PREVENCIÓN DE LESIONES EN INSTRUMENTISTAS DE CUERDA

INJURIES PREVENTION IN STRING PALLYERS

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RESUMEN

The aim of study is muculoskeletal disorders review on string instrumentalists. Sportdiscus and PubMed were searched, using the key elements of injury, string instrumentalists and sports practice. Several factors predispose string instrumentalists to suffer many muculoskeletal disorders, such as tendonitis, nerve entrapment syndrome and dystonia which can alter their physical wellbeing and professional career. The physical activity is recommended as well as mental relaxation exercises to recover body and mind balance. At the same time, the musician must take into consideration that it’s just as important to activate one’s organism before musical activity as it is to return it back to initial equilibrium and calmness by decreasing all physical activity gradually.

Palabras clave: Injury, string instrumentalists, muculoskeletal disorder.

ABSTRACT

El objetivo de este estudio es realizar una revisión sobre las principales dolencias que puede experimentar un músico de cuerda, para establecer cuáles son las acciones que podemos desarrollar desde el ámbito de la actividad física y el deporte para prevenirlas. Para ello consultamos las bases Sportdiscus y PubMed, utilizando como palabras clave: lesión, músico de cuerda y práctica deportiva. Muchos son las variables que pueden llevar al músico a sufrir una lesión: tendinitis, distonia, etc. Por ello se recomienda que practiquen actividad física y técnicas de relajación muscular como medida de prevención. Asimismo, es importante que los músicos preparen al organismo antes de la actividad musical y que lo vuelvan al estado de equilibrio inicial una vez finalizada la misma, disminuyendo progresivamente la actividad.

Keywords: Lesión, músico de cuerda, desórdenes musculares.
INTRODUCTION
The professional career of a string instrumentalist is long in time, in comparison to other professionals, like sportsmen, who have a relatively very short professional life. In that sense, and as a significant example, let’s place our attention on Arthur Rubinstein (pianist), who made his debut at the age of 3 and extended his soloist career till the age of 90 (Joubrel, 2001). In the same way, many distinguished violinists developed their professional careers all through their lives; some of them, like Arthur Grumiaux and Yehudi Menuhin, began to offer public concerts at the age of 5; Nathan Milstein at the age of 10, etc.

Likewise, we must consider the great effort and amount of dedication of string instrumentalists, who dedicate a minimum of 20 hours per week to instrumental practice (Joubrel, 2001; Fjellman-Wiklund, 2003) and give about 28 concertos per year (Joubrel, 2001).

With reference to the interpretative technique of string instrumentalists, we can say that it’s the result of a long and slow development based on a large number of very precise and accurate movements executed in a repetitive way by arms, forearms, wrists and hands. This causes that many instrumentalists only focus their activity on their extremities during their instrumental practice. In some cases, they subject their bodies to a very high tension, what produces a feeling of discomfort and frustration. Nevertheless, unsatisfactory results in musical interpretation are few times understood as symptoms of wrong corporal adjustment, and are related to other circumstances such as insufficient practice and dedication (Liu & Hayden, 2002; Lederman, 2003, 2006; Storm, 2006).

In that sense, the elevated tension exerted on specific muscular groups by instrumentalists during their instrumental practice, together with a high frequency of repetitive movements, represent, among other aspects, one of the main risk factors of injury in instrumentalists (Brandonfbrner, 2003; Guptill & Golem, 2008; Liu & Hayden, 2002;).

METHODS
The following relevant electronic databases were searched from the earliest available time to april to september 2007: Pubmed and SportDiscus. The search strategy consisted of three main elements: injury; string instrumentalists; sports practice. Injury was linked with synonymous terms such as muscular pain, severity, physioterapy with the ‘OR’ operator. For sport practice, warm-up, fitness, stretching were some of the synonyms that were combined with the ‘OR’ operator. Finally, all five elements were grouped together using the ‘AND’ operator so that trials included all five elements.

