Review Article

Surgical Music Therapy: A Narrative Review

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Abstract

This study is aimed to review the documents and clarify the relation between music intervention and surgical procedures. Surgical procedures are often accompanied by psychological feelings such as fear and anxiety, which can affect the anesthesia process and lead to increased sedation and undesirable physiological and metabolic changes. These changes can cause deleterious effects when exaggerated. According to neuroscience-based shreds of evidence, music can activate limbic and paralimbic brain structures, which play a role in changing the emotional state. In conclusion, music could help to alleviate unwanted feelings and control surgical stress.

Keywords: music therapy; perioperative; pain; anesthesia; surgery

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Introduction

Music is an abstract language that has a fundamental correlation with the human brain. Thaut considered archeological music through early humans "autonomous abstract languages of the human brain whose development was fundamental to the emergence of the cognitive ability to construct symbols that communicate meaning, a prerequisite for the development of complex cognitive abilities such as verbal and numerical languages". He has propounded in his study on the early origins of music therapy that "The notion of music as therapy is based on ancient cross-cultural beliefs that music can have a "healing" effect on mind and body" (1).

There is evidence of primitive therapeutic approaches to music since ancient times. Music had been used in pre-literature culture and early civilizations as supernatural petitions against illnesses that were assumed to be caused by supernatural forces. In ancient Greece, music's healing power was highly accepted (1, 2).

In 1914, Kane used a phonograph for the first time in the operating room to induce a sedative effect before general anesthesia and during local anesthesia. This report is regarded as the first official acknowledgment of modern music therapy by the American Medical Association (3,4).

In the nineteenth and twentieth centuries, Studies support the possible therapeutic applications of music in a variety of medical settings to manage pain, stress, and anxiety even in crucial situations like the

emergency department (5).

This study is a review of the literature to illustrate the prospect of music interventions as procedural support in surgery for patients undergoing general, local, and regional anesthesia.

Preoperative

As Haun said "Preoperative time is the time when anxiety levels are known to rise. The anxiety may be intensified by the patient's perception of the surgical suite as a threatening environment; the waiting time may be more traumatic than the surgery itself. Preoperative anxiety is characterized by subjective, consciously perceived feelings of apprehension and tension accompanied by autonomic nervous system (ANS) arousal" (6, 7).

Surgical fear and anxiety are directly related to facing an unfamiliar environment, unpredicted forthcoming, and fear of death and deformity (6, 8, 9). High anxiety also has effects on heart rate, blood pressure, and blood cortisol levels, which can in turn affect immune responses and delay wound healing, and augment the risk of infection (10). Moreover, anxiety stimulates the sympathetic nervous system and exhausts the vasomotor center (11). Furthermore, the presence of anxiety may complicate the induction of anesthesia (12).

Several types of research about music-based interventions have indicated the beneficial use of preoperative music interventions in patients (6, 13-21). In Wang's study, patients who underwent a form of music intervention before surgery were significantly less anxious. The anxiety level of the subjects of the music group showed a 16 percent decrease (P = 0.001), whereas the anxiety level of patients in the control group did not change (16).

Pharmacological medication not only increases the possibility of experiencing side-effects associated with the administration of drugs but can also produce an adverse effect (10, 15).

Bringman et al. designed a controlled-randomized trial between 2004 and 2007 to investigate whether music has a more significant anxiolytic effect than a standard dose of midazolam in the preoperative setting (15). The results interestingly represent anxiety reduction to a greater extent in patients of the music group who listened to selected music by a professional music therapist and for a specific time, in comparison with the anxiety levels of the subjects of the midazolam group who received a standard dose of pre-medication midazolam. The anxiety level of the subjects was demonstrated in terms of the State-Trait Anxiety Inventory (STAI). Besides, another research by Ganidagli et al. reported that music increases sedation during midazolam pre-medication (23). They investigated the level of sedation between patients who received music intervention after midazolam injection and patients in the control group subject to usual care. The level of preoperative sedation was assessed with the electroencephalograph bispectral index (BIS) and Observer's Assessment of Alertness/Sedation Scales (OAAS). This result is supported by another research conducted by Lepage, which indicated that patients who participated in music application in the preoperative setting required less midazolam to achieve a similar degree of relaxation as controls (11).

Consequently, the use of music was associated with an efficient reduction of anxiety and an increase in the sedation level in the preoperative period. However, Palmer et al. found no significant difference in the amount of propofol requirement to reach BIS 70 between the two groups of an experiment; the music intervention group and the control group (13). However, they also reported significantly less anxiety in subjects undergoing music intervention to assess GA-VAS anxiety scores.

Intraoperative

The stress response to surgery has been a matter of debate for physicians for many years (24, 25). These responses affect immunological, endocrinological, and hematologic pathways (23, 24, 25). Although these metabolic changes are known as human's natural protective response, they can bring about harmful impacts when overstated (24, 25).

