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Audio Distraction for Traction Pin Insertion

A Prospective Randomized Controlled Study

Melissa Albersheim, MD, Fernando A. Huyke-Hernández, MD, Stephen A. Doxey, DO, Harsh R. Parikh, MPH, Allison L. Boden, MD, Roberto C. Hernández-Irizarry, MD, Patrick B. Horrigan, MD, Stephen M. Quinnan, MD, and Brian P. Cunningham, MD

Investigation performed at HealthPartners Regions Hospital, St. Paul, Minnesota

Background: Insertion of a skeletal traction pin in the distal femur or proximal tibia can be a painful and unpleasant experience for patients with a lower-extremity fracture. The purpose of this study was to determine whether providing patients with audio distraction (AD) during traction pin insertion can help to improve the patient-reported and the physician-reported experience and decrease pain and/or anxiety during the procedure.

Methods: A prospective randomized controlled trial was conducted at 2 level-I trauma centers. Patients ≥18 years of age who were conscious and oriented and had a medical need for skeletal traction were included. Patients were randomized to receive AD or not receive AD during the procedure. All other procedure protocols were standardized and were the same for both groups. Surveys were completed by the patient and the physician immediately following the procedure. Patients rated their overall experience, pain, and anxiety during the procedure, and physicians rated the difficulty of the procedure, both on a 1-to-10 Likert scale.

Results: A total of 54 patients met the inclusion criteria. Twenty-eight received AD and 26 did not. Femoral fractures were the most common injury (33 of 55, 60.0%). Baseline demographic characteristics did not differ between the 2 groups. The overall patient-reported procedure experience was similar between the AD and no-AD groups (3.9 ± 2.9 [95% confidence interval (CI), 3.1 to 4.7] versus 3.5 ± 2.2 [95% CI, 2.9 to 4.1], respectively; p = 0.55), as was pain (5.3 ± 3.2 [95% CI, 4.4 to 6.2] versus 6.1 ± 2.4 [95% CI, 5.4 to 6.8]; p = 0.28). However, anxiety levels were lower in the AD group (4.8 ± 3.3 [95% CI, 3.9 to 5.7] versus 7.1 ± 2.8 [95% CI, 6.3 to 7.9]; p = 0.007). Physician-reported procedure difficulty was similar between the groups (2.6 ± 2.0 [95% CI, 2.1 to 3.1] versus 2.8 ± 1.7 [95% CI, 2.3 to 3.3]; p = 0.69).

Conclusions: AD is a practical, low-cost intervention that may reduce patient anxiety during lower-extremity skeletal traction pin insertion.

Level of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Skeletal traction is the preferred initial treatment for many lower-extremity fractures[1]. It can be applied quickly and safely, with minimal contraindications[2]. It stabilizes the soft tissues and reduces patient discomfort by improving fracture alignment and relaxing muscle spasms[2-5].

Skeletal traction pin insertion, however, can be intimidating, painful, and anxiety-provoking for patients. Furthermore, the physician's ability to insert the traction pin can be affected by an anxious, uncooperative patient. Studies in other fields have demonstrated improvements in the patient-reported experience during uncomfortable procedures with the use of various distraction methods[6-12]. Currently, there is a paucity of literature regarding the use of distraction techniques during orthopaedic procedures, including skeletal traction pin insertion.

The purpose of this study was to assess whether providing patients with the option to listen to music from an MP3 player during traction pin insertion (i.e., audio distraction [AD]) can improve the patient-reported experience and/or decrease pain and anxiety during the procedure. We hypothesized that patients receiving AD would report a better experience with the procedure, along with lower levels of pain and anxiety, compared with the non-AD group. A secondary aim was determining whether AD influenced the physician-perceived difficulty of the procedure, and we hypothesized that surgeons would report similar levels of difficulty completing the procedure regardless of patient AD use.

Disclosure: This study received grant funding from the University of Minnesota Department of Orthopaedic Surgery Research Committee, used for the purchase of MP3 players and headphones and for travel expenses between the 2 study sites. The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJS/H967).

