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Original Research

Noise-Canceling Headphones and Music Decrease Intraoperative Patient Anxiety During Wide-Awake Hand Surgery: A Randomized Controlled Trial



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Purpose: Wide-awake local anesthesia no-tourniquet (WALANT) hand surgery has gained popularity because of its cost savings, safety, favorable outcomes, and high patient satisfaction. However, the wide-awake nature of the technique causes many patients to experience anxiety during the procedure. Nonorthopedic studies have reported the anxiolytic effects of intraprocedural music in a variety of wide-awake medical procedures. This prospective randomized controlled trial investigated the effects of wearing noise-canceling headphones and listening to music on patient anxiety during WALANT hand surgery.

Methods: Institutional review board approval was obtained. Patients were randomized to one of the following groups: (1) a headphones group that wore noise-canceling headphones and listened to music (genre of their choice) during the surgery, or (2) a control group that neither wore noise-canceling headphones nor listened to music during surgery. Patient anxiety was assessed on a 10-point visual analog scale before, during, and after surgery. All patients completed an overall experience questionnaire after surgery.

Results: Fifty patients were enrolled, with 25 in each group. Both the groups were similar in terms of patient characteristics, diagnosed anxiety, and preoperative level of anxiety. The headphones group was found to have significantly less intraoperative anxiety (1.02 vs 2.32, respectively; $P = .017$) and a significantly greater net decrease in anxiety from the preoperative to intraoperative level (-1.78 vs -0.56 , respectively; $P = .033$) than the control group. In the headphones group, 92% (23/25) of patients stated that they would recommend wearing noise-canceling headphones and listening to music to other WALANT hand surgery patients. All (50/50) patients in both groups reported that they would choose to undergo WALANT hand surgery again if needed for the same problem.

Conclusions: The use of noise-canceling headphones with music during WALANT hand surgery significantly decreases intraoperative patient anxiety. This intervention represents an effective, safe, and inexpensive nonpharmacologic measure to improve patient anxiety and overall experience with WALANT hand surgery.

Type of study/level of evidence: Therapeutic I.

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Wide-awake local anesthesia no-tourniquet (WALANT) hand surgery has emerged as a popular technique in the field of hand surgery over the last decade. This technique has several advantages in terms of cost savings and patient safety, while resulting in outcomes comparable with those of hand surgery performed under general or regional anesthesia.^{1,2} Studies evaluating patient experience with WALANT hand surgery have also demonstrated high

