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ORIGINAL ARTICLE

Effects of an MRI Try Without program on patient access

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Abstract

Background Pediatric patients are often sedated for magnetic resonance imaging (MRI) scans to ensure images are of diagnostic quality. However, access time for MRIs requiring sedation is often long due to high patient volumes and limited sedation resources.

Objective This study examined the effectiveness of an MRI Try Without sedation program to decrease the wait time for obtaining an MRI while simultaneously ensuring diagnostic-quality images.

Materials and methods A retrospective chart review was performed on subjects who utilized the MRI Try Without program from April 2014 through June 2015 at a dedicated pediatric institution. Child life specialist preparations and access time (i.e. time from exam ordered to exam completed) were recorded in each patient's electronic medical record. MRI images were evaluated for image quality by a pediatric neuroradiologist.

Results A total of 134 patients participated in the MRI Try Without program (mean age: 6.9±1.7 years), all of whom received interventions from a child life specialist. The average number of days between when the order was placed and when the MRI was completed using the MRI Try Without program was 15.4±18.5 days, while the third-available appointment for sedation/anesthesia was 46.2 days (standard deviation [SD]±15.7 days). Nearly all patients received a "good" or "very good" image quality determination (87.3%) and only 5 (3.8%) patients were recommended for repeat examination for diagnostic-quality images.

Conclusion Utilization of an MRI Try Without sedation program, with child life specialist interventions, decreased the wait time for obtaining an MRI while still providing diagnostic-quality images.

Keywords Access · Anesthesia · Child life specialist · Children · Magnetic resonance imaging · Sedation

Introduction

The use of magnetic resonance imaging (MRI) continues to increase in the pediatric population [1]. MRI is recognized as a safe and precise imaging method, but it requires patients to be motionless for relatively long periods of time. In one study, approximately 30% of children undergoing MRI reported moderate to extreme levels of distress [2]. When asked which components of the MRI were most distressful, children identified intravenous (IV) injection (33%), confined space (25%), lying still in the magnet (24%) and noise (from switching of the gradient coils) (22%) [2].

Anxiety and distress often lead to failure to obtain diagnostic imaging and/or the need for many pediatric patients to receive sedation or general anesthesia to obtain interpretable images. Sedation/anesthesia use, however, brings increased cost [3–5] and risk to patient health [6, 7]. Approaches to reduce the use of sedation/anesthesia would likely improve population health outcomes and decrease costs [8]. Along with reducing health risk and cost, research shows that reducing sedation/anesthesia for radiology exams, such as computed tomography (CT) and MRI scans, increases patient satisfaction [4, 9] and decreases duration of the imaging visit [3].

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Reducing the number of patients who need to be sedated or anesthetized for pediatric MRI, therefore, is a desirable goal.

Sedation/anesthesia rates for MRI scans significantly decrease when appropriate preparation and support methods are put in place [5, 8, 10–18]. Studies have also shown that high-quality images can be obtained in non-sedated pediatric patients who participate in mock MRI preparation programs [11–13, 18]. Many health care institutions have non-sedation MRI programs to help pediatric patients complete their MRI without sedation. Often, these programs employ child life specialists who are specially trained to prepare and support patients during various medical procedures. Standard interventions by a child life specialist significantly reduce the need for sedation/anesthesia in pediatric MRI [13, 14, 18–20].

Although a growing body of evidence supports the use of MRI programs without sedation by using child life specialists, some aspects regarding the efficacy of these programs have yet to be studied; one such aspect is how these programs affect the timeliness of patient access to schedule an MRI appointment. A small number of studies have examined the relationship of non-sedate MRI programs and the quality of images [5, 11, 12, 18]. In this study, we examined these two aspects of a non-sedate MRI program to provide additional motivation and support for including and expanding such MRI programs, showing not only improved access to appointments but also diagnostic-quality images.

Materials and methods

We conducted a single-site retrospective chart review of patients ages 4 to 12 years who utilized our institutional MRI Try Without program from April 2014 through June 2015. The MRI Try Without program was previously instituted as part of standard of care at our academic pediatric institution. This study was approved by our local institutional review board and complied with the Health Insurance Portability and Accountability Act. Waiver of informed consent was granted due to the retrospective nature of the study.

All images were retrospectively evaluated for image quality by a single, fellowship-trained pediatric neuroradiologist (D.B.N.) with 15 years of experience with all types of MRI scans. Image quality was assessed on a five-point Likert scale from "very poor" to "very good." Exams classified as "good" and "very good" were considered diagnostic. Clinical data were not used for image evaluation.