RESULTS AND DISCUSSION
Risk factors of injury in instrumentalists
Considering that musculoskeletal disorders are one of the most important causes of lesion in string instrumentalists, the responsible factors of these disorders are varied, but they can be grouped as follows (Brandonfbrner, 2003; Dommerholt, 2009; Hoppmann, 2001; Liu & Hayden, 2002; Yavari, Hassanpour & Mosavizadeh, 2010; Zuskin et al., 2005):

- Intrinsic factors: age, gender and professional life are the most common.

- Extrinsic factors: we can find the following ones:
  - Large number of hours practising, or sudden increase in time of this instrumental practice (Newmark & Lederman, 1987; Revak, 1989).
  - Lack of breaks during instrumental practice (Heming, 2004).
  - Lack of training exercises in some of the several body segments involved in instrumental practice (Norris, 1997; Paul, 1997; Sardá, 2003).
  - Physical tension, which requires a relatively strong pressure executed by fingers or finger tips on strings and against the fingerboard (Moore et al., 1991; Stock, 1991).
  - Incorrect body position or posture: it’s important to consider the fact that a good posture during instrumental practice would imply a transfer of body weight to the half front of the spine. Lots of musicians have these functions altered and they transfer their weight to their half back, being this one of the main causes of pain in the lumbar area (Moore et

- Teacher replacement: this circumstance can imply an injury risk for the instrumentalist due to various changes in some specific aspects of his instrumental practice. As an example, with regard to the replacement of a teacher, it can happen that the instrumentalist may have to hold the instrument in a different way, or even to undergo important changes in several aspects of his own playing technique (Newmark & Lederman, 1987; Revak, 1989).

- Instrument replacements: generally there is a large number of outstanding physical and mechanical differences from one instrument to another, such as the distance from the strings to the fingerboard, implying considerable variation of the pressure exerted by one’s fingers on the strings. These changes in instrument size and shape are very noticeable, for example, in violas. (Newmark & Lederman, 1987; Revak, 1989).

Each one of these mentioned factors can end up in a sequence of characteristic lesions and injuries, being the most common ones known as repetitive strain injury (RSI) (Hoppmann, 1998; Liu & Hayden, 2002).

It’s important to emphasize that RSI are considered a Work Related Disorders (WRD). A WRD can be caused by a single tension, not necessarily a repetitive one, as well as by the existence of psychological and social factors in the WRD genesis.

The World Health Organisation considers that the WRD cause can be multifactorial (Hagberg, 1996), for this reason it’s important to recognize personal features and other environmental and socio-cultural factors which usually have a remarkable influence in these disorders. There are some examples of WRD development we can indicate:

- Instrumentalists with acute neck ache: It can be either (a) due to a bad position during instrumental practice or (b) stressing situations due to other circumstances like family problems or emotional (or affective) problems. In both cases we can find a trapezius muscle contraction.

- High psychological pressure exerted on the instrument player due to the high level required during music interpretation (Hagberg, 1996).

The eagerness to reach perfection and the will of the artist to improve is another relevant factor in the musician’s daily work. The artist has in his own mind a “musical idea” which he wishes to embody with total accuracy in his instrument; such thing can cause a physical and/or psychological overcharge.

Analysis of the main musculoskeletal disorders
Gesture repetition is sometimes a basic idea for instrumentalists, since it plays an important role in music and musician’s essence (Roset, Rosiné & Saló, 2000). For that reason, the musician must practice some movements many times to take the mechanics of the movement very close to perfection and, in this way, to crystallize the composer’s musical idea. Nevertheless, there are two risk factors for injury associated to the numerous repetitions of a single movement:

1. Unnatural repetition of a certain gesture. As an example, a violinist who lifts his right shoulder in an excessive way every time he plays in the lower half of the bow.

2. The muscular tension supported, without any direct movement, often leads the musician to make some mistakes due to the excessive time practising with high muscular tension in order to resolve a technical problem.

These two factors have an important incidence in general disorders and musculoskeletal injuries, being the most frequent: (a) tendonitis, (b) nervous trapping syndrome, and (c) dystonia.

a) Tendonitis is conceptualized as an inflammatory degenerative process of a sinew. In its first stages is characterized by a diffuse pain during practice, and in more advanced stages, by a constant pain, even after practising. Among the possible causes which originate this type of injury are the mechanical overcharge and also general traumatisms. (Martin, 1992).

