"Comparative Efficacy of Stretching and Strengthening Exercises Combined with Ergonomic Interventions in Managing Upper Extremity Repetitive Strain Injury Among Computer Professionals: An Experimental Study"

[1]Dr S Purna Chandra Shekhar, [2]Dr. T Karthikeyan, [3]Dr. Harsh kumar, [4]Dr Shanmuga Raju P and [5]Dr.A S Moorthy

[1]Professor, School of Physiotherapy, MNR University, Sangareddy, Telangana, India.

[2]Associate Professor, Department of Physiotherapy, Gurugram University, Gurugram, Haryana, India.

[3]Dr. Harsh kumar , Physiotherapy, Ortho Neuro Sports Healthcare Hardayal road, Gamitola, near petrol pump, Katihar, Bihar 854105

[4]Professor & HOD, department of Physiotherapy & Rehabilitation, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar-505001, Telangana

[5]Physiotherapist, The Department of Plastic, Reconstructive & Burns Surgery, AIIMS, New Delhi.

Abstract:

Background and Objectives:
Repetitive Strain Injury (RSI) of the upper extremity is increasingly prevalent among computer professionals due to prolonged and repetitive use of keyboards and mice. While ergonomic interventions are commonly implemented, their effectiveness without adjunct therapeutic exercise remains uncertain. This study aimed to evaluate the impact of integrating stretching and strengthening exercises with ergonomic modifications on reducing pain and muscular effort in individuals with RSI.

Methods:
Sixty computer professionals diagnosed with upper limb RSI were randomly assigned to two groups: Group I (n=30) received both stretching and strengthening exercises along with ergonomic guidance, while Group II (n=30) received ergonomic interventions only. Both groups followed the regimen five days per week for four months. Pain and muscular effort

were assessed pre- and post-intervention using the Visual Analogue Scale (VAS) and the Rapid Upper Limb Assessment (RULA), respectively.

Results:
Post-intervention analysis showed that Group I demonstrated statistically significant improvement in both VAS and RULA scores compared to Group II ($p < 0.05$), indicating reduced pain and muscular effort.

Conclusion:
Stretching and strengthening exercises significantly enhance the effectiveness of ergonomic interventions in managing upper extremity RSI among computer professionals.

Keywords: Repetitive Strain Injury; Stretching; Strengthening; Ergonomics; VAS; RULA.

INTRODUCTION

In 1981, when the first personal computer was unveiled by International

Business Machine (IBM), people fell in love with it for its speed and responsiveness. To its users the computer was a sophisticated toy. To business, it was a boon to efficiency and productivity. Unfortunately, the explosion of computer use created a problem so serious that it has been dubbed " the occupational disease of 90's",

Repetitive Strain Injury (RSI).[1]

In simple medical terms, RSI is defined as a cumulative trauma disorder stemming from strong repetitive, forceful or awkward hand movements. In addition to that poor posture, badly designed keyboard the pressure of fast paced workload and the stage is set for

serious injury. The result is damage to the muscles, tendons, nerves of the neck, shoulder, forearm and hand, which can cause pain, weakness, numbness

or impairment of motor control.

RSI is a national tragedy because it has drastically disrupted the lives and livelihoods of many in India as well as abroad. This tragedy is compounded by the fact that it is preventable in most of the cases. We don't require a lot of statistics to back up the pain we can feel in our body. However, we need to convince everybody else that

RSI is a serious public health problem. According to an article in Information Week

(November 9, 1992), RSI costs business $ 20 billion a year.[1]

RSI accounts for 60% of all job related injuries. To make matters more frightening, from the year 2000 three-quarters of all the jobs will probably require using computer. It is easy to identify many of the factors involved in RSI, but developing a successful treatment strategy is only possible if our appraisal of root causes is accurate. The root causes like – working in one position for years, millions of repetitions, work intensity, aging and loss of tissue resilience, physiology, anatomy, ergonomics, personality collectively leads to fatigue, slouching posture, muscle tension and chest compression initially followed by compensation and overloading. There is also inflammation, swelling, abrasion, irritation, nerve entrapment and loss of sleep, ultimately leading to pain, numbness, anxiety and depression. When exposed to sustained trauma, our body is unable to heal. Instead, it starts to compensate to manage the situation as well as possible.[1]

