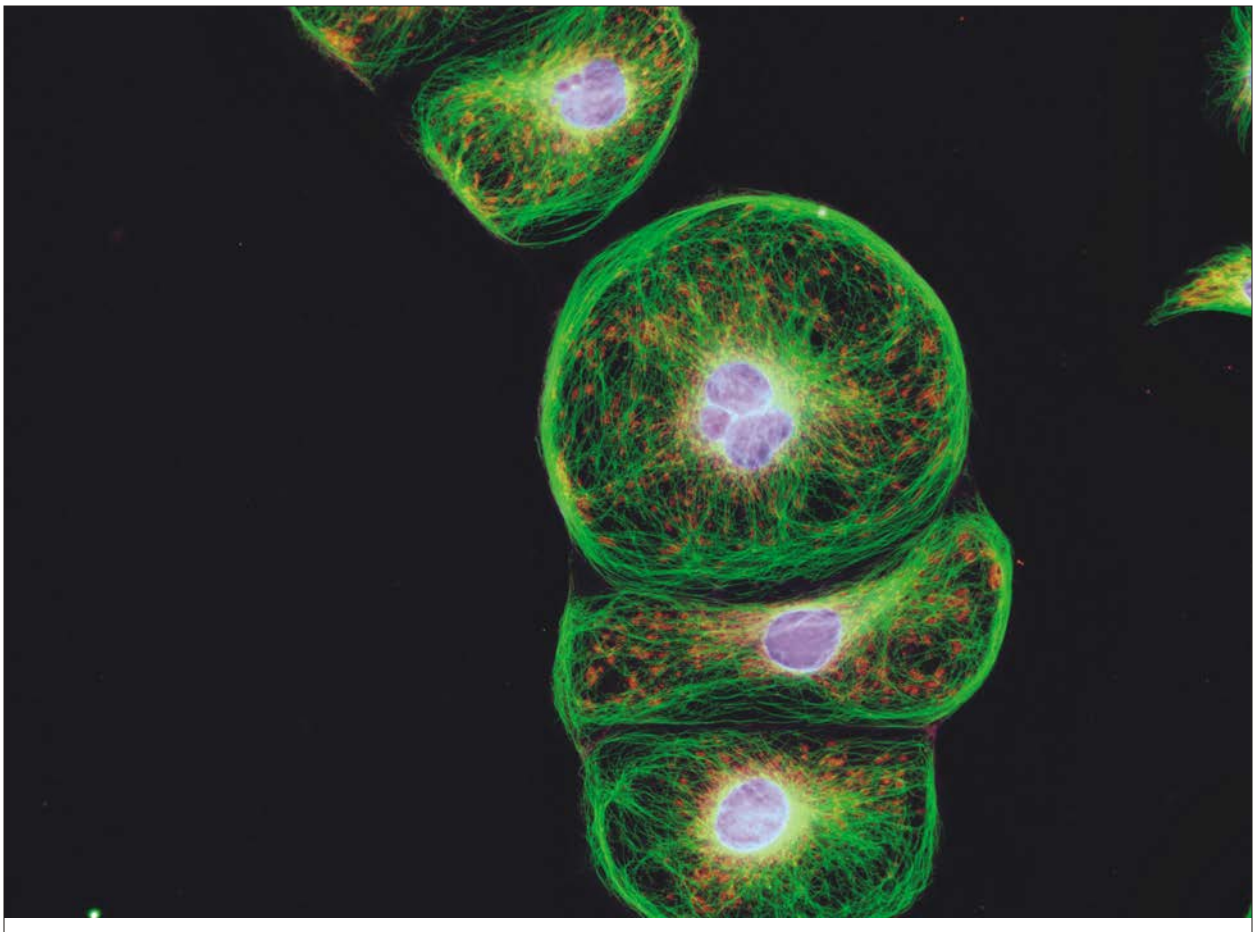

Asian Journal of Cell Biology

ISSN 1814-0068

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Cell Biology 3 (1): 41-46, 2008
ISSN 1814-0068