Regional Anesthesia: Koelsch et al. designed an experiment to investigate the cortisol and ACTH (adrenocorticotropic hormone) levels of patients under spinal anesthesia (14). They considered cortisol levels as physiological indices of subjective stress and ACTH levels regarding the hypothalamus–pituitary–adrenal (HPA) axis activity. This study used a randomized,

double-blinded design according to the standards of evidence-based medicine, through two groups of participants consisting of a group in which patients received a relaxing musical stimulus before and during surgery and a control group of patients who just listened to the noise of breaking sea waves to block the operating theatre noise, which was itself considered relaxing and pleasant by the patients.

The authors also measured the sedative requirement of propofol which was used to achieve the same target level of sedation. Also, due to the relation between HPA-axis activity and immune system activity, they measured IgA (Immunoglobulin A) levels which indicated the immune function.

Results indicated that cortisol levels were significantly lower in the music group between applying spinal anesthesia to the end of surgery compared with the control group, although no significant difference was seen between the two groups in the baseline cortisol levels before the induction of anesthesia. Notably, cortisol levels decreased in the music group during the preoperative period until the application of anesthesia, whereas it increased during the same time in the control group. Propofol consumption was also lower in the music group. The mean BIS value was normally lower in the music group compared with the control group, and this outcome also confirms Ganidagli's study (14, 23).

The authors found no significant difference in ACTH values and IgA values between the two groups of the experiment. Although IgA values were higher in the music group directly after the beginning of surgery and skin incision until the end of the process, this result was not shown to be statically significant. Moreover, the decline in IgA levels was interestingly less pronounced in the music group (14). Music can affect autonomic, endocrine, and immune systems (26). Therefore, as it is documented in some studies, music interventions can affect IgA levels desirably (27, 22).

Cortisol is a glucocorticoid that plays a major role in the response to physiological or psychological stress (14, 28). Other pieces of evidence have confirmed the considerable effect of musical interventions on the serum cortisol level (17, 28-31). However, Conrad et al. did not find a significant difference in cortisol levels after music intervention (32). It is noteworthy that the study had some limitations, such as small sample size, and was also held in the intensive care unit. They also reported a remarkable difference in interleukins-6 (IL-6) between critically ill patients who received music therapy and patients with usual care; IL-6 levels decreased significantly in the music therapy group while they remained unchanged in the controls. IL-6 and other cytokines have an important role in mediating immunity and inflammation (24, 25, 32).

Furthermore, the study revealed that patients who received music therapy did not require any additional propofol, although among patients in the control group propofol was occasionally necessary (32). Therefore, this finding corroborates other studies that indicate that music decreases sedative requirements during spinal anesthesia (4, 8, 14).

One research out of four that investigated the relation between music intervention and medication, assessed the amount of propofol and alfentanil requirement (8), the rest of the four studies investigated just propofol needs (4, 14, 32). However, a study conducted by Argstatter et al. reported that music therapy did not effectively influence the amount of medication regarding patients undergoing intracardiac catheterization (7). Nevertheless, they also find music interventions beneficial to reduce anxiety in terms of the State-Trait Anxiety Inventory (STAI) scale. An extra beneficial role was also suggested in patients with higher-than-average psychological strains.

Argstatter revealed that music intervention could effectively influence blood pressure (7). Mottahedian et al. also indicated that music intervention could bring about positive effects on blood pressure and pulse rate (28). Nilsson, in a systematic review, investigated the effect of music interventions through several randomized controlled trials (2). A significantly reduced heart rate was observed in the music intervention group in six of the twenty-two (27 percent) studies. In six studies (27 percent), a significant decrease in blood pressure was reported. A significant decrease in respiratory rates was reported in three of eight studies (38 percent). Nilsson's study includes investigations about different times including preoperative, intraoperative, and postoperative periods.

General Anesthesia: Several studies revealed that auditory perception remains active during general anesthesia; they also demonstrated that subconscious memory through auditory input might exist following the intraoperative period (33-36). As Tsuchiya says: "These findings suggest that auditory processing functions remain active under general anesthesia to a greater extent than was previously recognized. It is not unreasonable to suggest that manipulation of patients' auditory input under general anesthesia may also be similar to that demonstrated in conscious patients" (37).

These shreds of evidence lead the investigations through musical interventions' possible effects on human response to surgical stress. Tsuchiya et al. studied the hemodynamic changes of patients in an intervention group who listened to comforting sounds and patients who did not, during laparoscopic cholecystectomy surgery (33). Results demonstrated that auditory interventions during general anesthesia blunted hemodynamic changes upon emergence from anesthesia. Besides, patients in the intervention group reported increased acceptability of their experience of anesthesia. Nilsson et al. also investigated the beneficial effect of music therapy on patients who underwent hysterectomy under general anesthesia (38). They indicated that intraoperative music application might have some positive effects on postoperative recovery. Patients who received music therapy during anesthesia experienced less pain and less fatigue compared to the patients in the control group. They also were mobilized significantly earlier than patients with normal care. Finally, the authors suggest music therapy during surgery as an effective alternative to eliminate intraoperative awareness which can be associated with dissatisfaction, nightmares, anxiety and delayed or permanent mental disturbances (38).