Risk factors for RSI fall into two categories: intrinsic factor – which are those caused by body structure, disease, work habit; extrinsic factors are those caused by work station configuration, type of work, type of environment or keyboard. Accurate picture of RSI can be obtained by looking at the ergonomics of the workstation along with person's medical history into account. Once evaluation for physical or psychological predisposition towards RSI is done, environment consideration should be taken into account. People with no physical predisposition for RSI can injure themselves because of the way they use the keyboard.

RSI is an umbrella term for several cumulative trauma disorders caused by overuse of the upper extremity. The tendon, tendon sheath, muscles, ligaments, joints, nerves of the hand, arm, neck and shoulder can all be damaged by repetitive movements. The soft tissue injuries fall into 3 categories: tendon, ligament, muscle disorder; nerve disorder and impaired circulation. All these leads to tendonitis, tenosynovitis, de quervan's disease, trigger finger, cervical radiculopathy, epicondylitis, ganglion cysts, carpal tunnel syndrome, thoracic outlet syndrome, reflex sympathetic dysfunction, dupuytren's contracture, fibromyalgia etc.[2]

RSI develops over months and years, but when it finally settles in and does not go away even when computer use is discontinued, people tend to panic. RSI is serious and if we are not properly diagnosed, we risk permanent injury. So, nowadays the emphasis is laid on the treatment programme of RSI.

Before we start considering treatment options for RSI, we must first determine the extent of injury and the ways to treat it. For starters, exercises are the best remedy; people with mild to moderate injuries may be able to continue working through recovery, as long as they modify their workstation, learn how to position their hands properly and undergo physical therapy. Severely injured professionals may need many months to years or more off work to recuperate. There are many interdependent aspect of RSI from a therapeutic perspective and specific steps are needed to heal them. Some areas require assistance from a therapist, but guidance should be provided with tools to heal oneself if therapist is not available.

Computer professionals develop RSI because they don't know how to protect their muscles, the workstation set up not done correctly, they are never provided with exact training to use their hands properly, they are not equipped to pace up with workload demanding work pressure.

To reverse the damage of RSI, the factors need to be changed and the process begins in rehabilitation therapy. One must learn to pace oneself in order to allow one's muscles to rest. Pain induced immobility is replaced by gentle stretching and strengthening exercises. Along with various other measures like spasm release, resolving trigger points, carpal tunnel massage, myofascial release, endurance, nerve and tendon glides, improving joint mobility, cold packs, hot packs and postural awareness.[2]

Recent studies suggest that RSI is more common in upper extremity. **Novak CB** analyzed about treatment perspective in upper extremity work-related musculoskeletal disorders; and concluded that management must include patient education, posture correction and a specific physical therapy. As per **Ned Tijdschr Geneeskd's** study on the occurrence, etiology, therapy and prevention of RSI; found that an integrated approach aimed at improving the working posture, reduction of static load and job stretch were most effective.

Prevention is not an easy road, or necessarily an easy one. It is entirely possible that many individuals can afford to break all of the ergonomic rules. Some can afford to work in poor postures indefinitely, perhaps their body is young and resilient, or simply not susceptible to the tension that causes RSI. And others just won't heed any warnings until damage occurs. A reasonable approach is to take is to focus on sending out good information, establishing an atmosphere of vigilance about the health risk, mostly doing everything possible to encourage early detection and intervention. So this study is focused on the early intervention or rehabilitation for the subjects of RSI consists of stretching, strengthening and ergonomic measures.