Effects of Various Intervals Applied in Classical Music on the Ultrastructure of Reflector Nerve and Muscle Terminals (A Musical, Medical, Biological and Experimental Study)

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Abstract: The aim of the study was to explore the effects of these intonations on the reflector nerve and muscle terminals of guinea pigs using electron microscopic approaches. Spazmatic shrinking of myocyte myofibrils together with degenerative changes in myocytes and nerve terminals occur with the application of strained intonations. Transmission function is also damaged related with this situation. Clear relaxative extensions in myocyte myofibrils and decrease in activity of nerve terminals were determined with the application of more extensive intonations.

Key words: Music, intervals, nerve, muscle, ultrastructure

INTRODUCTION

Music has a striking affect on human beings, animals and plants (Ekici *et al*., 2007). It can create a strong current in human, mind and emotions. Music with beats can stimulate the body. Music that formed with strong melodies and harmonies that formed with senses can make human cry or stir with happiness. Music with a beat can stimulate the body; music with powerful melodies and harmonies performed with feeling can make human weep or cry out with joy and music like the fugues of Bach and Mozart can be mentally invigorating (Wicke, 2002b). When the term used positive to describe music, it tells about music that has beneficial qualities and is emotionally and spiritually uplifting, perhaps even healing. Negative music is the music that stimulates the negative emotions: Anger, frustration, depression, hatred and fear (Robertson, 1998).

Classical music has played a role in healing and synchrony of mind, body and spirit. In Vedic culture, sounds and music were used in balancing the body and mind, increasing health and supporting goodness before thousands of years. Nowadays it is understood that body functions such as respiration, pulse etc. work in certain period and rhythm. These rhythms are regulated by music and sounds (Wicke, 2002a).

Extensive records about music therapy, especially classical music have been used since 1950's. They were used for aches, migraine, cancer, stress, stomach defeats, fatigue and depressions etc. Music therapy decreases palpitation of the heart, blood pressure, respiration velocity, stress and anxiety (Wicke, 2002c). It is said that music has strengthen immune system and helped the synchrony between

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left and right hemispheres of frontal brain lobe according to recent findings. However, developments of plants with the effects of classical music were observed in the experimental studies. But these kinds of studies such as musical, medical, biological and experimental studies were rare. We study about the effects of classical music on the organisms from several years (Ekici *et al*., 2007; Mamedova *et al*., 2007).

The aim of this study is to investigate the effects of different musical intonations (intervals) on reflector nerve and muscle terminals in macromolecular (ultrastructural) level and to compare the functional differences.

MATERIALS AND METHODS

Musical items which were used in this study were chosen in Bilkent University, Faculty of Music and Performing Arts, Department of Music (Ankara-Turkey). Animal experiments and electron microscopy studies were done in Trakya University, Faculty of Medicine, Department of Histology and Embryology (Edirne-Turkey) in 2006. Fifteen guinea pigs were used in this study. Guinea pigs were separated into three groups. (1) Group-5 guinea pigs was control group. (2) Group- comprised of 5 guinea pigs which were affected with music that was established from strained kvarta and sekunda intonations (National Marches, Military Songs, Wagner Scene of Vernizberg, I.S. Bach Choral prelude etc.) for 6 h a day with 15 min intervals for a period of 10 days and (3) Group- comprised of 5 guinea pigs which were affected with lyric and romantic music that has more extensive intonations (Mozart-reminor piano concert, Bach-reminor piano concert, Chopin-Waltzes, Tchaikovsky-Seasons, Schubert-Ave Maria, etc.) for 6 h a day with 15 min intervals for a period of 10 days.

After 10 days, skeletal muscles from legs were taken from the guinea pigs. Conventional transmission electron microscopy methods were used for evaluation. (1 mm^3 pieces were taken then they put in 2.5% gluteraldehyde, % 1 OsO_4, ethyl alcohol series propyleneoxide, Epon 812, respectively. Sections were stained with uranyle acetate and lead citrate. Electron micrographs were taken with JEOL Jem l010 Electron Microscope).

