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Original Research Article

Neurogenic Involvement in Overuse Syndrome among Violinists

Leena R[1*], R.S. Gangatharan[2**], Reji K Samuel[2*]

[1]HOD, Neurophysiotherapy Department, [2]Principal,
[*]C.U. Shah Physiotherapy College, Surendranagar, Gujarat, India.
[**]Meenakshi College of Physiotherapy, Virugambakkam, Chennai, Tamilnadu.

Corresponding Author: Leena R.

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ABSTRACT

Repetitive Strain Injury (RSI) is commonly noticed among violinists, who have to maintain the unavoidable static postures for prolonged period which is more important in leading to overuse syndrome than repetitive movements. It was essential to determine the neurogenic involvement in overuse syndromes among violinists and to compare the neural tension in both upper-limbs of the violinists with that of non- violinists and to learn the basic mechanism of neurogenic involvement in violinists, so that preventive strategies and therapeutic approaches could be implied for this population. A total of 40 violinists were selected based on the selection criteria using convenient sampling method. Upper-limb tension tests (ULTT) were performed bilaterally, to test the extensibility of the neural tissue and they were compared with non-violinists. The result of the study showed that there was significant increase in nerve tissue tension ($p < 0.05$) in ULTT among violinists than non -violinists. Also left side neural tension was more than the right side with the significant difference between them among violinists. In case of non-violinists, normal responses were obtained and no neurological symptoms were found in all the upper limb tension tests. The study concluded that there was presence of neural tension in Upper limb [Left>Right], due to overuse syndrome among violinists when compared to non violinists.

Keywords: Overuse Syndrome, RSI, Upper Limb Tension Tests, Neurogenic, Violinists.

INTRODUCTION

Overuse syndrome is defined as the symptoms and signs of presumed injury to tissues, subjected to stresses that exceed their biological limits. They are caused, precipitated or aggravated by repeated exertions or movements of the body. Repetitive Strain Injury (RSI) is the common name given to the symptom complex of upper-limb and trunk pain, also called as Trauma Disorder, where the aggravating factor appears to be repetitious activity. [1]

Overuse syndrome can also be called as Repetitive Strain Injury or Occupational Cervico-brachial Syndrome, or Cumulative Trauma Disorder. [2] Repetitive Strain Injury includes symptoms of pain, muscle weakness and tingling, with concomitant loss of strength in the muscles in the limb concerned. Although the term implies that repetitive movement is responsible for the condition, abnormal postures and prolonged periods of work are more important in leading to the syndrome than repetitive movements. [3]

While it is an excellent form of stress management, playing an instrument is physically demanding, especially when stressful positions are required due to the design of the instrument. However,

musicians are often in awkward postures when they don't have to be. In addition, they abuse their bodies, forget basic ergonomic rules. [4] RSI occurs in musicians for several reasons: misuse or inefficient use of the body/ lack of general fitness/chronic muscle tension/ undeveloped upper-arm, shoulder and back muscles/stress (psychological or emotional)/fatigue/ ill-health/ playing "cold" without warming up the muscles before practicing/ insufficient rest breaks. There are certain ways of using the body that can lead to injury much sooner. These include awkward or asymmetric posture/sustained or prolonged muscle contraction/ movements that require a lot of strength or force/fast repetitive movements/ raised arms/ deviated wrist positions/strong gripping action with the thumb. The amount of stress on the body is a cumulative total of all of these factors, so when several risk factors are present, the potential for injury is much greater. The good news is that all of these stresses can be either totally eliminated or at least minimized.

Overuse injuries are a serious threat to all musicians, whether or not they play professionally. Repetitive Strain Injury (RSI) is highly likely if musicians practice and/or perform daily and use their hands and arms all day at work. Many articles focused on what one can do to prevent injuries before they happen, or treat them if experiencing problems. Surveys of symphony orchestras found that 64% to 76% of musicians were experiencing RSI that affected their performance. [5] These high percentages don't even take into account that many musicians who have had to abandon their careers due to serious injury. Professional musicians rarely admit having an injury since nobody wants to hire an injured musician. The pressure on professional musicians is greater than ever before. It is a stressful career requiring long hours of practice and repeated performances demanding peak performance each time. Musicians who travel often suffer from sleep deprivation and poor nutrition. These are all major contributing factors of Repetitive Strain Injury. [6]