Materials and Methods

We conducted a prospective randomized controlled study from 2018 to 2022 at 2 level-I trauma centers. The study was approved by the local institutional review boards and was registered at www.clinicaltrials.gov (NCT05927480). Patients ≥18 years old who were conscious and oriented and had a medical need for distal femoral or proximal tibial skeletal traction were included. Patients who had a medical contraindication to skeletal traction, required endotracheal intubation, were unable to participate in verbal communication throughout the procedure, had sensory impairment with respect to pain, or were unable to answer a written survey due to cognitive, motor, or visual deficiencies were excluded. Patients were randomized 1:1 into 2 groups, AD versus no AD, within blocks of 10. Envelopes with the study group assignment were then prepared in groups of 10 for the surgeon to select from at the time of pin insertion. A power analysis was conducted prior to the start of the study; to achieve a type-I error rate of 0.05 and 90% power, a minimum of 42 participants (21 in each group) would be required to detect an estimated effect size of 2.0 for pain, anxiety, and experience on the utilized 10-point scales if the standard deviation was 2.0. That effect size was determined to represent a clinically important difference based on prior work[13].

Pin insertion was performed by the orthopaedic surgeon on call at the time of injury. Because of the variability in the time to consultation, traction pins were inserted in various settings throughout the hospital (emergency department, trauma bay, or patient hospital room); however, insertion was always performed in a private room, not shared with other patients. Prior to the start of the study, a standardized study protocol was created for the surgeon to follow, to minimize variation among patients during the procedure. After obtaining patient consent to participate in the study, the surgeon would choose 1 of the 10 previously prepared envelopes that contained the randomized group assignment and open it in the patient's presence. An MP3 player with noise-isolating, in-ear headphones was provided to the patients in the AD group. The MP3 player contained 10 preloaded music genres for patients to select from.

After the pin insertion site was prepared, patients in the AD group were asked to start listening to their music genre of choice. Local 0.5% lidocaine anesthetic was then administered to all patients in both groups (10 mL at the entry point and 10 mL at the exit point). The area was draped with sterile towels, after which the surgeon palpated the landmarks of the femur or tibia, made a stab incision over the entry point, and performed blunt dissection down to bone with sterile forceps. A Steinmann traction pin loaded onto a manual drill was then introduced into the incision and was drilled through the bone until skin tenting was seen on the opposite side. A second incision was then made over the tented skin, and the traction pin was driven through. The pin sites were swabbed with Betadine (povidone-iodine) and dressed with sterile gauze. The traction pin was cut, pin covers were placed, and the pin was attached to a traction bow and appropriate traction frame with the desired amount of weight attached. At this point, the patients in the AD group were asked to stop listening to the music. The patients in both groups then filled out the procedure experience surveys, and their surgeons concurrently filled out their own experience surveys.

Patients were asked to rate their (1) overall experience, (2) anxiety during the procedure, and (3) pain during the procedure, each on a 1-to-10 Likert scale on which a lower number indicated a better outcome. The overall experience was rated from "tolerable" to "not tolerable at all," anxiety was rated from "not at all anxious" to "very anxious," and pain was rated from "no pain" to "worst possible pain."

Similarly, a survey with a 1-to-10 Likert scale for assessing the perception of the overall difficulty of the procedure was completed by the surgeon. Procedure difficulty was rated from "easy" to "most difficult," with a lower number representing a better outcome. Demographic, injury, and treatment characteristics were extracted for each patient through retrospective review of the electronic medical record.

Statistical Analysis

Continuous variables were compared between groups using independent-sample t tests, and categorical variables were compared using chi-square or Fisher exact tests. In addition to those univariate analyses, linear regression was used to evaluate potential predictors of patient pain and anxiety scores. Based on the univariate analyses, the following variables were included in these multivariable models: use of AD, an opioid prescription prior to admission, a prior history of smoking, Injury Severity Score (ISS), polytrauma, and open fracture. Significance was set at $p \leq 0.05$.