RESULTS

Skeletal muscle tissue is comprised of myocytes as it is seen in electron micrographs. There are myofibrils and other organelles in the cytoplasm of myocytes. Myofibrils are established from parallel lines (myofilaments). Electron dense A-dark bands (disks) and in light color I-light bands (disks) can be seen in myofibrils. Z-membranes can be observed in between the I-light bands. Myofilaments are of two types; thin type (myofilamenti tenueae) and thick type (myofilamenti crassi). Actin is synthesized in thin myofilaments and myosin is synthesized in thick myofilaments. I-disks are established from thin filaments and A-disks are established from thick filaments. Normally, in myofibrils of myocytes, shrinking of muscles, A-disks generally don't change but I-disks are shrunk much or they are lost (Fig. 1).

Clear destructive and degenerative changes were observed in macromolecules of peripheral nerve and muscle terminals with the effect of compositions those were established from sekunda and kvarta intervals which contain strained intonations. Chromatin material was rough in the nuclei of the myocytes. It was detected that outer membranes of nuclei was smashed in some region. Degeneration of some organelles in sarcoplasm was visible. A and I disks of myofibrils were extremely shortened. It was detected that Z membranes were electron dense and they were extended. Myofilaments were become thin and spazmatic shortening and degeneration of them were detected (Fig. 2 and 3). And also damages of nerves and muscles connections were observed. Cavities between degenerated peripheral nerve terminals and muscle cells were visible (Fig. 4).

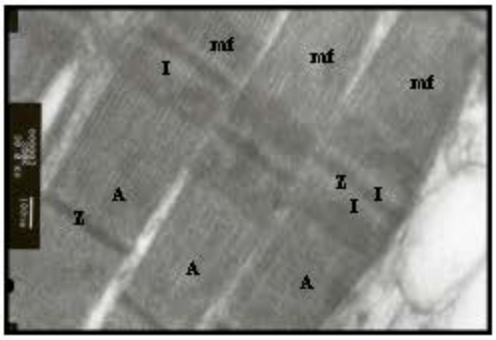

Fig. 1: Normal myocyte is shown. Myofibrils are visible in the cytoplasm. Filaments of myofibrils are parallel and tidy. A-dark bands and I-light bands are visible. Z-membrane can be seen in I-bands. x50000. (A: dark bands; I: light bands, mf, myofibrils, Z: Z-membranes)

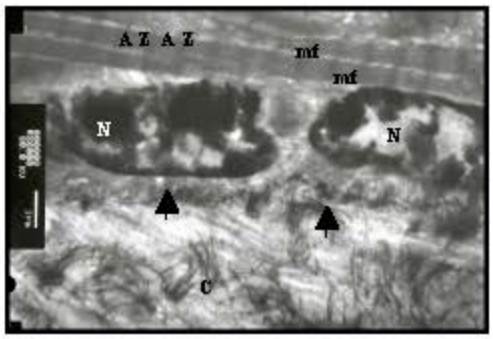

Fig. 2: Effects of strained intonations are shown. Sarcolemma is normal (arrows) Smashing of nuclear outer membrane and rough chromatin material is visible. Spazmatic shrinking of myofibrils is shown. Shrinking of A-disks and loss of I-disks are visible. Z-membranes are frequently seen. (A: dark bands, C: collagen fibrils, mf: myofibrils, N: nucleus, sarcolemma, Z: Z-membranes) x6000