In string instrumentalists, the first tendonitis experience often shows up as a sharp and acute pain,
located in the wrist area, right elbow, and left shoulder or in the base of the thumb (Williams, 2003). This pain sometimes is only located in the overcharged area and when such area makes a specific gesture. Nevertheless, in more serious cases the pain is continuous, and unlike the most simplest muscle tensions, these ones tend to persist for a longer period of time, being possible to prevent them in most cases by doing short warm-up exercises, flexibility exercises (Williams, 2003) and applying ice after practice. Among the more frequent kinds of tendonitis in instrumentalists, we must emphasize the De Quervain syndrome. This syndrome is a tendonitis located in the base of the thumb, with the wrist extensor muscles implicated: the abductor pollicis longus and the extensor pollicis brevis (Kulthanan & Chareonwat, 2007). This kind of syndrome can be sometimes mistaken for osteoarthritis, or for entrapment of the superficial branch of the radial nerve, but normally they can be differentiated by a specialist.

The sinews of this thumb extensor muscles must pass through a narrow fibre-bone tunnel, being pressed during the movement. For this reason, when there are repetitive actions, this area becomes much more susceptible to become inflamed. The sinew compression of the wrist extensors increase by doing certain characteristic movements; as an example, in the case of violinists and violists, when they played with the upper bow; the wrist is sometimes brought to a position of large ulnar deviation. On the contrary, playing with the lower bow, when hand and wrist are in an ulnar pronation position, the radial nerve in this area (superficial part of the radial nerve) is in a pronation position too, which causes a possible irritation of it. Another position that can cause this symptom among violinists and violists can be found by doing an acute flexion of the left wrist when playing in the highest positions of the left hand, or as it happens with the viola, with a bigger size, it can involve a higher flexion level in the upper wrist positions.

b) Among the nerve entrapment syndromes, we can mention the carpal tunnel syndrome (STC) and the cubital tunnel syndrome (CTS) as the most frequent and important. STC refers to the symptoms by compression of the median nerve in the hand, affecting the base of the thumb and as well as some areas of the index and middle fingers.

The symptoms of this syndrome are associated with pain, numbness, tingling and, in the most severe cases, muscular atrophy. On occasion, pain or electric shock-like sensation is observed in the hand or the arm by lightly banging over the wrist nerve, a test known as Tinel’s sign (Norris, 1997).

According to Norris’ study (1997) violinists, violists, guitarists, pianists and percussionists are the people who have the highest probability to develop STC, because of the special movements they performed in each one of these instruments. Moreover, symptoms can come in an early stage if the instrumentalists are smokers, obese, or they work with computers for many hours. In general, STC is associated with clumsy movements, loss of skill and great difficulty in handling small objects. These factors should be taken into consideration from the instrumentalists’ point of view.

In the case of string instrumentalists, the most important cause is the left wrist flexion in a prolonged or repetitive way. In that sense, Gelberman’s study (1981) shows that the pressure in the carpal tunnel increase when the wrist performs a flexion/extension movement, in a range of movement from -90º to 90º, making possible a high elevation of pressure inside the carpal tunnel and, therefore, STC appearance. In this sense, it’s remarkable how violin players reach specific extreme positions with their wrist, playing in the highest positions of the left hand, or as it happens with the viola, with a bigger size, it can involve a higher flexion level in the upper wrist positions.

CTS is due to ulnar nerve subluxation, hyper-pressure or external compression. The interaction of certain instruments with the cubital area predisposes the instrumentalist to have this kind of syndrome. It is characterized by pain in the elbow area, although other signs of this injury are nervous irritation and “pins and needles” sensation too (symptoms that often get worse when the elbow is flexed).

