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ORIGINAL ARTICLE

The midterm psychological effect of cast removal procedures in children

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ABSTRACT

Objectives: This study aimed to compare the course of anxiety change in children who used headphones during cast removal with controls in midterm follow-up.

Patients and methods: Sixty-six patients who underwent forearm fracture treatment with closed reduction and long arm casting between June 2021 and March 2023 were retrospectively reviewed. Patients were divided into two groups based on the use of headphones (n=27; 21 males, 6 females; mean age: 8.0±1.8 years; range, 6 to 12 years) or not (n=39; 27 males, 12 females; mean age: 8.9±1.8 years; range, 6 to 12 years) during cast removal with an oscillating saw. Primary outcome measures included preprocedure, postprocedure, and six-month anxiety assessments with the State-Trait Anxiety Inventory.

Results: There was an acute increase in the mean state anxiety scores after the procedure, which returned to below baseline at the six-month follow-up in the headphone (31.4±8.3, 33.3±8.7, and 25.1±4.1, respectively) and control groups (34.9±11.1, 37.4±9.5, and 27.3±5.3, respectively). The mean trait anxiety scores before the procedure, after the procedure, and at six months remained similar in the headphone (33.6±3.0, 34.6±3.2, and 32.4±2.8; p>0.05) and control groups (34.1±2.7, 33.7±3.0, and 33.7±3.0, p>0.05).

Conclusion: This study suggests that the acute anxiety during cast removal did not create anxiety sequelae in the sixth month regardless of headphone use.

Keywords: Anxiety, cast removal, headphone, pediatric fractures, psychology.

Several methods have been used to remove circular cast material after a fracture treatment, such as sharp knives, scissors, and soaking with vinegar. However, these methods have been preferred less frequently since the invention of oscillating power saws in 1943 by Dr. Homer Stryker. The design of an oscillating saw includes cutting hard material by oscillating motion but not the soft material.[1]

The use of oscillating saws can cause significant problems for patients as well as healthcare providers.[2,3] The oscillating saw may cause physical damage, including skin burns due to heat generation, in addition to psychological issues, such as anxiety due to the severe sound and vibration during the cast removal procedure.[4-7] The anxiety is strongly associated with tachycardia, elevated respiratory rate, increased sweating, and temporary shaking.[7] To overcome the negative impact of anxiety due to the use of an oscillating saw during cast removal, several attempts have been made in pediatric patients, such as using headphones,[4,7] virtual reality,[8] watching videos,[9] and listening to music.[10] These interventions have provided a reduction in acute anxiety during cast removal.

Heart rate is the most common tool to evaluate anxiety during cast removal in children. The shortcoming of using heart rate is that it only reflects the acute anxiety.[7] Patients' anxiety levels can also be evaluated with psychological measures, such as

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the State-Trait Anxiety Inventory. The state anxiety reflects the psychological and physiological reactions to a specific life event. The trait anxiety gives patients general anxiety trait of personality. The state and trait anxiety forms include 20 questions each. Higher scores are related to higher state and trait anxiety.[11]

There is no evidence in the literature regarding the mid to long-term psychological effect of cast removal with an oscillating saw in pediatric patients. We hypothesized that the acute anxiety during cast removal procedure with an oscillating saw may turn into chronic anxiety in pediatric patients. The aim of this study is to investigate the midterm psychological effect of cast removal with oscillating saw in pediatric patients.