Muscles work in unison, so one must learn to stretch and strengthen corresponding muscle groups to work harmoniously in physical therapy. The classic example of muscle imbalance in computer professionals is a neck strained forward,

rounded shoulders, and a slumped concave sternum. The overtly taut muscles in the front pull the shoulders forward, and this causes the muscles in the back to overstretch and weaken. The physiotherapist must stretch the tight areas, but now the relaxed muscle will stay in its new framework only if the corresponding muscles under the shoulder girdle are tightened by strengthening exercises.

To understand how exercise helps RSI, first the nature of the RSI should be understood: thousands of the repetitive movements cause micro trauma to muscle tissue, which leads to inflammation. The debris left by inflammation creates scar tissues, which down the muscles and strain tendons.

Stretching and strengthening exercises reverse the injury process and promote healing with enhancement in efficiency at work. Not just any stretching and strengthening exercises will do. One must learn to stretch and strengthen specific to the affected area. Overstretching areas that are already too flexible also creates problem. It is so because if one side of the hand, chest or arm is overstretched, the opposite side becomes too tight. Individuals eventually understand that they should not focus either on stretching or strengthening exclusively; but they must focus on both.[2]

The other important aspect of this study is ergonomic aspect of computer professionals in the prevention of RSI. Physiotherapist enables the professionals to know about the principles of balanced alignment so they are able to incorporate proper posture.

Good posture needs to be exercised regularly and consistently. Good posture plays a crucial role in preventing injury, but bad posture can be extremely difficult to change.

Several researchers have found the stretching and strengthening exercises to be an effective treatment plan for the patients of RSI among computer professionals.

These studies form basis for a new concept of treatment strategy for patients with RSI. The purpose of this study was to investigate more extensively about the effects of stretching and strengthening as a treatment programme for repetitive strain injury of upper extremity in computer professionals.

This study also helps the therapist to plan the stretching and strengthening exercises along with ergonomic measures for the computer professionals who are prone to RSI due to occupational strain.

OBJECTIVES OF THE STUDY

1. To compare the effect of stretching and strengthening exercises over ergonomic measures to reduce pain and muscular effort in the treatment of

   Repetitive Strain Injury of upper extremity in computer professionals.

REVIEW OF LITERATURE

The supporting literatures to be mentioned for the study are listed below:

Adedoyin RA et al (2005) did a study on musculoskeletal pain associated with the use of computer systems by framing questionnaire which contained questions to provide information on age, sex, years of computer usages, hours spent on computer per week, associated musculoskeletal pain, pain severity and knowledge of preventive measures. The result of this study indicated that low back pain, neck pain and upper limb disorders were common complaints which were attributed to bad ergonomics among the users.[3]

Hagberg M (2005) did a study to describe the clinical assessment and management of work related neck and upper limb disorders where clinical assessment consisted of clinical and exposure history, the evaluation of the laboratory and physical findings, where the physical examination included steps like inspection, testing for range of motion, testing for muscle pain and muscle strength, palpation for muscle tendon and insertions followed by specific tests. The result of this study indicated that prognosis for most work related disorders are variable, the general experience is for non-specific neck and upper arm that pain and discomfort may be decreased but not eliminated in majority of the cases so it is important to start early.[4] **Lassen CF et al (2005)** did a study to

examine the influence of work related and personal factors on the prognosis of severe elbow, forearm, and wrist hand pain among computer users by conducting a one year follow up study of 6943 computer users where 673(10%) participants reported quite a lot or more trouble due to elbow, forearm, or wrist hand pain during the 12 months preceding questionnaire. The results showed that during the follow up, 2/3 of the baseline cases improved were not influenced by ergonomic work place conditions; pain in other regions was a predictor of persistent arm pain. Prognosis was independent of psychosocial factors where as few cases with severe pain were affected at a level which could be compared to clinical pain conditions.[5]

Cole DC et Al (2003) studied on methodological issues in evaluating workplace interventions to reduce work related musculoskeletal disorders through mechanical exposure reduction. It was concluded that a set of interventions, observation modes for which relevant workplace indications prior to, during, and after mechanical exposure reduction could prove beneficial.[12]

