Prospective Randomized Study of the Effect of Music on the Efficiency of Surgical Closures

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Abstract

Background: Music is commonly played in operating theaters. Some surgeons believe music reduces stress and operative time, while others think music is a distraction and should be avoided. There is limited published evidence evaluating the effects of music on surgical performance.

Objective: The goal of this study is to evaluate the effect of music on simple wound closure.

Methods: Plastic surgery residents were asked to perform layered closures on pigs' feet with and without their preferred music playing. Simple randomization was used to assign residents to the music playing first or music playing second group. The time to complete the repair was measured and repairs were graded by blinded faculty. Results were analyzed to determine significant differences in time to complete the task and quality of repair. Participants were retested in a second session with music played in the opposite order to evaluate consistency.

Results: Listening to preferred music decreased repair time by 8% for all plastic surgery residents ($p = 0.009$). Subgroup analysis demonstrated even more significant improvement in speed for senior residents (PGY 4-6), resulting in a 10% decrease in repair time ($p = 0.006$). The quality of repair was also better in the music group, at 3.3 versus 3.1 ($p = 0.047$). Retesting revealed results remained significant whether music was played first or second.

Conclusions: Playing preferred music made plastic surgery residents faster in completing wound closure with a 10% improvement in senior residents. Music also improved quality of repair as judged by blinded faculty. Our study showed that music improves efficiency of wound closure, which may translate to healthcare cost savings.

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Many surgeons listen to music while they operate. From classical to rock, music can be heard in operating theaters across the world. A survey conducted in the UK showed that 90% of surgeons listen to music during operations, and that plastic surgeons play the most music.[1] Research by Ullmann et al[2] suggests that music has a positive effect on the staff in the operating room. According to their questionnaire, 77% of operating room nurses, residents, and senior physicians felt that music made them calmer and more efficient.[2] Allen et al[3] demonstrated that listening to music, especially that of a surgeon's choice, led to decreased stress and improved performance of arithmetic tasks in participants. Surgeon-selected music was associated with significant reduction in autonomic reactivity, evidenced by lower skin conductance, blood pressure, and heart rate.[3] These studies demonstrate a favorable impact, with lower stress levels and greater efficiency reported; however, there is limited evidence to specifically analyze the effects on technical performance while completing a surgical task. The purpose of our study is to evaluate the effects of playing music on plastic surgery residents performing layered wound closure on a simulation model using pigs' feet. We hypothesize that music decreases the time of repair while producing equivalent outcomes, with no significant difference in quality of the repair assessed by blinded faculty physicians.

METHODS

We asked all the plastic surgery residents presently rotating at the core facility of our integrated program PGY 1-6 (n = 15) to perform layered closure of incisions on pigs'

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feet. Pigs' feet were chosen because pig skin is widely accepted as similar to human skin. They are commonly used as a suture training tool for residents at many hospitals across the country and are easy to acquire. All the pigs' feet were obtained at a local food market shortly preceding the study. Prior to initiation, subjects expressed verbal consent to participate in performing layered closure with and without music playing. The repairs could not be identified by anyone other than the study authors. Participants were not informed of the outcomes being measured or the authors' hypothesis. Before use, pigs' feet were thawed in a warm water bath to room temperature.

During unannounced sessions, the participants were assigned a random seating position by drawing a number from a bag as they were invited into a protected resident office space. Each plastic surgery resident (n = 15) received a pig's foot. A 5 cm incision was marked with skin marker and made with a #15 scalpel. The residents were provided a laceration repair tray, which included a needle driver, forceps, and scissors as well as 3-0 and 4-0 Monocryl sutures with RB-1 needles. Instructions were provided to perform 5 deep dermal sutures with 3-0 Monocryl. The superficial layer was closed with a running subcuticular repair using 4-0 Monocryl suture with buried knots at the ends.

The study participants were asked their favorite genre of music and this preference was recorded for each subject. Simple randomization was performed by assigning residents according to their seating position: odd numbers were assigned to perform the task with music playing first and even numbers with music playing second. Each participant had headphones available connected to Pandora internet radio (Oakland, CA) with their preferred music genre station selected and uninterrupted playback confirmed.