PATIENTS AND METHODS

Consecutive patients who underwent forearm fracture treatment with closed reduction and long arm casting at Karabük Training and Research Hospital, Department of Orthopedics between June 2021 and March 2023 were retrospectively reviewed. The data was collected prospectively but evaluated retrospectively. Patients were assigned into two groups according to parents' preference based on whether they used headphones (the headphone group) or not (the control group) during cast removal with an oscillating saw. Patients who had a follow-up less than six months after cast removal (n=12), who had a history of casting with or without closed reduction for any type of fracture (n=4), who required a repeat closed reduction and casting for any reason (n=6), who had open fractures or multiple fractures other than a forearm fracture (n=2), and who were lost during follow-ups (n=4) were excluded from the study. A total of 66 patients met the inclusion criteria and were included in the study. There were 27 patients (21 males, 6 females; mean age: 8.0±1.8 years; range, 6 to 12 years) in the headphone group, and 39 patients (27 males, 12 females; mean age: 8.9±1.8 years; range, 6 to 12 years) in the control group.

Closed reductions of the forearm fractures were performed by a postgraduate year 3 (PGY-3) orthopedics resident using plaster of Paris under ketamine sedoanalgesia at the emergency room (Figure 1). The reduction of the fracture was confirmed using fluoroscopy. The patients were followed at one, two, and six weeks with anteroposterior and lateral forearm radiographs. The cast removal was performed at the sixth week of the follow-up using an oscillating saw (De Soutter Medical Ltd, Aston Clinton, Aylesbury, UK) by a PGY-3 orthopedics resident (Figure 2). The patients were informed beforehand about what they would feel or the sound they would hear during the procedure. There was no accompanying family member at the reduction or cast removal procedures. There was no sound or music coming from the headphones during the cast removal.

Primary outcome measures included anxiety assessment with the State-Trait Anxiety Inventory[11] before and after the cast removal procedure and at six months. Patients' heart rates were also measured before and 2 min after the procedure. Two groups were compared based on anxiety and heart rate change.

Statistical analysis

Data were analyzed using IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean±standard

FIGURE 1. An eight-year-old child after closed reduction and casting with plaster of Paris.

FIGURE 2. The oscillating saw used during the entire study.

TABLE I
Comparison of the mean heart rate and anxiety scores before cast removal, after cast removal, and at six months between the headphone and control groups

	Headphone group	Control group	
	Mean±SD	Mean±SD	*p*
Pre-cast removal mean heart rate (beat per minute)	105.8±13.8	104.4±14.6	0.477
After cast removal mean heart rate (beat per minute)	104.1±15.5	115.3±26.9	0.034
Pre-cast removal mean TX1 score	31.4±8.3	34.9±11.2	0.293
Pre-cast removal mean TX2 score	33.6±3.0	34.1±2.77	0.541
After cast removal mean TX1 score	33.3±8.7	37.4±9.5	0.136
Pre-cast removal mean TX2 score	33.6±3.2	34.3±2.8	0.404
6th month mean TX1 score	25.1±4.1	27.3±5.3	0.123
6th month mean TX2 score	32.4±2.8	33.7±3.0	0.102

SD: Standard deviation; TX1: State anxiety; TX2: Trait anxiety.

deviation (SD) for continuous numerical variables. Categorical variables were expressed as the frequency and percentage. Distribution of variables was measured with the Kolmogorov-Smirnov test. Statistical analysis was performed for continuous variables with Student's t-test, the Mann-Whitney U test, and a paired t-test when appropriate. Categorical variables were compared with the Pearson chi-square test. The results were considered statistically significant when the p-value was <0.05.

RESULTS

There was no significant difference between the mean ages of the groups (p=0.064). Furthermore, the sex distribution was similar between the groups (p=0.443).

There was no statistical difference in the mean heart rates between the headphone (105.8±13.8) and control groups (104.4±14.6) before cast removal (p=0.477). However, the mean heart rate was significantly higher in the control group (115.3±26.9) than the headphone group (104.1±15.5) after the cast removal procedure (p=0.034). Regarding the mean heart rate change within the groups, there was a significant increase in the control group (104.4±14.6 *vs.* 115.3±26.9, p=0.002), while there was no significant change in the headphone group (105.8±13.8 *vs.* 104.1±15.5, p=0.674).

