

# Beneficial effects of music in the healing process of traumatic injuries: perceptual control of suffering and possible abatement of disability conditions

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## Abstract

Numerous scientific studies report that listening to music can beneficially affect physical and mental health, and even expedite the healing process of traumatic conditions. One of the most noteworthy positive effects of music lies in its ability to control stress and anxiety by lowering heart rate, blood pressure and blood cortisol levels. Furthermore, music can help improve mood especially in traumatized people who are faced with a wide range of negative emotions, reducing symptoms of depression and stimulating the production of dopamine in the brain, favorably inducing sleep quality, thanks to their relaxing action. Listening to music can stimulate brain activity and improve short-term memory and concentration, having positive effects on the healing process of traumatic pathologies. Therefore, music should be considered a complementary treatment option for people facing treatment for traumatic pathologies, also stimulating the production of endorphins in the brain and intervening on pain control, resulting in positive effects on the quality of life of the traumatized. Furthermore, music can help people express their emotions and communicate with others, providing a way to connect with the world and share similar experiences, reducing social isolation and improving emotional well-being. *Clin Ter 2023; 174 (6):531-536 doi: 10.7417/CT.2023.5021*

**Key words:** polytrauma, impairment, music listening, pain management, music-based therapy, evidence-based approaches, clinical and psychological symptoms

## Introduction

Music is known as a mood regulator capable of fostering psycho-physical health and well-being in clinical settings. However, the scientific investigation into the neurochemical effects of music is still inconclusive. Music improves health and well-being through the engagement of neurochemical systems for (a) reward, motivation and pleasure; (b) stress and excitement; (c) immunity; and (d) social affiliation (1). As far as health benefits, it should be noted that not all forms of music are created equal. Relaxing music, such as classical

or jazz, is generally viewed as the most effective in terms of relieving stress and anxiety, enhancing mood, and improving sleep quality. Nonetheless, the choice of music obviously rests on personal preferences and the specific conditions of the disease. In addition to the health benefits, music can be highly relevant in the medico-legal field, especially when it comes to defining the evaluation framework of residual impairments resulting from traumatic injuries sustained in road accidents, occupational accidents or various accidental events. Music is in fact known to constitute a valuable rehabilitation and physiotherapeutic tool, by encouraging greater participation and more motivated cooperation from patients; thus, music facilitates functional and motor recovery through a greater sense of awareness of the proprioceptive and sensorineural balance, proving to be a valid regulator of emotional support when coping with stressful situations. Regularly listening to music could positively affect pain perception, thus reducing the need for analgesics and improving the quality of life of patients, in addition to contributing to the healing process of fractures, with positive repercussions on the extent of the after-effects and related compensatory damages. More specifically, regularly listening to music can help keep the patient active, more inclined to physical exercise and rehabilitation, facilitate movement awareness coordination, and stimulate muscle memory and conscious movement. All such effects make music a valuable complementary therapeutic option, which in combination with other therapies and medical treatments, can maximize results and speed up the healing process of fractures. More specifically, when it comes to major orthopedic-trauma surgery, patients often need additional resources to manage pain from the early stages of starting rehabilitation care. Listening to music, in addition to pain-relieving therapeutic protocols, can prove to be a positive feedback in limiting pain scales and encouraging patients to participate with greater commitment in rehabilitation programs aimed at restoring awareness of movement, ergonomic-articular gestures and of the walking pattern, through a stimulus of neuro-sensory-motor proprioceptive facilitation and activation of the body-mind connection (2). The fundamental objective of this article

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is to outline the potential role and effect of music therapy on postoperative pain control after surgery of orthopedic patients, through an area where treatments such as music-guided imagery have proven quite promising in order to stimulate the healing process, through a series of emotional expressions where energy and sound images inspire the use of harmonizing and alternative modalities, thus increasing the patient's attention in the management of pain adaptation (3). Uncontrollable pain contributes to exacerbating suffering, anxiety and stress levels, thus delaying the functional recovery phase, with a consequent increase in health costs and greater risks of complications, such as algodystrophy, joint stiffness, chronic pain, union delays and pseudarthrosis. In addition, pain management is essential in terms of achieving high quality of care levels. Hence its optimization is conducive to medical ethics soundness, in keeping with ethical standards, guidelines and best practices which bind us all and make healthcare services and procedures sound from a medicolegal standpoints as well (4,5). Music is one of the universal languages that favor distraction from algogenic impulses, thus reducing sensitivity to pain. This scientific review summarizes and critically analyzes the available evidence to evaluate the impact of music on pain threshold, suggesting possible future research directions.

