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Eye-tunes: role of music in ophthalmology and vision sciences

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Abstract: Although the healing effect of music has been recognized since time immemorial, there has been a renewed interest in its use in modern medicine. This can be attributed to the increasing focus on holistic healing and on the subjective and objective aspects of well-being. In ophthalmology, this has ranged from using music for patients undergoing diagnostic procedures and surgery, as well as for doctors and the operation theatre staff during surgical procedures. Music has proven to be a potent nonpharmacological sedative and anxiolytic, allaying both the pain and stress of surgery. This review aims to explore the available evidence about the role of music as an adjunct for diagnostic and surgical procedures in current ophthalmic practices.

Keywords: cataract surgery, glaucoma, music, ocular surgery, retina

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Introduction

Music has been an integral part of the human experience from time immemorial. The inextricable link between music and medicine perhaps finds representation best in the wisdom of the ancient Greeks; the Olympian Apollo was the God of both, medicine and music. Understandably, because music and medicine have many things in common, both involve extensive training to improve skills, endorse importance of teamwork in addition to individual brilliance and quest for perfection.¹ Another fascinating facet of music in medicine is its healing properties.

With advancing technology and research, today we are in a better position to understand the mechanisms of music-based interventions. Brain and music have been a hot topic for research, and body of evidence generated has thrown light on how music affects the brain and other body systems in a measurable way. Using this knowledge, health care providers integrate music with medicine to augment healing.

The link between music and ophthalmology is unique, the classical example being the combination of vision impairment and exceptional

musical ability. Immensely talented visually impaired musicians such as Ray Charles, Surdas, Stevie Wonder and Andrea Bocelli are testimony to this fact. What makes this wonderful combination tick? It has been observed that blind children are 4000 times more likely to have a perfect pitch – a traditional marker of exceptional musical ability – than their fully sighted peers.² The brain in children exhibits tremendous plasticity, synapses grow and connections are made all the time. Because the areas of brain involved in vision are not being used in blind children, the auditory areas become much more prominent. The greater focus on auditory input makes the brain develop in a different way.³ Music becomes a substitute language for children who cannot communicate in other ways.

The gate control theory is based on the fact that pain is an integrated sensory, affective, motivational system that modulates noxious input and attenuates the perception of nociceptive inputs. Therefore, logically pain and auditory pathways would inhibit each other. Preoperative music-induced activation of auditory pathway may disrupt the central transmission of nociceptive stimuli.

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Pain and anxiety before, during and after surgery can have far-reaching consequences. Anxiety is a common response to surgery⁴ and the prospect of being conscious during surgery done under local anaesthesia can be an unnerving experience for patients.^{5,6} Other stressors in operating room (OR) include the sounds and lights of the OR, feel of the surgeon's touch and concerns related to anaesthesia.⁷ Other auditory stimuli that include noise of phacoemulsification machine and professional conversations among surgeons heighten the anxiety and stress of the patient.⁸ Anxiety worsens postoperative pain and enhances the need for analgesics.⁹

In addition to preoperative use of anxiolytics, nonpharmacological interventions like intraoperative interaction and touch have been shown to significantly decrease intraoperative anxiety.¹⁰

In this context of nonpharmacological interventions, music has emerged as a useful anxiolytic and sedative. Musical interventions affect both physiological (blood pressure and heart rate) and emotional (perioperative anxiety) domains of patients.¹¹ It finds application in different situations: to reduce perioperative anxiety, rehabilitation of severely brain-injured patients, reducing pain after gynaecological surgeries and strengthening coping skills in communication.⁹ Above all, its role in 'healing the healer' is being increasingly explored.

In Ophthalmic literature, studies have addressed the question, 'What is the effect of music on an ophthalmic surgeon who relies on visuospatial skills, fine, precise and coordinated hand-eye movements to navigate inside the eye?'

This brief narrative review evaluates articles from PubMed that explore the use of music for ophthalmologic surgical procedures and investigative practices.

