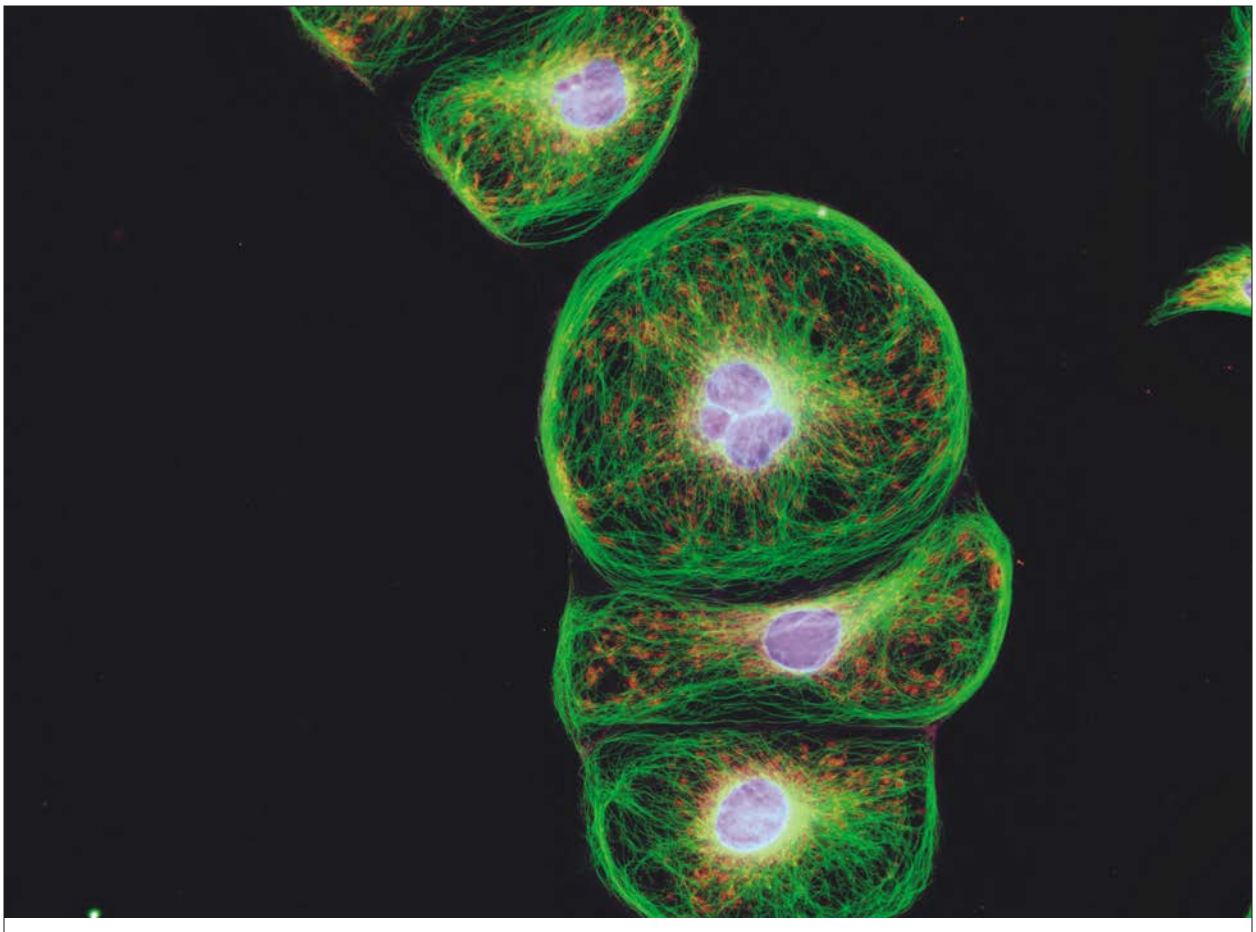

Asian Journal of Cell Biology

ISSN 1814-0068

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Cell Biology 2 (2): 43-49, 2007
ISSN 1814-0068

An Ultrastructural Study on the Effects of Different Musical Timbres on the Skeletal Muscle Cells (Musical, Medical, Biological and Experimental Study)

[1]Leyla Mamedova, [1]Işın Metin, [2]Nuran Ekici, [3]Murad Huseyinov,
[4]Gulara Huseyinova and [5]Mehmet Kanter
[1]Department of Music, Faculty of Music and Performing Arts,
Bilkent University, Bilkent-Ankara, Turkey
[2]Department of Biology, Faculty of Science and Arts, Trakya University, Edirne, Turkey
[3]Azerbaijan Government Music Academy, Baku, Azerbaijan
[4]Department of Pathology, Faculty of Medicine, Trakya University, Edirne, Turkey
[5]Department of Histology and Embryology, Faculty of Medicine,
Trakya University, Edirne, Turkey