During the study period, MRI Try Without appointments were identified and scheduled using a standard protocol and scheduling script. To qualify for the program, children were required to be age 4 or older and have a single order for one of these MRI scans: 1) brain/face/neck/orbit, 2) spine (cervical, thoracic, lumbar, total spine), 3) extremity (hand/wrist, shoulder, knee, foot/ankle) or 4) magnetic resonance elastography. Motion artifact is typically more prominent in chest and abdominal imaging, often affecting image quality, and, therefore, these types of scans were excluded from our study.

If the above criteria were met, the patient's caregiver was provided with a verbal description of the program and asked about an initial interest in scheduling an MRI Try Without appointment. If the caregiver expressed interest in their child participating, they were then asked additional questions to identify any variables that might make their child ineligible for the program, such as developmental concerns, tremors, tics, suctioning requirements and other medical needs.

MRI Try Without appointments followed a standard format. Patients and families met with a child life specialist who prepared them for the MRI by using videos and pictures of the MRI environment and equipment, demonstrating an MRI using a mock scanner with dolls, sampling noises of MRI scanners on an iPad, encouraging patients to rehearse lying still, and assisting patients in choosing a movie to watch during the scan. When the time came for the MRI, the child life specialist assisted the technologist in transitioning each patient to the MRI room. The patient then watched a movie or listened to music during the scan. Some patients in our study required IVs for contrast. When the patient's need for an IV was known before imaging began, the IV was placed in a separate room before the patient entered the MRI scanner room. A child life specialist prepared and supported the patient and family during the IV placement. If the patient's need for IV contrast was unknown until after the patient was positioned for imaging, the IV was placed while the patient was supine on the scanner bed. The latter scenario limited the child life specialist's ability to implement as many support tools/methods as when the IV was placed outside of the MRI scan room, often leading to less cooperative patients. If the patient was unable to hold still, he/she was rescheduled with sedation/anesthesia for another appointment. During this study period, child life specialist interventions were offered to select MRI patients who were not participants in the MRI Try Without program via referrals from staff in the Sedation and MRI departments. Data on these patients were not included in our study.

Demographic data, MRI-specific variables (i.e. type, delay/complication, wait time, reason for MRI, etc.) and child life interventions, as well as patient and family response (Table 1) data were collected retrospectively. Data were collected and managed using REDCap electronic data capture tools hosted at our institution [21].

Descriptive statistics are reported as means±standard deviation (SD) for continuous variables and frequency with percentage for categorical variables. Wait times for scheduling an MRI Try Without appointment were compared to third-available appointment times for sedation/anesthesia. Third-

Table 1 Descriptions of child life interventions, patient response and family response

Variable	Description
Child life specialist interventions	
Individual contact	CLS engaged in rapport building, wayfinding, introduction of services, and/or developmentally appropriate activities while patient waited.
Family support	CLS listened and responded to parent concerns, questions and input.
Teaching materials (preparation)	CLS utilized pictures of MRI, MRI video, and/or model MRI machine.
Explanation of sequence of events (preparation)	CLS used developmentally appropriate language to explain sequence of events for MRI process.
Sensory information (preparation)	CLS used developmentally appropriate language to explain common sensory experiences of patients getting an MRI.
Transfer (procedure support)	CLS escorted patient to MRI room and remained until scan started.
MRI presence (procedure support)	CLS remained present in room during patient's MRI scan.
Patient response	
Rehearsal	Patient rehearsed holding still for MRI.
Coping plan	Patient assisted in developing coping plan for MRI.
Video	Patient watched video during scan.
Music	Patient listened to music during scan.
Pride	Patient verbally expressed pride in outcome/achievement.
Family response	
Family presence	Family present in room during MRI scan.
Pride	Family verbally expressed pride in outcome/achievement.

CLS child life specialist, *MRI* magnetic resonance imaging

available appointment time is a widely used measure of access time. It is considered a more accurate reflection of true appointment availability than "next available" appointment as it accounts for chance occurrences due to cancellations or other unpredictable events [22]. Covariates contributing to "good" or "very good" image quality were evaluated using a multivariable modified Poisson regression model with robust error variance that allows direct estimation of adjusted relative risks. All statistical tests were two-sided and conducted at the alpha=0.05. Statistical analysis for this study was generated using SAS software, Version 9.4 (SAS Institute Inc., Cary, NC) and *R* statistical software [23].

Results

A total of 134 subjects were included in our study. The mean age was 6.9±1.7 years, and a little more than half of the subjects were male (54.5%) (Table 2). The majority of the subjects underwent a brain scan "(brain, neck, face and/or orbits) MRI (82.8%), followed by a scan of the spine (cervical, thoracic, lumbar and/or total spine) (7.5%), and 32 (23.9%) patients received contrast scans (Table 3). All subjects had a variety of child life specialist MRI preparation techniques, with a majority also receiving family support (91.8%), individual contact (97.8%) and a transfer the scan room or imaging support (91.8%) (Tables 1 and 4). At the end of the MRI, more than half of the patients (51.5%) and parents (60.4%) verbally expressed pride regarding the patient's ability to complete the scan (Table 4).