Study subjects were not informed of the purpose of the study: the residents were asked to do their best and to notify the authors, who served as proctors, upon completion of closure. They were not told that we were comparing times or that the results would be graded. Upon completion of the first repair, a second 5 cm incision was made and the resident was asked to repeat the repair using identical technique with the music either being turned on or off, in opposition to the first repair. Time to complete the repair was recorded with a stopwatch and the two incisions were labeled 1 and 2 (Figure 1). A key was kept separate to denote whether label 1 or 2 represented the music group. This step helped ensure blinding of the faculty judging the quality of the repairs. The resident's name was not identified to the blinded faculty. The pigs' feet were stored and separately presented to three blinded faculty plastic surgeons the following day for grading. The quality of repair was graded on a 1-5 scale. Factors taken into consideration by the faculty for the final summative grade included apposition of wound edges, evenness in superficial to deep plane, step-offs, overlapping, any gaping with manual spreading perpendicular to repair, suture knot visibility or unraveling, uniform appearance, and the amount of eversion (Figure 2). The grading was a single rating expressed as compilation of the overall repair and not separately discriminated. To eliminate bias, the resident author was excluded from being a study subject and the faculty author was not on the blinded faculty panel.

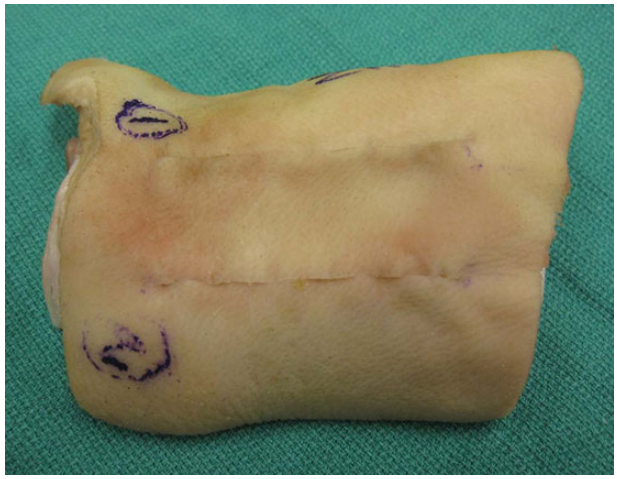

Figure 1. Simulated wound model of a pig's foot with repairs labeled.

We then asked the residents to return for a second, unannounced session in which music was played in the opposite order of the first round. All other parameters of the experiment were kept the same to evaluate for consistency of findings. Demographic information about the residents and the blinded faculty physicians was recorded. Secondary variables for subgroup analysis included age, gender, and level of training.

Statistical Analysis

Time of repair and quality ratings data were analyzed with paired *t*-tests and subgroup analyses were performed with independent *t*-tests. The results are presented as mean values ± standard error of the mean. A value of $p < 0.05$ was considered significant. All statistical analyses were performed with commercial software (Excel; Microsoft Corp., Redmond, WA).

RESULTS

Of the 15 residents who participated in the study, 12 residents completed both sessions and had their pigs' feet graded by all three faculty members, totaling 48 repairs and 144 ratings. There were 5 lower-level residents (PGY 1-3) and 7 upper-level residents (PGY 4-6). The average age of study participants was 31 years old, with a range from 27 to 33. There were four male and eight female residents (Table 1). The average age of the blinded plastic surgery