Results

A total of 54 patients (26 without AD and 28 with AD) were included in the final analysis. All enrolled patients completed the study (Fig. 1). Most patients (31, 57.4%) were male, with the mean patient age (and standard deviation) being 51.8 ± 20.6 years. The mean body mass index (BMI) was 28.5 ± 9.1 kg/m^2, and most patients (66.7%) were nonsmokers. Femoral fractures were the most common (33 of 55, 60.0%), followed by acetabular fractures (17, 30.9%). Half of the patients (27) had polytrauma, and 4 patients (7.4%) presented with an open fracture. The mean ISS was 12.5 ± 8.9 (95% confidence interval [CI], 10.1 to 14.9). Equal numbers of patients had the traction pin inserted in the femur (27, 50.0%) and in the tibia (27, 50.0%). The mean procedure time, from the local injection to completion of the setup of the traction apparatus, was 19.0 ± 11.7 minutes (95% CI, 15.9 to 22.1 minutes).

Baseline demographic characteristics (Table I) and the distribution of fracture patterns (Table II) were not significantly different between the 2 groups.

In the univariate analyses, the AD and no-AD groups did not differ with regard to the location of the traction pin (tibia or femur) ($p > 0.99$). Total procedure time also did not differ significantly between the AD and no-AD groups, although the AD group trended toward a shorter overall time (16.3 ± 7.9 [95% CI,

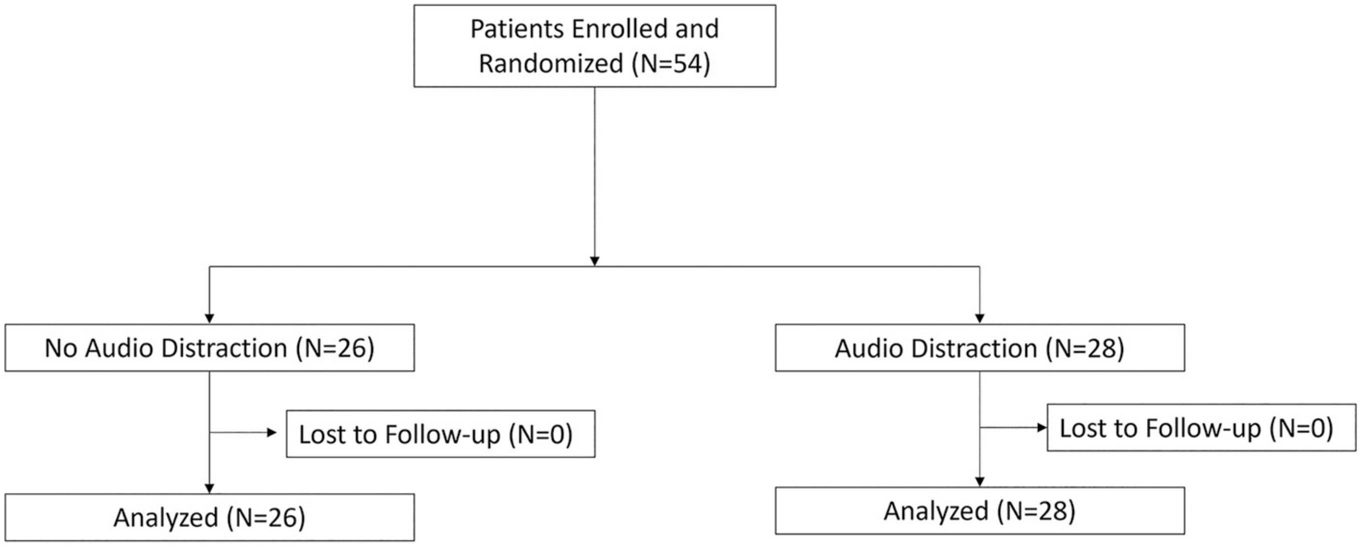

Fig. 1
Flow diagram for the study.