Effect of music on patients undergoing surgical procedures

Intravitreal injections

Needle penetration of the globe during intravitreal injections is associated with apprehension and discomfort. Improving patient experience during such a frequently done procedure is important.

With this premise, a randomized controlled trial was conducted to study the effect of music on patients undergoing routine intravitreal injections.¹² The type of music chosen was guided by a small prestudy survey of 12 patients belonging to different age groups. During their intravitreal injection procedure, these 12 patients were receptive to background music, with soothing and easy-listening instrumental being the most preferred type. So based on the prestudy choice, in the actual study the background score chosen was 'Relaxing Piano: Studio Ghibli Complete Collection'. Study patients were administered the State-Trait Anxiety Inventory (STAI)-S questionnaire before and after the injection with or without background music (both the groups had 37 patients each). Patients were also assessed for subjective pain, anxiety and satisfaction on a visual analogue scale (VAS) and future preferences. Age, number of previous injections, blood pressure, heart rate, STAI-S and VAS Questionnaire scores were analysed. The music group reported lower anxiety and pain and a greater reduction in the STAI-S score compared with controls although the difference was not statistically significant. The lack of significant difference was probably masked by the higher age of the control group; older age correlated with lower anxiety. Other possible confounders could be short procedural time and varied musical preferences among the different age groups.¹²

In another study, the effects of classical music therapy on anxiety, perceived pain and patient satisfaction were evaluated in patients undergoing intravitreal injections in an outpatient setting. The group in which music was used as therapy listened to classical music through computer speakers while waiting for and during the injection. The control group underwent the injection in the same setting without music. All patients completed STAI-S and a satisfaction and pain questionnaire pre- and postprocedure. The main outcome measures were objective anxiety derived from STAI-S scores and subjective pain and anxiety from the postprocedure questionnaire. Music therapy group had a greater decrease in anxiety vis-à-vis the control group.¹³

Exposure to music before and during intravitreal injections therefore was seen to decrease anxiety in patients, with most patients opting to have music played during future injections. The use of music was concluded to be a safe and cost-effective

intervention that reduces anxiety during intravitreal injections in the outpatient setting.

Cataract surgery

Cataract surgery in elderly patients can be extremely stressful given the higher rates of comorbidities, higher propensity to sedation-related complications and their inability to cope with pain or anxiety of hospitalization and surgery. Music accompanied by verbal reassurance can be a useful therapeutic modality in this subset of patients.

Music as an anxiolytic has been previously studied in cataract surgeries. Bellan and coworkers studied 144 patients undergoing cataract surgery and found that listening to music presurgery was associated with decreased anxiety.¹⁴ Cruise and colleagues reported that patients undergoing cataract surgery under retrobulbar anaesthesia were more comfortable in the presence of relaxing music vis-à-vis OR noise alone.¹⁵

A crossover clinical trial of pain relief using Korean traditional music (KTM) was conducted during sequential bilateral cataract surgery.¹⁶ The song had a simple melody without lyrics and with a limited dynamic range. It was recorded with Korean traditional zithers and an electronic keyboard. For patients in the KTM group, it was played repeatedly during the cataract surgery through earphones with an MP3 player. The intensity of pain experienced during procedure scored by each patient using a VAS showed a statistically significant reduction in the KTM group compared with that without. No significant differences, however, were seen in blood pressure or pulse rate. This study also highlighted influence of cultural factor on the type of music in different populations.

Laser PRP

A study by Quigley and colleagues assessed the safety and efficacy of music during PRP (panretinal photocoagulation) laser in patients with diabetic retinopathy. Patients were exposed to Western classical music comprising of Bach's Aria and Jesus, Greig's Morning Mood, Pachelbel's Canon, Mozart's Concerto, Satie's Gymnopédie, Liszt's Love Dream and Shostakovich's Waltz Number 2. The primary outcome was postprocedural pain, measured on a numeric scale of 0–10 immediately and 24 hours later. Randomization was done in the ratio of 2:1

(Music: Control groups). Pain perceived by both groups was similar with no additional complications noted in the music group. A smaller sample size, lack of choice of music and use of Pascal laser machine in this study, which has a shorter pulse duration, could be the possible factors why this study could not demonstrate a significant analgesic effect with music.¹⁷

Effect of music on patients undergoing investigative procedures

Standard automated perimetry

Standard automated perimetry (SAP) is a psychophysical investigation used as an aid in diagnosis and progression of glaucoma patients. It is highly subjective and reliant on patient cooperation and attention. Loss of concentration, inability to follow instructions, patient anxiety and fatigue adversely influence the reliability of the test results.