Abstract: The aim of this study is to investigate the effects of musical sound from different instruments (cello, piano and trumpet) on the skeletal muscle cells with using electron microscopy methods. Twenty guinea pigs were used in this study. Guinea pigs were separated into four groups. I. Group - 5 guinea pigs called control group. Nothing was done to this group. II. Group-during 10 days they affected with Mozart and Vivaldi played with cello, III. Group-the same opus from Mozart and Vivaldi played with piano, IV. Group-the same opus from Mozart and Vivaldi played with trumpet for 6 h a day with 15 min intervals. After 10 days, biopsy materials of skeletal muscle were taken from the guinea pigs. Conventional electron microscopy methods were used for evaluation. The electron micrographs showed that the macromolecules of the muscle cells taken from cello group were generally normal as in the control group. Reversible changes (swelling of mitochondria, vacuolization, strained myofibrils and destruction, activation of nuclei, increase of chromatin material and nucleoli) were detected in the piano group. Irreversible and degenerative changes (nuclei with rough chromatin, smashing and loss of nuclei and organelles, smashing of shortened and strained myofibrils) were detected in trumpet group. According to this study, cello timbres are similar to human voice and they affected better on skeletal muscle cells. In conclusion, cello timbres can be used in musical therapy.

Key words: Muscle cell, musical, timbre, ultrastructure

INTRODUCTION

Different characteristic or quality of musical sound is called musical timbre (Popova, 1958; Karinskaya and Utkin, 1983). Musical timbres can be similar to viola, cello, violoncello (stringed musical instruments), piano (keyboard instruments), tuba, trumpet, trombone (cupper wind instruments), human sounds and the others. It is known that musical intonations are used on the bases of all classical opuses, musical styles and musical characters. These intervals reveal the meaning of musical sentences. Musical intonations are composed of different kinds of intervals such as seconda, quarta, quinta, sexta, septima and octava. Seconda and quarta intervals are very strained. They are generally used for showing command, weeping, war, complaint, desperation, freedom and honest with

Corresponding Author: Nuran Ekici, Department of Biology, Faculty of Science and Art, Trakya University, 22030, Edirne, Turkey Tel: 90-284-2352824 Fax: 90-284-2354010

music. These intonations are often used in marches of states, national anthems and military songs and passages which showed activity. Other extensive intervals are used in lyric, romantic classical compositions. Quality and timbres of music are very important on the application of musical intonations. Various timbres form different kinds of emotional effects on organisms (Slepneva, 2000). Musical sound arrangements and musical sentences which are related to them were affected in different forms with various instruments. Different kinds of effects occur on the organisms when the same theme of the musical compositions played with stringed, wind or keyboard instruments. The effects of acoustic musical waves those were used in the musical compositions have not studied on the ultrastructural level yet. We have studied the effects of musical intonations on living things especially on plants (*Allium cepa*) since many years (Ekici *et al*., 2007). This is the first study in the literature which contains musical, medical, biological and experimental data. The aim of this study is to investigate the effects of musical sound from cello, piano and trumpet on the skeletal muscle cells with using electron microscopy methods and to offer the suitable timbres in the compositions which were used for musical therapy.

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) on between January and August 2006. Twenty guinea pigs were used in this study. Guinea pigs were separated into four groups. I. Group-5 guinea pigs called control group. Nothing was done to this group. II. Group-during 10 days they affected with Vivaldi (Four Seasons, Swan's death) and passages from Mozart played with cello, III. Group-the same opuses from Vivaldi and Mozart played with piano, IV. Group-the same opus from Vivaldi and Mozart played with trumpet for 6 h a day with 15 min intervals. In the other words they were affected with the same musical theme of different timbres. After 10 days, biopsy materials of skeletal muscle were taken from the guinea pigs. Conventional transmission electron microscopy methods were used for evaluation. (1mm^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 asetate and lead citrate. Electron micrographs were taken with JEOL Jem l010 Electron Microscope.) The electron micrographs showed that the macromolecules of the muscle cells taken from cello group were generally normal as in the control group.

RESULTS

Skeletal muscle cells of control group were detected normal in the electron microcpical investigation (Fig. 1). Mitochondria, endoplasmic reticulum, glycogen granules, Golgi apparatus and other organelles were observed in cytoplasm. Structures of myofibrils were normal. A-electron dense dark bands, I- light bands and Z membranes were normally detected. Myofilaments of myofibrils were regular and parallel to each other.

In the micrographs of Group 2 (Cello Group), skeletal muscle cells (myocytes) were generally normal. Myofilaments of myofibrils were detected regular and parallel in the sarcoplasm. A-dark bands, I-light bands and Z-membranes were preserved their normal structures. Slightly distrophic changes were observed in mitochondria, such as loss of cristas, swelling, vacuolization but it is detected that their outer membranes were preserved (Fig. 2 and 3).