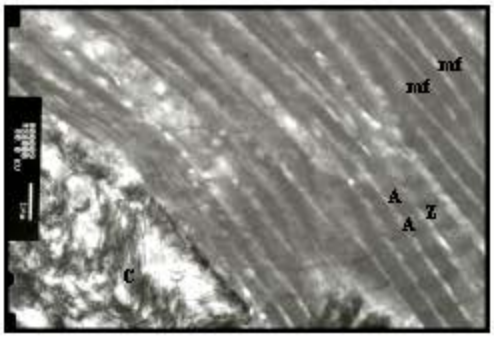

Fig. 3: Effects of strained intonations A region from myocyte is shown. Spazmatic shrinking and degeneration of myofibrils are visible. Z membranes are frequently seen. A disks are shrunk. x6000. (A: dark bands, C: collagen mf, myofibrils, Z: Z-membranes)

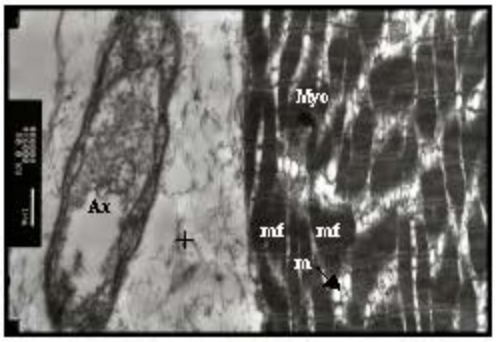

Fig. 4: An extension (loss of contact) (+) is shown between axon and myocyte and degeneration of connections is visible with the effects of strained sekunda and kvarta intervals. Degenerated mitochondria and electron dense, shortened myofibrils are shown in the myocyte sarcoplasm. Degeneration of mitochondria, neurofibrils and other organelles are visible in the axon matrix. (Ax: axon, m: mitochondria, mf: myofibril, Myo: myocyte) x6000

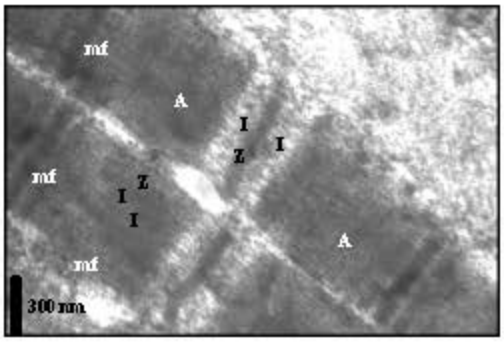

Fig. 5: Changes depended on relaxation in myocytes with the effects of extensive musical intervals are shown. Extensions of myofibrils are visible. Extensions and limpidity of A - dark bands and I-light bands, electron dense Z-membranes are shown. (A: dark band, I: light bands, mf: myofibrils, Z: Z-membranes) x50000

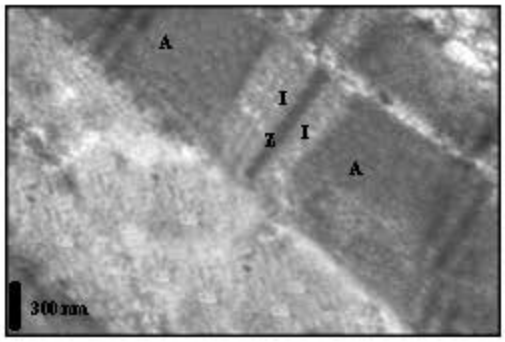

Fig. 6: Effects of extensive musical intervals (Romantic musical melodies). Extension of A-dark bands and I light bands are visible depending on relaxation of myofibrils. (A: dark band, I: light bands, mf: myofibrils, Z: Z-membranes) x50000

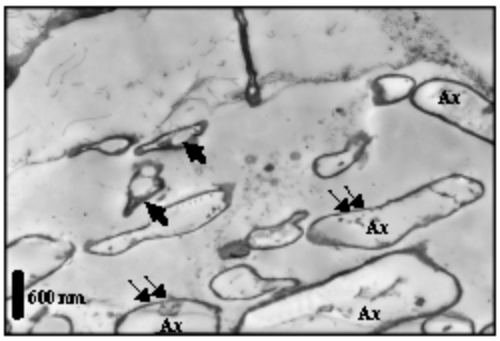

Fig. 7: Effects of musical sounds those established from extensive intervals. Peripheric nerves with myelin (♠) and with less myelin (♠♠) are shown. Membranes of nerve terminals are conserved. Decrease in number of organelles in neuroplasm is visible (Ax, axon) x6000

