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MANAGEMENT OF MUSICIANS' THERAPY

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***Abstract*:** *Over the last three decades, the medicine specialized in the musicians' treatment has been acquiring increasingly clear outlines. These professionals' special requirements have long been overlooked, but the rising requirements as regards the quality of musical performance have led to reconsidering them. Abroad, this branch of medicine has undergone a remarkable development, which is set forth in the material herein. In Romania, the musicians' specialized medicine has only known its outset.*

Keywords: *musicians' stress, professional diseases, specialty publications, organizing the musicians' medicine.*

1. Introduction

The key factor in conceiving an all-inclusive and successful treatment plan for the injured musicians is constituted by understanding the context wherein the health problems appeared. Although the physicians are not expected to be musicians themselves, the familiarity with the needs of high performance music, with the shape of the musical instruments and with the solicitations that the musician undergoes whilst performing and playing an instrument, the musician's working environment and the psycho-social aspects of his life are essential in determining the most adequate treatment [1]. In order to be recognized both by patients and by colleagues as an expert in the musicians' medicine, in-depth knowledge is required in neuromuscular anatomy, kinesiology, physiology and pathophysiology. Doctors and medium medical staff must be willing to study the literature related to the musical pedagogy, to the technical aspects of musical instruments, to the cumulative trauma disorder, to the diseases of the spine, to the ergonomics and biomechanics, to the occupational therapy, physical therapy as well as alternative treatments [2]. Most problems undergone by musicians are due to the over-attrition and to other regular disturbances of the muscular-skeletal system such as tendonitis, neuropathy and the symptom of thoracic outlet. There is particularly important for the treatment to consider the characteristics of the specific environment wherein the musician performs and lives. Every musician must be treated on the basis of his personal requirements, which are important characteristics of the musician's life concept that must be included in the decision-making process upon the treatment. [3]

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Musicians are often sophisticated patients: traditional diagnostic schemes might not be sufficient for a correct diagnosis. As the physical and psychic requirements of the study vary from one instrument to another and from one musician to another, the pre-set treatment schemes do not yield the expected results: the treatment must be individualized. [4] The development of a continuous-multidimensional thinking method that also considers the patient's characteristics is a pre-condition for the success in treating musicians. The doctor must know the musician's relations with his colleagues, professors and relatives, as well as he must know the instrument that the musician plays. Musicians spend many hours a day studying, rehearsing and performing in concerts; therefore music turns into the main preoccupation of their life. Rachmaninov would often state: "I am 85% musician and only 15% a human being!"

From the physical standpoint, musicians tend to lose their physical condition: most of them have a frail muscular structure. Musical instruments are not ergonomically conceived; therefore they force the performer to maintain an asymmetrical position of the body for a long time. Under these conditions, they must achieve repetitive movements of high qualification, at great speed, precision and dexterity. They likewise have to comply with the stress that ensues from their tendency towards perfection, both of artistic quality and of performance. The fear to compare on stage is the musicians' most frequently encountered problem. [5]

Many studies were elaborated in order to determine the nature and the incidence of the musicians' accidents. [6] Injuries of the upper body and of the muscular-skeletal system of the back are mostly encountered, much more frequently than they are undergone by the population with no musical preoccupations. Although the musicians' illnesses are supposed to be mainly due to their working with the instrument, traumatisms of the upper limbs not connected to their profession are very common and they may be an important source of discomfort.

During the phase of acute suffering, musicians may be treated according to the principles of sports medicine, inclusively RICE (rest, ice, compression, elevation). [7] Deneth [8] recommends total rest of the injured extremity for long periods of time. Rest is also recommended by Taubmann, who would have said to a musician "Take some holidays of 3 or 4 months, then call me unless the pains have disappeared or if they return when you perform!" Applying this recommendation into practice may however lead to even greater complications, as most injuries are caused by repetitive movements made in an abnormal body position, with imbalanced muscle solicitation, which leads to pains and other symptoms. Total rest may lead to increasing the imbalance among the various muscle groups, which would aggravate the patient's state. The most favourable recommendation would be to considerably reduce the musical activity, in both intensity and duration, but not to utterly interrupt it. Changing the repertory or choosing an easier repertory may suffice. In the case of a severe inflammation, an interruption of one week may be useful. [7]

As follows, the stress will be laid on education in preventive treatment, on correcting the position, on therapeutic exercises, on biofeedback and visual feedback; common aspects of the sub-acute treatment will not be analyzed, such as ice compresses, hot packs, electrotherapy, ultrasound etc.