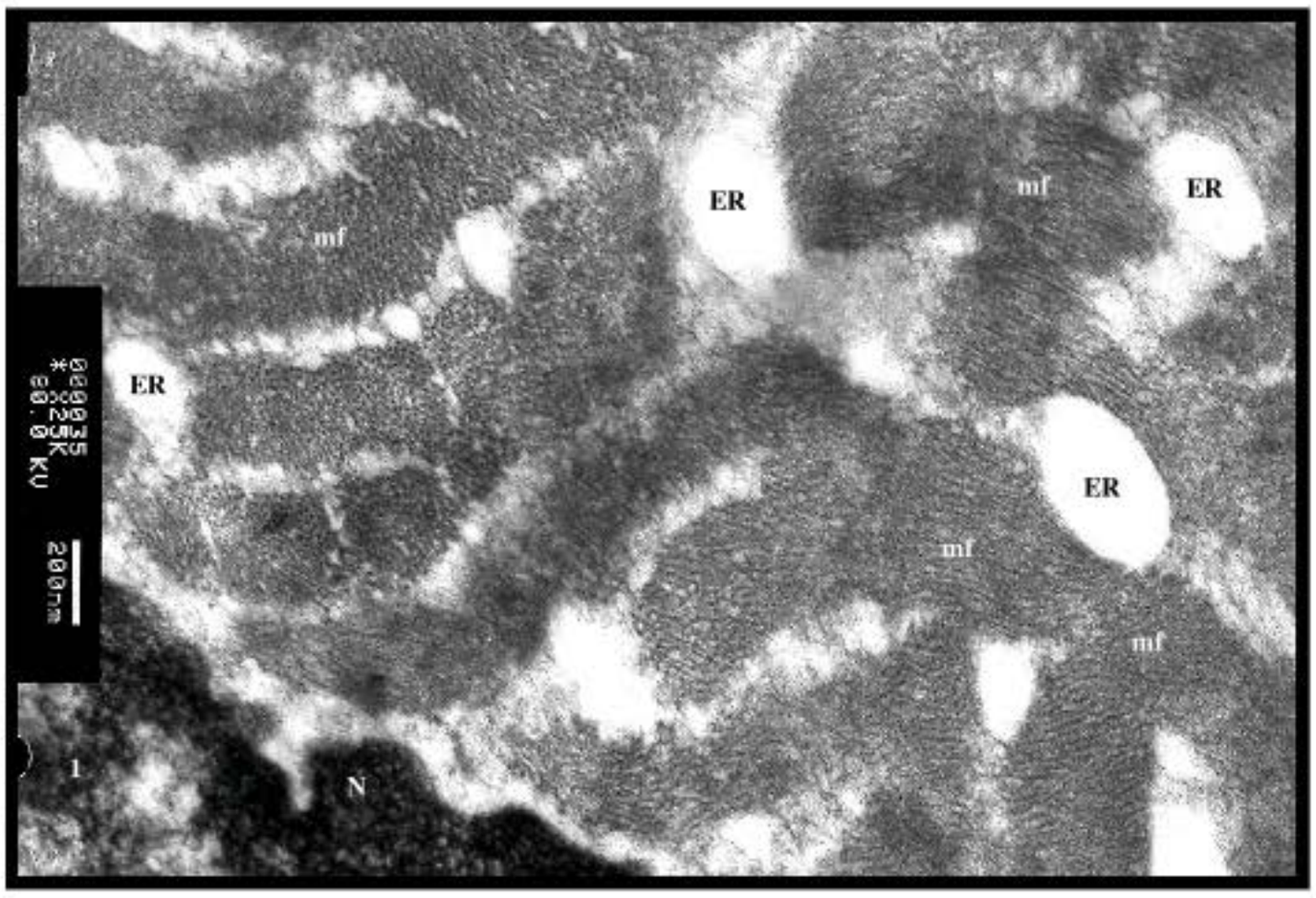

Fig. 1: Electron micrograph of Group 1 (Control group); Skeletal muscle cell is shown. Myofibrils, endoplasmic reticulum and nucleus are visible in the cytoplasm (Cross section). x25000. (ER, endoplasmic reticulum; mf, myofibril; N, nucleus)