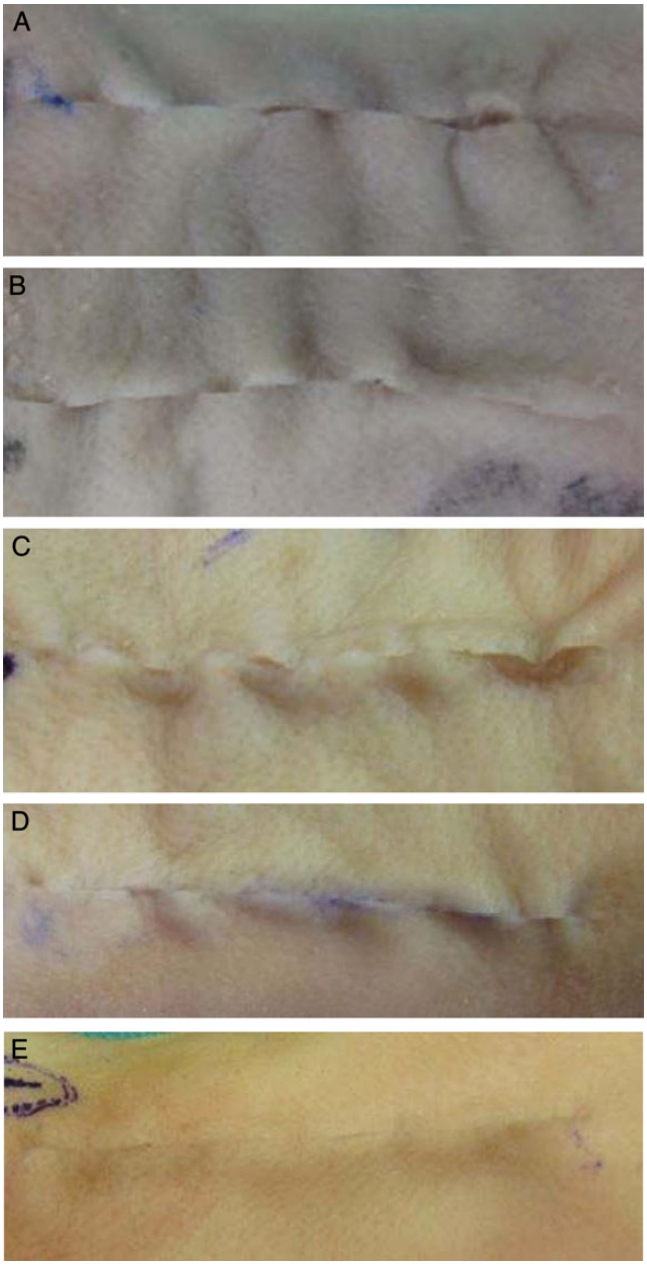

Figure 2. (A–E) in order of increasing quality of repair: (A) Wound edges not apposed, significant unevenness, step-offs, puckering, gaping without manipulation, exposed suture knot, not uniform. (B) Poor apposition, poor evenness, overlapping, step-offs, mild gaping without manipulation, poor eversion. (C) Fair apposition, fair evenness, mild gaping with manipulation, wavy/fairly uniform, fair eversion. (D) Good apposition, good evenness, no gaping with manipulation, mostly uniform, adequate eversion. (E) Superior apposition, great evenness contour, no gaping, uniform appearance, satisfactory eversion.

faculty was 46 years old with a range of 37-52. There were two male and one female faculty members. Two residents did not complete both sessions because of off-campus service obligations at the time of the second session and one faculty member had an unavoidable clinical duty and missed rating one of the resident's repairs within the allotted time, thus these three residents were excluded from the study. Genres of music preferred by the study participants included rock, hip-hop, pop, Latin, and classical, with a diverse distribution (Table 1).

Table 1. Demographics of Study Participants

Age	Gender	PGY	Music Genre
Average age 31; age range 27-33	M:F 4:8	Upper level = 7 (6^{th} = 3; 5^{th} = 2; 4^{th} = 2) Lower level = 5 (3^{rd} = 1; 2^{nd} = 2; 1^{st} = 2)	Rock = 3; 25% Hip-hop = 3; 25% Pop = 3; 25% Latin = 2; 17% Classical = 1, 8%

Time to Complete the Repair

The average time to complete the repair for all residents was 11.5 minutes without music and 10.6 minutes with music, a 7% difference (p = 0.04). Subgroup analysis showed that when excluding interns, the average time to complete repair was 10.3 minutes without music and 9.5 minutes with music (p-value 0.009), an 8% difference. PGY 1-3 completed the task with an average time of 13.8 minutes without music versus 13.3 minutes with music (p-value 0.57). PGY 4-6, in comparison, completed the task with an average time of 9.8 minutes without music and 8.7 minutes with music (p-value 0.006), a 10% decrease in time (Figure 3). Table 2 elucidates the percentage decrease in time for each respective group described. Female residents were 8% faster with music (p-value 0.04); though not significant, male residents were 4% faster with music (p-value 0.58). Similar to the findings of senior residents with a higher level of training (PGY 4-6), residents greater than thirty years of age were 11% faster with music (p-value 0.013).

Quality of Repair

The ratings, as judged by three blinded plastic surgery faculty physicians, demonstrated an overall improvement in repair quality while music was played. The average rating without music was 3.09 and with music 3.3, a 6% increase. This was statistically significant (p = 0.047; Figure 4). Subgroup analysis according to level of training revealed a similar, though not significant, trend. Senior residents had an average rating of 3.3 without music and 3.36 with music, whereas lower levels had a rating of 2.9 without music compared to 3.27 with music.