2. General Considerations

Pain stands for the main cause wherefore musicians seek to obtain medical care; although many of them think that pain is closely connected to the performance level whereat they work. Musicians usually do not trust their relation with the physician, for several causes:

- their previous experience has not been satisfactory, as only few doctors have specialized in treating the musicians' suffering. Therefore the former are not acquainted with the particularly demanding environment wherein the musicians work.
- the musician's opinion on illness may differ from the physician's opinion. [9]

The competition among musicians is so fierce that "playing under pain" still seems to be a plausible solution, instead of the alternative of losing one's job or missing a promotion. The fact that neither sickness insurance utterly covers the musicians' needs and other financial resources only exist to a small extent complicate even more the situation. A psychical process may happen to take place: musicians blame themselves for the injury and decide to ignore it. [10] In a first phase of his problems, the musician may rather feel hand numbness than pain.

The physician who treats such a patient must consider – beside the data from the anamnesis – a specific analysis for the musical field that should comprise opinions on the musician's technique and on the positions of his body during the performance; on this basis, the former must formulate hypotheses on the causes of the disturbances and he must even subsequently identify the causes. The key of the healing process consists in accurately determining the causes, which will afterwards lead to taking a succession of technical-musical and medical measures that should insure the patient's recovery. Only as a consequence of this cause-identification and deficiency-evaluation process, a plan of measures may be devised, which should lead to the patient's healing. There must be considered that important affective processes might underlie the pains felt by the patient. The first hypothesis must obviously be that the pain is caused by an unsatisfactory joint functioning, but it may have, to same extent, neurogenic or myogenic cause, as it appears in a muscular imbalance or in the case of the myofascial pain. Regardless of the cause, the result is always a diminution in the musician's capacity to perform at his habitual level. The observations during the treatment must be analyzed and the treatment plan must be revised and adapted to the new knowledge level: this allows an efficient management of the musician's suffering.

Fry [11] proposes that the severity of the dysfunction or of the injury should be assessed according to the following symptoms:

- Degree 1: The pain is limited to a single part of the body and it only appears when the musician plays his instrument.
- Degree 2: The pain appears in two or several parts of the body that are intensely solicited; the pain is associated to a certain loss of the movement coordination.
- Degree 3: The pain persists also when the musician does not practice or when he does other activities; and a loss of the coordination or of the force is visible. The anamnesis shows a persistent strain of the upper limbs. The musician finds it difficult to comply with great solicitations of the musical activity.

- Degree 4: The pain persists at night or during rest periods, regardless of the activity achieved by the musician. A normal work solicitation causes difficulties.
- Degree 5: The musician can no longer use his hand. His musical career is endangered or even interrupted.

Most accidents are of the first category (30%), the second (29%) and the third (22%). In order to complete this image, Bengtson and Schutt [12] recommend the use of a functional index that results from the division of the time required for his present performing in relation to the time necessary in the past. Unfortunately, this index does not illustrate that the musician sang under pains before being consulted by a physician. In this case, singing under pain is not highlighted as a medical problem.

3. Education

The purpose of the therapy is not to improve the current health state: this would not suffice for a musician! The main purpose of the therapy is to restore the musician's previous level of performance: this is utterly another goal than the one of the treatment applied to another non-musician patient, who suffers the same syndrome.

Due to this extremely complex and unusual goal, the physician must obtain the patient's conscious support, he must instruct the musician in issues of etiology, biomechanics, neural-psychology and in aspects related to preventing the accidents of the muscular-skeletal system. Especially younger physicians will be surprised to find that music schools do not offer their students any knowledge in these fields, although Spaulding [13] showed that those specialized courses contributed to a diminution in the number and severity of the musicians' injuries.