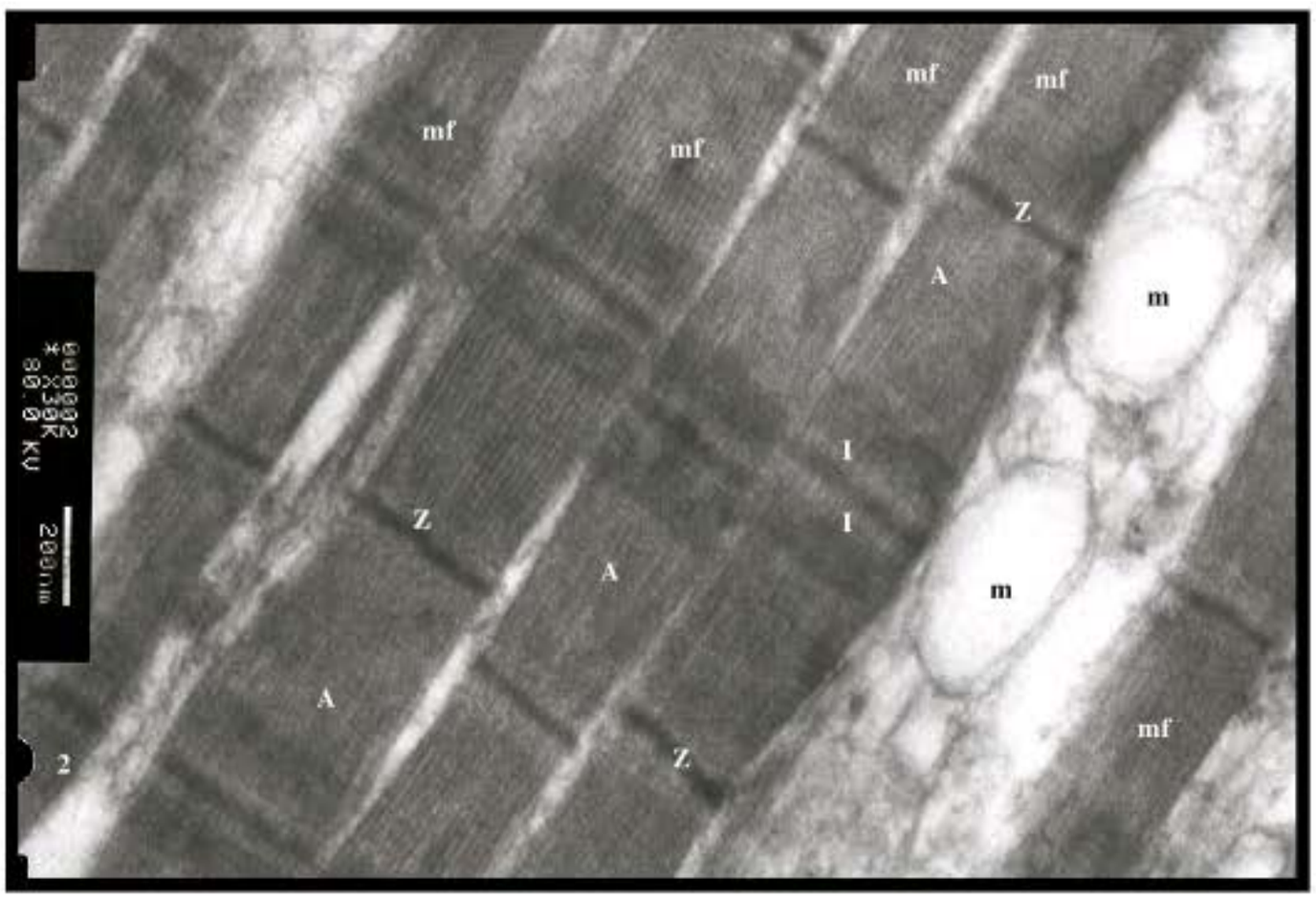

Fig. 2: Electron micrograph of experimental group 2 (Cello group); Effects of cello sounds on myocyte is shown. Myofibrils and mitochondria are in the sarcoplasm. Electron dense A-dark bands, I-light bands and Z-membranes were preserved. Swelling of mitochondria, limpidity of matrix, loss of cristas and vacuolization are visible. x30000. (A, dark bands; I, light bands; m, mitochondria; mf, myofibrils; Z, Z-membranes)

