

Use of Animated Cartoons with Children's Songs to Increase Compliance with Ultrasonography in Young Children

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Purpose: To evaluate the effect of animated cartoons with children's songs to increase compliance with ultrasonography (US) examination in young children. **Materials and Methods:** Animated cartoons with children's songs viewed on a cell phone were played just before the start of US examination when pediatric patients were agitated or irritable. The effect of this method was evaluated for initial responses and sustained responses (grade 0, no response; 1, partial response; and 2, good response). Site of US examination, scan duration, and the helpfulness of this method (0, useless; 1, partially helpful; and 2, very helpful) were also recorded. **Results:** Among 464 pediatric patients who underwent US during the study period, 88 children (19%) needed to be calmed (67 abdominal and 21 other parts of the body). All subjects were less than five years of age (mean 1.5 years), except for four patients with mental retardation. Scan duration was less than 5 minutes in almost all examinations. Five children refused to watch the cartoon. Initial responses were good in 75 and partial in eight children. Sustained responses were good in 70 and partial in 12 children. The cartoons were very helpful in 73 (83%) and partially helpful in nine (10%) children. The effect of watching the cartoon did not change with sex, age (less or more than one year), or site of examination. **Conclusion:** Animated cartoons with children's songs viewed on a cell phone were helpful (93%) in increasing compliance with US examination in young children of both the abdomen and other parts.

Key Words: Ultrasonography, compliance, child

INTRODUCTION

Ultrasonography (US) is commonly used in clinical diagnosis of pediatric patients, because this imaging method is non-invasive, relatively inexpensive, and has excellent resolution without the need for ionized radiation. Moreover, US can be performed without the need for sedation.^{1,2} However, there are some difficulties in acquiring images in young children who are uncooperative or crying. If a baby's irritability is too severe, the images will be blurred and distorted. Therefore, it is often a challenge for pediatric radiologists and sonographers to calm a crying child during US examinations.

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Multiple strategies have been developed to keep young patients still during examinations. Sedation is one way to keep children calm and is frequently used during diagnostic imaging or procedures such as CT, MR, echocardiography, biopsy, and gastrointestinal endoscopy.³⁻⁷ However, sedating a patient has many disadvantages, including increased patient risk, additional costs, and longer examination wait times. An anesthesiologist is also needed for full sedation.

In 1990, Stevenson, et al.⁸ suggested video viewing as an alternative to sedation for young children during echocardiography. Following their study, several alternative techniques for reducing the need for sedation, reducing costs, and improving patient safety were examined in studies using other imaging modalities, including CT and MRI.^{4,9-13} However, few have evaluated the use of these techniques for US examination. In our hospital, we attempted to calm children with animated cartoons with children's songs during US scans. The purpose of this study was to evaluate the effect of this method on compliance with US examination in young children.

MATERIALS AND METHODS

Patients

The institutional review board of our hospital approved this prospective study, and informed consent was waived. Consecutive US examinations were performed in pediatric patients who were referred to our hospital from March 2011 to April 2011 for routine care or follow-up examinations. A pediatric radiologist evaluated each child for agitation prior to the start of US examination. If the child was agitated or irritable even after soothing the child with conversation, singing, or a pacifier, a cell phone playing animated cartoons with children's songs was recommended. If the parents did not want to show these cartoons to their child, they were removed. The cartoons were also stopped whenever the child refused to watch. When the child responded to the cartoons, we did not use other methods to coax the child. For each child, age, sex, type of examination, and the presence of mental retardation were noted from medical records.

US examination and compliance evaluation

All US examinations were performed by one pediatric radiologist with the help of an assistant nurse and the child's parents. The examination was performed using an IU22 ultrasound unit (Philips Ultrasound, Bothell, WA, USA) with

a 5-8 or 1-5 MHz convex transducer or a 5-12 MHz linear transducer. The site of US examination and scan duration were recorded. US scan site was divided into two groups: abdomen or other parts of the body.

The effect of animated cartoons with children's songs in calming the child was evaluated for an initial response and a sustained response. Initial response was defined as the child paying attention to the animated cartoons with children's songs at the beginning of the US examination. Sustained response was defined as sustained attention to the video during the duration of US examination. These responses were graded into three categories according to the degree of attention paid: grade 0, no response; grade 1, partial response; and grade 2, good response.

The pediatric radiologist also recorded the helpfulness of this method according to three subjective categories: grade 0, useless; grade 1, partially helpful; and grade 2, very helpful.

Statistical analysis was performed using SPSS software, version 13.0, for Windows (SPSS Inc., Chicago, IL, USA). Almost all analysis variables were summarized by descriptive statistics. A Pearson's chi-square test was used to evaluate the effects of sex, age (more than or less than one year old) and examination site for initial response, sustained response, and finally, helpfulness. Scan durations were presented as medians (min-max) and analyzed with Kruskal-Wallis test for responses and final effects.