The doctor, together with the therapist, must review all factors leading to a musician's predisposition to accidents. The musician's education might prevent the possible injuries and might contribute to shortening the patient's healing time.

The accumulation of the local fatigue of the muscles in the case of an over-attrition is more important than the lack of the muscular force. Local fatigue is characterized by the rise of the intramuscular pressure, by the decrease of the blood flow to the muscles and by the accumulation of metabolites. [14] A typical cause for the apparition of the fatigue consists in playing the instrument for several hours, with no interruption. Although the musicians' activity is deemed easy, they achieve a suite of movements of very high precision, very well coordinated among themselves, at very high speed, which require special dexterity. The researches effectuated on this model of movements showed they were favourable to the apparition of the pains.[15] Many instruments further cause static charging of the muscles. (For instance: the left supraspinatus muscle when the viola is played). The supraspinatus muscle is important for the abduction of the shoulder and for the general stability of the glenohumeral joint. Even a reduced abduction may lead to a significant rise of the intramuscular pressure. There is recommended for the static charging of the muscles not to exceed 2-5% of the maximum voluntary contraction (MVC) [16] and for the duration of the solicitation not to exceed an hour. Upper and middle deltoid muscles, upper trapezius muscle, supra and infraspinatus muscles are more susceptible to fatigue when the arm is lifted above the level of the shoulder. Therefore, the use of the flute, violin, viola may lead to hampered blood circulation, which entails a deterioration of the muscle.

On the basis of these studies, the working sessions with the instrument must be limited to 45 minutes, followed by a pause of at least 10 minutes. Brief sessions followed by a pause allow the muscles to relax; consequently the musician may continue his activity in this rhythm for a few hours. Difficult musical passages must be fragmented and followed by frequent pauses. Meanwhile, the musician may practice another easier material or may mentally exercise the finger movement, without physically executing it. Another possibility is for the musician to repeat the music track with no instrument (Jehudy Menuhin calls this "play with the shade".) If he passes from one instrument to another – for instance from violin to viola, from guitar to piano – the musician must initially reduce the duration of the exercises and afterwards gradually raise it until he reaches the "normal" duration for him. The same recommendation must be made for the pupil who changes teacher, as this change is connected – usually – to a modification of the technique and of the arm position. They both lead to different biomechanical solicitations from the ones previously used.

After recovery from an injury, musicians must be encouraged to assimilate new techniques, to execute certain exercises, to improve the static and dynamic positions of their bodies. The stress must be laid on re-educating the movements so that the return to the capacity of maximum performance should be gradually done. Musicians may fear to even temporarily separate from their favourite instrument; therefore they tend, as soon as they feel an improvement of the situation, to restart their previous working schedule, even if this is premature. The physician must make written recommendations upon the way and the time period wherein the musician may resume his activity, he must give explicit advice upon the duration of the daily study and upon the duration of the compulsory pauses. [17]

4. Correction of the **Techniques Errors**

The musician must be aware of the possibility for him to have technique errors, from the biomedical standpoint. The physician is obviously not under obligation to make recommendations as regards the performing technique; however he may give medical advice as regards the biomedical aspect of the movements, which is known – usually – to neither the musician, nor his professor. The doctor must study the existing literature and to observe both the patient whilst practicing his profession and especially the professors while teaching their regular courses and during the master class courses: throughout them, the professors reveal aspects of the technique they do not show during regular courses. In time, the physician will get an overview on the variety of the musicians' pedagogical and performance techniques. There is necessary for the doctor to make available his knowledge of biomechanics and psychology.

Some of the most common errors of musical technique are the excessive muscle tension when violin players play "forte" and their use of a shoulder or chin support of inadequate height. [18] As regards pianists, they have been noticed to play harder, by resorting to a greater force than necessary or to have a finger position which much too intensely solicits the hand joints. An inadequately maintained instrument may likewise lead to using too much force in various musical passages.