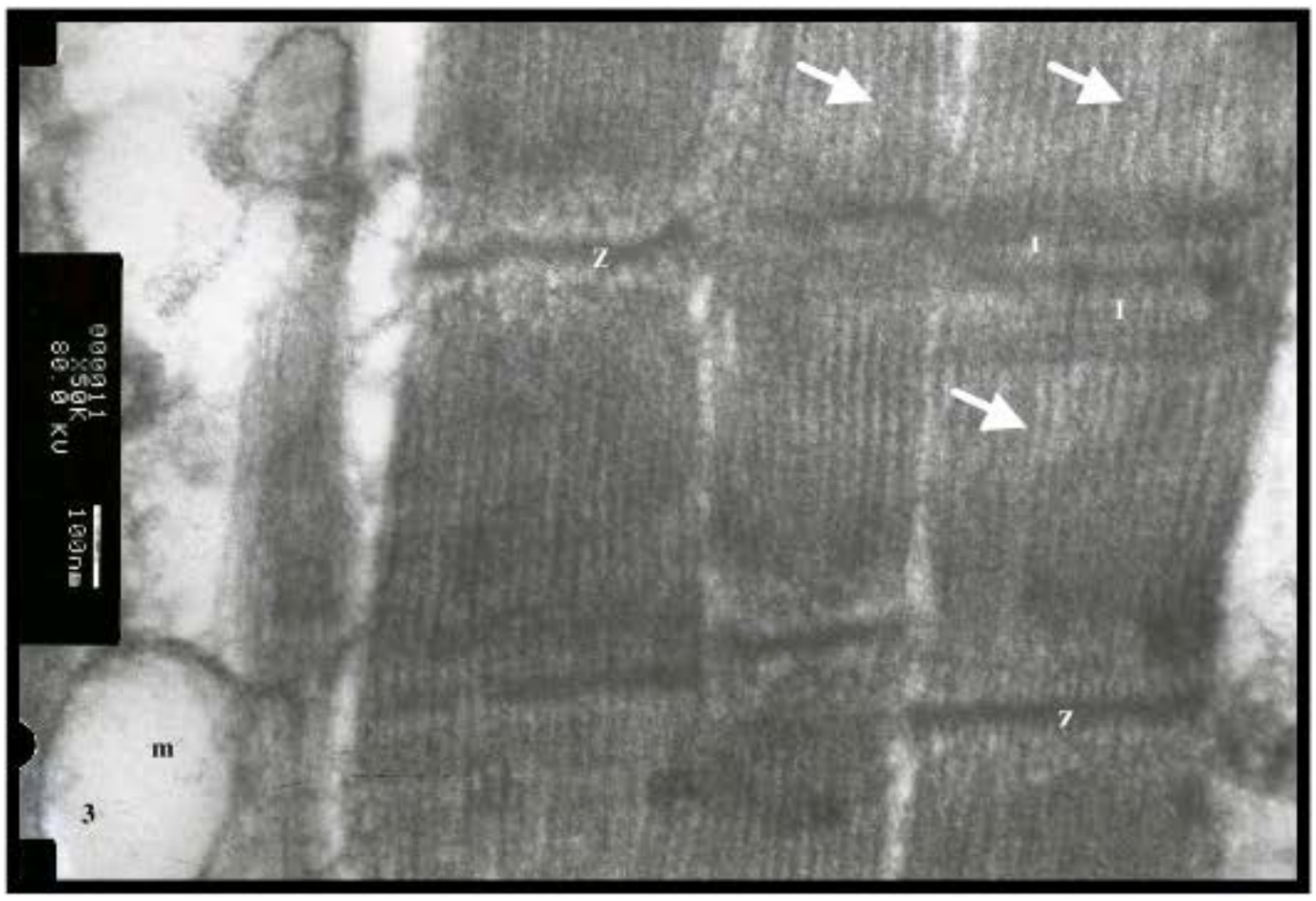

Fig. 3: Electron micrograph of experimental group 2 (Cello group); Effects of cello sounds on another myocyte is shown. Filaments of myofibrils are regular and parallel (arrows). Electron dense A-dark bands, I-light bands and Z-membranes were preserved. Outer membranes of mitochondria are also preserved. Limpidity of matrix and loss of cristas are visible. x50000. (I, light bands; m, mitochondria; Z, Z-membranes)