Overuse injuries are common among instrumentalists and they can be treated through a combination of proper treatments and a change in the habits of activities that caused them. Certain factors predispose a violinist to suffer from overuse injuries such as general physical conditioning of the individual, the nature of activity that provides stress to the neuromusculoskeletal tissues and are related to duration, frequency and intensity. One of the most common technical error is playing with excessive tension, which causes the muscles to work extra hard. This is particularly common in string players, left hands when bowing, with right pressing down the bow harder than necessary may have a cumulative effect and result in gradual, progressive overuse injury. Since not two individuals are anatomically and physiologically identical, exposure to same risk factors and neuromusculoskeletal stresses may result in a large variability of results. Violins are usually chosen for their musical potential, rather than for the physical comfort of the musician. Switching from one size violin to another or to an instrument that has a different bridge height can all predispose towards overuse injuries, error in practice habits, prior injuries of sufficient severity could present limitations to current neuromusculoskeletal demands. Injured tissue is replaced by inelastic scar tissue, which is less flexible or resilient than the original normal tissue. If an injury has occurred, forced playing is likely to exacerbate the problem. This is true even when pain or discomfort is minimal or absent. A slumped posture and other poor body mechanics increase the risk of injury, particularly neck problems. This also applies to carrying instruments of course, the heavier the instrument, the more problems it presents, especially for a smaller person. Holding/ manipulating

violin often requires body segments and the spine to assume and maintain a fixed position for prolonged periods of time superimposed on the static posture of body parts is the intricate violin playing. The fixed/constrained body position which is maintained for a prolonged time may alter the neurobiomechanics and may lead to Work Related Neuromusculoskeletal disorders. [7,8]

The term 'Overuse Syndrome' was originally proposed by FRY to explain the symptoms of pain and weakness in the arms of musicians. International Conference of Symphony (ICSOM) conducted a largest and most comprehensive study on 2212 instrumentalists. The study proved that 58% of them had neurogenic involvement and also they proved that, string players appeared to be more susceptible to such disorders than wind instrumentalists. [9]

Repetitive Strain Injury is commonly noticed among violinists, who have to maintain the unavoidable static posture for prolonged period. Neurogenic pain arises from, or is caused by, the nervous system. The term is a catch-all phrase for pain that occurs because of central or peripheral nervous system dysfunction. Types of neurogenic pain may include: neuropathic pain (due to nerve damage or disease), central pain (arising from a lesion in the central nervous system - such as thalamic pain following stroke), or deafferentation pain (stemming from loss or interruption of sensory nerve fiber transmissions). [10,11]

The posture of violinists during violin playing is as follows: Holding the violin with protracted shoulder, forward head posture with lateral flexion and rotation to the left and increased kyphotic curve of thoracic spine. [This high-tension posture limits the freedom of upper-limb movement during adaptive changes in positions and activities during violin playing. Overtime the pectoralis muscle shortens, tighten and strengthen and the muscles controlling the scapula become weak, which leads to shoulder dysfunction]. Left shoulder is protracted and hyper-adducted. [It causes excessive forearm supination, shoulder rotation and wrist deviation]. Too intense finger pressure on strings [It leads to more rapid fatigue & decreased dexterity]. Too rigid right shoulder posture (bowing arm)[It results in increased elbow motion and deviated and flexed wrist].Sitting slouched posture [It limits upper trunk movement and increases internal disk pressure]. [12,13]

Manchester (1988) reviewed the occurrence of problems in a well-defined population of music students, focusing on upper extremity symptoms. The incidence of hand problems in this group has 8.5 episodes per 100 students per year. Further analysis indicated that string players had greater incidence rate than wind instrumentalists and were identified as neurological in origin. Physiotherapy is leading the way in research and treatment of Repetitive Strain Injury and upper limb disorders. [14] Several clinical studies have already shown reproduction of patient's upper limb symptoms by the upper limb tension tests procedure indicating that adverse mechanical tension in the neural system may have a significant role in several musculoskeletal conditions. [15]

It is essential to learn the basic mechanism of neurogenic involvement in violinists. So the effort of this study was to determine the neurogenic involvement in overuse syndromes among violinists and also to compare the neural tension in both upper-limbs of the violinists with that of non- violinists. Preventive strategies and appropriate therapeutic strategies could be developed based on the study and thereby greater benefits could be drawn for the violinists and the ultimate goal is the preservation of the society's most cherished resources, the performing artists (violinists).We hypothesized that there was significant neurogenic involvement in overuse syndromes among violinists.