Severelyextension of myofibrils in the sarcoplasm of myocytes were observed with the effect of romantic compositions those have extensive intervals. It was detected that extensive I-light and A-dark bands were long. I bands were clearly gleaming. Electron dense Z membranes were observed. Paralellism of myofilaments did not damage (Fig. 5 and 6). Membranes of peripheral nerves were undamaged. Decrease in number of organelles in neuroplasm was observed (Fig. 7).

DISCUSSION

Various intervals are used in the base of classical music. These intervals are established with special rules and form intonations (Popova, 1958) which depicts the meanings of all music styles, characters and sentences. Each musical intonation consists of sekunda, kvarta, kvinta, seksta, septima, oktava intervals. Sekunda and kvarta intervals are very strained and generally depict command, weeping, war, complaint, desperation, honesty with music. These intervals are used military songs, state marches and other musical passages which showed activity.

More extensive intervals are applied in lyric and romantic music passages. Musical sound arrangements and musical sentences those were related with them were applied and affected with various intervals in different ways (Karinskaya and Utkin, 1983).

Music therapy has been applied in neurosis, depressions and other reactive conditions for a long time past (Wicke, 2002a). Musical sounds form emotional effect in organism as reflector and normalize psychovegetative processes. Music therapy is generally used for catharsis, emotional relaxation and to reduce agitation. Recently, many music studios are opened and in these studios special classical music passages are chosen and patients listen to them. Compositors create special classical passages for the music therapy. Music therapy has been very important for the scientists in ancient Ottoman, Canada, China and Japan (Bailey-Lloyd, 2003-2004). High Seratonin levels were detected in the animal experiments when they listened to Mozart passages in the applied experimental studies (Vollero, 2001; Wicke, 2002d). It is observed that this neuromediator's level generally decreases in depressions and other vegetative disorders. Mozart phenomenon is frequently used in music therapy as positive music (Wicke, 2002b). Clear ultrastructural changes occurred in macromolecules of nerve and muscle terminals (Heffner, 1992) with the effect of continuous strained intervals according to our results. Shrinking of myofibrils, constriction of A dark disks, loss of I-light disks electron dense Z membranes in myocyte cytoplasm show spazmatic constriction of muscles. These ultrastructural changes show decrease in actomyosin synthesis functionally. Degeneration of mitochondria proves decrease in synthesis of ATP. Degenerative changes in peripheral nerve terminals (Ortiz-Hidalgo and Weller, 1992), formation

of large cavities between nerve and muscles show damage in reflector connections and decrease in transmission function. Degenerative changes in myocytes especially smashing of outer membranes of nuclei can be evaluated as irreversible phenomenon. More extension of myofibrils in myocyte cytoplasm, dilation of A-dark and I-light disks with the effect of extensive intervals those were used in romantic and lyric passages are depend upon relaxation in muscles. Undamaged peripheral nerve membranes but decrease in number of organelles and loss in somewhere shows decrease in activity of nerve terminals and increase in strain of muscles related with this according to us.

In this manner, spazmatic shrinking of myocyte myofibrils together with degenerative changes in myocytes and nerve terminals occur with the application of strained sekunda and kvarta intonations continuously. Transmission function is also damaged related with this situation. It was observed that clear relaxative extensions in myocyte myofibrils and decrease in activity of nerve terminals with the application of more extensive intervals.

Application of these intervals, each in turn in classical music passages those were created for musical therapy is more effective according to us. Application of the same intervals continuously can be harmful to organism. In conclusion, sekunda and kvarta intervals can be used for stimulation of emotional effects and extensive intervals can be used for relaxation of organism.

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