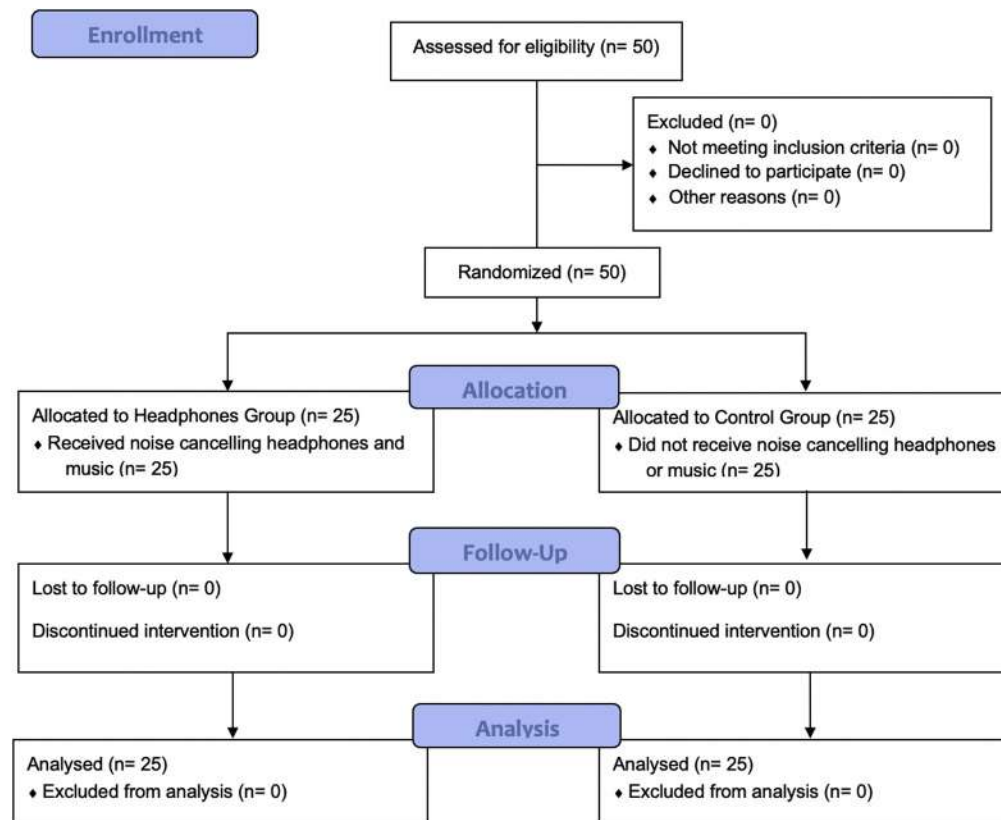


Figure 1. Consolidated Standards of Reporting Trials flow diagram for study enrollment.

patient satisfaction rates, with one study reporting that 94% of patients would choose to undergo surgery with WALANT again if they had to undergo another procedure.² However, many patients report experiencing anxiety during wide-awake hand surgery, as well as during wide-awake foot and ankle surgery.^{3,4}

Previous nonorthopedic studies have evaluated the effects of music on patient anxiety during a variety of wide-awake medical procedures. Intraoperative music has been shown to improve patient anxiety during parturition, nasal bone fracture reduction, craniotomies, breast biopsy, transrectal prostate biopsy, extracorporeal shock wave lithotripsy, and colonoscopies.^{5–11} Intraoperative music has also been found to improve patient pain and blood pressure.^{6,11,12} Dentistry literature has reported similar findings, with many studies reporting improved patient anxiety during wide-awake local anesthesia dental procedures when listening to music.¹³ However, to date, no studies have been conducted evaluating the effects of intraoperative music on patient anxiety while undergoing wide-awake hand surgery.

Although music has independently been shown to improve patient anxiety during wide-awake procedures, it is possible that the unfamiliar sounds of the operating room, such as the equipment and conversation about case details, could be contributing factors to patient anxiety during wide-awake hand surgery. The purpose of this prospective randomized controlled trial was to investigate whether wearing noise-canceling headphones and listening to music intraoperatively has an effect on patient anxiety and satisfaction with wide-awake hand surgery. We hypothesized that patients using noise-canceling headphones with music will have lower intraoperative anxiety.

Materials and Methods

Institutional review board approval was obtained prior to beginning this study. This study was registered on [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT04636463). All patients older than 18 years undergoing any elective WALANT hand surgery by 1 of 2 fellowship-trained orthopedic hand surgeons at a single outpatient surgery center were eligible for participation in this study. Per the participating surgeons' standard practice, all procedures included in this study were only offered to patients to be performed with WALANT; so, the patients did not choose between having their surgery performed with WALANT versus with sedation. Following consent and enrollment, the patients were randomized to 1 of the following 2 groups: (1) a headphones group that wore noise-canceling headphones and listened to music during surgery, or (2) a control group that neither wore noise-canceling headphones nor listened to music played in the operating room during surgery. Fifty patients were enrolled in this study, with 25 patients in each group. No patients withdrew from the study, and all patients fulfilled all study requirements (Fig. 1).