MATERIALS AND METHODS

In this Observational study, participants were recruited from Government Music College, Raja Annamalaipuram, Chennai, Tamilnadu. The questionnaire was issued to 64 violinists and to 50 non-violinists. The questionnaire obtained information about demographic details, medical history, hand dominance, pain history, and professional history/musical history. Upper extremity physical examination contained information about range of motion of all joints, muscle power evaluation, sensory evaluation and special tests to neck and upper limb. All subjects completed a screening questionnaire and screening examination to rule out pre-existing pathology of the neck or upper extremity. A total of 40 violinists were selected based on the selection criteria, 64 violinists who were screened with thorough physical examination and 40 violinists who fulfilled the selection criteria [16-18] were recruited to volunteer in this study.

40 eligible participants who were of age group between 15-60 years, both gender, practicing violin for more than 5hours /day [19] experience pain for a year and above, [20] who practice violin for more than 2 years [21] who have symptoms like pain/paraesthesia/heaviness/sensory changes/feeling of weakness in the neck/ thoracic spine/upper extremity. And Non-violinists, who were not having pain in their arm/neck and who were willing to volunteer in this study. The participants were excluded if they had history of recent fracture, recent trauma to neck/upper limb, degenerative diseases of cervical region, Vertibro-Basilar Insufficiency, spinal cord symptoms and Non-violinists, who were involved in any repetitious activity. The study obtained prior approval from the institutional Ethical Committee. All participants provided their demographic details (Table 1) after signing the informed consent form before collecting baseline data. The outcome measure was Range of Motion through Upper limb Tension Testing. The subjects were selected according to convenience sampling technique and the study duration was 3 months. The clinical test used to test the extensibility of the neural tissue was Upper-limb tension tests, ULTT 1 (median nerve), ULTT 2b (radial nerve), ULTT 3 (ulnar nerve). Each component of the upper-limb tension test consists of an ordered sequence of upper-limb movements, which selectively increases tension within the neural tissues and their connective tissue coverings. The test was considered to be positive, if it reproduced the local and referred symptoms and it was applied until the first onset of symptom. The range of motion encountered at this point of symptom response was measured by goniometer and recorded.

For the control group, the normal responses for the upper-limb tension tests were noted. With sensitizing and desensitizing maneuvers physiological symptoms (i.e. normal symptomatic responses to the stretch of the structures) and clinical physiological symptoms (abnormal symptoms provoked by the test but in areas where there is nothing wrong with the underlying structures) could be analyzed further to prove whether they are neurogenic in origin, and thus to confirm the diagnosis. [22] The tests were done on both upper limbs of all subjects.

Statistical analysis: All data were analysed statistically. Mean and Standard Deviation were calculated using descriptive analysis. t-test was performed to compare the parameters. Confidence interval was set up at 95%.

RESULTS

The demographic details at baseline were analyzed and found to be homogenous (age, height, weight, BMI, gender) with $p>0.05$(Table 1).

Post Evaluation, comparison of elbow flexion (ULTT 1-median nerve) in violinists and non-violinists showed statistically significant increase in elbow flexion ($p<0.05$), which in turn reveal that

there was, decreased elbow extension in both upper limbs for violinists. (Table 2).It revealed that there was statistically significant increase in elbow flexion, which in turn revealed that there was, decreased elbow extension in left upper limb than right upper limb. Also it showed statistically significant increase in elbow flexion in both upper limbs, which in turn reveal that there was, decreased elbow extension in both upper limbs in violinists.

Comparison of ulnar deviation (ULTT 2b-radial nerve) in violinists and non-violinists showed statistically significant decrease in ulnar deviation ($p<0.05$) in left upper limb in violinists (Table 3). It also showed statistical significant decrease in shoulder abduction and ulnar deviation in left upper limb than right.

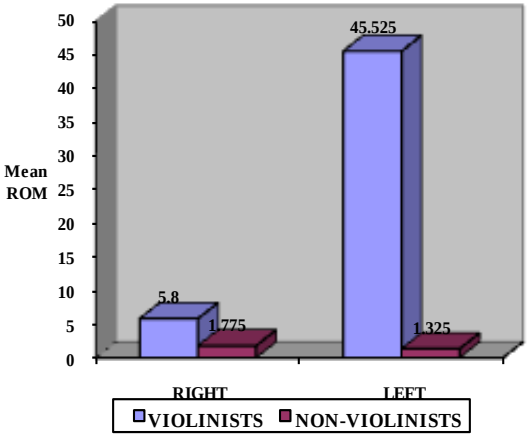
Comparison of shoulder abduction (ULTT 3-ulnar nerve) in violinists and non-violinists showed statistical significant decrease in shoulder abduction ($p<0.05$) in both upper limbs in violinists (Table-4). It also showed statistical significant decrease in shoulder abduction in both UL in violinists.