In general, musicians must tend towards a joint position as close to the natural one, during musical performance. A violoncello player who bends and twists his right fist round his instrument needs increased muscular effort as his fist flexion will reduce the possibilities to hold the bow and will lead to a rise in the injury danger or carpal tunnel syndrome. The combination of repeated movements of the fingers with wrist bending and relaxation and with the development of a bow grasping force may lead to the attrition phenomenon and to the rise of the pressure in the carpal tunnel. In the violin player's case, the chin and shoulder supports may be modified, so that the shoulders and the neck should acquire a position as close to the natural one as possible.

Warming up before the exercises ad relaxing after finishing them may likewise contribute to preventing the injuries, especially when the performances take place in the open. The temperature decrease reduces the muscle contraction rate, diminishes its resistance and raises its fatigue. The repertory is another potential factor for the over-attrition. Certain music tracks require an excessive hand opening or some finger movements beyond the musician's anatomical and physiological possibilities. Especially contemporary music puts musicians in such situations difficult to overcome. [19]

5. Use of the Splints

Splints may be recommended to facilitate the recovery process. They are mostly used to ensure the immobilization of joint, tendon or muscle, which was solicited to over-attrition. There is very important to consider all anatomical aspects of the place to immobilize. Splints are usually made according to measure, in order to ensure a perfect fit.

The splint wearing program is important: they must not be worn when the musician plays his instrument, as this might lead to a modification of the musician's original movement. There is likewise not recommended to permanently wear the splints, as this could lead to the tendon or muscle hardening and also to the loss of the muscular force. The time of wearing them must be permanently reduced; and, after their removal, the musician must make light exercises so as to re-accommodate more easily to the natural position.

The splints may be used to limit the degree of liberty of a joint: for instance, a splint used for the elbow limits its movement liberty to the purpose of preventing the irritation of the ulnar nerve. The allowed degree of mobility may be gradually raised. The therapist must take into account that the limitation of the joint movement might lead to compensatory movements of some other group of muscles and joints, which might cause new problems. An important part of the physician's activity consists in modifying the patient's daily activities and in educating him so that he might use his hands even when he wears a splint.

6. Correction of the Position

There must be considered, from the very beginning, that various types of positional dysfunctions are specific for every instrument. Every musician's anthropometrical data are different and they might not correspond to the standard data that the instrument was built for. The technique that the musician uses might

lead to arm and leg positions forcing him to exaggeratedly twist his trunk, to stretch too much or to bend his head forwards too much. When he starts his musical activity, during childhood, the instrument is much too big and, over time, the unconscious opinion forms that performing music requires an awkward body position.

The physician must analyze both positions of the body: the one assumed during practicing music and the one assumed when the musician does not perform. The most current deviations from the "normal" position of the violin player's body are pushing the head forward, followed by a neck rotation, with the shoulders bent forwards, with a pronounced kyphosis of the chest and with the loss of the lumbar lordosis, with posterior pelvic rotation, with scoliosis, with valgus deformity of the left shoulder and arm and with ulnar fist deviation. From this description, it follows that a violin player's body is already in a state of rest so twisted that it is little wonder if he suffers at all times profession-specific pains. As regards the blowers, the position of the head, bent forwards, modifies both the embouchure and the airflow. The trumpet players who attempt to play high notes change their body position from the regular one for low or medium notes. The optimal coordination of the body position with the respiration is one of the keys to success, not only for vocal artists, but for all instrumentalists. [20]

Musicians may express their feelings both through their music and through their body position. [21] The therapist may train the musicians to intensively use their body positions to highlight the intensity of their feelings. For instance, the flute players are recommended to horizontally hold their instrument whilst playing. As this position leads to a premature fatigue of the adductors in the shoulder joint, many flute players lower their arm, turn their head to the left and tilt to the right. This position is, in its turn, unnatural and fatiguing. The therapist may explain to the musician that the static position whilst performing is not advantageous: to the purpose of limiting the static solicitation of the thorax muscles, the musician may execute all movements allowed by his torso; always having, of course, the musical instrument to his lips. A musician's playing position must be considered to be subject to the changes correlated with the performing activity.

In the case of the musician who plays seated on a chair, the form of his body is profoundly influenced by the inequality of the activities on the right and left sides of his body. The modifications do not appear from the very beginning, but over time, consequently the initiation period has a special importance in ensuring a less deformed body position as possible, and in maintaining the health state until the end of his career, [22] resorting to principles of biomechanics and ergonomics.