14.2 to 18.4] versus 27.2 ± 17.1 [95% CI, 22.2 to 32.2] minutes; p = 0.10). Although there was no difference in patient-reported pain levels (5.3 ± 3.2 [95% CI, 4.4 to 6.2] versus 6.1 ± 2.4 [95% CI, 5.4 to 6.8]; p = 0.28), patients who received AD reported lower anxiety during the procedure compared with those who did not receive AD (4.8 ± 3.3 [95% CI, 3.9 to 5.7] versus 7.1 ± 2.8 [95% CI, 6.3 to 7.9]; p = 0.007). The overall patient-perceived experience regarding the procedure was similar (3.9 ± 2.9 [95% CI,

TABLE I Baseline Characteristics of Audio Distraction Versus No-Distraction Group (N = 54)*

Variable	No Distraction (N = 26)	Audio Distraction (N = 28)	P Value
Age *(yr)*	52.5 ± 19.5 (46.8, 58.2)	51.2 ± 21.8 (45.3, 57.1)	0.82
Sex			0.25
Male	17 (65.4%)	14 (50.0%)	
Female	9 (34.6%)	14 (50.0%)	
BMI *(kg/m²)*	29.2 ± 11.8 (25.7, 32.7)	27.7 ± 5.6 (26.2, 29.2)	0.55
Smoking history			0.44
Never	15 (57.7%)	21 (75.0%)	
Former	3 (11.5%)	2 (7.1%)	
Current	8 (30.8%)	5 (17.9%)	
Substance abuse history	4 (15.4%)	7 (25.0%)	0.38
Mental health diagnosis	6 (23.1%)	11 (39.3%)	0.20
Open fracture	2 (7.7%)	2 (7.1%)	>0.99
Polytrauma	13 (50.0%)	14 (50.0%)	>0.99
ISS	11.0 ± 6.4 (9.1, 12.9)	13.8 ± 10.5 (11.0, 16.6)	0.28
Pin location			>0.99
Distal femur	13 (50.0%)	14 (50.0%)	
Proximal tibia	13 (50.0%)	14 (50.0%)	
Prior prescription			
Opioids	3 (11.5%)	3 (10.7%)	>0.99
Anxiolytics	1 (3.8%)	4 (14.3%)	0.35
Muscle relaxants	3 (11.5%)	4 (14.3%)	>0.99
Surgical treatment	26 (100%)	28 (100%)	>0.99

*Categorical data are shown as the number of patients with the percentage in parentheses. Continuous data are reported as the mean ± standard deviation with the 95% confidence interval in parentheses. BMI = body mass index, ISS = Injury Severity Score.

TABLE II AO/OTA Fracture Classification[22] for All Included Fractures (N = 55)*

Fracture Location and Type	No Distraction (N = 26)	Audio Distraction (N = 29)	P Value
Femur	15 (57.7%)	18 (62.1%)	0.30
31A	3	3	
32A	9	10	
32B	1	3	
32C	2	1	
33C	0	1	
Acetabulum	9 (34.6%)	8 (27.6%)	0.70
62A	4	4	
62B	0	2	
62C	5	2	
Pelvic ring	2 (7.7%)	3 (10.3%)	>0.99
61A	1	0	
61B	0	1	
61C	1	2	

*Data are shown as the number of fractures with the percentage in parentheses. One patient in the audio distraction group had 2 included fractures.

3.1 to 4.7] versus 3.5 ± 2.2 [95% CI, 2.9 to 4.1]; p = 0.55) (Fig. 2). The surgeons also reported similar overall procedure difficulty in the 2 groups (2.6 ± 2.0 [95% CI, 2.1 to 3.1] versus 2.8 ± 1.7 [95% CI, 2.3 to 3.3]; p = 0.69) (Table III).

In the multivariable analysis of all 54 study subjects, the only significant predictors of patient-reported pain levels during the procedure were the presence of polytrauma and having had an opioid prescription prior to presentation to the hospital. Patients with polytrauma reported scores 1.9 units lower, on average (−1.9 ± 0.9 [95% CI, −3.7 to −0.1]; p = 0.04), and patients with an opioid prescription reported scores 2.6 units higher, on average (2.6 ± 1.2 [95% CI, 0.2 to 5.1]; p = 0.04) (Table III). AD was the only significant predictor of lower anxiety scores, with scores being 2.1 units lower, on average (−2.1 ± 0.9 [95% CI, −3.9 to −0.3]; p = 0.02) (Table IV).