RESULTS

Patients

During the study period, 464 pediatric patients underwent US examinations of various body parts. Among these patients, 88 (19%) children needed to be calmed at the beginning of the US examination, and no parents refused to show the cartoons to their children. There were 56 boys and 32 girls. Age ranged from one month to 15 years, including four patients with mental retardation (ages: 5, 7, and 15 years). The children without mental retardation were all younger than five years, with a mean age of 1.5 ± 1.1 years old. Forty-four (50%) children were younger than one year. With regard to examination site, abdominal US was performed in 67 (76.1%) children, and US was performed at other parts of the body in 21 (23.9%) children. The purpose of abdominal US was to evaluate hydronephrosis (n=23), other urinary disease (n=11), abdominal mass (n=11), systemic disease (n=11), postoperative follow-up (n=9), and biliary disease (n=2).

Other US included neck US (n=9), musculoskeletal US due to palpable lesion (n=9), scrotal US due to swelling (n=1), hip US to evaluate congenital hip dysplasia (n=1), and back US to evaluate spinal dysraphism (n=1).

Compliance

The responses to the animated cartoons with children's songs are summarized in Table 1. Among the 88 children who needed to be calmed at the beginning of US examination, five (5.7%) refused to watch the cartoons and were categorized as the no response group with regard to the initial response. The remaining 83 children watched the cartoons. Eight (9.1%) children had a partial response to the cartoons, and 75 (85.2%) children showed a good initial response. In the evaluation of sustained response, one (1.1%) patient from the partial initial response group showed no sustained response. Twelve (13.6%) participants showed partial sustained responses, including seven from the partial initial response group and five from the good initial response group. Seventy (79.5%) children, all from the good initial response group, showed a sustained good response. The four children with mental retardation all showed good responses to the cartoons from the beginning to the end of the US examination.

The helpfulness of the animated cartoons with children's songs was assessed as very helpful in 73 children (83%) and partially helpful in nine children (10.2%). It was considered to be useless in six (6.8%) children.

Scan duration was 41-346 sec and less than 5 minutes in almost all examinations except for one scrotal US in a nine-month-old boy. The examination times for each group according to responses and final effects are presented in Table 2. And there was no significant difference in scan time between each group.

When considering the effects of sex, age (more than or less than one year old) and examination site, no effect was found on initial responses ($p=0.219$ for sex, $p=0.184$ for age, and $p=0.436$ for site), sustained responses ($p=0.371$ for sex, $p=0.132$ for age, $p=0.268$ for site), or helpfulness ($p=0.293$ for sex, $p=0.129$ for age, $p=0.353$ for site).

DISCUSSION

US is a fundamental imaging method for evaluating children. However, it is limited in some cases. The overall image quality of US can be affected by many factors, including the imaging system, body part being imaged, operator experience, and patient compliance. Among these, the most important factor may be patient compliance when evaluating children. Children can be irritable during US examinations due to the darkness of the US room, presence of unknown people, and unfamiliarity with the procedure. Sometimes the patient's irritability and motion can be significant, especially in young children or patients with mental retardation. Therefore, methods are needed to coax children into com-

Table 1. Initial and Sustained Responses to Animated Cartoons with Children's Songs during Ultrasonography Examination

Initial response	Patient number (%)	Sustained response	Patient number (%)
No response	5 (5.7)		
Partial response	8 (9.1)	No response	1 (1.1)
		Partial response	7 (8)
Good response	75 (85.2)	Partial response	5 (5.7)
		Good response	70 (79.5)

Table 2. Scan Duration [Median (Min-Max)] of Ultrasonography in Each Group According to Response and Helpfulness

		Scan time (sec)	<i>p</i> value*
Initial response	No response (n=5)	117 (85-220)	0.860
	Partial response (n=8)	132.5 (69-273)	
	Good response (n=75)	139 (41-346)	
Sustained response	No response (n=6)	105.5 (69-220)	0.538
	Partial response (n=12)	147.5 (88-273)	
	Good response (n=70)	137.5 (41-346)	
Helpfulness	Useless (n=6)	105.5 (69-220)	0.465
	Partially helpful (n=9)	151 (89-273)	
	Very helpful (n=73)	136 (41-346)	

*From Kruskal-Wallis test.

pliance in these circumstances.

The use of sedatives is one way to calm children during examinations or procedures. However, there are some risks of adverse effects and even sedation failure.^{3,12} Therefore, numerous studies have sought to find alternative methods. In 1990, Stevenson, et al.⁸ became the first to examine the effect of video viewing as an alternative to sedation in children who underwent cardiac US examinations. They showed that 35 of 38 patients (age: 5 to 64 months; mean age: 18.6 months) who underwent complete echocardiographic examinations with video viewing of an age-appropriate videotape required no sedation. Subsequently, other studies have been performed to investigate alternative techniques for calming children without the use of sedatives.