In the headphones group, patients wore SONY wireless Bluetooth noise-canceling over-ear headphones (model WHCH710N; Appendix, available on the *Journal's* website at www.jhsgo.org). After the standard operating room time out, the headphones were placed on the patient and music was started. The research staff verified that the headphones were working properly both prior to placing them on the patient and via a verbal confirmation from the patient after starting the music. Patients listened to the music genre of their choice, played through the Pandora mobile phone application. If a patient had no music preference, the Mozart Pandora

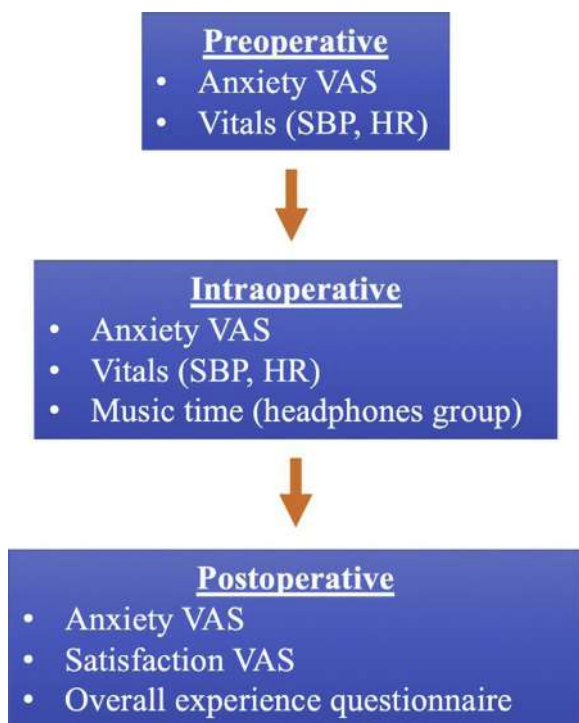


Figure 2. Outcomes collected at each time point. HR, heart rate; SBP, systolic blood pressure.

station was played. The volume level was adjusted to the individual patient's comfort level. If at any time the patient wished to communicate with the surgeon or staff, the operating room staff simply stopped the music or removed the headphones.

The same outcomes were assessed in both the headphones and control groups (Fig. 2). Preoperative data were recorded in the preoperative holding area approximately 15 minutes prior to surgery. Intraoperative data were recorded just prior to the conclusion of the procedure in order to maximize the intraoperative time spent wearing the headphones and listening to music in the headphones group. Postoperative data were recorded in the postoperative holding area just prior to patient discharge. A 10-point visual analog scale (VAS) was used to assess anxiety (0 = no anxiety, 10 = worst anxiety) and satisfaction (0 = least satisfied, 10 = most satisfied).

The sample size was determined based on an interim analysis of the first 34 patients to detect a difference in intraoperative anxiety VAS scores. To achieve a power of 0.80 and an alpha value of 0.05, it was determined that a total of 50 patients was needed (25 in each group). Continuous data were summarized using means and SDs and analyzed using the independent Student *t* test. Categorical data were summarized using counts and percentages and analyzed using the chi-square test. Statistical significance was set at $P < .05$.

Results

The study subjects consisted of 24 (48%) men and 26 (52%) women, with an average age of 60.8 (SD 11.8) years. The study groups were similar in regard to patient characteristics, such as age, sex, and the percentage of patients diagnosed with anxiety at baseline (Table 1). The procedure types were similar between both groups, with the majority of procedures being soft-tissue procedures in both groups (Table 2). In the headphones group, the average

Table 1
Patient Demographics

Variable	Headphones Group	Control Group	<i>P</i> Value
N	25	25	
Age, years (SD)	58.4 (10.4)	63.2 (12.8)	.155
Sex			.571
Male (%)	13 (52)	11 (44)	
Female (%)	12 (48)	14 (56)	
Diagnosis of anxiety at baseline (%)	5 (20)	6 (24)	.733

time spent wearing noise-canceling headphones and listening to music was 11.1 (SD 6.0) minutes.