DISCUSSION

In our current health care environment, the cost and quality of health care have taken center stage. As surgeons, we are

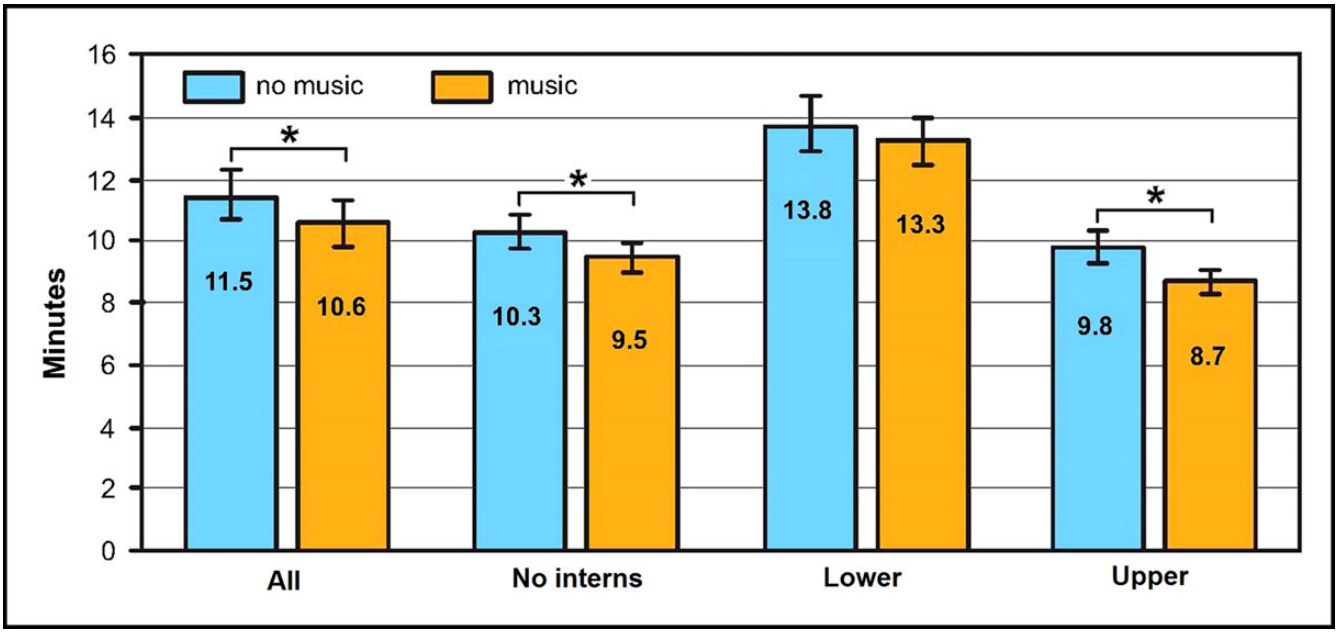

Figure 3. Time to complete task comparison without and with music. All residents: PGY 1-6; no interns: PGY 2-6; lower-level residents: PGY 1-3; upper-level residents: PGY 4-6. Error bars demonstrate standard error of the mean. * indicates statistical significance.

Table 2. Time to Complete Task Subgroup Analysis

	All	No Interns	Lower	Upper
No music	11.5	10.3	13.8	9.8
Music	10.6	9.5	13.3	8.7
% diff	7	8	3	10
P-value	0.04	0.009	0.57	0.006

All residents n = 48 repairs. Excluding interns = PGY 2-6; n = 40 repairs. Lower-level residents = PGY 1-3; n = 20 repairs. Upper-level residents = PGY 4-6; n = 28 repairs.
% diff = percentage decrease in time to complete task.

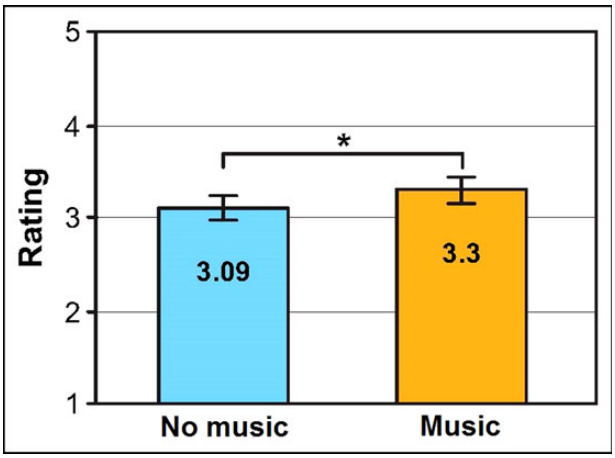

Figure 4. Quality rating by blinded plastic surgery faculty on a 1-5 scale. Error bar demonstrates standard error of the mean. *indicates statistical significance. 144 ratings total: 72 without music, 72 with music.