Lucchini R et al (2003) did a study to prepare a protocol for health surveillance of workers exposed to repetitive arm movements by forming a work group on this problem and concluded that health surveillance for the prevention of upper limb disorders must be based on the degree of risk and the risk assessment procedures should

be based on the methodology currently available for ergonomic analysis and should also consider the frequency of upper limb disorders in exposed workers.[13]

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Kidd PS et al (2000) did a study to find out the anatomic and physiologic considerations for RSI in youth in relation to normal growth and development for which the data source were extensive literature review, laws relating to youth labor and the authors experience. Conclusion was drawn that early detection of youth at risk for RSI is crucial for prevention and treatment. And to reduce injury include gradual increase in training load, improving flexibility and strength, improving biomechanics and correcting mal alignment, for which the assessments should include flexibility, laxity and muscle symmetry.[21]

Lynn McAtamney & E Nigel Corlett (1993) did a survey to establish that RULA (Rapid Upper Limb Assessment) can be used for the ergonomics investigations of workplaces where work-related upper limb disorders are reported. It requires no special equipment in providing a quick assessment of the postures of the neck, trunk and upper limbs along with muscular effort. They said that RULA can be used as a screening tool or incorporated into a wider ergonomics assessment of epidemiological, physical, mental, environmental and organizational factors.[22]

MATERIAL AND METHODS

STUDY DESIGN:

This study was an experimental design involving the comparative analysis of stretching, strengthening and ergonomics. In this study, the subjects were analysed with pain and muscular effort as the dependant variables measured using Visual Analogue Scale(VAS) and Rapid Upper Limb Assessment (RULA) respectively. This study was done in the year 2006 in ITC Infotech,Gurugram.

SAMPLE SELECTION:

Sixty computer professionals were selected based on selection criteria using convenient sampling (purpose) from ITC Infotech, Gurugram. All these subjects participated in the study voluntarily after signing a consent form. The demographic data was collected from each subject and the purpose of the study was explained to all the subjects.

The selection criteria are listed below:

INCLUSION CRITERIA:

- Computer Professionals with II degree Repetitive strain injury of upper extremity according to Damany-Bellis RSI Scale[2]
- Computer Professionals working in proper ergonomic set up (Annexure-2).
- Both male and female individuals.

- Age group between 25-40 years.

EXCLUSION CRITERIA:

- Age group below 25 and above 40 years.
- Computer Professionals with I or III degree Repetitive strain injury of upper extremity according to Damany-Bellis Scale.
- Individuals diagnosed with ganglion cyst, guyon's canal syndrome, reflex sympathetic dystrophy and fibromyalgia syndrome.
- Previous history of major trauma.
- History of any orthopedic and neuromuscular problems

PARAMETERS OF THE STUDY:

- Visual Analogue Scale to assess Pain
- Rapid Upper Limb Assessment (RULA) to assess muscular effort of upper limb. (Annexure-4).

MATERIALS USED:

- Ergonomics Chart

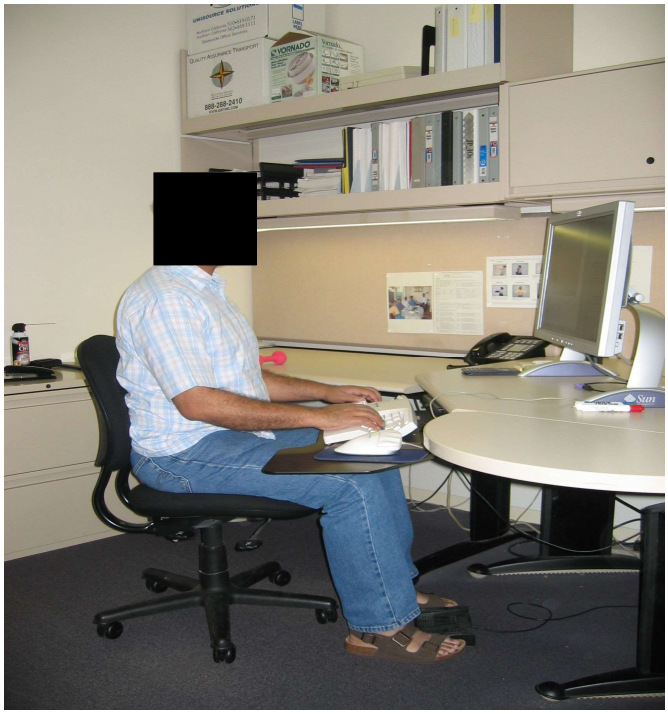
- RULA Scoring Sheet
- Rubber bands
- Weights
- Strengthening Hand gloves