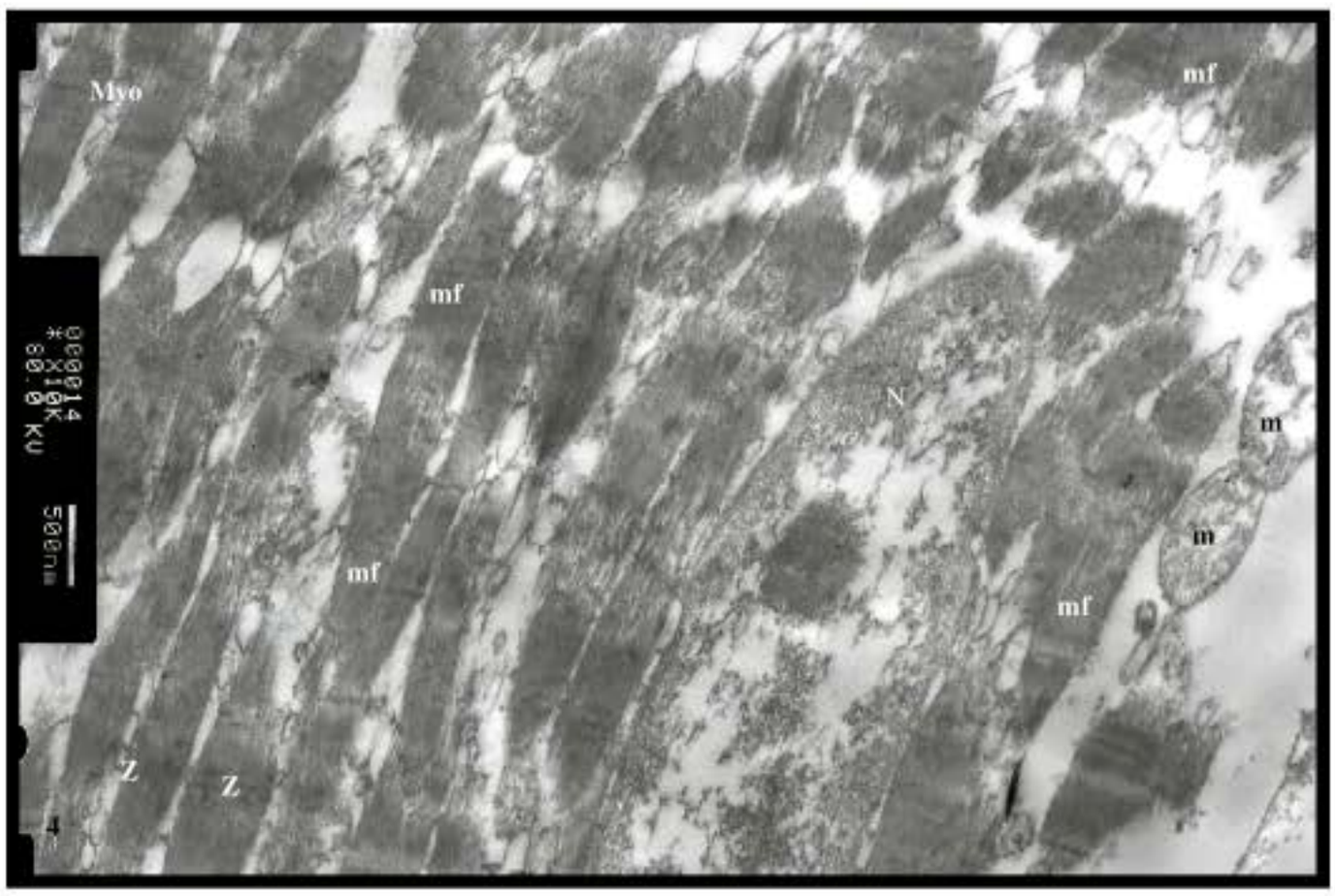

Fig. 4: Electron micrograph of experimental group 3 (Piano group); Effects of piano sounds on myocyte is shown. Myofibrils, mitochondria and other organelles are in the sarcoplasm. Degeneration of some myofibrils is visible. Loss of cristas and vacuolization are shown in the mitochondria. An increase in nucleus chromatin and formation of nucleoli are visible. x14000. (m, mitochondria; mf, myofibrils; Myo, myocyte; N, nucleus; Z, Z-membranes)

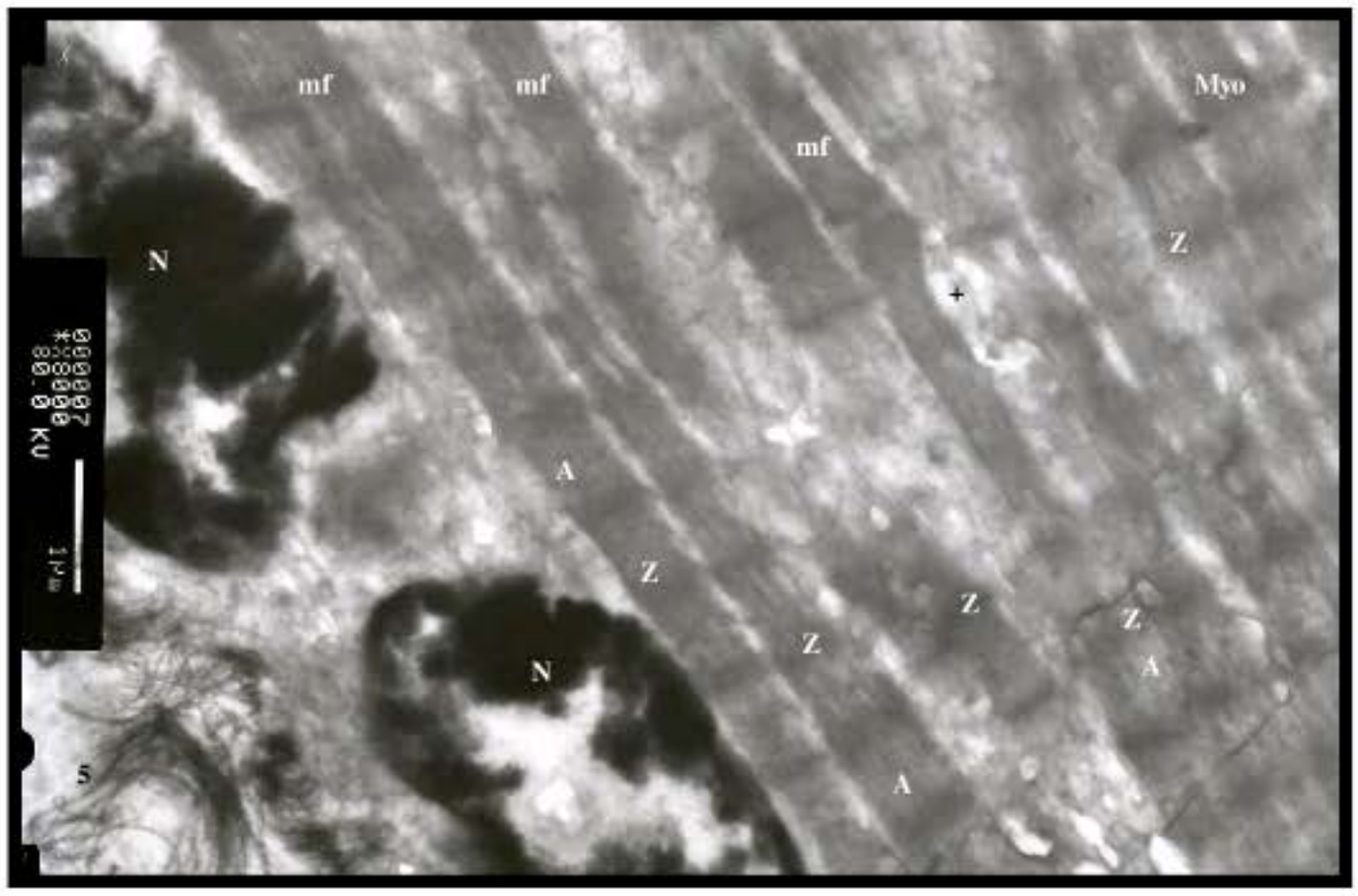

Fig. 5: Electron micrograph of experimental group 4 (Trumped group); Effects of trumped sounds on myocyte is shown. Chromatin materials of nuclei were rough and smashing of outer membranes of nuclei is visible in the myocyte. Myofibrils are very thin. Loss of I-light bands, shortenning of A-dark bands, electron dense Z-membranes are visible. Destruction of myoflaments and contractures are shown in some regions. X8000. (A, dark band; mf, myofibrils; Myo, myocyte; N, nucleus; Z, Z-membranes; +, destruction of protofibrils)