Discussion

Skeletal traction pin insertion is frequently performed for lower-extremity musculoskeletal trauma but, to our knowledge, no studies have analyzed the effect of distraction methods on patient pain and anxiety during the procedure. This prospective randomized controlled study evaluated the impact of a distraction technique involving music on the patient- and physician-reported experience. Although pain levels were not found to differ between

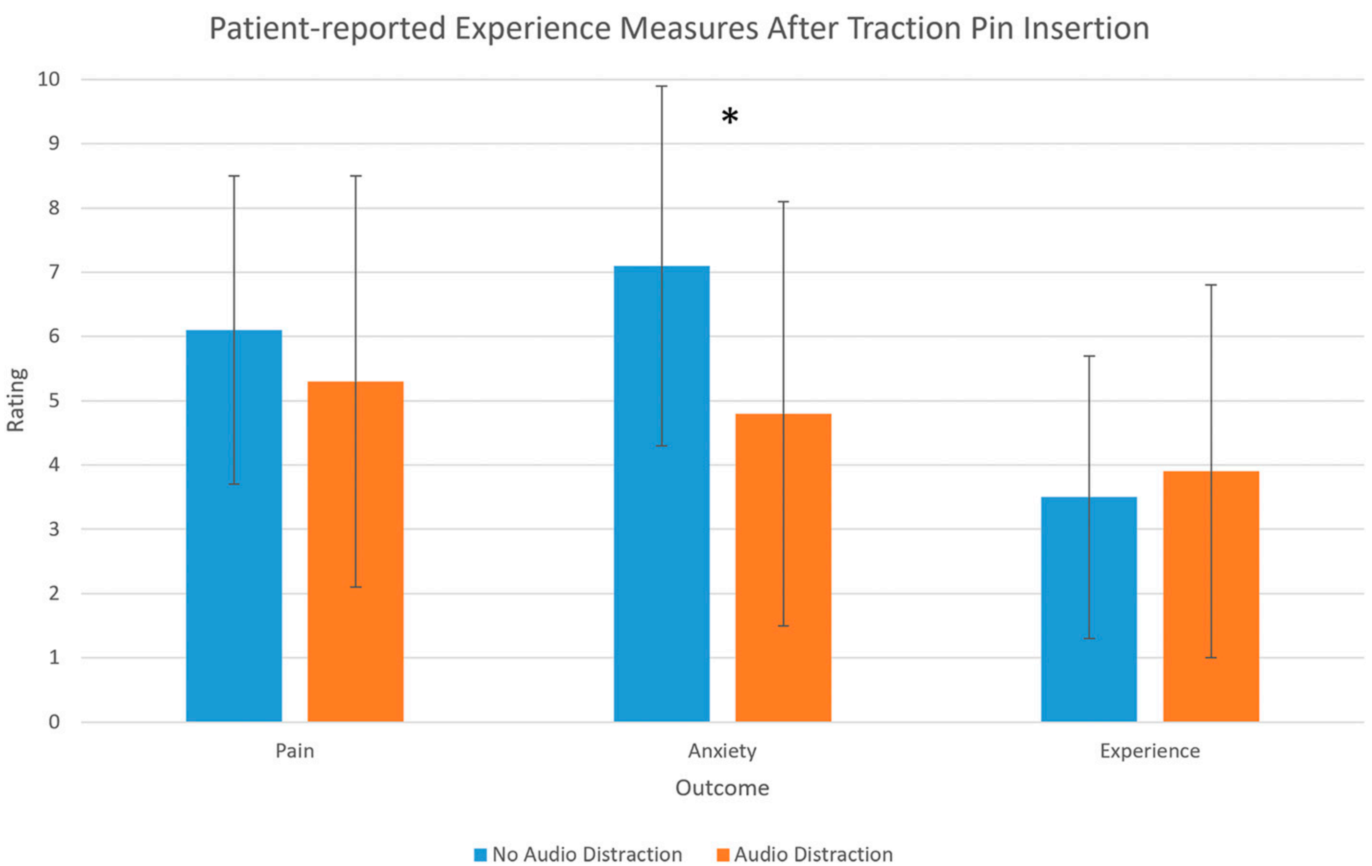

Fig. 2
Patient-reported experience measures after traction pin insertion. The values represent the mean survey response and standard deviation. *P ≤ 0.05.