Both the headphones and control groups were found to have similar preoperative anxiety levels (2.80 vs 2.88, respectively; $P = .89$; Table 3, Fig. 3). However, the headphones group was found to have significantly less intraoperative anxiety than the control group (1.02 vs 2.32, respectively; $P = .02$). Both groups experienced net decreases in anxiety from the preoperative to intraoperative level, with the headphones group experiencing a significantly greater net decrease in anxiety (-1.78 vs -0.56 , respectively; $P = .03$; Fig. 4). There was no difference in postoperative anxiety between the groups ($P > .05$). Vital signs were recorded before and during surgery and trended for net changes. There was no difference in net changes in systolic blood pressure or heart rate from the preoperative to intraoperative level between the headphones and control groups ($P > .05$). In the headphones group, there was no correlation between the total time spent wearing headphones and listening to music and the net change in anxiety from the preoperative to intraoperative level ($r = -0.033$).

A subanalysis was performed on the patients in both groups who were diagnosed with anxiety before surgery (Table 4). No anxiolytics were prescribed to any study patient prior to their WALANT surgery. Despite the fact that the headphones group had slightly greater preoperative anxiety than the control group (6.0 vs 4.33, respectively; $P = .11$), they had significantly less intraoperative anxiety (1.3 vs 4.0, respectively; $P = .04$). The patients in the headphones group who were diagnosed with anxiety were also found to have a significantly greater net decrease in their anxiety level from the preoperative to intraoperative level than the control group (-4.7 vs -0.33 , respectively; $P < .01$).

Postoperatively, both the headphones and control groups had similar satisfaction with their surgery experience based on VAS score (9.94 vs 9.72, respectively; $P = .10$; Table 3). When the headphones group was asked if they would recommend using noise-canceling headphones and listening to music during WALANT hand surgery to other patients, 72% (18/25) responded that they would definitely recommend, 20% (5/25) responded that they would probably recommend, 4% (1/25) were neutral, and 4% (1/25) responded that they probably would not recommend. The one patient who stated that they would not recommend using noise-canceling headphones did so because they preferred to converse with the surgeon during the procedure. All (50/50; 100%) patients in both groups reported that they would choose to undergo WALANT hand surgery again if needed for the same problem. The patients in the headphones group were invited to leave open-ended comments on their experience during surgery, and these comments are presented in Table 5.

Two patients underwent bilateral carpal tunnel release during the study period. Both these patients were randomized to the control group for their first surgery and were subsequently randomized to the headphones group for their second surgery. One patient had an intraoperative anxiety score of 0 for both of their surgeries. The other patient reported a preoperative anxiety score

Table 2
Procedure Types in Each Study Group

Headphones Group	n	Control Group	n
CTR	7	CTR	8
TFR	6	TFR	8
CTR and TFR	2	Dupuytren's	2
Cyst removal	2	CTR and TFR	1
Dupuytren's	2	Cyst removal	1
Mass excision	2	DeQuervain release	1
Skin flap	2	DIP joint fusion	1
DeQuervain release	1	DIP joint debridement	1
DIP joint fusion	1	Mass excision	1
		Skin flap	1

DIP, distal interphalangeal; CTR, carpal tunnel release; TFR, trigger finger release.

Table 3
Results of the Headphones and Control Groups

Variable	Headphones Group	Control Group	P Value
Anxiety			
Preoperative (SD)	2.8 (2.5)	2.88 (1.6)	.892
Intraoperative (SD)	1.02 (1.2)	2.32 (2.3)	.017
Net change from the preoperative level to intraoperative level (SD)	-1.78 (2.2)	-0.56 (1.7)	.033
Postoperative (SD)	0.4 (0.9)	0.76 (1.4)	.270
Satisfaction			
Postoperative (SD)	9.94 (0.2)	9.72 (0.6)	.102
Vital signs (net change from the preoperative level to intraoperative level)			
Systolic blood pressure, mmHg (SD)	-0.4 (8.9)	1.5 (7.0)	.422
Heart rate, bpm (SD)	-2.6 (5.4)	-2.5 (7.0)	.944

bpm, beats per minute; mmHg, millimeters of mercury.