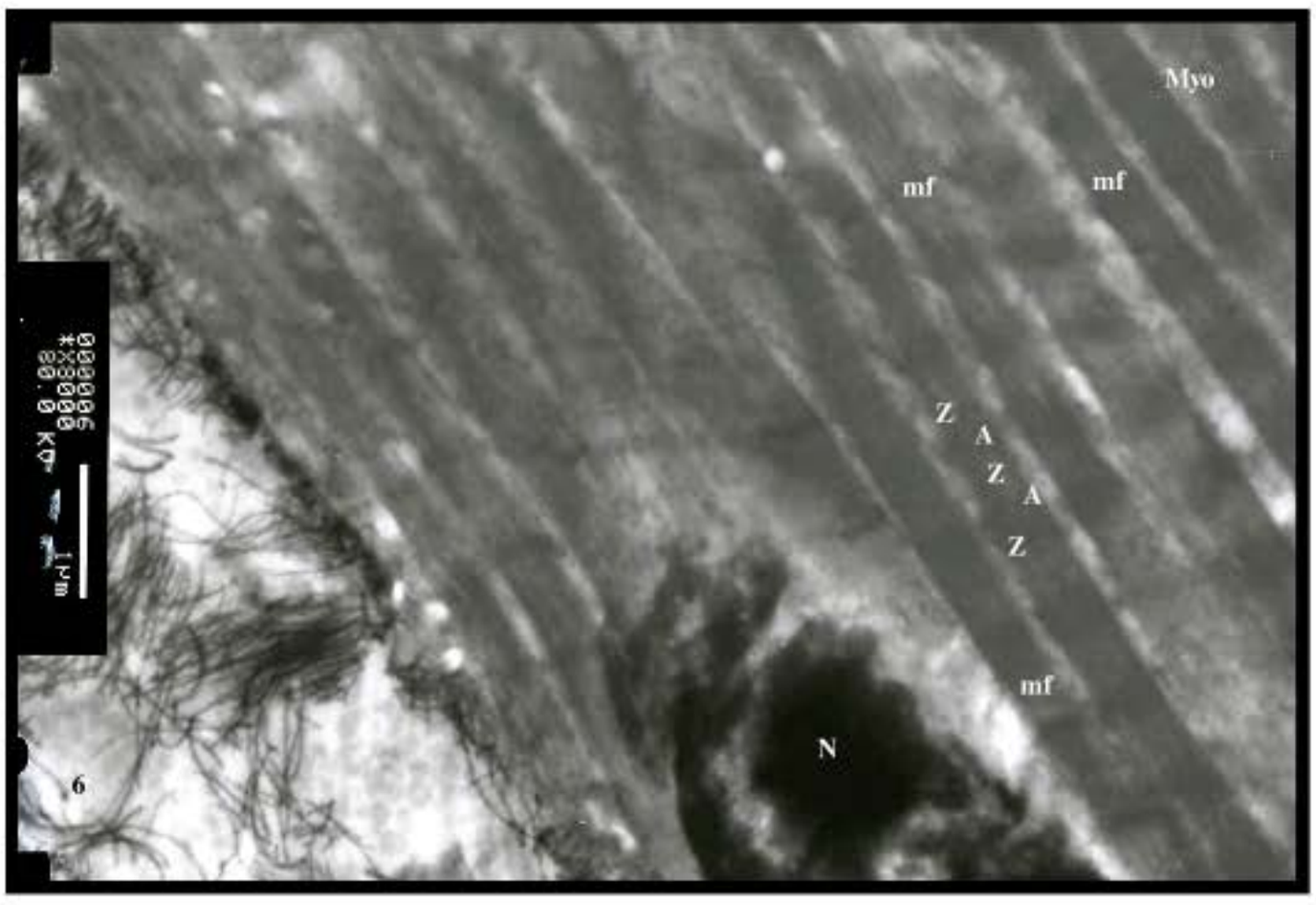

Fig. 6: Electron micrograph of experimental group 4 (Trumped group); Effects of trumped sounds on another myocyte is shown. Karyorrhexis of nucleus, shortening of A bands, loss of I bands and electron dense Z-membranes are visible. x8000. (A, dark band; Col, collagen; mf, myofibrils; Myo, myocyte; N, nucleus; Z, Z-membranes)

In the micrographs of Group 3 (Piano Group), degeneration of myofibrils was detected in the sarcoplasm. Shrinking of myofibrils was visible. Loss of cristas in mitochondria and vacuolization were observed. Distrophic changes in the other organelles were detected. Activation of nucleus was also observed (Fig. 4).