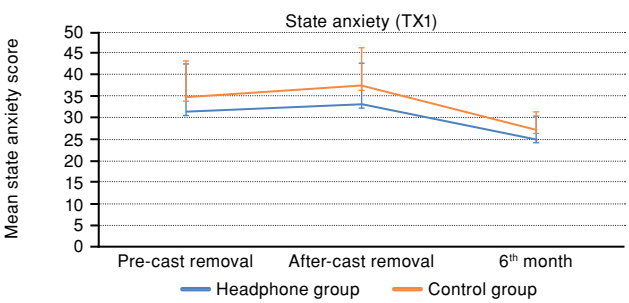

FIGURE 3. The course of state anxiety during follow-ups in both groups.

There was no statistical difference in the mean state anxiety and trait anxiety scores before cast removal, after cast removal, and at the six-month follow-up in both groups (Table I). The mean state anxiety increased after the cast removal and returned to below baseline in both groups (Figure 3). The mean trait anxiety remained similar before cast removal, after cast removal, and at the six-month follow-up in both groups (Tables II, III), Figure 4).

DISCUSSION

The immediate anxiety after cast removal procedure in pediatric patients has been well studied in the existing literature;[4,8] however, mid to long term consequences of this acute anxiety are not known. To the best of our knowledge, the present study is the first study examining the midterm effect of acute anxiety that occurred during the cast removal procedure. Our data showed that the utility of headphones decreased acute anxiety during cast removal; however, the acute anxiety did not cause chronic anxiety in midterm.[12] In addition, patients' trait anxiety returned to below baseline, possibly due to the termination of fracture care treatment.

Acute acceleration of heart rate is one of the physical signs of acute anxiety. Carmichael and

TABLE II
Comparison of anxiety scores within the headphone group

Headphone group	Pre-cast removal	After cast removal	
	Mean±SD	Mean±SD	*p*
Mean TX1 score	31.4±8.3	33.3±8.7	0.398
Mean TX2 score	33.6±3.0	33.6±3.2	0.655
	Pre-cast removal	6th month	
	Mean±SD	Mean±SD	*p*
Mean TX1 score	31.4±8.3	25.1±4.1	<0.001
Mean TX2 score	33.6±3.0	32.4±2.8	0.007
	After cast removal	6th month	
	Mean±SD	Mean±SD	*p*
Mean TX1 score	33.3±8.7	25.1±4.1	<0.001
Mean TX2 score	33.6±3.2	32.4±2.8	0.012

SD: Standard deviation; TX1: State anxiety; TX2: Trait anxiety.

TABLE III
Comparison of anxiety scores within the control group

Control group	Pre-cast removal	After cast removal	
	Mean±SD	Mean±SD	*p*
Mean TX1 score	34.9±11.2	37.4±9.5	0.104
Mean TX2 score	34.1±2.77	33.7±3.0	0.102
	Pre-cast removal	6th month	
	Mean±SD	Mean±SD	*p*
Mean TX1 score	34.9±11.2	27.3±5.3	<0.001
Mean TX2 score	34.1±2.77	33.7±3.0	0.478
	After cast removal	6th month	
	Mean±SD	Mean±SD	*p*
Mean TX1 score	37.4±9.5	27.3±5.3	<0.001
Mean TX2 score	33.7±3.0	33.7±3.0	0.262

SD: Standard deviation; TX1: State anxiety; TX2: Trait anxiety.

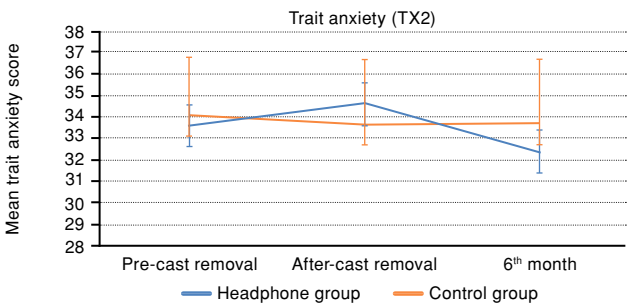

FIGURE 4. The course of trait anxiety during follow-ups in both groups.