Image quality evaluation was performed on all 134 subjects by a single, fellowship-trained pediatric neuroradiologist (D.B.N.). Nearly all patients received a "good" (26.9%) or "very good" (60.4%) image quality determination. Only five (3.8%) patients were recommended for repeat examination for

Table 2 Patient demographics for MRI Try Without participants

Variable	Total (*n*=134)
Age, *n* (%)	
<6 years	31 (23.1%)
6–7 years	57 (42.5%)
8+ years	46 (34.3%)
Age (years), mean±standard deviation	6.9±1.7
Sex, *n* (%)	
Female	61 (45.5%)
Male	73 (54.5%)
Race, *n* (%)*	
White	93 (69.4%)
Asian	5 (3.7%)
Black or African American	19 (14.2%)
Unknown/not reported	17 (12.7%)

*Individuals could select multiple races

Table 3 Patient MRI characteristics

Variable	Total (*n*=134)
Had patient had prior MRI, *n* (%)	
Yes	24 (17.9%)
No	110 (82.1%)
Type of MRI examination ordered, *n* (%)	
Brain/face/neck/orbit	111 (82.8%)
Spine (cervical, thoracic, lumbar, total)	10 (7.5%)
Extremity (hand/wrist, shoulder, knee, foot/ankle)	9 (6.7%)
Other (magnetic resonance enterography)	4 (3.0%)
Use of contrast, *n* (%)	
Yes	32 (23.9%)
No	102 (76.1%)
Wait time to get MRI (days), mean±standard deviation	15.4±18.5
MRI image quality good or very good, *n* (%)	117 (87.3%)
Does exam need to be repeated for adequate diagnostic interpretation? *n* (%)	
Yes	5 (3.8%)
No	129 (96.2%)

adequate image interpretation. There was no significant difference in age or need for IV between those who were recommended for repeat examination versus those who were not. To determine the predictors of "good" or "very good" image quality, multivariable modified Poisson regression with robust error variance was used. The predictors used in this analysis were patient age, gender and location of MRI (brain/face/neck/orbit) versus other. The analysis found that only gender, using male reference, was statistically significant regarding having a "good" or "very good" quality image (relative risk=1.17; 95% confidence interval [CI]: [1.03, 1.33]; *P*=0.014). No statistically significant differences were found between image quality and exam type, use of contrast or type of child life interventions used. The average number of days between when the order was placed and when the exam was completed using the MRI Try Without program was 15.4 (SD ±18.5) days, while the third-available appointment with sedation/anesthesia was 46.2 (SD±15.7) days.

Table 4 Child life interventions and patient/family response

Variable	Total=134
Child life involvement*	
MRI preparation	134 (100%)
Family support	123 (91.8%)
Individual contact	131 (97.8%)
Support/preparation for intravenous contrast	20 (14.9%)
Transfer to scan room or imaging support	123 (91.8%)
No support	6 (4.5%)
Patient/family response, *n* (%)	
Rehearsal	94 (70.1%)
Coping plan	89 (66.4%)
Patient watched video during scan	127 (94.8%)
Patient verbally expressed pride in outcome/achievement	69 (51.5%)
Family verbally expressed pride in outcome/achievement**	81 (60.4%)

*Individuals could have multiple interventions

**Per child life specialist documentation in patient's electronic medical record

Discussion

Similar to other studies [10, 12, 13, 17], our study supports the use of child life specialist interventions and MRI Try Without sedation programs as successful avenues for obtaining high-quality, interpretable images for pediatric patients undergoing MRI without the use of sedation/anesthesia. Also consistent with other studies [4, 9], ours showed that caregivers were highly satisfied with the services provided through an MRI Try Without program. During child life specialist interactions with caregivers, virtually all expressed high satisfaction with the MRI Try Without program, and a majority expressed pride in the outcome of the MRI.

A key finding of our study was that the use of the MRI Try Without program greatly reduced the amount of time patients had to wait to get an MRI. This finding has not been highlighted in previous literature and supports the rising call for MRI Try Without programs in all institutions serving pediatric patients. Our experiences lead us to conclude that MRI Try Without programs offer a smoother, more effective patient flow. In our MRI Try Without program, a decrease in the number of patients needing sedation/anesthesia reduced average per-patient procedure time, resulting in an increase in procedural volume and reduction in scheduling backlog, yielding shorter wait times for MRI patients and more sedation/anesthesia appointments available for those who needed them. Our findings support the continued use of a child life specialist as a dedicated resource within the radiology department at our institution and encourage us to further explore and evaluate their use as a dedicated resource in other areas of the institution as a means of improving flow, patient safety, and patient and family experience.