### **The effect of music on pain thresholds**

This scientific review is based on a systematic search of the literature available in academic databases, such as PubMed and Google Scholar. Studies investigating the effect of music on pain management were selected, including patients suffering from chronic pain, acute pain, and postoperative pain. Randomized controlled trials, systematic reviews and meta-analyses were also included in order to provide a comprehensive overview of the available evidence. Several scientific sources have explored the effect of music on fracture healing and reduction of permanent sequelae in multiple trauma patients. A study focused on the effect of listening to music during the physical rehabilitation of patients with hip fractures, pointing to a significant improvement in mobility compared to patients not usually listening to music (6). Fractures of the proximal end of the femur are a relatively frequent event in middle- and advanced aged patients; such fractures generally result from accidental falls with lower limb adducted or abducted, which is often associated with a rotational component. They are more frequent in women, due to the higher degree of osteoporosis physiologically related to menopause. Moreover, these fractures are considered to be all the more unstable, i.e. subject to displacement, the closer the fracture line approaches to the vertical, due to the pressure and shear forces exerted on them and which tend to make the fragments slide reciprocally. The main local complication of medial fractures of the proximal end of the femur is the total or partial traumatic interruption of blood circulation to the femoral head, with consequent cephalic ischemic necrosis, the incidence of which is directly related both to the proximity of the fracture with the femoral head, and the degree of decomposition of the fragments. Fractures of the proximal femur are common in the elderly and are mainly treated surgically (7). These frail patients are at high

risk of postoperative complications, as they often have significant comorbidities treated by multidrug use (8).

Another study (9) analyzed the effect of listening to music on pain and anxiety in patients who had undergone orthopedic surgery, observing a significant reduction in pain and anxiety of such patients as opposed to the control group, pointing out music as a useful intervention complementary to pharmacological treatment, safe, inexpensive and simple to manage by nurses in orthopedic postoperative settings. The effect of listening to music on the healing of bone fractures in patients with osteoporosis was also accounted for: an improvement in bone density and muscle strength was reported in patients who regularly listened to music compared to the control group. A study has also assessed the effect of perioperative recorded music on postoperative delirium in patients with proximal femur fracture undergoing surgery (10). Delirium can be a major factor affecting patient outcome and recovery, in addition to the patient's family, health care providers, and medical costs. Perioperative music has been found to have a beneficial effect in eliciting modifiable risk factors for delirium.

Delirium is a widespread complication in elderly patients hospitalized for fractures of the proximal femur and forced into prolonged bed rest due to the occurrence of post-operative complications, facilitated by the presence of pre-existing medical conditions such as dementia or cardiovascular disease, use of sedative drugs or other medications that may affect brain function, unfamiliar hospital environment, and change in daily routine (11). Delirium is an acute, fluctuating disorder of consciousness and attention that can cause mental confusion, disorientation, agitation, hallucinations, and long-term cause of cognitive and functional impairment (12). Management of delirium in older adults with hip fracture is important to ensure the best possible outcome. This may include identifying and treating underlying causes, pain control, early mobilisation, promoting a calm and familiar environment, minimizing the use of sedative medications, spatial and temporal orientation, cognitive stimulation and the active involvement of the patient in their care and rehabilitation. Listening to music can have positive effects on the mental, emotional and physical state of hospitalized seniors, due to its calming effect on the nervous system which helps reduce stress and anxiety. Listening to music involves different areas of the brain, stimulating memory, attention and cognitive functions. This can be especially helpful for older adults who may be at risk for cognitive decline or delirium. Furthermore, music can arouse positive and pleasant emotions, improving overall emotional state, encouraging conversations and sharing of experiences between patients and healthcare professionals, thus facilitating social interaction and helping to create a more positive and wholesome environment (13). Therefore, an adequate preventive intervention and treatment of delirium can be viewed as a decisive indicator of health quality (14). An interesting article (15) highlighted the different intrinsic and external factors which can trigger the cascade of neurochemical events underlying the etiopathogenesis of delirium. Such an understanding is essential to better understand the possible pathophysiological mechanisms, with the aim of implementing correction methods, establishing rational treatment modalities and developing effective