In order to correct his professional body positions, the musician must be informed by the therapist upon the manner of reaching a balanced body alignment, of becoming aware of it and dynamically maintaining it during his activity. Correcting defective positions requires auxiliary exercises and a high awareness of the goal; musicians cannot always avoid special body positions. The positioning exercises must refer to the alignment of the kinetic chains of the overall body, having the pelvis as orientation centre.[23] The exercises must ensure the dynamic restoration and the stabilization of the

pelvis and of the spine, the motor-actuating control, the flexibility, the muscular equilibrium, the force, the resistance to effort and the respiratory rhythm. All these must be effectuated in close correlation with the musical instrument. Some musical instruments are heavier; therefore special attention must be paid to their lifting and transportation technique.

At the beginning, the corrected movements must be effectuated without instrument. After the musician has acquired the basic movements and has understood the significance of a correct position, the program may be extended over the use of the instrument.

Many skeletal and muscular problems may be prevented through a regular program for improving the physical condition. The therapist must advance an individualized set of exercises for every musician that should comprise the gradual drive of the muscles, the rise of the body flexibility, the muscle strengthening and the rise of the resistance under effort conditions, as well as the neuromuscular control and the cardiovascular training.

7. Other Techniques

One of the problems that the therapist is confronted to is that musicians will continue to follow other medical or physical-condition programs, especially if they are fashionable. Among them, mention should be made of Qikong, Alexander, Pilates, Feldenkrais or Mensendieck techniques. It is good for the therapist to be open towards their use, to be informed in this respect and to notice the obtained results. As follows, a few of these methods are briefly presented.

7.1. Mensendieck System

Bess Mensendieck developed a system of exercises for the improvement and correction of the body positions, especially destined for women. The therapist Ans Samama adapted this system [24] for musicians. It is based on consciously identifying the defective positions and transforming them into correct positions. Through cognitive trainings, musicians become aware of their movement schemes and are guided towards acquiring and subsequently maintaining a correct position, with or without their musical instrument.

The system distinguishes among the muscles that contribute to accomplishing music and the muscles that only support the body or the instrument; and the musician is trained to be aware which muscles to drive and when. The correct position is defined as a biomechanical alignment of the body parts which are maintained through the contraction of certain specific groups of muscles.

7.2. Alexander Technique

Alexander technique is well known by musicians, actors, dancers and by those who have the opportunity to currently deliver lectures. The technique was developed by the Australian actor Frederick Alexander, after having suffered from periods of voice loss, because of the pressure. The technique considers the "correct" relation among head, back and neck– called *primary control* – as basic element for an adequate scenic movement and for achieving performance. The goal of this technique is to improve the kinesthetic awareness, the position, the

movement and the overall motion, to the purpose of reducing the useless efforts. The technique leads to inhibiting the regular or acquired reactions, which may interfere with the performer's normal activity. [25] During a lesson with Alexander Technique, the therapist offers verbal, tactile or kinesthetic advice.

7.3. Feldenkrais Method

The physician Moshe Feldenkrais developed his method to the purpose of reprogramming the neural-motor-actuating and central nervous system. The beginnings of his experiences with him himself consisted in a sports accident, for whose treatment he resorted to his knowledge in anatomy, physiology, neurology, psychology and martial arts. Feldenkrais method lays the stress on exploring one's own capacities and encourages every person to find one's own original style of movement, without considering the "correct position".

To this purpose, Feldenkrais provides two inter-correlated groups of lessons – Awareness through Motion, respectively Functional Integration. [26] Applied to musicians, the method offers an excellent possibility of becoming aware of one's own body activity.