There continues to be an increasing need for sedation/anesthesia to complete pediatric MRI examinations, which results in higher costs [24]. One of the many possible reasons for this increase could be that the rising number of pediatric patients needing an MRI has not been met with an equal increase in the availability of MRI Try Without programs. An

opportunity for future investigations would be to examine this relationship.

Multiple components are required for a successful MRI Try Without program, including 1) audiovisual equipment, such as movie goggles [25, 26] for use during the MRI scan; 2) preparation and distraction supplies, such as mock scanners, movies and MRI-compatible distraction toys, and 3) child life specialist training, salaries and compensation packages. Estimates on how many non-sedation exams could be conducted for the cost of a single sedated exam under various cost scenarios suggest that, on average, the amount of money charged for a single sedated exam could be used to pay for 10–20 exams without sedation [8]. The total annual cost savings for an institution has been estimated at $500,000–$1,500,000 in settings with program volumes of 200–400 participants per year [8]. In addition, individual families who utilize an MRI Try Without program could save time and money, not only via lower medical bills, but also through reduction in time away from work and school.

Of all the variables we investigated to predict a quality image, only gender was significant. Females were 17% more likely than males to have a quality image scan. Other studies have found gender differences in the likelihood of pediatric patients completing an MRI exam without sedation [10], while others have not found such differences in completion rates for those who participate in an MRI Try Without program [11, 19, 27]. Further examination of this variable and other patient variables as predictors of success in MRI Try Without programs could prove valuable. A child's temperament, medical experiences and parental expectations have been linked to predicting which children will successfully comply with an MRI procedure and which will require general anesthesia [11]. One study found that a child's ability to obey instructions was the variable that had the greatest association with not requiring general anesthesia during MRI [27]. There is also evidence to support the use of a brief screening tool to identify children who may benefit from simulation-based training before MRI [28].

Image quality was not impacted by exam type, use of contrast or type of child life specialist interventions used. This finding leads us to conclude that MRI Try Without programs can potentially be effective for patients of all ages and exam types. As with our MRI Try Without program, some subsets of the pediatric population have typically been excluded from participation in MRI Try Without research studies, particularly those with behavioral and developmental diagnoses. There have been methods found to be successful in helping patients with autism and developmental delays accomplish MRIs without sedation or anesthesia [29]. We see promising potential to include such subsets in future MRI Try Without program research and design.

Our study had a few limitations. First, the amount of time allowed to attempt an MRI without sedation/anesthesia may have varied among participants. In general, time allotted for each MRI Try Without patient was 30–60 min. No extra time was allotted for MRI Try Without patients versus patients scheduled for an MRI under sedation/anesthesia. At our institution, all radiologists rotate through various shifts (e.g., day, evening, night). The majority of the MRI Try Without participants were scanned in the evening. Various radiologists would have staffed the MRI Try Without program and there may have been variability in the "try time" allotted to participants. Additionally, if an MRI Try Without participant was scheduled during an anesthesia block, their "try times" may have also varied due to patient volume and flow of the unit. Second, the existing electronic medical records did not provide the type of detailed information needed to assess scheduling availability for individual patients. Thus, we used administrative data to assess long-term trends in wait times. MRI wait times were based on hospital metrics run at 3-month intervals, not on daily availability. Third, our study did not include all types of MRI scans; most of our participants had neurological MRIs. The body part being imaged is often a large determinant of the chosen approach to pediatric MRI, with a widely held general belief that it is easier for a child to maintain a fixed position for the required length of time for limb and head imaging than for imaging requiring breath-holding or respiratory triggering [30]. Due to our concern for an increased potential for physiological motion, MRIs involving cardiac or abdominal imaging were excluded in our study.

Despite these limitations, our study shows that utilizing an MRI Try Without program, with child life specialist interventions, decreased the wait time for obtaining an MRI while still providing diagnostic-quality images. We deem our MRI Try Without program a success based on patient and family satisfaction, with only five scans (3.8%) needing to be redone, and a marked decrease in time for patient access to MRI. Our study's key finding of improved time for patient access to MRI has not been previously noted and lends further support to the development and implementation of MRI Try Without programs. MRI Try Without programs are key in providing high-quality patient and family-centered care. We advocate for the inclusion of MRI Try Without programs wherever pediatric MRIs are conducted.

Conclusion

Utilizing an MRI Try Without sedation program, with child life specialist interventions, decreased the wait time for obtaining an MRI while still providing diagnostic-quality images.

Acknowledgments All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its

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Compliance with ethical standards

Conflicts of interest None

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