of 4/10 before both surgeries, but had an intraoperative anxiety score of 5/10 without headphones and music and an intraoperative anxiety score of 2/10 with headphones and music. Three additional study patients underwent WALANT hand surgery prior to the study period and were randomized to the headphones group. Of the 5 patients who underwent WALANT hand surgery both with and without the noise-canceling headphones, 4 (80%) stated that they preferred their surgery with the noise-canceling headphones and music over their other surgery with no headphones.

Discussion

This prospective randomized controlled trial revealed that WALANT hand surgery is well tolerated by patients, with both study groups having generally low mean anxiety levels and all 50 patients stating that they would choose to undergo surgery with WALANT again. We observed that the intraoperative anxiety of patients wearing noise-canceling headphones and listening to music during WALANT hand surgery was less than half of the intraoperative anxiety of those who did not wear noise-canceling headphones or listen to music. Additionally, the headphones group's net decrease in anxiety from the preoperative to intraoperative level was more than 3 times that of the control group. These findings were accentuated in the subanalysis of patients who were diagnosed with anxiety at baseline, with the headphones group experiencing one-third of the amount of intraoperative anxiety and more than 10 times the net decrease in anxiety as the control group. The majority of patients in the headphones group (23/25; 92%) stated that they would recommend using noise-canceling headphones and listening to music to other patients undergoing WALANT hand surgery. To our knowledge, this is the first study to evaluate the effects of intraoperative music, with or

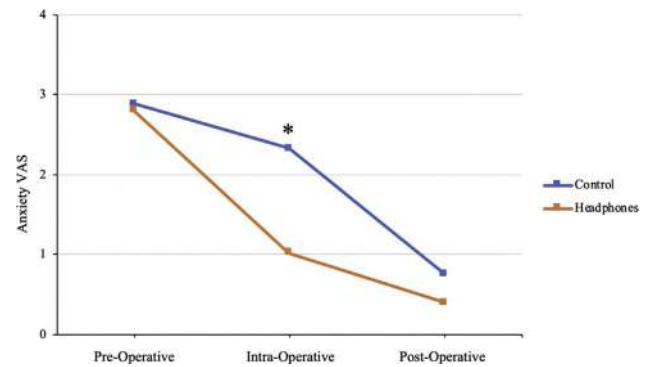


Figure 3. Pre-, intra-, and postoperative anxiety levels of both the headphones and control groups. *Statistically significant.

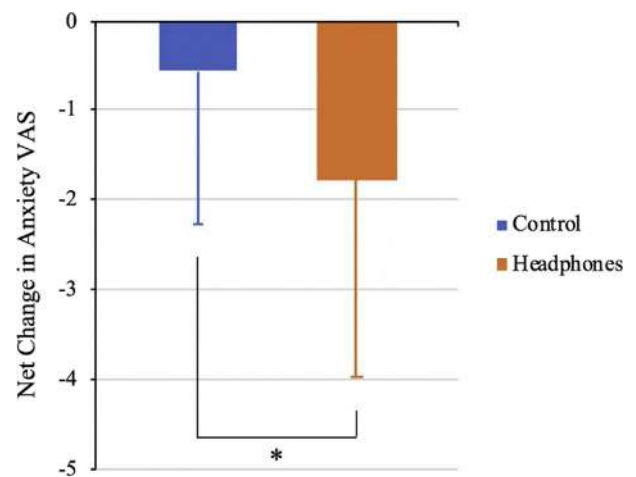


Figure 4. Net change in anxiety from the preoperative to intraoperative level. *Statistically significant.

without noise-canceling headphones, on patient anxiety and experience during WALANT hand surgery.

