

# Prevalence of Carpal Tunnel Syndrome Among Workers Engaged in Manufacturing Industry

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**Abstract**— Carpal Tunnel Syndrome is a symptomatic compression neuropathy of the median nerve at the level of the wrist/hand characterized physiologically by evidence of increased pressure within the carpal tunnel and decreased function of the nerve at that level. It is characterized by patients as producing numbness, tingling, hand & arm pain, loss of hand and pinch strength and muscle dysfunction. CTS is caused by physical occupational activities, such as repeated and forceful movements of the hand and wrist and also by doing work in awkward posture. Present work is focused on studying CTS on the workers engaged in Railway Workshop Kalka. The study is conducted on 90 workers comprising of all men (mean age of  $47.9 \pm 9.02$  years). The objective of present work is to study the probability of occurrences of Carpal tunnel syndrome of the workers engaged in Railway Workshop Kalka by comparison of potential CTS symptoms. This is done by conducting the appropriate health surveillance, data collection using surface electromyography (sEMG) on Abductor Pollicis Brevis (APB) muscle. First of all designing of health surveillance form is done followed by data collection. Statistical analysis using ANOVA, Fisher's Exact test. ANOVA was used to analyze the Body Mass Index (BMI) data obtained from the health surveillance. F value calculated came out to be 0.110 for the degree of freedom (3, 16). This calculated F value is less than the critical value (3.24). So the BMI considered in present study significantly contribute in the occurrence of the carpal tunnel syndrome. To observe the occurrence of potential CTS symptoms among Slender and Obese workers, Odd ratio test was performed which reveals that obese workers has approximately 1.5% times greater risk of having CTS than that of slender worker. Fisher's exact test is used on all the three type of pinch strengths i.e. Tip pinch, key pinch and palmer pinch which reveals that workers with low pinch strength have more probability of CTS than that of the workers with high pinch strengths. ANOVA test with the help of SPSS software is use to analysis of sEMG signals of APB muscle in present study shows healthy worker have better sEMG single than that of non healthy workers which reveals that non healthy workers are more prone to CTS.

**Keywords**— Carpal tunnel syndrome, BMI, RSI, pinch strength

## I. INTRODUCTION

Repetitive Strain Injury (RSI) is a generic term and often used to describe work-related musculoskeletal disorders [1] RSI is an umbrella term used to describe a number of specific musculoskeletal conditions, i.e. carpal tunnel

syndrome (CTS), as well as 'diffuse RSI', which is more difficult to define. These conditions are often occupational in origin. Lack of adequate diagnosis or access to appropriate treatment can bring the conditions and sometimes leads to job loss and economic hardship [2]. RSI is the more commonly known term for a set of disorders called Work Related Upper Limb Disorders (WRULD'S).

RSI covers a wide range of injuries to muscles, tendons and nerves. Usually hands, wrists, elbows or shoulders are affected but knees and feet may also suffers especially if a job involves a lot of kneeling or operating foot pedals on equipment. The highest percentage of work injuries resulting from repetitive motion occurs in the manufacturing sector, where assembly-line works are common [3] Initially, symptoms may only occur when the individual is doing the repetitive task - they will slowly go away when the person rests. Eventually, though, symptoms may be present all the time, if left untreated. The most common RSI signs and symptoms include: Tenderness in the affected muscle or joint, Pain in the affected muscle or joint, A throbbing (pulsating) sensation in the affected area, Pins and needles (tingling) in the affected area, especially the hand or arm, Loss of sensation in the hand, Loss of strength in the hand, Weakness, lack of endurance[2]

A common factor in developing carpal tunnel symptoms is increased hand use or activity. While repetitive activities are often blamed for the development of CTS [4][5] the correlation is often unclear. Physiology and family history may have a significant role in individual's susceptibility [6]. CTS is associated with stress, trauma, pregnancy, as well as several diseases including multiple myeloma, amyloid, rheumatoid arthritis, acromegaly, mucopolysaccharidoses, hypothyroidism. Women are three times more likely than men to develop CTS,[4] perhaps because the carpal tunnel itself may be smaller in women than in men.