Kahloul et al. support these investigations through their study in 2016 (39). They found more stability regarding the hemodynamic profile in patients listening to music during surgery. The study evaluated different types of surgery under general anesthesia and demonstrated that subjects in music intervention groups experience less pain and a calm recovery in terms of Riker score and Visual Analog Scale (VAS) and this finding corroborates Nilsson's investigation. Moreover, Kahloul revealed that the incidence of intraoperative awareness in participants of the music group was lower, however, the difference was not of statistical significance; this may support Nilsson's suggestion regarding the beneficial use of music therapy upon intraoperative awareness (39).

Postoperative

The postoperative fluctuation in hormone levels can be higher than those during the surgery itself in some cases. This increase has a direct impact on the amounts of postoperative analgesics (40). Music intervention can improve patients' experience in the recovery period as well as before and during the surgery (30, 41-45). Finding new psychological interventions and regimens to relieve anxiety and depression postoperatively to shorten convalescence is of importance (46).

Music therapy may bring about a pain-reducing effect in the postoperative period (30, 41, 43, 45, 46). The amount of morphine requirement can be calculated to assess the degree of patients' postoperative pain. Investigations have demonstrated that postoperative music interventions substantially reduce morphine consumption (41, 30). Consequently, patients who benefit from music therapy in their recovery time, experience significantly less pain.

Also, music intervention can efficiently affect postoperative surgical stress which is associated with an increase in cortisol levels (40). Cortisol is one of the most important markers of postoperative stress (47, 48). Cortisol levels can remain elevated during the days following surgery (49). Furthermore, increases in cortisol levels cause a rise in blood glucose levels, and a high level of blood glucose can subsequently result in deleterious effects on the process of wound recovery (28). Studies indicate that music intervention may lead to a reduction in serum cortisol levels during recovery from surgery (30, 42). Also, evidence confirms that patients who had listened to relaxing music in their recovery period and bed rest experienced significantly less anxiety compared with patients with usual care (30, 43, 44). High anxiety can affect the immune response and wound healing process, hence, an increased risk of infection (10).

Notably, five out of the seven aforementioned studies included patients undergoing cardiac surgery, often accompanied by high pain and anxiety (50).

A closer look

Plourde et al. found that both the primary and secondary auditory cortex remained responsive to auditory stimulation during anesthesia (51). Thus, Plourde's finding can be the answer addressed to the question of how music can affect unconscious patients undergoing general anesthesia.

Music can considerably affect humans, not only in psychological parameters but also in physiological parameters (52). It evokes feelings and sensory centers to contribute to improving the patients' negative emotions (53). Music can also have a desirable impact on the sympathetic nervous system and parasympathetic neural activity, which is followed by lowering the cortisol level and consequently reducing surgical stress (53).

An fMRI study conducted by Koelsch et al. demonstrated that music activates an extensive neural network of limbic and paralimbic structures, including the amygdala, parahippocampal gyrus, and temporal poles (54). As Koelsch describes "Limbic and paralimbic structures are involved in some functions underlying the processing of a variety of emotions" (54). Amygdala, for instance, is a central structure within the limbic/paralimbic neural circuitry which plays an important role in the initiation, generation, detection, maintenance, and termination of emotions that are assumed to be important for the survival of the individual such as fear-related or negative emotions (54, 55). Studies demonstrated that the amygdala responds to different auditory stimuli, including consonant sounds (a combination of musical notes that sound pleasant together) and dissonant sounds (a combination of musical notes that do not sound pleasant together). However, the reason for the increase in amygdala activity remains unclear (54, 55). This stimulation can be followed by a decrease in anxiety, depression, and fatigue. Moreover, as Koelcsh explains, "emotions also are closely linked to peripheral physiological effects. Emotions always have effects on the vegetative (or autonomic) nervous system, the hormonal (endocrine) system, and the immune system" (26). Therefore, music therapy can efficiently benefit from these music-evoked emotions.

Future studies

This study consists of several investigations and experiments, which used a wide range of different musical materials while music consists of different components such as style, tempo, harmony, timbre, and many other musical elements. Consequently, its effect would vary on patients, taking into account the diverse range of cultures, tastes, and musical backgrounds. Similarly, some studies have demonstrated that different types of music bring about different psychological and physiologic results (56, 57). Future researches could investigate the association between the improvement of patients' experiences and different musical materials.

Also, since different surgeries may include various procedures, finding the proper and most effective window for music therapy interventions remains still a matter of debate.

Conclusion

In summary, our data indicate that music (both in music therapy and music medicine settings) is a non-pharmacological, non-invasive, safe, and economic implementation, which can manage anxiety and surgical stress and lead to decreased pharmacological intervention without any side effects. Moreover, it significantly improves patients' postoperative experiences and shortens their recovery period by alleviating negative emotions such as anxiety and reducing the pain sensation. Thus, it is strongly suggested to consider music therapy as an adjunct to the standard surgical setting.

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