Music has consistently been shown to improve patient anxiety during a wide variety of wide-awake medical procedures, with many studies delivering the music through headphones.^{6,13} However, most headphones are unable to block out the surrounding sounds of the operating room, which we hypothesized to be a contributing factor to patient anxiety. To address this hypothesis, we used headphones with active noise-cancellation technology, which is a relatively new feature of some headphones.

Few studies have evaluated the effect of noise-canceling headphones and music in wide-awake local anesthesia medical procedures, and no known studies have evaluated the effect of noise-canceling headphones and music in wide-awake hand surgery. Karalar et al¹⁰ conducted a prospective randomized study evaluating the effects of noise-canceling headphones and music on patient anxiety and pain during shockwave lithotripsy for the treatment of nephrolithiasis. Patients were randomized into one of the following three groups: group that wore noise-canceling headphones with music, group that listened to music without noise-canceling headphones, or a control group that received neither. Anxiety was assessed using the State-Trait Anxiety Inventory (STAI) survey, and pain was assessed using the VAS. The group that wore noise-canceling headphones and listened to music was found to have significantly lower postprocedural STAI scores and pain than both the group that listened to music without noise-canceling headphones and the control group. Tsivian et al⁹

Table 4
Results of Patients Diagnosed With Anxiety

Variable	Headphones Group	Control Group	P Value
N	5	6	
Preoperative anxiety (SD)	6.0 (2.0)	4.33 (1.0)	.107
Intraoperative anxiety (SD)	1.3 (1.9)	4.0 (1.8)	.037
Net change in anxiety (SD)	−4.7 (1.0)	−0.33 (1.6)	.001

performed a similar prospective randomized study evaluating pain and anxiety in men undergoing transrectal prostate biopsy, comparing a group that used noise-canceling headphones with music, a group that used noise-canceling headphones without music, and a control group that received neither. Using STAI to assess anxiety, they found that the group that used noise-canceling headphones with music had the lowest mean STAI scores after the biopsy, although this difference was not statistically significant. They also observed that diastolic blood pressure remained stable in the group that used noise-canceling headphones with music but increased in the other two groups, which they believed indicated that the music modulated the physiologic response to intra-procedural anxiety and pain. The studies by Tsivian et al⁹ and Karalar et al¹⁰ showed that the combination of noise-canceling headphones and music results in decreased anxiety compared with either intervention individually, supporting our theory of the additive effects of these interventions.

Most patients in the headphones group in our study reported that they either could not hear any operating room conversation over the music or could only hear muffled sounds that they were unable to understand. In the postoperative open-ended feedback, many patients specifically cited this effect as helping to decrease their anxiety during surgery. Several patients stated that they preferred not being able to hear the operating room conversations and sounds. One patient in the headphones group who underwent a contralateral carpal tunnel release prior to the study period preferred not being able to hear the “crunching and zinging” sounds from their prior procedure, which likely referred to electrocautery. Both our quantitative results and subjective feedback support our hypothesis that foreign operating room sounds and stimuli represent a source of anxiety for patients. The noise-canceling effects of the headphones plus the music likely compound to decrease intraoperative patient anxiety.

A few patients listening to softer music, such as classical or spa music, at a lower volume stated postoperatively that they could still hear some conversation in the operating room. Therefore, the specific music type and volume level could diminish the noise-canceling effects of these headphones. If using this intervention, surgeons and staff should be aware that a patient wearing noise-canceling headphones can sometimes still hear conversations, depending on music type and volume.