Persons with diabetes or other metabolic disorders that directly affect the body's nerves and make them more susceptible to compression are also at high risk. It is estimated that three of every 10,000 workers loses time from work because of CTS. Half of these workers missed more than 10 days of work. The average lifetime cost of CTS, including medical bills and lost time from work, is estimated to be more than rupees 15 lacs for each injured worker.[7]

Activities associated with the development of CTS may arise from ordinary movements that include repetitive activities such as gripping and reaching [8]. These movements may become hazardous without sufficient rest or recovery time. The major risk factors include; forceful exertion, repetitive motions, awkward postures, localized contact stresses[4][8][9] These risk factors are classified largely into two groups: occupational (physical) factors consisting of task and environmental conditions, and other is personal factors including age, gender, anthropometric factors and medical history

Most jobs require some degree of force to move loads, resist gravity, and stabilize the body. Manual tasks in manufacturing and production environments often require exertion of high pinch or grip forces on hand tools or workplaces, often within very short cycle times, amounting to thousands of forceful pinches per day [10]. Previous researchers have reported that the risk of CTS increases with an increase in forceful exertions[11] Based on CTS prevalence for active workers in high incidence jobs[12] reported that the odds ratios for risk of CTS and Carpal tunnel disorders (CTDs) for high force jobs compared to low force jobs were 1.8 and 4.9, respectively. [13]found that the odds ratio for forceful exertions increased to 9.0 for external forces greater than 1.0 kg. The typical symptoms of CTS are tingling of the thumb, and of the index, middle, and ring fingers, and night pain [14]. The pain awakens the patient, but is often relieved by shaking, hanging, or massaging the hand. Pain may involve not only the hand, but also the arm and the shoulder. Numbness and loss of manual dexterity occur in more advanced cases. Weakness of the hand also occurs, causing difficulty with pinch and grasp. The victim may drop objects or be unable to use keys or count change with the affected hand. The skin may dry because of reduced sweating.

## II. MATERIALS AND METHODS

As many industries rely on repetitive and forceful work for successful completion of a task, it is impossible for any industry that this repetitive and forceful work would be wholly eliminate from a work process. This work does however require the adoption of awkward postures. Awkward postures in this work increase the likelihood that workers are exposed to physical strain, which in turn create risk (potential CTS symptoms) to workers in the form of potential CTS symptoms[15]. Therefore, the present study focuses the identification of risk factors such as hand pain, wrist pain, numbness, tingling, weakness, difficulty in grasping, age, BMI, Cycle time and many more on workers.

Present study sample consists of 90 manual manufacturing workers from Railway workshop located in Kalka, Haryana. Health questionnaire form was designed according to the information required like age, height, weight, duration of job, levels of potential symptoms to study the prevalence of potential CTS symptoms amongst manufacturing workers. Also the standardized health surveillance guidelines were used to authenticate the design considered in present study by experts from industry and medical profession.

Job categorization is done according to level of repetition (per sec), force involved (kg), BMI ( $\text{kg}/\text{m}^2$ ) of the workers. The participants ranged in age from 24 to 60 years with a mean of 47.9 (SD 9.15) years. The mean body mass index (BMI;  $\text{kg}/\text{m}^2$ ) of the participants of this study was  $24.6 \text{ kg}/\text{m}^2$  (SD 3.72), and it ranged from  $17.2 \text{ kg}/\text{m}^2$  to  $37.9 \text{ kg}/\text{m}^2$ . The workers had been performing work for a mean of 24.6 years (SD 8.2). All the data related to the potential symptoms obtained from the health surveillance form are collected