7.4. Pilates

Pilates stands for a training method especially used by dancers. Its goal consists in re-modelling the neural-muscular-skeletal system. The method may be well used in the musician-recovery process, allowing the improvement of the dynamic stabilization of the spine, the strengthening of the musculature, the increase of the resistance to effort, the improvement of the cardiovascular system. [27]

7.5. Qikong

Qikong, traditional Chinese method, comprises meditation, attentively coordinated movements and respiration exercises, which contribute to accumulating energy in the body and to distributing it along the meridians known within acupuncture. The exercises may range from very simple to reaching an extremely high complexity level. Although the Qikong bases cannot be explained with current knowledge, it is undeniable that Qikong contributes to increasing the flexibility, physical force, relaxation and to becoming aware of one's body and mind. Starting as a very delicate method of physical exercises and meditation, Qikong may turn into a very significant instrument of stress management, of use both in daily life, so dynamic, and in treating the musicians' very high degree of pressure.

7.6. Mobilizing Soft Tissues

The myofascial syndrome must be deemed the first cause of the musician's pains, as – on one hand – it appears very often and, on the other hand, may be very easily and efficiently treated. Some doctors do not consider muscles to be a source of pain unless there is a palpable contraction. The myofascial pain has muscular origin, although its central point may be found in other tissues, such as tendons, ligaments, periosteum and skin. The clinical aspects of the myofascial syndrome are characterized through a strongly painful

spot in a group of muscles, through the reduction of the movement liberty, through local nervous tics, through reference areas of the pain, through dysfunction signs, which also include differences in the skin temperature, piloerection and transpiration. [28] The diagnosis can only be done through carefully palpating the painful spot in the muscles; in the radiography, no tissue modification can be noticed.

The treatment consists in inactivating the painful spot, through classical massage or through the compression of the painful spot. Unless the pain yields, injections can be made in the painful spot itself; likewise, acupuncture, shiatsu massage and other similar forms of treatment may be resorted to.

7.7. Biofeedback

Psychical-physiological biofeedback may be a helpful instrument in treating the problems of the muscular-skeletal system. By determining the electrical parameters of the muscular activity both during rest and performance, the differences may be noticed and the rise of the muscular tension may be localized: this one may constitute a basis for a treatment through biofeedback.

Portable biofeedback units allow obtaining these information even at home, during the exercises. Their use has not extended very much as it is difficult for musicians to simultaneously watch both the score and the electronic records. The computerized devices are preferred, which allow simultaneously recording the sound, the musician's image and the muscle tension. From the analysis of the images taken after a period of treatment, the recorded progress may be documented. [29]

7.8. Videofeedback

Video records showed the amazing speed of the pianists' musically pressing the keyboards: up to 24 notes within a single second were recorded! Of course, at this speed, the eye cannot perceive the movements and the ear cannot record every sound in part. Video records followed by a slow presentation may provide a clear image upon the movements, which may be used to purposes of both scientific research and treatment. The therapist, the musician and the professor are thereby able to analyze the most interesting images and subsequently to forward proposals for the technique improvement in view of eliminating pains.

8. Conclusions

The injury causes of the musicians' musculoskeletal system are variegated and they often include practice errors, ergonomic errors, not being aware of one's body position or of its movements, as well as various psychical-social factors. In this lecture/paper, the treatment possibilities were analyzed, resorting both to traditional methods and to their modern alternatives, physical therapies.

Injured musicians constitute a very motivated group of patients. Their attitude may be used for devising a complex treatment program. The return on stage of a musician having undergone treatment is an exciting and moving moment, due to his marvellous offer for the audience.