Table-1: Demographic Details of Group A (Violinists) and Group B (Non -Violinists)

Group A (Violinists)(n=40)					Group B (Non -Violinists)(n=40)			
Variables	**Mean**	**SD**	**Max.**	**Min.**	**Mean**	**SD**	**Max.**	**Min.**
Age(yrs)	38.9	14.18	65	15	37.65	13.33	62	16
Height(cms)	161.9	11.09	179	120	159.2	10.7	178	136
Weight(kgs)	55.45	7.13	68	28	54.55	8.5	68	35

Table-2: Comparison Of Elbow Flexion (ULTT 1-Median Nerve) In Violinists And Non-Violinists

Elbow Flexion		Mean±SD	T test	P -value
Right	Non-violinists	1.7750±4.8	2.052	0.044*
	Violinists	5.8000±11.4		
Left	Non-violinists	1.3250±4.08	29.101	0.000*
	Violinists	45.5250±8.6		



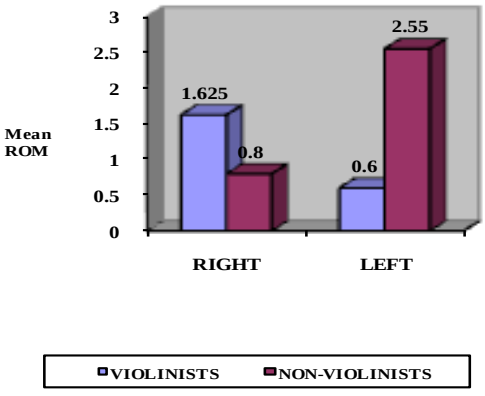
* - Significant difference at 5% level

Table3: Comparison Of Ulnar Deviation (ULTT 2b-Radial Nerve) In Violinists And Non-Violinists

Ulnar Deviation		Mean±SD	T test	P -value
Right	Nonviolinists	0.8±2.8	0.878	0.383
	Violinists	1.625±5.2		
Left	Nonviolinists	2.55±5.4	2.101	0.000*
	Violinists	0.6±2.2		

Table-4: Comparison Of Shoulder Abduction (ULTT 3-Ulnar Nerve) In Violinists And Non-Violinists

Shoulder Abduction		Mean±SD	T test	P -value
Right	Non-violinists	16.000±4.3	18.050	0.000*
	Violinists	0.9750±2.9		
Left	Non-violinists	27.225±5.1	24.048	0.000*
	Violinists	1.5750±4.3		



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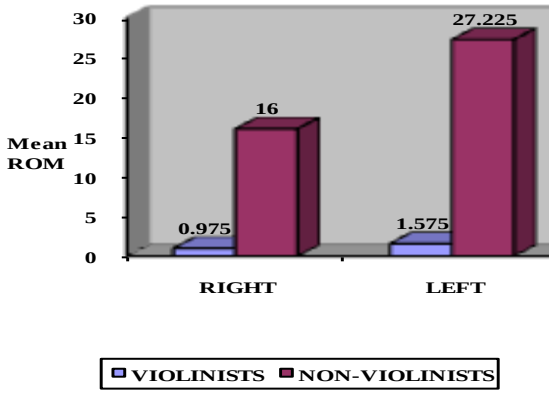

* - Significant difference at 5% level

DISCUSSION

The purpose of this study was intended to find out the neurogenic involvement in overuse syndromes among violinists when compared to non violinists and it was demonstrated by using Upper limb tension tests.

In this study all the participants of Group A showed presence of neural tension in the outcome scores and the evaluation methods were well tolerated by the entire participants. No major adverse effects were noted during and after the evaluation with Upper limb tension tests. Playing related symptoms among instrumentalists are frequently neurological in origin among instrumentalists was well documented by other researchers. [23] After evaluating and comparing the results of both groups (violinists and non –violinists) it was proved that statistical significance which showed presence of neural tension among violinists when compared with non violinists ,as well as there was significant difference which showed left upper limb was more involved than right upper limb among violinists. Thus violinists were found to have highly significant difference in the range of motion of joints, measured during upper-limb tension tests.