Among the possible causes associating string instrumentalists to this syndrome, the most remarkable ones are the repetitive actions with a flexed elbow, which we can observe, for example, in the left arm of a double bass player and cellist when
playing in first position. In the case of violinists, the problems developed differ from the cellist ones, because the elbow is never flexed in the same way as it is with the cello (left arm supine), where the arm exerts an additional tension over the nerve. The flexor carpi ulnaris muscle (which forms the tunnel sides and surrounds the ulnar nerve) is a very much used muscle when playing in the seventh position and in the highest violin positions. For this reason the contraction of this muscle contributes to create an additional pressure over the nerve, increasing the risk of suffering this injury. The high tension over the left hand could develop this syndrome, as well as tendonitis. This is the case of those string instrumentalists who have the habit of increasing the pressure in their left hand when ‘forte’ is indicated in the score.

Right academic formation in music profession is really important to prevent the appearance of this syndrome. In this way, a way of prevention would be based on stretching and doing self-massages on arms, hands and shoulders.

c) Dystonia, as indicated by Jabusch (2004), is the result of an abnormal process of liberation of chemical neurotransmitter substances in an area of the brain, as consequence of repetitive movements or by adopting an incorrect body posture. Basically the symptoms are involuntary muscular contractions. The three main aspects that show dystonia symptoms are: deterioration in handwriting after writing several lines, foot cramps or fast eye blinking. These symptoms can be noticed at first in a discreet way, but then they become more acute after long efforts (Sakamoto, 2007).

Several psychological features have been related to dystonia: depression, sensitive and hysterical characters and anxiety. Many anxiety and depressive diagnostics have been identified in instrumentalists affected by cervical dystonia, even they show a high prevalence of social phobia (Jabusch, 2004; Sakamoto, 2007).

Focal dystonia in string instrumentalist is understood as the loss of voluntary motor control when playing the instrument (Jabusch, 2004). The involuntary movements done with the left hand fingers and the right arm are some of the most important coordinating injuries which affect violinists and violists. It is a painless muscle discoordination where the symptoms persist for many years.

According to Schuele’s study (2004), among violinists and violists affected by dystonia, only 38% were capable of keeping up with their musical career. Moreover, 57% of these instrumentalists had precedents at the beginning of the symptoms, such as a change in their instrumental execution technique, instrument and/or teacher replacement or an increase of instrumental practice time.

Injury prevention strategies
During their professional activity, instrumentalists do not only execute a mental activity, but as many other several sportmen and dancers, their implication is also physical. In this sense, to obtain a correct motor response is necessary to set up a basic preparation in good mental and physical health to learn how to avoid injuries due to repetitive and precise movements during the execution with the instrument.

Heming’s study (2004) attribute musculoskeletal disorders problems to a poor physical instrumentalist condition, related to the high level required when playing the instrument. Instrumentalists with weak physical conditions are more susceptible to suffer injuries due to the tension exerted on one’s body by repetitive movements. These aspects, added to the unnatural postures and continuous repetitive movements, can cause serious injuries that reach extremely high levels, including total incapacity (Hagberg, 1996). In this sense, it is necessary to dedicate special attention to children who have just started with their practice of musical instrument since their musculoskeletal system is still in the middle of development.

Several studies (Horvath, 2008; Norris, 1997; Sardá, 2003; Wilke, Priebus, Biallas & Frohöse, 2011) show how warm-up exercises reduce the risk of muscular pain, and even reduce injury possibilities. These warm-up exercises, amongst other things, increase the muscle temperature, which improves muscular mechanic efficiency. At the same time, it produces some improvements in joints movements due to an increase of blood circulation which means reaching the cartilaginous textures, getting better blood irrigation and making the joints more stable.
Warm-up exercises, according to Bishop (2003), should be carried out systematically where we can recognize two different parts. First of all, general warm-up prepares the whole body for a further and more intense work program. Secondly, specific and more located warm-up prepares the specific parts of the body involved in the physical activity that will be carried out. Therefore, these are the physical exercises which we recommend according to the objectives and different needs of the string musicians (Table 1).

