

Impact of music in reducing patient anxiety during pediatric ultrasound

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Abstract

The use of noninvasive ultrasound examinations can potentially result in significant anxiety in the pediatric population. The purpose of this study was to assess the influence of music during pediatric ultrasound examinations to reduce anxiety measured by heart rate. A total of 44 patients were recruited; 21 controls and 23 experimental. Each participant was randomized to either music or no music (control) after parental consent was obtained. Pulse oximeters were used to monitor heart rate at 15 second intervals for a total of 1 minute, with mean values calculated prior to entering the procedure room, during the middle of the procedure, and after the procedure was completed. The total scan time was determined from the initial image acquisition until the last image recorded by the ultrasound technologist. At the completion of each procedure, the ultrasound technologist scored the ease of performance for the scan on a subjective scale of 1-10 based on prior experience. When utilizing music during pediatric ultrasounds examinations, our study demonstrated significantly decreased heart rate variability from pre-procedural to post-procedural periods. There was no statistical significant difference in total scan time or ultrasound technologist scoring between the two groups. This study demonstrates that music is an inexpensive and effective means of reducing anxiety during pediatric ultrasound as indicated by heart rate.

Introduction

Ultrasound examinations although noninvasive can cause significant anxiety in the pediatric population. Patient anxiety can lead to longer procedure times and possible delayed diagnosis. Children with less anxiety are easier to manage in a clinical setting.¹ Pharmacotherapy has been shown to be effective in reducing some of the pain and anxiety associated with medical procedures, but it can come with worrisome side effects. Music has the potential to obviate or decrease the need

for pharmacotherapy. Music can ease pain and anxiety by moving conscious thought away from symptoms.² Symptoms of anxiety manifest as autonomic dysfunction evidenced by objective measuring of heart rate and blood pressure variability.³ Previous studies have demonstrated that increases in heart rate correlate with anxiety and stress in the clinical setting.⁴

Liu *et al.*⁴ demonstrated benefit with playing soft music to decrease anxiety in young children during orthopedic casting procedures. Hartling *et al.*⁵ demonstrated music might have a positive impact on pain and distress for children undergoing intravenous line placement studying patients ages 3-11 years old. Many of the patients that present for pediatric ultrasound suffer from nonspecific complaints of abdominal pain. Walker and Greene noted in their evaluation that psychological stress does not discriminate between patients with and without identifiable etiology of abdominal pain and high levels of anxiety and stress in these patients may represent *hidden morbidity*.⁶ It is also important to note that children experience anxiety both before and during procedures.⁷ The utility of music during pediatric ultrasound examinations has yet to be established.

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Materials and Methods

Our institution's IRB committee approved the protocol for this study. The inclusion criteria for this study were children between the ages of 1 to 10 years old scheduled for pediatric ultrasound on an inpatient or outpatient basis. All examinations were performed in the ultrasound department with outpatients making up majority of the patients in our study. Each participant was randomized to either music or no music (control) after parental consent was obtained by the physician investigators.

Acoustic lullaby music was chosen for this study, similar to Liu *et al.*, because of universal appeal to younger patients and lack of disruptive features. The music volume was preset at a low volume to avoid distress and confusion (less than 50% of the maximum achievable level of the sound system). Directed speakers were used to play the music in close proximity to the patients. No headsets were used, as the music was played on a stand-alone speaker system connected to a standard desktop computer. Use of headphones was not pursued in this study because this would interfere with any verbal commands necessary during the ultrasound and would require additional equipment.

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The pediatric patients included in this study were not allowed to select the specific music. Additionally, the music playlist consisted of the same set of 10 pre-selected songs set to random, eliminating bias. The music was played throughout the ultrasound procedure. The primary instrument in these musical pieces was the piano and common lullabies were chosen so the majority of the pediatric patients and their families would recognize them. No vocals were included in the musical selections.

Pulse oximeters were used to monitor heart rate at 15 second intervals for a total of 1 minute, with mean values calculated prior to entering the procedure room, during the middle of the procedure, and after the procedure was completed. Secondary outcomes of total scan time and reported technologist score were also recorded. The total scan time was determined from the initial image acquisition until the last image saved as recorded by the ultrasound technologist. At the completion of each procedure, the ultrasound technologist was asked to score the ease of performance for the scan on a subjective scale of 1-10 (1 equating to the least challenging exam and 10 equating to the most challenging based on prior experience). All consents, pulse oximeter placement and recordings were performed by one of two physician investigators (AK, MB) with over 8 years of combined clinical experience.

Statistical analysis was subsequently performed on the collected data set with significance set at $P < 0.05$. Both mean heart rates for each portion of monitoring as well as heart rate variability were utilized for the subse-

quent calculations. T-test was used to compare the mean heart rates between music and control groups. Mann-Whitney nonparametric test was used to compare the distributions of means between the two groups.

Results

A total of 44 patients were recruited; 21 controls and 23 experimental. Of the 44 patients, 27 were female and 17 were male. The mean age for the music group was 3.8 (SD=2.9) and the control group was 5.5 (SD=2.5). The most common type of ultrasound examination performed in both groups was renal ultrasound for hydronephrosis, comprising approximately half of all examinations studied. The remaining ultrasound studies were abdominal, testicular, thyroid, extremity and transabdominal pelvic. Exams were performed on suspected acute and chronic conditions, however emergency room patients were excluded from our study. The mean preprocedural heart rates for the control group and music group were 95.7 beats per minute (bpm) (SD=19.4) and 100.2 bpm (SD=21.3). The mean procedural heart rates for the control group and music group were 102.5 bpm (SD=16.9) and 94.6 bpm (SD=21.6). The mean postprocedural heart rates for the control group and music group were 98.2 bpm (SD=16.5) and 88.2 bpm (SD=18.2). When assessing the mean heart rate variability or change over time from preprocedural to procedural heart rate, the control group demonstrated increase of 6.9 bpm while the music group demonstrated decrease of 5.7 bpm. For the mean heart rate variability from preprocedural to postprocedural heart rate, the control group demonstrated increase of 2.5 bpm while the music group demonstrated decrease of 12.0 bpm. These results were statistically significant. The mean procedure times and the mean ultrasound technologist scores were not significantly different between the two groups; 22.1 min and 4.3 for the control group and 20.8 min and 3.9 for the music group.