TABLE III Outcomes for Audio Distraction Versus No-Distraction Group (N = 54)*

Variable	No Distraction (N = 26)	Audio Distraction (N = 28)	P Value
Patient-reported			
Pain	6.1 ± 2.4 (5.4, 6.8)	5.3 ± 3.2 (4.4, 6.2)	0.28
Anxiety	7.1 ± 2.8 (6.3, 7.9)	4.8 ± 3.3 (3.9, 5.7)	0.007
Overall experience	3.5 ± 2.2 (2.9, 4.1)	3.9 ± 2.9 (3.1, 4.7)	0.55
Physician-reported			
Procedure difficulty	2.8 ± 1.7 (2.3, 3.3)	2.6 ± 2.0 (2.1, 3.1)	0.69
Procedure time *(min)*	27.2 ± 17.1 (22.2, 32.2)	16.3 ± 7.9 (14.2, 18.4)	0.10

*Data are shown as the mean ± standard deviation with the 95% confidence interval in parentheses.

study groups, patients who received AD reported a significantly lower anxiety level. The overall patient experience, however, was not influenced by AD, and physician-reported procedure difficulty and procedure time were not found to increase with the use of AD.

The effectiveness of distraction methods has been assessed during other invasive procedures, with varying results regarding their influence on the patient experience[6-11,14-16]. Lower pain scores were reported by patients who listened to music during colonoscopy in several randomized controlled trials[7,9,10]. However, a recent systematic review of 7 randomized controlled trials found the pain-reducing effect of music during colonoscopy to be small and not significant[14]. Audiovisual and virtual-reality distraction methods are also becoming more popular[11,15,16]. In 1 study, patients who underwent elective upper-limb procedures with regional anesthesia had audiovisual distraction provided to them; although >75% reported being anxious before or during the procedure, >95% reported that the distraction decreased their anxiety[11]. Similarly, the current study demonstrated that patients who received AD had lower anxiety, although pain and the overall experience were not affected.

The prevalence of preinjury opioid use among patients with trauma has been reported to be approximately 16% to 20%[17]. This prior exposure to opioids can lead to opioid tolerance and is associated with greater pain intensity as well as decreased satisfaction with pain relief after surgery[18,19]. Patients with preadmission opioid use in the current study demonstrated pain levels that were 2.6 points higher on the Likert scale during traction pin insertion. In contrast, patients with polytrauma reported lower pain levels during the procedure. This may be because the insertion of the traction pin produced relatively minor pain compared with the other injuries that the patients were experiencing at the time. Another possibility is that the patients with polytrauma may have received more preprocedural pain medications compared with the patients without polytrauma. Both polytrauma and opioid usage serve as unique areas for further investigation.

As health-care costs continue to increase, methods of providing high-quality care at lower cost continue to increase in relevance. Value is defined as the ratio of outcomes to cost[20].

TABLE IV Multivariable Analysis of Predictors of Procedure Pain and Anxiety (N = 54)