Multiple studies have been undertaken to assess the improvement in performance of SAP after exposure to Mozart's Sonata. In 2006, Fiorelli and colleagues randomized young normal subjects naïve to SAP into music group and no music group. The music group was exposed to first 10 minutes of Mozart's Sonata for two pianos in D major (K 448) immediately before taking the SAP test. The time between completion of the sonata and visual field testing could not last more than 10 minutes. It was observed that the music group had significantly lesser number of fixation losses, false positive and false negative errors.¹⁰

The same methodology was repeated again a few years later with elderly subjects naïve to SAP. The music group exhibited a significantly lower false negative rates and a lower visual field reliability index as well as a shorter test duration.¹⁸ It was therefore concluded from these studies that listening to the Mozart's sonata increased attention span among subjects, thereby reducing test duration as well as improved reliability indices.

As a modification of the above two studies, Bing and colleagues evaluated the Mozart effect and its impact on reliability of SAP in glaucoma patients who were randomized into three groups: control, headphones (noise cancelling headphones but no music) and music (Mozart's Sonata for Two Pianos in D Major) for 10 minutes before visual field testing. Music group showed no signs of

improved reliability compared with the control group. This could be attributed to the possibly decreased effect of Mozart's music in older patients or in patients with glaucoma. Also, the visual field test reliability indices may not be sensitive enough to pick up subtle improvements in patient performance. Because a reliable visual field generally requires the false positives, false negatives and fixation losses rates to be below 30%, it could be possible that the Mozart effect becomes evident only in subjects with worse baseline reliability.¹⁹ Although the authors use the term 'Mozart effect', it is actually a debunked concept rampant in late 1990s, when the Mozart effect referred to a theory that Mozart's music boosted the intelligence quotient (IQ).

Glaucoma

Type A personality and increased mental stress are postulated risk factors for elevated intraocular pressure (IOP) in glaucoma patients. Exposure to relaxing music may positively impact these patients with a favourable effect on IOP and its fluctuations. This is an area that is less explored and there is paucity of data on the effect of music on IOP and disease progression.²⁰ Physiological (IOP, ocular blood flow) and psychological variables of patients have been shown to be positively influenced by hypnosis, and music hold promise owing to their cost-effectiveness and safety.²¹

Similarly, the short-term effect of additive relaxation music on physiological and psychological parameters of primary open-angle glaucoma patients was studied by Bertelmann. Best corrected visual acuity, IOP and short-term mental state (using KAB [Knowledge, Attitude and Behaviour], a one-dimensional and bipolar questionnaire) were seen to be significantly better in the study group compared with controls, whereas visual fields, long-term mental state and stress hormones like adrenalin, cortisol and endothelin-1 levels did not show a statistically significant difference owing to the small sample size and a short study duration of 10 days.²²

Effect of music on doctors performing surgical procedures

Simulated intraocular surgery

Ophthalmic surgery in contrast to general surgery requires higher level of precision owing to its microscopic nature. Surgeons are reliant on

visuospatial skills and hand-eye coordination to manoeuvre instruments in the surgical field, which requires utmost concentration and vigil. To study the effect of music on ophthalmic surgeons, a study conducted in Germany requires residents and ophthalmologists to execute two surgical tasks on a virtual intraocular surgical simulator to measure precision and hand tremors. They were randomized into two groups—with and without exposure to Mozart music. No statistically significant differences were observed in the two groups, although it was concluded that music did not have an adverse impact on the surgical skill when studied in a virtual setting. As the study was conducted on a simulator, its results must be translated to reality cautiously.²³