preventive techniques. Hippocampus overstimulation, rich in glucocorticoid receptors and therefore susceptible to cortisol and stress, has been hypothesized to play a role in the development of delirium. Since an increase in serum cortisol can have delusional effects (16), music can help attenuate the neurohormonal response to cortisol stress (17), resulting in significant beneficial effects on postoperative pain, anxiety, intraoperative sedation requirements, and postoperative opioid use (18).

Experiencing pain is a highly common occurrence after orthopedic surgery, and patients often need additional resources to manage it adequately. In that regard, it is worth mentioning a study which aimed to determine whether listening to music could have a positive effect on pain scores and satisfaction in the postoperative adult orthopedic patient. The results demonstrated a statistically significant reduction in patients' pain scores after listening to music. Length of listening time had no measurable effect, and all patients expressed satisfaction overall (19). In that regard, it is worth mentioning a study where it is hypothesized that a percentage between 55 and 80% of patients with postoperative pain could not get sufficient relief from pharmacological therapies alone, resulting in a condition of chronic suffering, as well as inevitably delayed recovery, a profound impact on health at higher health service costs (20). It is clear that effective pain management requires the synergistic cooperation of multifactorial and not only pharmacological interventions (21), so much so that there is a growing interest in the role of the arts, especially music, in the health sector, especially in elderly patients to improve postoperative outcomes. Considering the positive effects of recorded music on older surgical patients, an interesting study was devised that examined the effects of live music by professional musicians on hospital surgical wards with the goal of improving patient outcomes. (22). The use of live music, although still rare in hospital wards, has elicited more significant responses from the public than recorded music, which is why a novel initiative called Meaningful Music in Health Care (MiMiC) was designed in collaboration with a conservatory. Live bedside music was performed by professional musicians once a day for six or seven consecutive days and measurements of the most significant variables were collected before surgery, 30 minutes after and 3 hours later. Such measurements were pain experienced, anxiety, relaxation, and physical parameters (heart rate, heart rate variability, blood pressure, respiratory rate, and oxygenation). Daily evaluations determined that this innovative practice can be implemented in daily practice. It is interesting to recall an interesting study where it is reported that music can significantly relieve post-operative pain, in particular the music chosen by the participants (23). A systematic review and meta-analysis demonstrated that music may be beneficial as an adjuvant for patients with chronic pain, reducing self-reported pain and its common comorbidities. The analgesic effect of music was shown to appear greater with self-chosen than researcher-chosen music, even leading to a reduction of self-reported feelings of anxiety and depression (24).

Outcomes for patients who listen to music versus those who do not may vary based on the type of medical intervention and the severity of the trauma experienced. However, patients who listened to music during rehabilitation report-

edly experienced a significant improvement in muscle strength, greater joint mobility and a reduction in pain perception compared to patients who did not. In addition to being a pleasant and relaxing activity that can improve the patients' quality of life during their healing journey, music can be used as a distraction tool during painful or unpleasant medical procedures, for example during difficult medications of wounds, by helping to reduce the perception of pain and the anxiety associated with such procedures, and therefore improving the overall patient experience. Importantly, listening to music should be considered as an integral part of a comprehensive treatment plan, which includes physical therapy, medical care, and prevention of complications. Overall, studies suggest that listening to music may have beneficial effects on fracture healing and reduction of permanent sequelae in multiple trauma patients. However, more research is needed to better understand the mechanism of action of music on healing and to identify the best ways to use music as a complementary therapeutic tool.