**Table 1. Exercise classification.**

<table>
<thead>
<tr>
<th>EXERCISES SPECIFICATIONS</th>
<th>EXERCISE PROPOSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>General dynamic exercises</td>
<td>Exercises involving global body movements.</td>
</tr>
<tr>
<td>Specific dynamic exercises</td>
<td>Specific exercises of all or some of the technical movements performed by instrumentalists.</td>
</tr>
<tr>
<td>Stretching</td>
<td>Exercises in which muscles are stretched in a continuous way (statically) or in a intermittent way (dynamic).</td>
</tr>
<tr>
<td>Psychological exercises</td>
<td>Mental exercises “executing” usual movements only with the mind.</td>
</tr>
</tbody>
</table>

Furthermore, physical activation can be achieved in an active way, in a passive way, or with a combination of both ways. The active method is more recommended for string musicians, although passive methods – like massages – can be used as an additional way. In this sense, we propose the following exercises which always have to be executed previously to any practice of musical instrument.

Among the recommended exercises to prevent injuries during instrumental practice are remarkable

the following ones:

a) Global exercises: Activities which facilitate a greater activation of the organism and the muscles during its execution (walking, jogging, swimming…). It is recommendable to practice them with exercises of joint mobility (flexo-extensions, circunductions, rotations, abductions and adductions) as we can see in the picture. For string musicians would be recommendable a short walk (5 minutes) along the concert hall or dressing room, together with some mobility exercises on the upper extremities and trunk. In the following table are indicated the exercises that can be executed depending on the anatomic localization.

b) Specific exercises: Exercises directly related to the activity, that is to say, with the type of instrument. It’s important to take into consideration the progression from low to high complexity.

c) Stretching: There are several techniques and methods to execute stretching exercises, among them are remarkable:

- Passive static method. Muscle is slowly stretched without voluntary contraction till its maximum, without causing pain. Later, this position is held for 10 and 30 seconds. The appropriate strength would be that in which tension disappears after 3-4 seconds without having reached the maximum position.

- Active static method. It means that the antagonistic muscle (the muscle which is not going to be stretched) contracts. The technique is similar to the previous one, but in this case, when the maximum position of stretching is reached, the antagonist contracts.

- PNF method or contraction – relaxation. This technique consists first of all of stretching the muscle slowly till its maximum. Then, the muscle is contracted in an isometric way, without getting shorter, against a resistance. This
contraction will be held for 6-10 seconds. Once this action has been executed, the muscle is relaxed during 2-4 seconds, holding joints position. Finally, the muscle is stretched again for 10 seconds. The whole process will be done twice as much.

In this context, we have to consider that incorrect execution of mobility and stretching exercises during several sessions will have a negative influence on the musician’s wellbeing. Table 2 represents some of the exercises that are not recommended under any circumstances.

**Table 2 Classification of non recommended articulation exercises.**

<table>
<thead>
<tr>
<th>NOT RECOMMENDED EXERCISES</th>
<th>ARTICULATION MOVEMENTS TO BE AVOIDED</th>
<th>ANATOMIC LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over flexion</td>
<td>Over extension</td>
<td>Knees, spine, (lumbar area and cervical zone)</td>
</tr>
<tr>
<td>Lateral straining flexion</td>
<td>Maximal vertebral rotation</td>
<td>Spine</td>
</tr>
<tr>
<td>Circunduction</td>
<td></td>
<td>Spine (cervical area).</td>
</tr>
<tr>
<td>Continuous hypercifosis</td>
<td></td>
<td>Spine (dorsal zone).</td>
</tr>
</tbody>
</table>

At the same time, we must take into consideration that it’s just as important to “activate” one’s organism before activity as it is to return it back to initial equilibrium and calmness by decreasing all physical activity gradually and in a gentle way, especially when our main performance is ended. (Takahashi, Okada, Hayano & Tamura, 2002). To achieve this state, musicians must execute the following exercises: static and passive stretching exercises specifically on those muscles used during musical practice, mental relaxation exercises, and above all, breathing exercises.

Also, and not only as a prevention strategy of injuries but related to health and general well-being of the musician, it would be recommendable to practice regularly some kind of sports activity, since this can contribute to improve the professional activity of string instrumentalists (Hansen, Stevens & Coast, 2001; Sarda, 2003; Storm, 2006).

Related to the above mentioned injuries we can propose a pack of physical and sport activities that can be very useful to string instrumentalists, and at the same time they can prevent lesion and injuries, as it helps to improve musical performance.