We also found that this intervention could potentially serve an educational purpose in an academic setting. This study was conducted at an academic center with either a resident or fellow in every case. In an effort to make patients feel more comfortable during their wide-awake hand surgery, teaching and verbal discussion with the trainees are often limited compared with when a patient is under sedation. This could potentially hinder intraoperative resident and fellow education during wide-awake surgery. Throughout this study, trainees regularly stated that they felt more comfortable discussing case details and asking questions during surgery when patients were wearing noise-canceling headphones and when the music was sufficiently loud so that the patient was unable to hear conversation. For complex or longer-duration wide-awake hand surgeries in which trainees can benefit from more detailed discussion, this intervention can be an

Table 5
Postoperative Open-Ended Comments Made by Patients in the Headphones Group

- “The headphones got my mind off of the surgery.”
- “The headphones were a welcome distraction from the procedure and really made a difference. I was able to take mind off the surgery. My anxiety went from an 8 to about a 2-3 after putting the headphones on.”
- “I couldn't hear the surgeon, which was a good thing, good idea.”
- “They made the experience better and took my mind off of everything.”
- “I loved it because I couldn't hear the conversations.”
- “It kept me relaxed.”
- “They helped me a lot. It helped me concentrate on the music and not the surgery.”
- “They very much so helped me relax.”
- “They helped tremendously, definitely recommend, especially to people that have anxiety like I do.”
- “I found it a nice distraction and gave me something else to think about. It really helped my anxiety.”
- “I would have preferred catching up with the nurses instead.” (Patient was a former operating room nurse.)

Patients who had WALANT hand surgery both with and without noise-canceling headphones and music:

- “The headphones made a big difference for me, it was much better than my other surgery.”
- “I prefer the headphones a lot more. Hearing the crunching and zinging sounds wasn't for me.”
- “I prefer no headphones. The banter was distracting when I had my other side done.”

effective way to improve the intraoperative educational experience for residents and fellows.

Visual distraction may also be beneficial in WALANT hand surgery to improve patient anxiety and overall experience. Hoxhallari et al¹⁴ conducted a randomized study of 41 WALANT hand surgery patients, investigating the effects of virtual reality on patient pain, anxiety, and fun. They observed significantly lower intraoperative anxiety and significantly higher “fun” scores in the virtual reality group than in the control group. However, in their study, 5/41 (12%) patients experienced side effects related to the virtual reality, which included dizziness (n = 3) and nausea (n = 2). No patients in our study experienced any side effects related to the noise-canceling headphones and music, and no potential side effects were identified in the literature.

This study has several strengths in addition to its prospective randomized design. It is the operating surgeons' practice that all of the hand procedures included in this study are only offered to patients to be performed with WALANT. This effectively eliminates the chance of a selection bias of patients choosing wide-awake versus general anesthesia for their surgery based on their intrinsic anxiety level. All the procedures were performed at the same outpatient surgery center, which controls for any facility differences in the patient surgical experience.

This study also has several limitations. First, there was variability in the length of the procedures, which might have affected the anxiolytic effects of the music. However, we found no correlation between the total time spent wearing the headphones and patient anxiety. Second, the intraoperative music genre was not standardized because we let the patients select the music that they preferred to listen to. It is possible that different music genres could have different effects on patient anxiety. Third, we did not investigate music as an independent factor, so the effects of intraoperative music without the use of noise-canceling headphones on wide-awake hand surgery patients are unclear. Fourth, a downside to using noise-canceling headphones could be a reduction in the patient education opportunity during the wide-awake procedure, which has been cited as a benefit of WALANT hand surgery.¹

This study again shows that WALANT hand surgery is extremely tolerable for patients, as highlighted by the very high satisfaction

scores in both groups and by 100% of patients stating that they would choose to undergo surgery with WALANT again. With the continued shift of orthopedic surgery reimbursement to value-based plans, WALANT hand surgery can serve as a cost-saving measure that does not compromise patient safety or surgical outcomes.¹⁵ Therefore, it is imperative to maintain high patient satisfaction and ensure a positive experience with WALANT hand surgery. The use of noise-canceling headphones and music represents an inexpensive, effective, and nonpharmacologic intervention to improve patient anxiety and overall experience with WALANT hand surgery.

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