Westmoreland[7] suggested that the use of headphones prevents the acute increase in heart rate during cast removal procedures in pediatric patients. The authors also noted that patients aged below six years of age benefit from using headphones, with a 9.7% less increase in heart rates. The reduction was 8.8% in patients aged seven to 12 years and 4.5% in patients aged 13 to 17 years.[7] Katz et al.[4] witnessed the death of an 18-month-old child with underlying cardiomyopathy due to triggered arrhythmia secondary to anxiety during a cast

removal procedure. The authors also investigated the effect of headphones on heart rate during cast removal in pediatric patients and found that patients with headphones had 11.1% increase in heart rates, while patients without a headphone had 26.9% increase.[4] The present study also showed that using headphones can control the acute acceleration of heart rate during cast removal in pediatric patients. We may argue that controlling the physical signs of acute anxiety could prevent cardiac complications in patients with undiagnosed cardiac issues.

The oscillating saw creates a high amplitude of sound, and it has been shown to cause acute anxiety in pediatric patients during cast removal.[13] Distraction methods have been tried to reduce the anxiety created by the oscillating saw in pediatric patients. Liu et al.[10] tried music during cast removal and demonstrated a reduction of acceleration in the heart rates of children. In addition, watching videos,[9] therapeutic games,[14] and virtual reality[8] also have been shown to control the physical signs of acute anxiety (heart rate) during cast removal. The present study showed that using headphones controls the heart rates of the patients; however, the acute anxiety scores were similar after the cast removal. We believe that heart rate acceleration may not reflect the entire anxiety of the patients. Although using headphones can control the heart rate during cast removal, it may not control the global anxiety of the patients during cast removal.

Cast removal procedures may result in posttraumatic stress disorder in children.[15,16] To the best of our knowledge, there is no study showing the midterm effects of cast removal procedures on anxiety in children. The present study is the first study investigating midterm anxiety in children after cast removal. One of the striking findings of our study was that trait anxiety scores in children using headphones were lower at six months, creating a statistically significant difference compared to the baseline. When determining the anxiety level, we used the state and trait anxiety scale as well as the heart rate. We believe that children's fear of not being able to use their extremities and returning to their former state could be reasons that patients have experienced higher basal trait anxiety scores. We observed that these midterm trait anxiety scores reduced under the baseline score before cast removal after the realization of the child being able to use the extremity normally. Exposure to the loud sound of the oscillating saw in the control group may have increased their already high anxiety due to the fracture and may have caused their trait anxiety scores to be higher in the midterm than in the headphone group.

The present study has some limitations. This is a retrospective single-center study with a relatively limited patient population. The cast material was plaster of Paris; thus, the results may differ with different casting materials. The normal range of heart rate varies depending on the age of the patients. The anxiety level of the patients cannot be associated with only the cast removal procedure, some life events may have happened during the follow-ups that could cause bias. The study was not blinded. The baseline anxiety level of the patients before the fracture was absent, but we believe obtaining that measure is quite difficult. The pain scores were not recorded during the study.

In conclusion, this study suggests that the use of headphones during cast removal reduces acute anxiety during cast removal in children. However, the acute anxiety during cast removal did not create anxiety sequelae in the sixth month regardless of headphone use.

Ethics Committee Approval: The study protocol was approved by the Karabük University Non-Interventional Clinical Research Ethics Committee (date: 01.10.2021, no: 2021/661). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from the parent of each patient for participation in the study.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design, control/supervision, data processing, literature review, writing of the article, critical review: U.D.; Idea/concept, data collection, literature review, writing of the article: O.A.; Idea/concept, design, literature review, writing of the article, critical review: Y.E.; Idea/concept, design, control/supervision, data processing and analysis, literature review, writing of the article, critical review: E.Ö.

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