In the micrographs of Group 4 (Trumpet Group), clear degenerative changes were occurred in the sarcoplasm. Chromatin materials of nuclei were rough and smashing of outer membranes of nuclei was occurred in the myocyte. Myofibrils were very thin in the sarcoplasm. Loss of I-light bands, constriction of A-dark bands, electron dense Z-membranes were observed. Straining, shortening and degeneration (loss of parallelism) were generally visible in all structures of myofibrils. Degeneration and loss of mitochondria and the other organelles were detected (Fig. 5 and 6).

DISCUSSION

As it is known that sound waves are form reflector reactions in the organisms. There are plenty of peripheral receptors (nerve and muscle terminals) (afferent and efferent terminals) in the skin and muscle tissues. Musical impulses firstly touch afferent receptors and they transmit to central nervous system with afferent ways. Then, musical impulses return back with efferent ways and they form different reactions on the muscles (effectors) (Ortiz-Hidalgo and Weller, 1992; Heffner, 1992).These reactions are depended upon individual peculiarities of the organisms. Music was used in therapy of various illnesses since ancient times. Effects of musical therapy are better on nervous system illnesses (depressions) and the others. Musical compositions help patients for their psychological tensions and they normalize psychovegetative changes of the patients (Wicke, 2002a).

In recently years, Japanese, Chinese and Canadian scientists consider to musical therapy important and various studies are done (Wicke, 2002b-d). Medico-musical studios have been opened for the therapy of various diseases. Special methods are carried out to cure diseases of various systems of organisms in these studios. But there are very few studies in the literature concerning medical, musical, biological and experimental knowledge. In one of these studies, an experiment has been done with several Guinea pigs. One of the Mozarts opuses has been played for them and researchers have found out that serotonin (a kind of nerve hormone) levels have been increased in their blood analysis (Vollero, 2001). And also it was detected that cows have given more milk when they listened to Mozart.

It can be said that separation of musical timbres used in compositions is very important for the musical therapy. According to present findings, no macromolecular change was occurred in muscle cells with the effects of cello timbres. Myocytes were generally normal in shape. They are very similar to muscle cells of the control group. No change was observed in parallelism of the A-dark bands, I-light bands, Z-membranes and myofilaments. Slightly reversible changes in organelles were detected such as swelling of mitochondria, vacuolization in matrix, but outer membrane was preserved. Changes in the muscle cells were more remarkable in the group which was affected by piano timbres. Shortening of myocytes and degeneration of the organelles were detected. Activation of nucleus was remarkable; increase of chromatin material and formation of nucleoli.

When the same passages were played with trumped, degenerative changes were increased and some of them were irreversible in several regions such as karyorrhexis, shortening, becoming strained and smashing of myofibrils, damaged parallelism, contracture formation, degeneration and loss of other organelles.

In conclusion, reversible and irreversible changes can be occurred especially in the muscles with the effect of different musical timbres. Cello timbres are the most similar to human sounds and they can affect in better way for the relaxation of the muscles as for trumpet timbres affects in opposite

way. They cause shortening of muscles and they become strained. Function of transmission and processes of metabolism are decreased. Therefore, cello timbres can be used effectually in musical therapies.

REFERENCES

Ekici, N., F. Dane, L. Mamedova, I. Metin and M. Huseyinov, 2007. The effects of different musical elements on root growth and mitosis in onion (*Allium cepa*) root apical meristem (Musical and biological experimental study). Asian J. Plant Sci., 6: 369-373.

Heffner, Jr. R.R., 1992. Skeletal Muscle. Histology for Pathologists. Raven Press-New York.

Karinskaya, L. and V. Utkin, 1983. Elementarnaya Teoriya. Moskova Muzika.

Ortiz-Hidalgo, C. and R.O. Weller, 1992. Peripheral nervous system. Histology for Pathologists. Raven Press-New York.

Popova, J., 1958. Musikalnıe Janrı I formı. Moskova Muzkız.

Slepneva, A., 2000. MelodıI zdorovya. Moskova Muzkız.

Vollero, M., 2001. How Neural Transmitters Effect Learning. In: Nurturing the Body and Mind in Physical Education with Mozart. (accessed on 02.03.2007) http://www.yale.edu/ynhti/curriculum/units/2001/6/01.06.07.x.html.

Wicke, R.W., 2002a. Herbalist Review, Issue 2002 #1: Effects of music and sound on human health; Historical references to the health effects of music (accessed on 11.07.2006) http://www.rmhiherbal.org/review/2002-1.html.

Wicke, R.W., 2002b. Herbalist Review, Issue 2002 #1: Effects of music and sound on human health; Using baroque music to enhance learning a new language (accessed on 11.07.2006) http://www.rmhiherbal.org/review/2002-1.html.

Wicke, R.W., 2002c. Herbalist Review, Issue 2002 #1: Effects of music and sound on human health; The Mozart Effect (accessed on 11.07.2006) http://www.rmhiherbal.org/review/2002-1.html.

Wicke, R.W., 2002d. Herbalist Review, Issue 2002 #1: Effects of music and sound on human health; Heart-Kidney non-communication (accessed on 11.07.2006) http://www.rmhiherbal.org/review/2002-1.html.