well aware of many factors that affect the outcome of our procedures. Some of these factors are intrinsic to the patient and the disease process. Factors such as patent's age, gender, and comorbidities all play significant roles in the surgical outcome. There are also extrinsic factors that affect the surgical outcome, such as availability of certain medical devices and the surgical technique and experience of the surgeon. Although some of these factors are very hard to measure and quantify, physicians and policymakers alike are starting to pay more attention to them with the goal of reducing cost and improving quality of care. As music becomes commonplace in the operating room, we felt the need to explore its' potential effects on surgical outcomes. It was surprising to find only limited data available regarding the effect of music. Our anecdotal experience showed that playing upbeat music in the operating room, especially during wound closure, decreased operative time. Our study confirmed that listening to the surgeon's preferred music made surgical closure faster and better. We also showed that the effect augmented as the experience of the surgeon grew. The senior residents were much faster at wound closure than junior residents, and playing their preferred music led to a 10% reduction of operative time. Spending less time in the operating room can translate to significant cost reductions, particularly when incision closure constitutes a substantial portion of the case, such as in abdominoplasty. A study by Shippert[4] showed hospital operating room fees averaged $62 per minute; adding an additional $4 for anesthesiologist professional fee, the total becomes $66 per minute. A 10% reduction in operative time per hour equals savings

of $396 per hour. In the course of the year, depending on the number of cases performed, the increase in efficiency can translate to hundreds of thousands of dollars saved. Longer duration under general anesthesia is also correlated with increased risk of adverse outcomes,[4-7] postoperative nausea and vomiting,[8] thromboemboli,[9,10] infection,[11,12] hypothermia,[13] and other perioperative complications.[14-16] Reducing the time that patients are under anesthesia will improve outcomes in the long run.

Music has been shown to have positive effects on athletic performance: volleyball players warming up with music had significantly higher peak anaerobic power,[17] subjects exposed to music achieved higher stationary bicycle mileage,[18] and netball players improved their shooting.[19] Surgical performance, similar to athletic performance, can be affected by mental focus, muscle memory, and operative environments. Research by Karageorghis et al[20,21] indicates that music has a positive effect on these factors. Music narrows a performer's attention, diverts the mind from sensations of fatigue, promotes rhythm and effective movement patterns, and alters the psychomotor arousal fostering an optimal mindset and enhanced mood. Operating room staff feel more comfortable when music is playing, leading to an overall improvement of the operative environment. The benefit to the patient has been illustrated through many well-conducted studies. Music therapy effectively reduces sensations of pain and distress,[22-26] opiate need and administration,[27,28] and patients' perceptions and manifestations of pain and anxiety.[28] Music intraoperatively has also been shown to reduce sedative requirements.[28,29] Nilsson et al[25] found that patients undergoing surgery under general anesthesia who were exposed to music intraoperatively reported lower pain in the post-anesthesia care unit.

It is important to note that music is not for everyone. We believe that while music can improve focus and efficiency when performing a routine task, it may be a distracter when performing a complex and unfamiliar task. In our study the interns, at only two months into their residency, struggled with wound closure and music did not make much of a difference in repair time. In one intern, music showed a trend of slowing the repair. In a study by Miskovic et al[30] junior surgeons with no previous laparoscopic experience achieved lower scores when performing their first trial in simulation laparoscopic procedures while listening to music. We suggest that if any unexpected situation arises or the case is at a critical junction, the music should be turned down or simply shut off to facilitate communication and decision-making.[31] We routinely turn down or shut off the music when performing microvascular anastomosis at our institution.

We recognized that our subjects could potentially improve on the second repair simply as the result of repetition. This effect was reduced by the randomization of the study subjects. To further eliminate this bias, we ran a second session with the order in reverse. The result held up during the second test. Limitations of the study include potential observer effect. Although the subjects were never told we were comparing times as an outcome measure, the inherent trend for residents to identify time as being measured may have caused some to rush repairs. Selection bias of enrolling only plastic surgery residents limits the translation of results to other surgery specialties. The blinded faculty grading is a subjective measure of repair quality, yet faculty opinion is analogous to residency training methods and there was no significant inter-observer variability in faculty ratings. Unfortunately, we were unable to draw any conclusions as to the best music genre to play in the operating room. Intuitively, faster pace music may lead to faster repairs. Most residents in our study chose faster pace music as their preference. We plan to investigate the effects of music genres in a future study. Similar to Bosanquet et al,[32] we recommend that each operating theater reach a harmonious consensus. Music has been shown to have a plethora of benefits for the patient, surgeon, and operating room staff.[32] Our study provides supporting evidence for a prevalent practice of playing music in the operating room and encourages ongoing discussion for a controversial topic.

CONCLUSION

Our study showed improved efficiency of repair in a simulated wound model while residents listened to music of their preference. There is an overall reduction of operative time of 8% in all residents. The reduction improved to 10% in upper-level residents. The quality of the repair also improved slightly in the music-listening group. In the current health care environment, where cost reduction is center stage and operative time is money, every second counts.

Disclosures

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