another limitation is that the children were not scanned on the same scanner. Some of the children had the opportunity to watch movies during their scanning, while others could only listen to music. This may have affected their ability to lie still and perform the scan without GA.

Scan time and preparation

The standard scan time for the examinations was between 20 minutes and 60 minutes. In addition, we sometimes had to scan sequences repeatedly, if a child had moved. Although this prolonged the scan, it is still associated with considerably less risk to the child than undergoing the MRI scan in GA. It should also be noted that all scans were subsequently approved by a radiologist and none of the children were recalled for MRI scan under GA.

The pre-scan preparation method with the application 'HC And' can be used anywhere, and is not dependent on special equipment other than a tablet. Other studies show that preparation can be done with other virtual tools that similarly improved knowledge about the MRI scan and reduced anxiety [6]. In the current study, the radiographers did not receive any special training to use the educational video application for preparation of the children. Future studies may reveal if the effect seen in the study primarily emerge from the use of the application or from the interpersonal contact between radiographer, child and parents. As the study was conducted at a single site further studies should be conducted in other sites to account for different patient categories, age groups and local context. Furthermore, studies specifically addressing image quality should be carried out.

Implications for practice

The use of the educational video application 'HC And' is implemented as part of the daily routine at the department and all children aged four years or older are prepared using the video application and many complete the MRI scan without GA. Only in case of obvious reasons for GA the aforementioned preparation is omitted. MRI scans with GA usually block the scanner markedly

longer than MRI scans without GA. When more children are able to complete MRI scans without GA, we expect more scanner capacity to be released, and as a result of that we expect that the waiting time for both MRI scans with and without GA will be reduced.

Conclusion

The results suggest that the number of children that can complete MRI scan without GA may increase when thirty minutes of preparation using application-supported communication is implemented in the daily routine. Furthermore, the children's confidence as mediated by parents' perception may increase by the use of the custom-designed educational video application.

References

1. Munn, Z. and Z. Jordan, *Interventions to reduce anxiety, distress and the need for sedation in adult patients undergoing magnetic resonance imaging: a systematic review*. Int J Evid Based Healthc, 2013. **11**(4): p. 265-74.

2. Westra, A.E., et al., *Discomfort in children undergoing unседated MRI*. European Journal of Pediatrics, 2011. **170**(6): p. 771-777.
3. Gårdling, J. and M. Månsson, *Children's and Parent's Perceptions of a Magnetic Resonance Imaging Examination*. Vol. 33. 2014. 30–34.
4. Serafini, G. and N. Zadra, *Anaesthesia for MRI in the paediatric patient*. Curr Opin Anaesthesiol, 2008. **21**(4): p. 499-503.
5. Edwards, A.D. and O.J. Arthurs, *Paediatric MRI under sedation: is it necessary? What is the evidence for the alternatives?* Pediatr Radiol, 2011. **41**(11): p. 1353-64.
6. Szeszak, S., et al., *Animated educational video to prepare children for MRI without sedation: evaluation of the appeal and value*. Pediatr Radiol, 2016. **46**(12): p. 1744-1750.
7. Runge, S.B., et al., *Children centered care: Minimizing the need for anesthesia with a multi-faceted concept for MRI in children aged 4-6*. Eur J Radiol, 2018. **107**: p. 183-187.
8. Rothman, S., et al., *Does preparation of children before MRI reduce the need for anesthesia? Prospective randomized control trial*. Pediatr Radiol, 2016. **46**(11): p. 1599-605.
9. Gardling, J., et al., *Age-appropriate preparations for children with cancer undergoing radiotherapy: A feasibility study*. J Child Health Care, 2017. **21**(4): p. 370-380.
10. Walker, B., et al., *Parent perspectives and preferences for strategies regarding nonsedated MRI scans in a pediatric oncology population*. Support Care Cancer, 2018. **26**(6): p. 1815-1824.