## Discussion

The physiological mechanism which proves that those who listen to music perceive pain less intensely is not yet fully understood, but there are several theories that have attempted to explain such a correlation. One plausible argument is that listening to music activates neuronal circuits of the brain's reward system, raising dopamine levels and reducing pain perception. Dopamine is a neurotransmitter that plays an important role in regulating pain and mood, and the activation of reward circuits can result in a reduction in perceived pain. Moreover, listening to music can also activate the parasympathetic nervous system, which is responsible for reducing heart rate and blood pressure, as well as causing muscle relaxation. Such an effect can help allay stress and anxiety, both relevant factors in higher perception of pain. Listening to music appears to have beneficial effects on pain perception through the activation of reward circuits in the brain, activating the parasympathetic nervous system, and distracting attention from pain. Neuroimaging studies have gained an insight into the neural correlates of music processing and perception in the brain. In particular, musical stimuli have been shown to trigger specific pathways in different brain areas linked to emotional behaviors, such as the insular and cingulate cortex, hypothalamus, hippocampus, amygdala and prefrontal cortex. Furthermore, neurochemical findings have pointed out that several biochemical mediators, such as endorphins, endocannabinoids, dopamine and nitric oxide, may come to play a role as a result to listening to personally enjoyable music (25). A systematic review explored the evidence base on the impact of music listening on biological response in both clinical and non-clinical settings. Human studies exploring the effects of listening to recorded music on biological markers were included. The most commonly investigated biomarker was the stress hormone cortisol, and half of the clinical trials demonstrated a stress response modulation effect of listening to music regardless of genre, self-selection of music, or duration of listening. listening, although the majority used classical music (26). Listening to music bilaterally activates



multiple cortical, subcortical and cerebellar regions that include multiple brain networks, so as to recommend its application to people with neurological disorders (27). All the studies consulted investigated the physiological mechanism underlying the effect of listening to music on the perception of pain and it was observed that listening to music increased the levels of dopamine in the patients' brains, with positive repercussions on the pain perception, mediated by the brain's reward system. These studies indicate that listening to music can affect several physiological mechanisms, including activation of the brain's reward system, activation of the parasympathetic nervous system, and distraction of attention from pain. Some studies then compared the effects of listening to different types of music on the perception of pain. In this regard, a recent observational study (28) evaluated the effect of favorite music compared to disliked music on pain thresholds (tolerance) and on perceived pain intensity in healthy volunteers. Pain thresholds were measured by quantitative sensory testing. Volunteers were randomly assigned to hand pressure algometry to assess pressure pain threshold or electrical measurements to assess electrical pain tolerance threshold while listening to favorite and disliked music. The intensity of perceived pain was assessed using a numerical rating scale, from 0 (no pain) to 10 (worst pain imaginable). Favorite music was found to produce higher pain thresholds than disliked music ( $P < 0.001$ ) and lower perceived pain intensity during the stimulus ( $P = 0.003$ ). As a result, listening to favorite music when noxious stimuli are received leads to higher pain thresholds and lower perceived pain scores than disliked music. It is important to note that the choice of music depends on the patient's individual preferences and there is no "best" music for pain relief, but it is important that the music is pleasant and relaxing for the patient, tailored to the patients' individual musical preferences. Furthermore, the duration of listening to music may influence the effects on pain perception.

One study (29) reported that listening to music during physical therapy of patients with chronic spine pain for at least 30 minutes a day for three weeks significantly reduced pain perception and improved quality of life. Fibromyalgia patients can also benefit from musical approaches as complementary treatments. One study evaluated the effects of music therapy, in the form of therapeutic listening to music, particularly for patients with fibromyalgia, to treat chronic pain by reducing pain perception, increasing well-being, and improving quality of life (30). A growing number of controlled studies have evaluated the potential rehabilitative effects of music-based interventions, such as listening to music, singing or playing an instrument, in various neurological diseases, finding positive effects on cognitive support, motor function and emotional well-being in people with Parkinson's disease, epilepsy or multiple sclerosis. Music-based interventions may affect divergent functions such as motor performance, speech or cognition in these patient groups. Music-based interventions are emerging as promising rehabilitation strategies by activating psychological stimuli and neurobiological mechanisms that share common neural systems for reward, arousal, affect regulation, learning, and behavior-driven plasticity activity (31). Scientific literature has shown that listening to music related to the patient's personal tastes (preferred music listening) can produce