Reported alternative methods consist of multiple components to avoid sedation in children including a certified child life specialist, the use of a pacifier (dummy) and sucrose, swaddling, feeding, installing a moving color light-show device, and image viewing systems for CT, fluoroscopy, and MRI.^{4,11,12} Edwards and Arthurs⁴ reported that these alternative techniques can reduce the need for sedation during MRI and therefore improve patient safety and reduce costs. However, almost all of these studies were performed during echocardiography, CT, fluoroscopy, or MRI. There is no study of the use of these alternative methods during US examination. Sedatives are not routinely used during US examination. However, there is a real need to increase patient compliance in some cases of US in children.

Use of a pacifier (dummy) or feeding is a simple, readily available, and cost effective way to reduce neonatal discomfort, which can be also used during US examination. However, the use thereof is limited to infants. Swaddling is a method which restricts patient motion and can reduce crying and encourage sleep. However, this method is also limited to infants and cannot be used during abdominal US.

Other studies have examined play therapy or environment change. Play therapy and practice MRI can be useful in improving participant compliance in children aged 4-8 years.^{4,9} Anastos¹⁴ showed a 28% reduction in sedation rates during CT in young children (<4 years) under patient-controlled environmental lighting, play with a model scanner, and projected images during the examination. Projecting moving color images or video goggles also can be effective in calming and distracting young children less than seven years of age during CT and MRI, with a 34.6% reduction in the need for sedation in MRI and a 44.9% reduction in those undergoing CT.¹² Harned and Strain¹³ demonstrated that the

introduction of an audio/visual system consisting of video goggles and earphones significantly decreased the need for sedation, cost, and scanning time in children older than 3 years of age in a large study group of more than 1000 children. However, the use of goggles had no impact on the need for sedation in children under the age of 3 years in their study. Lemaire, et al.¹⁰ also showed that an audio/visual system was a successful method for reducing patient motion and obtaining quality diagnostic MRI images without the use of sedation and was most advantageous in patients 4-10 years of age. However, none of these studies were performed during US. Therefore, our study is the first trial to use animated cartoons with children's songs as an alternative method to calming children without the use of sedatives during US examination.

We used a cell phone to play animated cartoons with children's songs as an alternative method to calming children. We did not restrict the use of this method according to patient age. Eighty-eight (19%) pediatric patients needed to be calmed at the beginning of US examination during our study period. Finally, 70 (79.5%) children showed good responses to the videos from the beginning to the end of the US examination. The use of the cartoons was helpful in 82 (93%) children and useless in six (6.8%) children, although these results are somewhat subjective. Age and scan time were not different between these groups. In addition, we could not compare the effect of this method to previously reported methods because we did not use sedatives during US. Nevertheless, it is meaningful that almost all examinations were performed in less than five minutes, and the pediatric radiologist felt that it was very helpful in 83% of patients.

Our method was also helpful in very young children. Half of our patients were younger than one year of age, and age did not affect the response or helpfulness. Previous studies using video goggles during CT or MRI were effective in only children older than three years. However, our method using a cell phone containing animated cartoons with children's songs was effective in younger children during US. Khan, et al.¹² reported that some children who require sedation may be less likely to benefit from alternative techniques, including patients with behavioral problems, mental retardation, developmental delay, movement disorders, and visual impairments. However, in our study, children with mental retardation also showed good responses to this method, although there were only four children with mental retardation in the present study. Moreover, it was effective for US examination of both the abdomen and other

parts of the body. Therefore, we recommend this method for use in all children during US examination.

Our method is also cost-effective. The cost of a previously reported MR audio/visual system was about \$37,000 United States dollars in 2001.¹³ However, our study used a cell phone, which is easy to obtain. It is also cost-effective because it can reduce overall US examination time. Almost US examinations were performed in less than five minutes in our study, except for one case. However, scan duration was not different according to the response or helpfulness.

There are several limitations to the present study. First, the results are subjective. We did not evaluate the effect of the animated cartoons with children's songs on image quality or diagnostic performance. Patient motion and irritability can affect image quality and final diagnosis. However, evaluating the image quality of images obtained during US examination, such as image blurring, is also subjective. In order to evaluate diagnostic performance, a large number of patients and data are required over a long period of time. A randomized control study of the effects of showing animated cartoons is another possibility for determining objective results, although there could be ethical problems with this approach. The second limitation of our study is that this study was performed by only one pediatric radiologist. A multicenter study with a larger number of pediatric radiologists is needed. The third limitation is that we did not evaluate the weakness of our method. Cell phones are a possible route of infection. In addition, children could get hurt by a dropped cell phone, although this rarely happened.

In conclusion, showing animated cartoons with children's songs viewed on a cell phone during US examination was a helpful method in 93% of pediatric patients for increasing patient compliance when there was a need to calm children during US. It is safe and cost-effective without the risks of anesthesia. It also was shown to be effective in children younger than one year of age and children with mental retardation. Therefore, we recommend using this method in all children during US examinations.

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