Effect of music on the OT staff

In a questionnaire-based study conducted in India to study the effect of music on the OR staff, it was seen that a major proportion of the subjects responded in favour of music played in the OR. It was credited to be a mood elevator and improved the cognitive function of the listeners. In addition, music helps in reducing the heightened autonomic reactivity of staff during stressful surgeries.²⁴

Another study in New Zealand assessed the perception of OR staff towards exposure to music in the OR by administering an online survey to them. Most respondents were again in favour of music, attributing it to improve mood, calmness and work efficiency. On the contrary, some respondents were of the view that it had an adverse impact on communication and hampered vigilance, and therefore preferred it in longer, more familiar and nonurgent surgeries at a low to medium volume.²⁵ These studies reinforce the beneficial effects of playing music in the OR. Tempo of music around 60–80 beats per minute has been found to be the best for soothing the nerves.²⁶

Do different types of music have different effects?

Binaural beat audio

Binaural beats are special sounds perceived when two auditory stimuli of different frequencies are presented to each ear. They influence the brain through entrainment of brainwaves. They alter the arousal levels *via* the activation of the Reticular Activating System (RAS), thus reducing anxiety

and increasing pain threshold. For the beating to be heard, the frequency presented to each ear must be below about 1000–15,000 Hz. Binaural beat frequency, which is equal to the difference in frequencies applied to each ear, must be small about 30 Hz for the effect to be seen.

The anxiolytic effects of music with and without binaural beat embedded audio on operative anxiety were investigated in patients undergoing cataract surgery under local anaesthesia. Patients were randomized into three groups: binaural beat, plain music groups and control group without music. Blood pressure and heart rate were measured at admission, at the beginning and 20 minutes after the start of the surgery. Perioperative anxiety was assessed with STAI-S questionnaire. The binaural beat audio and music group showed significant reduction in the STAI-S score compared with control group, but the difference between binaural beat and plain music group was not significant. Systolic blood pressure was significantly lower in both music groups while significant heart rate reduction was observed only in the binaural beat group.⁸

Mozart music and the Mozart effect

The presence of right frontal and left temporoparietal electroencephalogram (EEG) coherent activity induced by listening to Mozart's Sonata for Two Pianos in D Major is indicative of increased cortical firing patterns and thereby temporal-spatial reasoning for an approximate duration of 10 minutes. This widely studied and documented phenomenon came to be known as the Mozart effect.¹⁰ It is also postulated that music with a high degree of long-term periodicity may find resonance within the brain, decreasing seizure activity and enhancing spatial-temporal performance.²⁷

These effects, however, are known to vary between individuals and may also depend upon the spatial tasks evaluated, with little impact on general intelligence. Also, these results have not been limited to Mozart's compositions, and the musical criteria conducive for a favourable outcome elude definition.²⁸

Meditative music

Innes and coworkers found that both Kirtan Kriya (KK) meditation and listening to music significantly enhanced subjective memory function and objective cognitive performance in adults with subjective

cognitive decline, which can be noted in many elderly patients suffering from cognitive disorders.²⁹ KK is a multisensory meditation practice that includes a Kirtan (repeated singing of the 'Sa-Ta-Na-Ma' mantra; a form of devotional music), a motor component (touching each fingertip to the thumb in sequence with the chant) and a visualization component.

Conclusion

The epidemiological shift in the history of health and well-being has been dramatic. From battling short, fatal diseases, the scourge of mankind now is the chronic diseases that run a slow and protracted course, gradually affecting an individual's quality of life. As modern medicine, therefore, focuses more on the narrative of health, bringing into focus both the subjective and objective aspects of life experiences, it is only natural that music be central to this development.

Whether it is Dante Alighieri negotiating the seven terraces in *Purgatorio* to *Sanctus*, literally health, or allegorically, salvation, or Bob Marley singing *One good thing about music, when it hits you, you feel no pain*, music has guided mankind through tribulations both physical and spiritual. It therefore stands to reason that ophthalmologists consider music to be an integral part of their therapeutic armamentarium.

Conflict of interest statement

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