Variable*	Unstandardized β†	95% CI	Standardized β	P Value
Predictors of pain				
Polytrauma	−1.9 (0.9)	−3.7, −0.1	−0.3	0.04
Prior opioid prescription	2.6 (1.2)	0.2, 5.1	0.3	0.04
Audio distraction	−0.6 (0.7)	−2.1, 1.0	−0.1	0.45
Open fracture	−1.5 (1.6)	−4.7, 1.8	−0.1	0.37
ISS	0.0 (0.1)	−0.1, 0.1	−0.1	0.77
Never smoked	−0.1 (0.9)	−1.8, 1.6	0.0	0.90
Predictors of anxiety				
Polytrauma	−2.0 (1.0)	−4.1, 0.1	−0.3	0.06
Prior opioid prescription	1.2 (1.4)	−1.6, 4.0	0.1	0.41
Audio distraction	−2.1 (0.9)	−3.9, −0.3	−0.3	0.02
Open fracture	−0.8 (1.9)	−4.5, 3.0	−0.1	0.69
ISS	0.1 (0.1)	−0.1, 0.2	0.1	0.44

*ISS = Injury Severity Score. †Data are shown as the beta coefficient with the standard error in parentheses.

One component of cost is the time of the personnel involved in providing care. The current study demonstrated that AD did not increase the procedure difficulty or the personnel time required. By maximizing the patient experience and maintaining the total procedure time (and thus its cost), the overall value of the procedure increased. Furthermore, widespread implementation of the method seems feasible. With approximately 84% of households in the United States having access to smartphones capable of playing music, hospitals would not need to drastically increase expenditures to minimize patient anxiety[21]. Patients could use their own headphones, or reusable headphones could be supplied as needed. Considering the practicality and low cost of this intervention, AD may be implemented effectively to reduce patient anxiety during lower-extremity skeletal traction pin insertion.

A strength of the study is that the design allowed for adequate comparison between the groups. Another strength is the standardized protocol of traction pin insertion, which limited variation among the surgeons. One weakness of the study is the lack of documentation of pain medications prior to the procedure. We chose not to include this factor in the study because it is probable that the patients had received various degrees and types of analgesia before pin insertion. However, all patients were fully conscious and oriented during the procedure. Also, the setting for pin insertion was not standardized, and this may have influenced patient anxiety and experience scores, as an emergency department trauma bay is a different environment compared with a patient's room on a hospital floor. To minimize this variability, the traction pin was always placed in a private setting, with no other procedures being performed concurrently. It is possible that the noise-reducing capability of the headphones rather than the music produced the anxiety-reducing effects demonstrated in the AD group. Future studies should evaluate the use of noise cancellation compared with AD to determine the benefits of noise reduction alone. In addition, the level of experience varied among the surgeons, which may have affected physician-reported procedure difficulty. Finally, another weakness is that the patients and physicians were not blinded to the intervention. As a result, this study is susceptible to observer and confirmation biases, which may have affected the validity of the survey responses from patients and physicians.

Conclusions

Patients who underwent skeletal traction pin insertion with AD reported lower anxiety levels during the procedure compared with the control group, with no added time or difficulty for the procedure. In a world of rising health-care costs and scarcity of resources, low-cost interventions such as AD are particularly valuable. With many patients having access to a mobile device on which music or videos are available, providing AD may be considered to be a relatively cost-effective intervention to decrease patient anxiety while not increasing procedure duration or complexity. ■

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Melissa Albersheim, MD[1]
Fernando A. Huyke-Hernández, MD[2,3]
Stephen A. Doxey, DO[2,3]
Harsh R. Parikh, MPH[3,4]
Allison L. Boden, MD[5]
Roberto C. Hernández-Irizarry, MD[6]
Patrick B. Horrigan, MD[1,4]
Stephen M. Quinnan, MD[7]
Brian P. Cunningham, MD[1,2,3]

[1]Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, Minnesota

[2]Department of Orthopaedic Surgery, Park Nicollet Methodist Hospital, St. Louis Park, Minnesota

[3]Department of Orthopaedic Surgery, TRIA Orthopaedic Institute, Bloomington, Minnesota

[4]Department of Orthopaedic Surgery, HealthPartners Regions Hospital, St. Paul, Minnesota

[5]Department of Orthopaedic Surgery, University of Miami, Miami, Florida

[6]Department of Orthopaedic Surgery, Emory University, Atlanta, Georgia

[7]Paley Orthopaedic and Spine Institute, West Palm Beach, Florida

Email for corresponding author: brian.cunningham@parknicollet.com

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