FIG-1

MATERIALS USED

FIG-2

A SUBJECT WITH ERGONOMIC SET UP & MEASURES



MEASUREMENT TOOLS:

Visual analogue scale (V A S):

The VAS is the most commonly known and used for measurement of pain. The scale consists of a straight line of a specified length (100 mm) with verbal descriptors at each end. The line may be horizontal or vertical, NO PAIN is on one end of the line and WORST PAIN is on the other end of the line. The subjects are instructed to place a mark on the line to report the intensity of pain experienced at that moment. Scoring is done by measuring the millimeters from the low end of the scale to the subjects mark.

RULA:

RULA was developed to investigate the exposure of individual workers to risk factors associated with work related upper limb disorders. The method uses diagrams of body postures and three scoring tables to provide evaluation of exposure to risk factors (Annexure-4). RULA was developed to:

a) provide a method of screening a working popu!ation quickly, for exposure to a likely risk of work-related upper limb disorders,

b) identify the muscular effort which is associated with working posture, exerting force and performing static or repetitive work, and which may contribute to muscle fatigue.[22]

PROCEDURE:

Sixty individuals aged between 25 to 40 years were selected based on the selection criteria and divided into two groups: namely group I and group II consisting of thirty subjects each.

Group I was given stretching and strengthening exercises along with ergonomic measures and group II was given only ergonomic measures. Each subject in group I and group II received treatment only once in a day. Both the groups were given treatment for

a period of 5 days a week, for 4 months. All the subjects were measured for clinical status at the end of 2nd and 4th month of the treatment session.

All the subjects were clearly instructed about the purpose of the study and the informed written consent was taken from each one of them before starting with the training session.

A) STRETCHING EXERCISES FOR GROUP I :

The subjects of Group I were treated with the following Stretching exercises that was given 30-45 minutes per session with 2 minutes of rest in between each

stretching.[2]

Discussion

Repetitive Strain Injury (RSI) is a major occupational health concern in the digital age, especially among computer professionals engaged in repetitive hand and wrist movements. This study reinforces the idea that ergonomic improvements alone, though beneficial, may not sufficiently address the musculoskeletal demands of prolonged computer use. Participants in the combined intervention group showed significantly greater reductions in pain and muscular strain, suggesting a synergistic effect of targeted exercises and ergonomic modifications.

Stretching helps improve flexibility and reduce tension in the affected musculature, while strengthening enhances the resilience and endurance of the musculoskeletal system to repetitive tasks. The use of RULA and VAS as assessment tools provided objective and subjective measures, respectively, and their combined use adds reliability to the results.

Previous literature supports similar multimodal interventions for occupational RSI management. For instance, Andersen et al. (2012) and Rempel et al. (2008) observed significant benefits from resistance training in reducing upper limb discomfort in office workers. Importantly, the long-term adherence to such integrated regimens might play a critical role in sustainable symptom relief.

The findings advocate for employers and health practitioners to implement exercise-based wellness programs alongside ergonomic redesign in workplace settings to effectively manage and prevent RSI.

Conclusion

Combining stretching and strengthening exercises with ergonomic measures significantly reduces pain and muscular effort in computer professionals with RSI. A multimodal approach should be emphasized in occupational health strategies to achieve optimal long-term outcomes for repetitive strain injuries affecting the upper extremity.

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