**Table 3. Recommended exercises for physical and sports practice.**

<table>
<thead>
<tr>
<th>Fitness</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Duration</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart and lung</td>
<td>At least  three times a week</td>
<td>From 55 to 90% of the maximum heart beat frequency</td>
<td>&gt;20’.continuously or intermittent breaks.</td>
<td>Walking, slow jogging, bicycle riding, swimming, skating, dancing, etc.</td>
</tr>
<tr>
<td>Muscular strength and resistance; Body fitness.</td>
<td>At least two times a week.</td>
<td>Use a weight that can allow work for 30’ to 45’, then stop for one hour and then again exercises.</td>
<td>Programs of 8 to 12 exercises executed from 1 to 3 times completely</td>
<td>Programs of strength exercises based especially on muscular development.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>At least twice a week</td>
<td>One feels slight tension that will disappear in 3” or 4”. Keep up for 10’ to 30’.</td>
<td>Minimum altogether 15’</td>
<td>Stretching, yoga, pilates, etc.</td>
</tr>
</tbody>
</table>

In this sense, an important aspect is to get fit all body structure and trunk muscles paying especial attention to control the spine stability. Among others factors,
string instrumentalists will be better off with these exercises because of the body posture improvement which will avoid problems caused by incorrect positions during prolonged practice sessions. Therefore, and as it has been observed, warm-up exercises, physical sports activity and, possibly, relaxation exercises, are the most remarkable exercises with regard to musculoskeletal injury prevention in string instrumentalists. However, it’s essential to follow some guidelines that constitute a specific work program in instrumentalists, taking into consideration the different objectives to be reached and, essentially centred in injury prevention during instrumental practice (Storm, 2006).

CONCLUSIONS

It’s worth considering the fact that a correct technical execution is determined by a correct combination of biomechanical, psychological, and physiological factors of the instrumentalist, such as skill, precision and instrument control. The correct technical execution can be distorted due to the fact that many instrumentalists are not aware of what their body implies for the musical practice, acting in detriment to musical interpretation and adding a risk factor that can lead to a musculoskeletal disorder or injury, very weak at the beginning, but if it is not paid the right attention, it can become a chronic and irreversible injury.

Instrumentalists and musicians in general have a great lack of information and educational formation on the possibility of suffering serious physical injuries due to musical practice without risk prevention programs (Joubrel, 2001). This emphasizes the high percentage of disorders and musculoskeletal injuries in string instrumentalists compared to other kind of instrumentalists. These disorders and injuries are related to the action of “playing the instrument”, and can be caused by some of the following conditions and factors: asymmetric postures that musicians must adopt during practice, as well as the static load required, without forgetting factors like personal features and environment and socio-cultural factors which surround the instrumentalist.

In the same way, the importance of establishing prevention programs become evident, increasing the contents in this area in educational centres, orchestras and in other institutions, with the only purpose of helping their instrumentalists, as happens in other professional areas where occupational prevention is a reality.

In these injury prevention programs it would be especially positive to inculcate in musicians (in general) a habit of preparing one’s organism to develop a correct rehearsal and instrumental practice. In the particular case of string instrumentalists, it’s important to perform and execute these exercises especially with one’s arms, back, torso, abdomen, neck and shoulders with dynamic stretching and mobility exercises. Furthermore, proprioceptive exercises will also help musicians to improve body self-control and to be able to avoid lesions and physical injuries like dystonia. Once again, it’s important to make musicians understand the importance of putting an end to any of their wrong musical practice routines with a series of exercises (active and passive) like breathing, stretching, relaxation and self-awareness. All these exercises will help musicians and instrumentalists to improve their skills and at the same time to develop a good mental attitude to be able to avoid injuries caused by wrong postures and lack of active and passive exercises previous to musical interpretation.

On the other hand, there are not enough investigation programs focused on the analysis of injuries caused by instrument playing techniques, in which ergonomic and muscular factors and several playing techniques used should be analyzed. This includes instrument dimensions, weight and size, and is related to the corporal segments in musicians. Having knowledge about possible injury causes, it would be relevant to study specific strategies which could reduce the number and the severity of injuries.

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