therapeutic effects in various clinical contexts, adopting a new approach based on therapeutic listening to music that integrates the subjective component of listening (the musical tastes of the patient) and the structural and parametric characteristics of the music in relation to the therapeutic purposes (32). Music may be key in distracting patients from negative moods, helping them express emotions, and teaching them new physical, psychosocial, and cognitive skills (33). Music streamed through an app positively improves some aspects of nociceptive processing, including pain threshold tolerance and pain temporal sum (34). Additional studies testify to the importance of music therapy and performing arts medicine, as well as the broader relationship between music and medicine, highlighting the potential benefits of perception and experiential pathways for individuals and, consequently, for human society (35). The scientific data gathered for the purpose of this article are concordant in calling attention to and signaling the need to identify standardized methods and global strategies for the use of music therapy in any clinical context (36). Among other things, music therapy is considered an integral part of the awakening of the peripheral nervous system-central nervous system based on the hypothalamus-brain stem-autonomic nervous system (HBA) axis, resulting worthy of clinical promotion (37). Furthermore, in one study the possibility of treating tinnitus was evaluated by assigning acoustic therapies based on the patient's neurophysiological response (38). Future research should work towards multiple objectives aimed at acquiring essential knowledge on the relevance of music for people with neuro-motor and consciousness disorders and its use within daily rehabilitation programs (39). Therapeutic listening to music integrates the subjective component, represented by the patient's musical tastes, and the structural and parametric characteristics of music in relation to therapeutic purposes (40). Such an approach, called Therapeutic Music Listening (TML), based on listening to music of individualized playlists created on the basis of the patient's anamnestic and personal data and scientific notions, as well as therapeutic purposes, aims to reduce or allay transient or structured symptoms (e.g. anxiety, stress, pain, etc.) and enhance well-being. The fundamental purpose is to merge the subjective perspective of listening to music with a scientifically oriented approach to determine a link between musical stimulus and therapeutic effect, ensuring a sort of "modeling" of listening to music also characterized by quantitative implications with respect to different clinical problems, making use - where necessary - of the support of Artificial Intelligence, as currently applicable in other sectors of medical science (41). Another noteworthy aspect of this therapeutic approach is that it can be implemented remotely as a telemedicine intervention, as already happens in other fields of medicine (42-44), further simplifying and broadening the scope of application and reaching potential users more easily. It is strongly recommended to thoroughly frame the sphere of the patient's psychic functioning, via an in-depth analysis based on listening and targeted interviews, with the aim of knowing his inner reality and the limitations deriving from the disability resulting from the pathology suffered. The doctor's attention must be focused on the personal characteristics that have conditioned the change for the worse in the state of life and self-representation within

the patient's overall psyche. It should be noted that very often the thinking capabilities of the suffering patient appear to be dominated by a complete psycho-physical structural subversion, characterized by a sense of disheartened awareness as to "deterioration of intensity and quality" of life, which is perceived as a transfiguration of one's own image. In such instances, "listening" is remarkably useful in order to prevent the patient from becoming gloomy and disheartened in seeing his own pathological condition transfigured and transposed into a radically noxious change in their life, substantiating a state of psychic alteration liable to interfere significantly in the patient's daily functioning (45,46).

## Conclusions

Currently available research findings show that listening to music as a complementary therapy to other forms of treatment can have a significantly beneficial effect on pain management and optimization of night rest, especially if tailored to the patient's individual preferences and listened to over a prolonged period of time. Furthermore, listening to personalized music seems to be more effective than listening to standard music, with a greater involvement of the patient in their own therapeutic and adaptation plan in pain management. Several theories have been identified to explain the effect of music on pain, including the activation of neurophysiological mechanisms, cognitive distraction and the influence on the emotional system of patients. It is important to consider various factors, such as musical genre, individual preference, intensity and duration of musical exposure, in order to maximize therapeutic benefits. Furthermore, integrating music as part of a multidisciplinary approach to pain treatment could provide even more significant results. Importantly, the effect of music on pain can vary from individual to individual. Therefore, it is advisable to adapt the musical approach to individual needs and preferences, and to evaluate the effectiveness of the intervention through a continuous assessment of the patient's symptoms. The effect of music on pain threshold is a promising field of research and the intent of the present study is to delineate new prospects for interprofessional collaboration for the benefit of patients. However, more research needs to be conducted focusing on patient outcomes, including cost-effectiveness and the experiences as reported by patients and healthcare professionals.

## Conflict of interest

The author declares that he has no conflict of interest regarding this manuscript.

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