Table 1 demonstrates the mean heart rates during the measured time periods and the p value for the differences in the two groups. Table 2 demonstrates the changes during the various time periods using heart rate variability calculated from preprocedural, procedural and postprocedural values as well as the p value for these differences. Figure 1 shows the average heart rate values with the standard error of the mean. The x-axis represents the three separate time periods. The y-axis represents the heart rate values in beats per minute. The slope of the curve demonstrates the differences or heart rate variability during these time periods.

Discussion and Conclusions

When utilizing music during pediatric ultrasound examinations, our study demonstrated decreased heart rate variability indicative of lower levels of anxiety from pre-procedural to post-procedural periods. Liu *et al.*⁴ performed a randomized clinical study that found lower anxiety levels in the music group compared to the control group in children during cast removal procedures. Increased anxiety can lead to multiple short term and long-term issues including impaired performance and technically limited examinations potentially delaying diagnosis and treatment.

Despite differences in the group size, the starting heart rate was higher in the music group than the control group. This difference is likely due to lower basal stress reaction in this group by randomization, natural differences in heart rates based on age or other confounding factors. However, heart rate variability in the music group used as a surrogate for anxiety, demonstrated consistently decreased values during the measured time periods. There was lack of significant difference in the mean procedure time and in the mean ultrasound technologist score, however given a large enough sample size or further standardization distinctive trends may be seen.

The overall cost of implementation of this

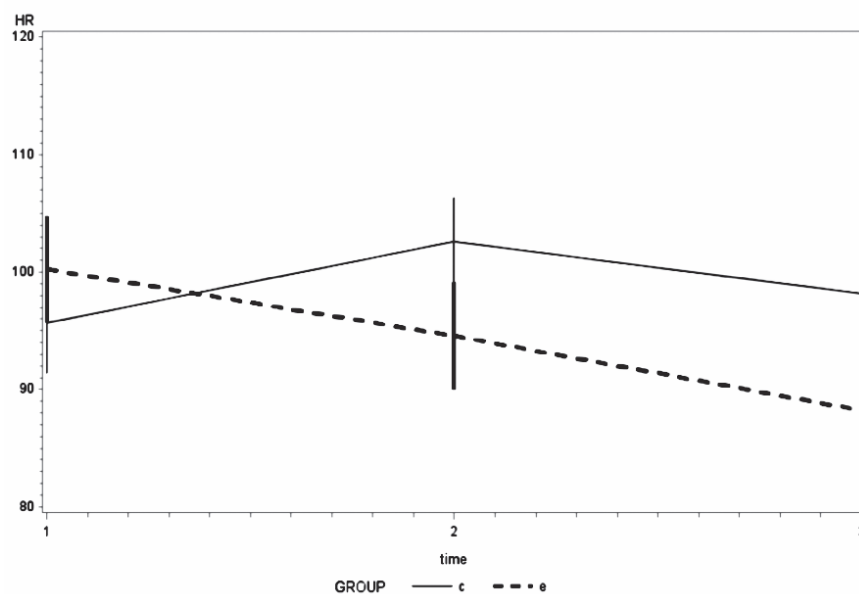


Figure 1. Mean heart rate plot with standard error mean.

Table 1. Mean heart rate data.

	Pre-procedure HR (SD)	Procedure (SD)	Post-procedure (SD)
Control	95.7 (19.4)	102.5 (16.9)	98.2 (16.5)
Experimental	100.2 (21.3)	94.6 (21.6)	88.2 (18.2)
P value	0.5	0.2	0.06

HR, heart rate; SD, standard deviation.

Table 2. Heart rate variability data.

	HRV 1	HRV 2	HRV 3
Control	6.9	4.4	-2.5
Experimental	-5.7	-6.3	-12
P value	0.006	0.7	0.03

Heart Rate Variability (HRV) 1: procedural – preprocedural; 2: postprocedural – procedural; 3: postprocedural – preprocedural.

type of intervention is negligible. For example, our institution has computer stations in each ultrasound room and can be preloaded with the selected music at no additional cost. Software for playing the music is available on modern workstations or could be obtained in most departments from existing resources. This study also demonstrated no significant difference in scan time between the two groups, indicating that the music intervention did not hinder performance of the pediatric ultrasounds and would not be detrimental to workflow within the department. It is also conceivable that the music may decrease exam time secondary to better patient tolerance and cooperation if tailored to specific examinations. This study demonstrates that music is an inexpensive and effective means of reducing anxiety during pediatric ultrasound as indicated by heart rate. It is possible that similar protocols can be established in other ultrasound departments to aid in pediatric diagnostic testing or interventions.

The limitations of this study included low sample size, large age range and initial heart rate differences between the two study groups.

The investigators and participants involved in the study were not blind to the intervention, however this was unavoidable in this type of encounter. The subjective scoring scale rating the level of exam difficulty by the ultrasound technologist was an additional limitation, however it was provided as a secondary assessment. Further research with larger patient populations, subsets of age ranges and additional measures of anxiety such as hormone levels, parent or patient interviews (when possible) and pain scale evaluation protocols may also be helpful.

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