References

1. Wagner C. *Physiologische and Pathophysiologische Grundlagen des Musizierens*. In: Blum J, ed. Medizinische Problemen bei Musikern. Stuttgart, Germany: Georg Thieme Verlag; 1995.
2. Materson RS, Dommerholt J. *Industrial, Spine and Related Rehabilitation*. In: MelvinJL, Odderson IR, es. Phisical Medicine and Rehabilitation Clinics of North America. Philadelphia, PA: WB Saunders; 1996.
3. Dommerholt J. *Musica et Medicina*. Arnhem, the Netherlands: Interstudie Academie voor Fysiotherapie; 1996.
4. Higgs J, Jones M. *Clinical Reasoning*. In: Higgs J, Jones M, eds. Clinical Reasoning in the Health Professions. Oxford, England: Butterworth-Heinemann; 1995.
5. Fishbein M, Middlestadt SE, Ottai V, Straus S, Ellis A. *Medical Problems Among ICSOM Musicians,* Med Probl Perform Art. 1988.
6. Amadio PC, Russoti GM. *Evaluation and Treatment of Hand and Wrist Disorders in Musicians*, Hand Clin, 1990.
7. Lowe C. *Treatment of Tendinitis, Tenosynovitis , and other Cumulative Trauma Disorders of Musicians' Forearms, Wrists, and Hands, Restoring Function with Hand Therapy*. Hand Ther, 1992.
8. Dennett X, Fry HJH. *Overuse Syndrome: a Muscle Biopsy Study*. Lancet. 1988.
9. Cherkin D, Deyo RA, Berg AO. *Evaluation of Physician Education Intervention to Improve Primary Care for Low Back Pain. 1: Impact on Patients,* Spine. 1991.
10. Quarrier NF. *Performing Arts Medicine: an Evolving Speciality*. J. Orthop Sports Phys. Ther. 1993.
11. Fry JHH. *Overuse Syndrome of the Upper Limp in Musicians*.Med J Aust. 1986.
12. Blum J, Mastroianni T, Norris R. *Musikschulen und hochschulen und ihre praventiven Aufgaben bezuglich zukunftiger Erkrankungen bei Musikern*. In: Medizinische Probleme bei Musikern, Stuttgart, Georg Thieme Verlag. 1995.
13. Spaulding C. Before Pathology: Prevention for Performing Artists. Med Probl Perform Art. 1988.
14. Edwards RTH, Hill DK, McDonell M. *Myothermal and Intramuscular Pressure Measurements During Isometric Contractions of the Human Quadriceps Muscle*. J. Physiol. 1973.
15. Veiersted KB, Westgaard RH, Andersen P. *Pattern of Muscle Activity During Stereotyped Work and its Relation to Muscle Pain.* Int Arch Occup Environ Health.1990.
16. Johnson B. *Measurement And Evaluation of Local Muscle Strain in the Shoulder During Constrained Work.* J. Hum Ergol. 1982.
17. Norris RN. *Return to Play After Injury: Strategies to Support a Musician's Recovery*. Work. 1996.
18. Levy CE, Lee WA, Brandfonbrener AG. *Electromyographic Analysis of Muscular Activity in the Upper Extremity Generated by Supporting a Violin with and without a Shoulder Rest.* Med Probl Perform Art. 1992.
19. Brandfonbrener AG. *Preliminary Results of Medical Survey of MTNA Teachers*, Am Mus Teach. 1989.
20. Balfoort B. *Houding, adem en keel; Fundamenten voor zangers, blazers en sprekers*. Baarn, the Netherlands: Bosch & Keuning. 1985.

21. Buytendijk FJJ. *Algemenetheorie der menselijke houding en beweging*. Utrecht, the Netherlands: Het Spectrum. 1964.
22. Calliet R. *Abnormalities of the Sitting Posture of the Musicians*. Med Probl Perform Art. 1990.
23. Sahrmann SA. *Adult Posturing*. In Kraus S, ed. TMJ Disorders: Management of the Craniomandibular Complex. New York, NY: Churchill Livingstone. 1988.
24. Samama A. *Muscle Control for Musicians*. Utrecht1, the Netherlands: Bohn, Scheltema & Holkema.1981.
25. Jones FP. *Body Awareness in Action*. In: Murphy M, ed. The Future of the Body. Los Angeles, Calif: Jeremy P Tarcher. 1992.
26. Feldenkrais M. *Awareness Through Movement*. New York, NY: Harper& Row. 1977.
27. Friedman P, Eisen G. *The Pilates Method of Physical and Mental Conditioning*. New York, NY: Warner Books. 1980
28. Gerwin RD. *Neurobiology of the Myofascial Trigger Point*. In: Masi A, ed. Balliere's Clinical Rheumatology. 1994.
29. Flor H, Miltner W, Birbaumer N. *Psychophysiological Recording Methods*. In: Turk DC, Melzack R, eds. Handbook of Pain Assessment. New York, NY: Guilford Press.1992.