Abstract

Carpal Tunnel Syndrome (CTS) is a symptomatic compression neuropathy of the median nerve at the level of the wrist/hand. This is characterized by physiological evidence with increased pressure within the carpal tunnel and decreased function of the nerve at that level. Patients suffering from CTS report numbness, tingling, hand and arm pain and muscle dysfunction. Excessive use of hand for nature of work having repetition, excessive force, awkward posture, mechanical stress and use of vibrating tools or machines are responsible for CTS. In assembly line of a manufacturing unit, job is of repetitive nature and there is extensive use of wrist/hand under different conditions to meet the production target.

In this thesis four case studies have been discussed to find out the prevalence of occurrence of CTS in workers of manufacturing unit in Northern part of India. Information has been obtained through structured questionnaires and interviews with workers performing the repetitive jobs. In order to establish the occurrence of CTS in workers, tests such as the Phalen’s test, Tinel's test, vibration test, pinch test are conducted as per requirement of the study. Muscle activity has been tested by sEMG. Correlation, chi-square test and ANOVA test are used for analysis of the data for finding association of manual assembly line job with CTS occurrence. Quantitative analysis of the data is carried out through the Statistical Package for the Social Sciences (SPSS).

In a first case study, glass channel rubber assembly unit developing a sealing product for automotive industries is considered. In this assembly line it is found that workers are doing repetitive work and are not aware of the problems caused due to the nature of their work. Study presented here has been designed for a) operation wise symptomatic analysis for various demographics and b) occupational and personal risk factor based symptomatic analysis. Different questionnaire were planned to find out the different factors related to the prevalence of CTS symptoms. It has been observed that the ‘work with fingers’ and the ‘difficulty in grasping’ symptom are correlated to each other. Difficulty in grasping is more prone to CTS occurrence in comparison to other potential CTS symptoms. Job duration at the site, hand grip strength and tingling are the most alarming occupational risk factors towards CTS occurrence. CTS sufferers have low muscle activity and have low surface electromyography root mean square (sEMG-RMS) values.
A comparative study of traditional and semi-ergonomic shocker assembly units in respect to CTS risk factors and productivity has also been considered as a second case study. The data have been interpreted with the help of SPSS software package. There are statistical differences between these assembly units based on job duration, shoulder strength and production rate. These differences in hand grip strength and cycle time are not statistically significant. The CTS sufferers in traditional assembly unit are approximately three times to the semi-ergonomic designed assembly unit. Similar trend is observed in almost all the potential CTS symptoms. There are 28.6% more awkward posture stations in traditional assembly unit as compared to semi-ergonomic assembly unit. This indicates that the workers in the traditional unit face more difficulty due to awkward posture. The workers in ergonomically designed workstations share less heavy load in comparison to traditional unit. It has been found that the probability of having CTS is more in traditional shocker assembly unit.

In the next case study, effect of hand-arm vibration on CTS symptoms severity and occurrence has been worked out. It is found that there is no symptom at high and severe level in the population under study. The most prevalent symptom at moderate level is numbness (57.8%), followed by weakness (26.7%) and tingling (19.8%). Analysis shows that the vibration exposure time-duration in a day has impact on severity of CTS symptoms except for the symptom numbness. It has been found that there is good positive correlation of various potential CTS symptoms with duration of job and these symptoms tend to increase in severity as the duration/length of job increases. There is no statistically significant association between any of the operations and CTS symptoms. Hence, there is no significant impact of workplace or type of work under study on severity or occurrence of CTS symptoms. Further, this study suggests that there is no significant correlation of severity of CTS symptoms with the vibration amplitude exposure level. Correlation of ‘sEMG’ and ‘vibration amplitude exposure level’ also verifies the same. Hence, the statistical significance between hand grip strength and sEMG can not be established.

Finally, in order to describe the effect of pinch strength on occurrence of CTS, a study is conducted in the assembly line of automobile muffler manufacturing plant. Association of CTS occurrence with age, body mass index (BMI), job repetition and grip strength has been investigated. Analysis has been made at
confidence limit of 95%. There are negative moderate correlation between grip strength of dominant /non-dominant hands and almost all CTS symptoms except for ‘difficulty in grasping’ and ‘weakness’. ‘Wrist pain’ and ‘numbness’ has strong positive correlation with CTS prevalence. The wrist pain and numbness can be considered as strong indicators for CTS prevalence and can be used to predict CTS in muffler assembly unit. The pinch strengths of CTS sufferers are significantly (statistically) lower than the non-CTS sufferers except in case of pulp pinch in supinated position for non-dominate hand with digit II and III. It indicates that the worker with CTS has low pinch strengths.

The thesis is organized into eight chapters. Basic review of the phenomena of musculoskeletal disorders including repetitive strain injury and carpal tunnel syndrome (CTS) has been discussed in First chapter. It also contains defined objectives for the work. In the Second chapter, review of the past work in the same field has been mentioned along with identified research gap. Material and methods for the study are covered in the Third chapter. In the Fourth chapter focus is on investigating prevalence of CTS occurrence in EPDM assembly line workers. The comparison of prevalence of CTS in a traditional and a semi-ergonomic shocker manufacturing assembly line has been presented in Chapter five. In Chapter six potential CTS symptoms, symptoms severity scale and hand-arm vibration exposure to find out their relation with CTS occurrence are discussed. The study of pinch strength on prevalence of CTS in workers has been presented in Chapter seven. Finally conclusion of the thesis and scope for further research are presented in the Chapter eight.

The present research work is aimed at investigating and making use of the findings in predicting possibility of the CTS occurrence in the workers involved in manual assembly units. This shall enable the management to take preventive measures for avoiding the possible losses. Further, methods for identification of CTS may also be utilized in industry to redefine process in order to reduce prevalence of CTS in workforce and to develop suitable process planning accordingly.