### I. Impact of Body Mass index (BMI) on probability of CTS symptoms

The BMI ( $\text{kg}/\text{m}^2$ ) was calculated for each subject and subgroups were created based upon the BMI distribution reported for the state of Michigan: slender, BMI > 20; normal, BMI 20-25; heavy, BMI 25-29; and obese, BMI > 29. In Table 3.4 Mean of Hand grip strengths (left), Hand grip strengths(right), Pinch strengths(Tip), Pinch strengths(key) and Pinch strengths(palmar) (detail about pinch strengths is explained in section 3.5) has been taken from the different subgroups i.e. Slender, Normal, Heavy and Obese

For  $\alpha = 0.05$ , the critical value of F with degree of freedom (3, 16) is 3.24 (Montgomery, 2005) and calculated F value is 0.1110 in present case F calculated is less than F critical so the treatment i.e. BMI values in different groups significantly contributes in occurrence of potential CTS symptoms odd ratio is calculated among the slender and obese workers it shows that the obese person has 1.5 times greater risk of having CTS symptoms as compared to slender person as explained in 3.3. The findings of this study support the hypothesis that individuals with a higher BMI are at increased risk for CTS. The pathophysiology that would explain this relationship is not well understood

### A. II. Impact of Pinch strengths on probability of CTS symptoms using Fisher's exact test

It is observed that Pinch strength is a major symptom to decide the probability of CTS sufferers. Pinch strength of the worker were taken in neutral position i.e. Tip pinch, Key pinch, and Palmar pinch. And it is divided into two group i.e. from 0-7 kg (Group 1) and >7 kg (Group 2) and probability of having CTS. To test the probability of having CTS is more amongst Group 1 as compared to Group 2, Now all the data has been categorized, operation wise according to the Group and probability of having CTS Collected from survey form

P values are calculated through Fisher's exact test to find out the significant values of potential CTS sufferers. A parameter is significant if  $0.01 < P < 0.05$ , highly significant if  $P < 0.01$  and not significant if  $P \leq 0.05$ . All calculated p-values are less than the standard value (0.05) whereas p value of trimming shows highly significance ( $< 0.01$ ). As the data is significant

Hence, the probability of being CTS sufferer is more amongst Group 1 i.e. having lesser pinch strengths, which may be due to reduced gripping strength because of median nerve problems i.e. median nerve compression, swelling and other problem due to repetitive and force full work.

### III. IMPACT OF RMS SEMG SIGNAL OF APB MUSCLE

To analyze the result of healthy and non-healthy workers with mean RMS sEMG signal values of APB muscle has been taken and one way ANOVA has been used with the help of SPSS. Results show the significant value RMS sEMG which reveals that workers with better sEMG signal have less probability of potential CTS symptoms

#### B. RESULTS AND CONCLUSIONS

In this present work effect of Repetitive hand movements and forceful work has been studied on human body in terms of potential CTS symptoms. ANOVA, Chi square test, odd ratio, difference between proportion, Correlation analysis and electromyogram signal analysis were used to achieve the objectives. Following conclusions have been made from this dissertation:

ANOVA was used to analyse the Body Mass Index (BMI) data obtained from the health surveillance. F value calculated came out to be 0.110 for the degree of freedom (3, 16). This calculated F value is less than the critical value (3.24). Therefore, the BMI considered in present study significantly contributes in the occurrence of the potential CTS symptoms. To observe the occurrence of potential CTS symptoms among slender and obese workers, Odd ratio test was performed which reveals that obese workers have approximately 1.5% times greater risk of having potential CTS symptoms than that of slender worker. Fisher's exact test is used on all the three types of pinch strength i.e. Tip pinch, key pinch and palmer which reveals that workers with low pinch strength have more probability of potential CTS symptoms than that of the workers with high pinch strength with the help of SPSS software ANOVA test is used to analysis of sEMG signals of APB muscle in present study shows healthy workers have better sEMG signal than that of non healthy workers which reveals that non healthy workers are more prone to potential CTS symptoms.

Further there is scope of extending the work with a larger sample size, also several risk factors may have been studied, different occupation environmental conditions, and postures to analyze muscles conditions and identify the problems related to CTS.

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