The statistical analysis reveal that there was increased median nerve tension in left upper limb than right upper limb, increased ulnar nerve tension in left upper limb than right upper limb. Analyzing all Upper-limb tension tests, it had been statistically proved that there was positive relationship between right and left sides. In this study it has been found that there was significant association of signs and symptoms in left side than right side in violinists and thus inferring that left side neural tension was more than the right side with the significant difference between them. In case of non-violinists, normal responses were obtained and no neurological symptoms were found in all the upper limb tension tests. The finding is in accordance with earlier studies conducted in instrumentalists with neural tension due to repetitive activity. [24] The presence of neural tension due to repetitive activities may be due the following. Sustained violin performance requires a continuous blood flow of oxygen and energy rich blood into the tissue in addition to removal of metabolic waste products. Metabolic fatigue certainly occurs as the result of sustained posture, maintained by violinists. (Susan. J. Isrenhagen, 1995).

The repetitive motions of playing violin with shoulder protraction and hyper adduction, elbow flexion, wrist flexion and deviation caused accumulated micro insults to tissues and created neural tension in violinists. The repetitive movements of wrist in flexed and deviated position in a static posture might have produced neural tension in left upper limb in violinists. The non-neutral posture and repetitive strain are likely to develop adverse neural tension. Adverse neural tension is defined as abnormal physiological and mechanical responses produced from nervous system structures when their normal range of movement and stretch capabilities are tested.

This problem has a long latency period and symptoms do not appear overnight. Predisposed individuals need to do something about prevention before they get to the stage of obvious neurogenic symptoms. They are presumed to originate from pathology involving the nervous system, as far as they can possibly be ascertained by examination. The pathology that leads to adverse neural tension may be extra-neural or intra-neural. Despite initial presentation distally, Work Related Upper Extremity Disorders are a diffuse neuromuscular illness with significant proximal upper body findings that affect distal function.

The concept of examination of neuro-meningeal tissues has gained considerable popularity and acceptance to examine the involvement of these tissues, clinical tests referred to as tension tests

have been suggested. (David. S. Butler, 1991). Tension tests examine the mechanical and physiological function of the nervous system. The upper limb tension test is one of the tests proposed to assess the status of the upper quadrant neural tissues and their neural structures. The impact of different components of the neural tissue provocation test on the range of motion (ROM) of the elbow and wrist and the sensory responses elicited by the test showed that the addition of each test component resulted in a significantly reduced range of motion. Sensory responses were predominantly evoked at the region of the added component. The different test components, whose mechanical influence on the nervous system had been demonstrated in anatomical studies, also had an effect on joint range of motion and sensory responses during neurodynamic testing, when individually or simultaneously added. If the nerve bedding was elongated throughout its whole length, the available range of motion was markedly reduced and sensory responses can be elicited throughout the entire arm (Coppieters M.W et al, 2001)

The result of this study was in accordance with the study conducted by Joubrel et al, (2001), to evaluate the frequency and types of neuromusculoskeletal problems of instrumental musicians, who were in music schools, professional and not professional orchestras. The study reported 76.6% out of 635 musicians suffered from overuse syndrome and concluded that the instrumental musicians often present with neuromusculoskeletal problems and recommended a specific management would be useful to limit eventual drammatical consequences.

The result of Upper limb tension tests of violinists help to make an early diagnosis and record of prognosis of their work related disorders. The questionnaire developed for the study may also serve as template for further outcome measures for further studies, in Upper limb tension tests and also help to guide therapists in determining appropriate intervention and assessing the outcomes of that intervention.

This study had certain limitations such as it was difficult to maintain the depression component and measuring the joint range of motion simultaneously in all the 3 Upper limb tension tests and also the ratio of male participants was more than that of female participants.

Further studies could be carried out on other professionals, who are involved in repetitive work and those who maintain a static posture for a prolonged time with more number of participants and to find out, if any correlation exists between the years of experience of the violinists with that of neural tension.

CONCLUSION

The study found that there was presence of neural tension in Upper limb [Left>Right], due to repetitive activity among violinists when compared to non violinists. Thus the study supports the hypothesis that there was neurogenic involvement in overuse syndrome in violinists. Moreover the questionnaire developed for the study may also serve as template for further outcome measures for further studies, in Upper limb tension tests and also help to guide physiotherapists in determining appropriate intervention and assessing the outcomes of that intervention.

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